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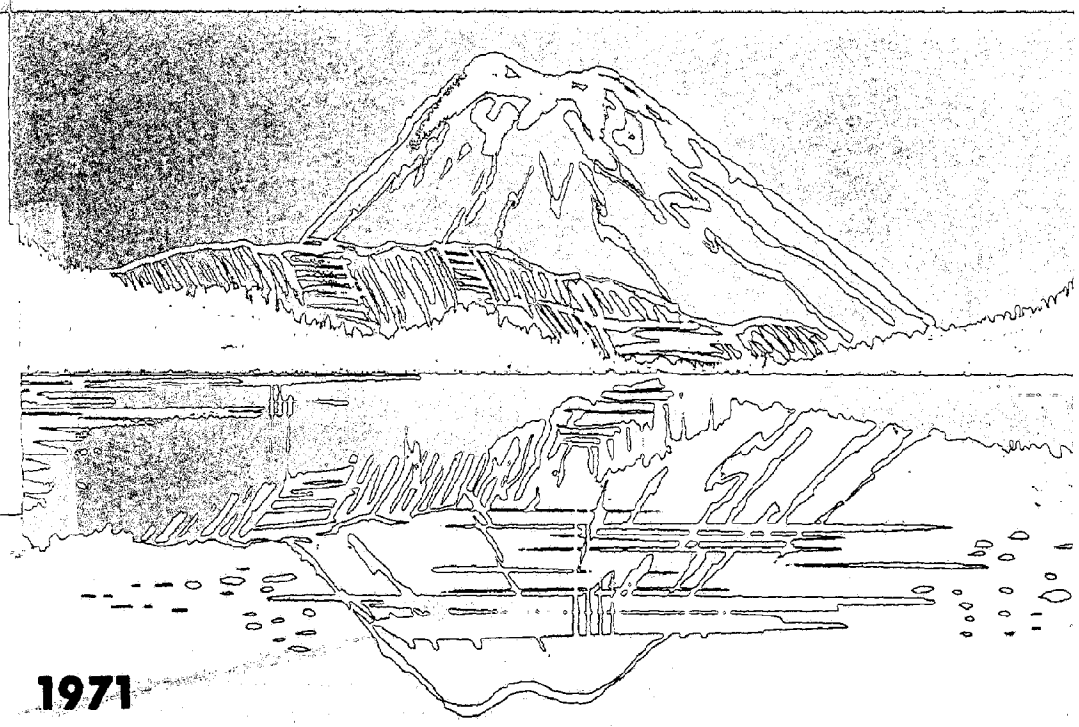
Comprehensive Study of Water and Related Land Resources

Puget Sound and Adjacent Waters

State of Washington

Summary Report

Puget Sound Task Force—Pacific Northwest River Basins Commission



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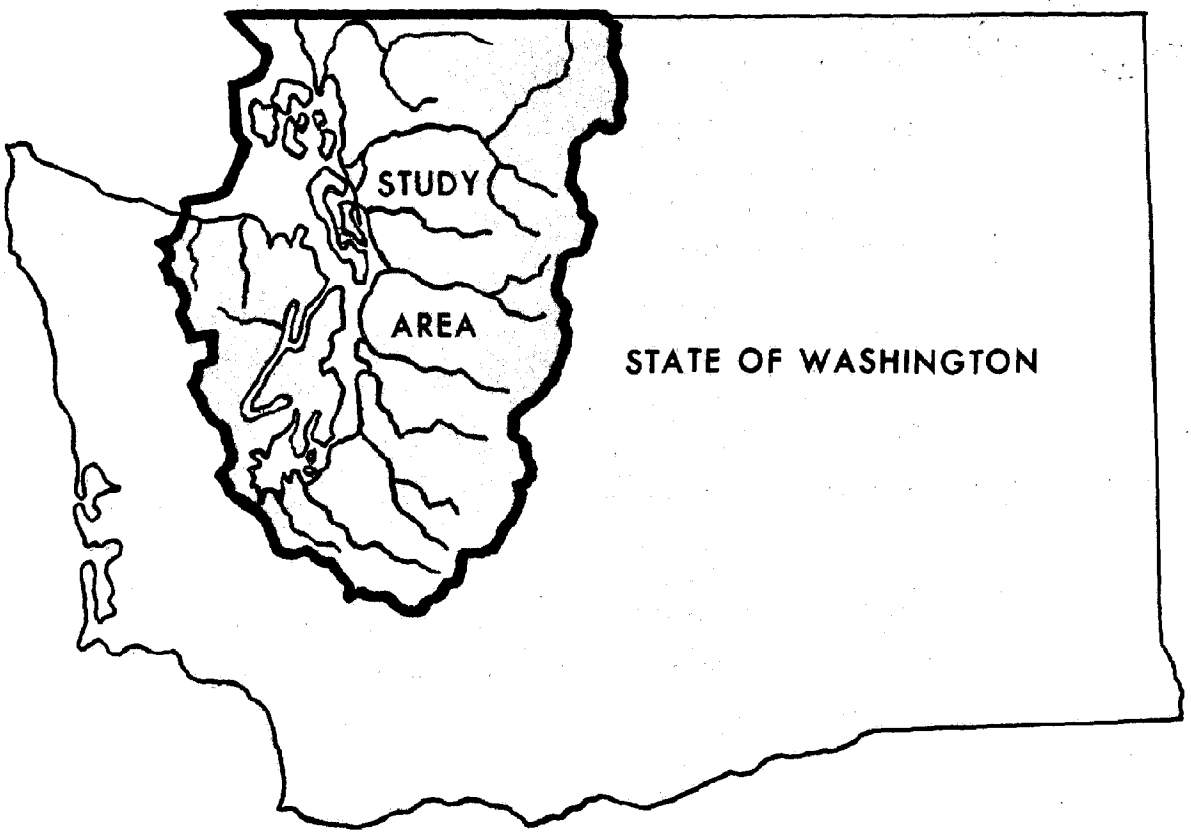

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Comprehensive Study of Water and Related Land Resources

Puget Sound and Adjacent Waters

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PUGET SOUND TASK FORCE of the PACIFIC NORTHWEST RIVER BASINS COMMISSION

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FOREWORD

This report describes the expected needs of the Puget Sound Area's future population for water and related land resources projected to the year 2020 and presents a comprehensive plan for meeting these needs. This plan is intended as a guide to the future use of water and related land resources. Along with a plan and alternatives, a discussion of the effects of the plan on the Area and the requirements of implementation are included together with the conclusions and recommendations of the Puget Sound Task Force.

The Summary Report is supplemented by fifteen appendices. Appendix I contains a digest of public hearings. Appendices II through IV contain studies on the political, natural and economic environments. Appendices V through XIV each contain an inventory of present status, present and future needs, and a means to satisfy the needs, based upon a single use or control of water, Appendix XV contains a detailed description of the Comprehensive Plan for the Puget Sound Area and its individual basins and describes the alternatives considered in formulating this multiple-purpose plan.

River basin planning in the Pacific Northwest was started under the guidance of the Columbia Basin Inter-Agency Committee (CBIAC) and completed under the aegis of the Pacific Northwest River Basins Commission. A Task Force for Puget Sound and Adjacent Waters was established in 1964 by the CBIAC for the purpose of making a water and related land resource study of the Puget Sound based upon guidelines set forth in Senate Document 97, 87th Congress, Second Session.

The Puget Sound Task Force consists of ten members, each representing a major State or Federal agency. All State and Federal agencies having some authority over or interest in the use of water and related land resources are included in the organized planning effort.

The published volumes include the following:

SUMMARY REPORT

APPENDICES

I. Digest of Public Hearings
II. Political and Legislative Environment
III. Hydrology and Natural Environment
IV. Economic Environment
V. Water-Related Land Resources
   a. Agriculture
   b. Forests
   c. Minerals
   d. Intensive Land Use
   e. Future Land Use
VI. Municipal and Industrial Water Supply
VII. Irrigation
VIII. Navigation
IX. Power
X. Recreation
XI. Fish and Wildlife
XII. Flood Control
XIII. Water Quality Control
XIV. Watershed Management
XV. Plan Formulation

COMPREHENSIVE STUDY OF WATER AND RELATED LAND RESOURCES PUGET SOUND AND ADJACENT WATERS JUNE 1971

The Summary Report has been reviewed and accepted by the Puget Sound Task Force composed of representatives of the State of Washington and the Federal Departments of Agriculture; Army; Commerce; Health, Education, and Welfare; the Interior; Transportation; Labor; and Housing and Urban Development; and the Federal Power Commission. The State of Washington acted as chair agency.

This report was prepared at field level and presents a guide for the development and management of the water and related land resources of the Puget Sound Area. The report is subject to review by the interested Federal agencies at departmental level, by the Governor of Washington, and by the Water Resources Council prior to its transmittal to the President of the United States for his review and ultimate transmittal to the Congress for its use in evaluating Federal participation in implementing elements of the Comprehensive Plan presented herein.

The Summary Report contains the recommendations of the Puget Sound Task Force. Recommendations that may be included in the appendices are suggestions by the authors and are not to be construed as Task Force recommendations unless so indicated in this report.

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SYLLABUS

The water and related land resources of the Puget Sound Area are presently serving a population of about 2,000,000 persons. Both the population and the resulting demands for these resources have been increasing rapidly and if present expectations are realized, the resources will experience demands related to a population of about 6,800,000 by 2020.

Comprehensive planning was undertaken to determine the potential and the limitations of the natural resources of the study area so that orderly use and development may occur. A legislative framework is proposed within which the public interest can be defined and adopted as a basis for action programs involving all levels of government and the private sector.

Multiple-purpose projects have been included in the Comprehensive Plan to satisfy needs for flood control, fish and wildlife enhancement, irrigation, water quality control, recreation and municipal and industrial water supply.

The urban and rural demand for municipal and industrial water supply, projected to increase substantially from the present 660 mgd to 3,160 mgd by 2020, would be met by utilizing both ground and surface supplies. Water quality, availability, and cost were considered in determining the most logical sources of supply in meeting the needs throughout the Area.

There are now about 91,700 acres of land irrigated. To meet the Area's share of the projected national requirements for food and fiber would require irrigation of an additional 304,000 acres. However, based on past increases in irrigated lands, location and extent of potentially irrigable lands, availability of adequate water supplies, urban encroachment, and climate, an increase of 131,300 acres or a total of 223,000 acres of land are expected to be irrigated by 2020. A water supply for irrigation of these lands would be available. The Area has historically been required to import many of its needs for food and fiber; future increasing deficiencies would be met by additional importation.

The Comprehensive Plan proposes adequate sewage treatment facilities and minimum streamflows for assimilation of residual biochemical oxygen demand where treatment plant effluent is discharged into fresh waters. Secondary or tertiary treatment of effluent discharged into fresh water and the deep marine water discharges of primary treatment effluent are viewed as being the most economical means of meeting water quality standards. Establishment of surveillance stations on fresh and marine waters would provide a means of insuring compliance with the Federal and State water quality standards.

The river and harbor channel improvements and small boat harbors in the Plan would meet projected navigation needs of the Area. Improvement of 29 river and harbor channels and retention of 41,500 acres of land designated as being suitable for terminal and water transport-oriented development would enable continued growth of water-borne commerce, contributing to the local and national economies. The provision of 94 small boat harbor projects with over 100,000 wet moorages would meet most of the projected salt water recreational boating needs of the Area.

Power needs of the Area are projected to increase from about 3,500,000 kilowatts in 1965 to about 90,000,000 kilowatts by 2020. Satisfaction of these needs is planned through continued use of the Pacific Northwest's regional power supply with electrical power imported from outside the Area to supplement power developments within the Area. Construction of new hydroelectric and nuclear power plants within the Area would be accomplished as they are found to be economically justified and in keeping with overall environmental quality objectives. Most of the future energy requirements are expected to be supplied from thermal-nuclear generation. The pumped-storage potential of the Area is considered an excellent source of additional peaking power when required in the future by the regional power system.

A combination of flood plain management, levees, multiple-purpose storage projects, channelization and watershed management practices is contained in the Plan as the most efficient means of achieving flood control in the Area. In addition to the multiple-purpose storage projects, nearly 150 miles of levees and approximately 50 miles of channel improvements are included for flood control purposes. Flood plain management, including zoning, floodproofing, and flood warning systems are integral parts of the Plan for reducing future flood damages. The Plan provides facilities which would reduce present and potential flood damages about 90 percent.

Measures for watershed rehabilitation and protection of all land, and water management practices for the development of land for urban, rural, nonfarm, and cropland uses planned are of both a structural and a management nature. Twenty-five small watershed projects are proposed before 1980. On small streams, combinations of structural and

vegetative measures would reduce damages from erosion, flooding, and sediment pollution, and enhance a wide range of other values. A five-year study of the marine shoreline is included to define problems of loss and determine possible means of solution. Similar studies of streambank and lakeshore erosion and sedimentation problems, and resource deterioration associated with various forms of faulty land use are needed.

Prudent selection of land according to its capability for various uses, and treatment of the land according to the use selected, are recommended to prevent deterioration of these resources. Careful selection of land for intensive development, and planned development of such land to moderately high density urban population would assist in preserving open space valuable for hydrologic, productive, aesthetic, and many other purposes. Open space thus provided would also preserve options for future judgment and the planned development of land for intensive use would result in large savings in the cost of furnishing public services.

As there is a significant shortage of outdoor recreation facilities in the Area, there is an urgent need for new facilities and additional access to existing natural recreational areas. Campgrounds, picnic areas, beaches, swimming pools, and boating facilities are included in the Plan to satisfy recreation needs of the Area. Multiple-purpose storage projects included in the Plan would provide opportunities for boating, water skiing, swimming and sightseeing. Emphasis is placed on the protection and enhancement of recreation resources and natural beauty as shown by plan elements such as green belts, open-space areas, development of strip parks along the streams, the development of parks in the urban areas, retention of Federal lands for eventual use as park areas, and land acquisition to supplement the existing public lands, particularly along the marine shoreline where a need is high.

The fish and wildlife resources are recognized as significant contributing factors to the economy and environment of the Area. The Plan includes projects and programs which would result in increased production of anadromous fish, resident trout, shellfish and marine fish and the conservation and enhancement of waterfowl and other forms of wildlife. The need to maintain adequate flows for fish in the streams is recognized with further detailed studies of minimum flows required to maintain current levels of fish production proposed to be undertaken before 1980. The results of such a study would provide a basis for modification of the Comprehensive Plan. The Plan, as now envisioned, provides fish passage facilities at various natural stream barriers, 223 miles of channel clearance, 12 miles of artificial spawning channels, 855 acres of rearing ponds and facilities, and 37 hatcheries. Other measures include acquisition of access to 510 miles of streambanks and 129 access areas to fresh and salt water to provide entry for fishermen.

The Plan provides for continuation of many of the present programs in the Area, expansion of some of these programs, and implementation of new programs. Some of these programs are flood plain management, water quality surveillance, and watershed management programs such as cover cropping, beach erosion control, forest fire control, logging practices, range management, fish and wildlife surveys, and rural and urban water management practices. Programs for fish and wildlife include range and stream habitat management, rehabilitation and fertilization of lakes, developing cooperative programs with landowners to maintain, develop and assure hunter access, and methods to increase fish and shellfish production.

A coordinated sea coast resource management program is included in the Comprehensive Plan which provides for an appraisal of the present and potential resource, a determination of opportunities for multiple use and preparation of guidelines for future use.

The early action portion of the plan includes ongoing and new programs amounting to $846,773,000 and projects costing from $1,180,975,000 to $1,191,475,000. A total 50-year investment of $6,999,898,000 to $7,120,798,000 is required to implement proposed programs and projects. Although the total cost to the year 2020 appears large, it must be remembered that this represents investment costs over the next half-century. Additionally, as mentioned above, many of these costs are for ongoing programs that would have been carried out in the absence of this study. Based upon a population of 6.8 million, the fifty year investment would amount to approximately $1,000 per capita or about $20 per year per person.

ADDITIONAL STUDY REQUIREMENTS

Problem areas unresolved by this study include the future use of the Skagit River and the Nisqually

Delta. The Skagit River is under consideration for designation as a National Wild, Scenic or Recreation river. Additional flood control and hydroelectric power development are possible in the Skagit River Basin from a multiple-purpose storage project on the Sauk River.

In the Nisqually River delta, opportunities exist for development of a wildlife refuge and outdoor recreation area as well as for terminal and water transport-oriented industrial development. Further studies and public expression are required before a final determination can be made as to the best use or uses of these areas.

An equitable method of sharing of water treatment facilities investment and increased operating costs is required before municipal watersheds should be opened to satisfy outdoor recreation needs. The treatment facilities are needed to insure protection of public health. Public expression on this issue also is considered to be desirable and necessary.

Additional detailed land use planning, with due regard given to urban needs, is suggested as an adjunct to this study. A comprehensive detailed land use plan is needed to insure that future industrial and residential needs of the Area would be met in a manner that is harmonious with the environment.

A 5-year study of marine beach and shore erosion is proposed to identify and evaluate areas where significant erosion is occurring. The study would determine relevant factors for evaluation, describe justifiable remedial measures, and establish priorities for treatment.

The minimum streamflows necessary to maintain present fish production levels are unknown with cross-sectional stream surveys required to obtain this information. These stream surveys, recommended as part of the Comprehensive Plan, would also make possible a determination of base flow requirements for fish production in Puget Sound streams.

The estuaries and related shorelands of Puget Sound and adjacent waters constitute one of the Area's most valuable geographic features. Competition for shoreline space and water surface use have increased rapidly in recent years resulting in an urgent need for a coordinated program of sea-coast use management.

Model studies are required to determine the effects of thermal plant and other waste discharge on the Puget Sound eco-system.

There is a need for joint studies by Federal and State agencies and the marine industry which would lead to a navigation control system that will minimize the possibilities of collisions.

A questionnaire survey of Puget Sound Area pleasure boaters revealed that about 50 percent of those surveyed desired the availability of harbors of refuge which would provide temporary havens for small craft in distress or seeking shelter from approaching storms. The many miles of unprotected shoreline and uncertainty of weather conditions tend to constrain the activity of many boaters. A study is needed to determine the exact requirements for harbors of refuge and to locate suitable sites for development.

Further economic and environmental impact studies are needed before thermo-nuclear electric power plants can be constructed in the Area. Consideration must be given to alternative power sources, cluster development of plants, and ecological effects.

Additional studies are required in land management and its impacts on various environmental factors, such as the production and effects of sediment. Cooperative studies involving long-term measurement and evaluation of sediment production, movement, and impacts on various economic and ecologic factors are proposed.

There is an identified need to complete cooperative soil surveys on Area lands, update older inadequate surveys and initiate surveys of greater intensity in areas expected to become part of metropolitan developments.

A study team composed of local, State, Federal, and Canadian interests should explore all the recreation resources of the San Juan Islands and associated Gulf Islands in Canada to:

(a) Determine those islands or island areas that should be developed for outdoor recreation.

(b) Classify areas for management and administration to meet public recreation needs.

(c) Suggest alternative methods for acquisition or control.

A management program should be prepared for the future use of Puget Sound and adjacent marine waters on the basis of a study evaluating the needs for commercial and recreational navigation, aqua-culture and preservation of unique ecological areas.

Studies by the State leading to the establishment of a Statewide system of recreation rivers and a Statewide system of special interest areas should be undertaken.

A study is required to establish a program for debris prevention, control and removal on all recreational waters.

An urgent need exists for additional hydrologic information to facilitate improved management of the Area's water resources. More temperature and

precipitation stations are needed above elevation 2,000. The existing stream-gaging network should be expanded with more stations provided in small watersheds including the numerous islands in the Puget Sound Area. Analytical and interpretive studies should be made of physiographic and geologic characteristics to more accurately determine drainage basin yields. More information is needed on the groundwater resources of the area with exploratory drilling and aquifer testing required.

The high country in the Cascades has a fragile ecological balance and while the apparent need is to increase capacity through a strong development program, care must be taken lest the resource itself be destroyed. A study is needed to find answers to the question of the proper level of human use in the high country, prior to initiation of development programs. Both winter and summer sport activities are involved. This concept is applicable to most other areas receiving intense recreation use and should be studied wherever appropriate.

PLAN IMPLEMENTATION

The Comprehensive Plan provides a framework for the orderly development of the water and related land resources to meet the foreseeable needs of the Area. The Plan has been formulated on the basis of providing the best uses and combination of uses of the resources in meeting economic and environmental objectives. Implementation of the Plan would require the acceptance and support of the public. Because of the varied and wide range of interests, coordination between local, State and Federal groups and agencies is of extreme importance. Further detailed studies also are necessary before some specific elements can be implemented and periodic updating of the Plan itself must be undertaken in order to remain relevant. Expenditures at all levels of government, and by the private sector, are necessary for Plan implementation. However, many expenditures called for by the Plan are already included in ongoing programs.

An entity representing various levels of government, with leadership by the State of Washington, is required to coordinate future development within the framework of the Comprehensive Plan and to provide a means of updating the plan. The existing Puget Sound and Adjacent Waters Task Force or some similar entity could be the logical body to provide future leadership and guidance in performing this task. Citizens advisory groups, responsible for arranging continuous and broad public participation in all future studies and actions leading to implementation of the Comprehensive Plan, are recommended as important adjuncts to the follow-on coordinating entity. Authorities and responsibilities of various local, State and Federal bodies are outlined in detail in Appendix II, Political and Legislative Environment and summarized in this report.

The public review of the Plan, undertaken prior to hearings conducted in May and June 1970 and during county workshops held from November 1970 through early April 1971, revealed that some elements of the Plan may be modified or other alternatives selected during detailed implementation studies. However, the Plan as presented provides a reasonable basis for future planning. (See Exhibit C for a summary of the public workshops and how issues raised at the workshops were responded to by the Task Force. Additions and changes were made to the Summary Report to reflect comments received from the workshop participants. A brief summary of the final hearings is presented in Exhibit D. Also see Appendix I, Digest of Public Hearings, Volumes II and III for a more detailed presentation of the hearings and workshops.)

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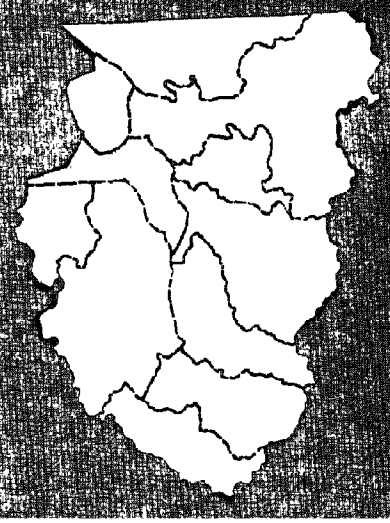
Part One
Introduction



ARRANGEMENT

This report first introduces the authority, history and organization, and purpose and scope of the Puget Sound and Adjacent Waters Comprehensive Water and Related Land Resources Study. The objectives and methodology employed in the comprehensive plan formulation process then follow. A description of the Study Area and its resources is presented, and the water and related land needs of the Puget Sound Area are defined. The opportunities considered and alternative means for satisfying needs are discussed in the same order as in Senate Document 97, 87th Congress, 2nd Session. The Comprehensive Plan for the Puget Sound Area, its accomplishments, alternative elements, and the cost of implementing this Plan are contained herein. The effects of the Plan and its implications are identified, and the requirements of implementation are discussed. Finally, the conclusions and recommendations of the Puget Sound Task Force are presented.

Exhibits appended to this report include: Exhibit A—individual basin plans; Exhibit B—comparison of economic projections; Exhibit C—county workshops, including summaries, issues raised and Task Force responses, an evaluation by the workshop coordinator, and suggested guidelines for future public participation; and Exhibit D—summary of final hearings. A glossary of terms is provided following the exhibits.

PHOTO 1-1. Glacier Peak in the Cascade Mountain range, part of the eastern boundary of the Puget Sound Area. National Park Service Photo

AUTHORITY

On the basis of the recommendations of the Senate Select Committee on Water Resources Planning, and at the request of the President, a program for comprehensive planning to cover the United States (except Alaska) was developed by appropriate agencies. This program was presented by the Executive Branch in its Fiscal Year 1963 budget. The program, which has been approved and partially funded by Congress, provides for a group of framework studies covering major river basins and a group of detailed comprehensive studies to provide a basis for authorization of specific projects. The Puget Sound and Adjacent Waters Comprehensive Water and Related Land Resource Study is one of those included in the program.

The various Federal agencies participated in the investigation under specific Congressional authorities as follows:

(1) **Department of Agriculture.**

Soil Conservation Service, Economic Research Service, and Forest Service–Section 6 of the Watershed Protection and Flood Prevention Act (Public Law 566), 83rd Congress, 68 stat.

(2) **Department of the Army.**

Corps of Engineers–Flood Control Act of 1962 (Public Law 87-874, Section 209).

(3) **Department of Commerce.**

Weather Bureau–Section 601 of the Economy Act of 1932 (47 stat. 417).

(4) **Department of Health, Education, and Welfare.**

Public Health Service–The Public Health Service Act of 1944 (Public Law 410, 42 U.S.C. 201 et seq.); the Inter-departmental Agreement concerning consultation on Health Aspects of Water Pollution Control, September 1, 1967; the Clean Air Act, as amended December 13, 1963 (Public Law 88-206, 42 U.S.C. 1857 et seq.); and the Solid Waste Disposal Act of October 20, 1965 (Public Law 89-272, 42 U.S.C. 3251 et seq.).

(5) **Department of the Interior.**

(a) Fish and Wildlife Service–Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

(b) Bureau of Outdoor Recreation–Public Law 88-29, Stat. 20 of May 28, 1963.

(c) Bureau of Mines–Section 601 of the Economy Act of 1932 (47 Stat. 417).

(d) Geological Survey–Section 601 of the Economy Act of 1932 (U.S.C. Title 31, Section 686).

(e) Bonneville Power Administration.

(f) National Park Service–Park, Parkway, and Recreation Area Study Act of June 23, 1936.

(g) Federal Water Pollution Control Administration–Public Law 85-500 and Memorandum of Agreement between the Department of the Army and the Department of Health, Education, and Welfare Dated November 4, 1958, relative to Title III of the Water Supply Act of 1958 as amended; and the Federal Water Pollution Control Act as amended (33 U.S.C. 466 et seq.). Responsibility for these activities was transferred from Department of Health, Education, and Welfare to Department of the Interior by reorganization Plan No. 2 of 1966 effective May 10, 1966.

(h) Bureau of Indian Affairs.

(i) Bureau of Land Management.

(j) Bureau of Reclamation–Act of June 17, 1902, 32 Stat. 388 and Acts amendatory thereof and supplementary thereto.

(6) **Federal Power Commission.**

Federal Water Power Act of 1920, Federal Power Act of 1935. The Flood Control Acts and other statutes.

(7) **Department of Labor.**

(Ex-Officio.)

(8) **Department of Transportation.**

Federal Maritime Law.

(9) **Department of Housing and Urban Development.**

Department of Housing and Urban Development Act of September 9, 1965 (Public Law 89-174, 79 Stat. 667, 5 U.S.C. 642, 42 U.S.C. 3531 et seq.).

Agencies of the State of Washington provided leadership on the Task Force and the technical committees, assisted in the development of the plan of study and report outline and participated in the informal and formal agency reviews of appendices and the Summary Report.

The various units of State government participated in the study in accordance with specific legislative authorities as follows:

State of Washington Departments and Agencies

(a) Department of Agriculture–RCW Chapter 43.23

(b) Department of Commerce and Economic Development–RCW Chapter 215, Laws of 1957

(c) Office of Nuclear Development–RCW Chapter 41.31, Sections .010-.280

(d) Department of Fisheries–RCW Chapters 43.17, 75.04, 79.20, 90.48

(e) Department of Game–RCW Chapters 77.04 and 77.12

(f) Department of Health[1]–RCW 43.20, .050

(g) Department of Highways–Chapter 47.001, .120

(h) Oceanographic Commission–(81) Chapter 243, Laws of 1967

(i) Department of Natural Resources–RCW Chapters 43.30, 76 and 79

(j) Department of Water Resources[1]–RCW Chapters 43.21, .37, Chapters 81, 233 and 242, Laws of 1967

(k) Canal Commission–RCW Chapter 91.12

(l) Parks and Recreation Commission–RCW Chapters 43.51 and 70.88

(m) Planning and Community Affairs Agency–RCW Chapter 74, Laws of 1967

(n) Soil and Water Conservation Committee–RCW Chapter 89.08.030

(o) Water Pollution Control Commission[1]–RCW Chapter 901.48

(p) Counties–Chapter 35.63 RCW 1935 as amended and 86.13 and Chapter 36.70 RCW (1959)

(q) Cities and Towns–RCW 35.31.090, 310, 35.92.020

(r) Interagency Committee for Outdoor Recreation–RCW Chapters 43.98 and .99

(s) Metropolitan Municipal Corporations–RCW 35.58.030, .050.200, etc.

(t) Puget Sound Governmental Conference–Chapter 44, Laws of 1935, RCW 35.63.070

(u) Special Purpose Districts–RCW 86.09, 154, 163, 385, RCW 89, RCW 54, 57, 87 RCW 53

(v) Department of Employment Security –Chapter 62, Laws of 1970

(w) Department of Ecology[1]–Chapter 62, Laws of 1970

HISTORY AND ORGANIZATION

Several Federal agencies as well as State and local agencies were involved in water and related land resource studies in the Puget Sound Area in the early 1960's. The Corps of Engineers was authorized to make a comprehensive study of Puget Sound and Adjacent Waters by the Flood Control Act of 1962, Section 209, Public Law 87-874. This was one of a series of comprehensive river basin studies authorized throughout the country. The Federal Water Pollution Control Administration of the Department of the Interior (formerly the Public Health Service of the Department of Health, Education and Welfare) had underway a comprehensive study for water supply and water quality control throughout the Columbia River Basin, including the Puget Sound region. The Soil Conservation Service was preparing various Public Law 566 studies on the Green River, Snohomish River, and planning studies in other basins. The Forest Service was engaged in related land resource planning for the national forests of the basins. The

[1] In 1970 the State Legislature merged the environmental quality functions involving solid waste, air and water quality control and water resource planning and management to a single agency, the Department of Ecology. This single State agency has the authority to manage and develop the air and water resources of the State in an orderly, efficient and effective manner, and to carry out a coordinated program of pollution control involving these and related land resources. This merger resulted in the consolidation of the Department of Water Resources, the State Air Pollution Control Board, the Water Pollution Control Commission and the Solid Waste Management Unit of the Department of Health into the Department of Ecology.

Bureau of Reclamation and the Bureau of Sport Fisheries and Wildlife also had studies underway in the Puget Sound Area. The Bureau of Outdoor Recreation was engaged in broad scale studies of the recreation potential covering the State of Washington. The Geological Survey was planning general studies on quality and quantity evaluations of runoff throughout the State.

State and local efforts in comprehensive planning included undertakings by the Local Affairs Division of the Department of Commerce and Economic Development, the Puget Sound Governmental Conference, the Municipality of Metropolitan Seattle and several city and county governments in the study area.

Since the early 1960's there has been an accelerating transition from single-purpose planning at all levels of government to the concept of comprehensive multi-agency resource planning and action programs.

To avoid duplication of effort and to achieve coordination in the water resource planning efforts, the Federal Inter-Agency River Basin Committee requested that the Columbia Basin Inter-Agency Committee coordinate the comprehensive water resource studies in the Pacific Northwest. Responsibility for this action was assigned to the Subcommittee for Coordinated Planning, CBIAC. The Subcommittee established the Puget Sound Task Force on 12 March 1964, for coordination and general procedural guidance for the accomplishment of the Puget Sound Comprehensive Study.

Task Force membership was made up by representatives of each of the following organizations:

State of Washington
Department of Agriculture
Department of Army
Department of Commerce
Department of Health, Education and Welfare
Department of the Interior
Department of Labor
Federal Power Commission

Other organizations which subsequently participated in the study were the Department of Housing and Urban Development and the Department of Transportation.

A representative for the Director, Department of Conservation, State of Washington, and a representative of the Department of Army, Corps of Engineers, were appointed as Co-Chairmen of the Task Force. During the investigation, a representative of the Pollution Control Commission, State of Washington, was selected as Co-Chairman to represent the State, and later acted as single chairman to the Task Force.

The Coordinated Planning Subcommittee furnished the Task Force a set of guidelines which included the following principal objectives:

a. Coordination between Federal and State agencies to avoid overlapping of work and duplication of effort.

b. Provision for a full consideration of State and local viewpoints.

c. Informing the public about the nature and progress of the study and holding public hearings as appropriate.

d. Preparation of a report outline and development of work plans and division of labor among participating groups. Following establishment, the Puget Sound Task Force formed the Report Planning Committee and 12 technical committees in various fields. Later an additional committee and a plan formulation team were added. The Report Planning Committee was formed to finalize the report outline, provide assistance to the technical committees, to control, monitor, and manage the work. Technical committees or teams functioning were:

Political and Legislative Environment
Hydrology and Natural Environment
Economic Environment
Water-Related Land Resources
Municipal and Industrial Water Supply
Irrigation
Navigation
Power
Recreation
Fish and Wildlife
Flood Control
Water Quality Control
Watershed Management
Plan Formulation

Contacts were made in April and May of 1964 with county commissioners, soil conservation districts, municipal and other responsible parties interested in water and related land resource planning in each of the 12 counties encompassed by the Puget Sound Study. An Information Bulletin describing the study objectives was published in July. On 15 July, a meeting was held by representatives of key Federal and State agencies involved in the study, and county and local interest representatives throughout the 12-county area. At this meeting, the Governor of the State of Washington endorsed the comprehensive

study and offered the full cooperation of the State in the study effort. Representatives of Federal and State agencies commented on the broad objectives of the study to county and local participants.

The Task Force held public hearings at Anacortes, Everett, and Olympia, Washington, in October 1964. Testimony presented at the hearings was assembled into an appendix. The needs of the study given in the testimony were analyzed and catalogued for use in the comprehensive study.

The Report Planning Committee designated by the Task Force prepared an outline for the comprehensive study report. Technical committees prepared outlines for the report appendices. A coordinated plan of study was prepared defining the efforts of each agency participating in the study. A second Information Bulletin was published and widely distributed in March 1967. The Governor sent a copy of this bulletin to each of the counties in the Puget Sound Area inviting them to appoint water resource advisory committees for the purpose of assisting in the comprehensive study.

Throughout the course of the study liaison was maintained with county commissioners, councils of government such as the Puget Sound Governmental Conference (covering Snohomish, King, Pierce, and Kitsap Counties) and planners and other groups and organizations interested in or having responsibilities for water and related land resource use and management including the Washington Environmental Council, and Water Research Centers at the University of Washington and Washington State University. During the initial stages of the study meetings were held with local resource advisory and planning committees to describe the study and to receive comments. Presentations were made before the American Society of Civil Engineers and the Society of American Foresters. Panel discussions were presented on television. Detailed presentations were made before the planners and Boards of County Commissioners for each of the twelve counties comprising the Area in separate series of conferences during the plan formulation phase of the study. More than 50 meetings were held with State, county and municipal officials and organizations, as well as private groups and individuals having interests in or responsibilities for water and related land resources.

The first public review of Task Force's preliminary findings took place at three public hearings held May and June 1970 in Mount Vernon, Everett and Olympia. During the course of these hearings it became evident that a significant number of citizens desired an additional opportunity for review of the study findings. Consequently, local levels of Government were encouraged to organize workshops in which the study could be reviewed. Each of the 12 counties and 17 of the largest cities were provided with copies of the report draft and appendices and the State appointed a coordinator to facilitate the workshop effort. Members and staff of the Task Force also made themselves available to assist as requested. Following completion of the workshop sessions, participants were requested to prepare comments on the Task Force report draft and appendices.

Two final public hearings were held in Bremerton and Seattle in April 1971 during which the salient issues raised during the workshops were discussed and additional public comments were received. The workshop issues were reviewed carefully by the Task Force and appropriate additions, deletions and changes were made in the Summary Report to reflect the Task Force response to these issues.

The complete report of the workshop coordinator is appended as Exhibit C. This report contains a summary of the county workshop conclusions and recommendations, an evaluation of the workshops by the coordinator, a compilation of significant issues raised at the workshops and the Task Force responses, and guidelines for future public participation. Exhibit D contains a summary of the testimony received at the final hearings. The full transcript of the three 1970 hearings and the two 1971 hearings are contained in Volumes II and III, respectively, of Appendix I, Digest of Public Hearings.

PURPOSE AND SCOPE

Future use of the resources in the eleven major river basins comprising the Area has been planned to satisfy environmental as well as economic objectives. This report summarizes water and related land resource needs of the Puget Sound Area and presents a comprehensive plan of projects and programs to meet these needs.

An inventory of the water and related land resources of the Puget Sound Area was made and the physical, economic, political, and legislative environ-

ments were examined in depth. Future water and related land resource needs were projected for the years 1980, 2000, and 2020 on the basis of economic and resource studies. Single-purpose means to satisfy water and related land needs, given in Appendices V through XIV, provided a basis for developing a comprehensive water resource plan and alternatives that would best serve all purposes. Economic analyses, including benefit-cost evaluations, were made for projects required by 1980 and investment costs were estimated for projects proposed for implementation between 1980 and 2020. Investment costs were also estimated for programs planned over the 50-year study period. Although the Comprehensive Water and Related Land Resources Study of Puget Sound and Adjacent Waters did not deal directly with urban related social problems, most of the studies dealt with needs which directly or indirectly affect urban centers. The broad land use planning undertaken serves as a basis for further detailed land use studies, including future management of Puget Sound estuaries.

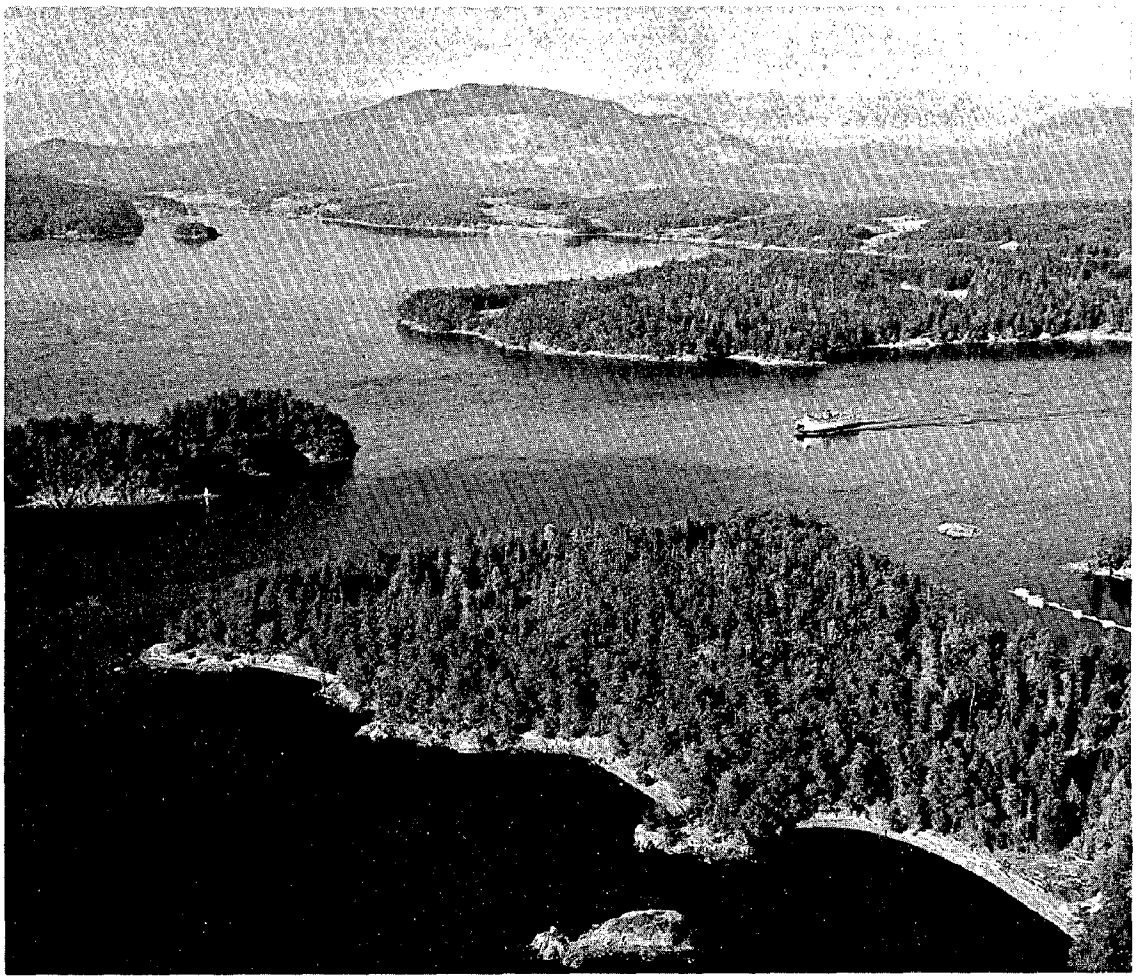


PHOTO 1-2. Salt-water beaches and sheltered inlets of Puget Sound Area. Washington State Department of Commerce and Economic Development Photo

PLANNING OBJECTIVES AND METHODOLOGY

PLANNING OBJECTIVES

Planning for the preservation and development of water and related land resources requires complete inventory of resource as well as consideration of basic national, regional, and local goals. Also involved are specific water resource policies at various levels of government which reflect the overall objectives and the legislative framework of water law as it is today, and as it may evolve in the future.

Senate Document No. 97, 87th Congress, 2nd Session provides objectives and guidance for planning the use and development of water and related land resources. These broad objectives are:

"**A. Development.**—National economic development, and development of each region within the country, is essential to the maintenance of national strength and the achievement of satisfactory levels of living. Water and related land resources development and management are essential to economic development and growth, through concurrent provision for:

Adequate supplies of surface and ground waters of suitable quality for domestic, municipal, agricultural, and industrial uses—including grazing, forestry, and mineral development uses.

Water quality facilities and controls to assure water of suitable quality for all purposes.

Water navigation facilities which provide a needed transportation service with advantage to the Nation's transportation system.

Hydroelectric power where its provision can contribute advantageously to a needed increase in power supply.

Flood control or prevention measures to protect people, property, and productive lands from flood losses where such measures are justified and are the best means of avoiding flood damage.

Land stabilization measures where feasible to protect land and beaches for beneficial purposes.

Drainage measures, including salinity control where best use of land would be justifiably obtained.

Watershed protection and management measures where they will conserve and enhance resource use opportunities.

Outdoor recreational and fish and wildlife opportunities where these can be provided or enhanced by development works. Any other means by which development of water and related land resources can contribute to economic growth and development.

"**B. Preservation.**—Proper stewardship in the long-term interest of the Nation's natural bounty requires in particular instances that:

There be protection and rehabilitation of resources to insure availability for their best use when needed.

Open space, green space, and wild areas of rivers, lakes, beaches, mountains, and related land areas be maintained and used for recreational purposes; and

Areas of unique natural beauty, historical and scientific interest be preserved and managed primarily for the inspiration, enjoyment and education of the people.

"**C. Well-being of people.**—Well-being of all of the people shall be the overriding determinant in considering the best use of water and related land resources. Hardship and basic needs of particular groups within the general public shall be of concern, but care shall be taken to avoid resource use and development for the benefit of a few or the disadvantage of many. In particular, policy requirements

and guides established by the Congress and aimed at assuring that the use of natural resources, including water resources, safeguard the interest of all of our people shall be observed."

Pursuant to the basic objectives cited previously, and to State policies and guidelines, the Comprehensive Water and Related Land Resource Study of Puget Sound and Adjacent Waters considered the objectives of economic efficiency, environmental quality and regional development. These objectives are broad in scope and general in definition, yet they are specific enough to provide the basic principles and guidelines for the formulation of plans of water and related land resource development.

Economic Efficiency

The economic efficiency objective of planning is the maximization of economic return to the Nation in water and related land resources. Alternative project and program elements were examined that would achieve maximum benefits over costs in meeting the total needs. Only plan elements proposed for undertaking prior to 1980 were subject to benefit analysis. Projects and programs selected for construction or implementation after 1980 were based upon least cost and/or judgment, with several alternatives usually presented.

Projections of employment for selected industries, total earnings, personal income, population, and agricultural production have been made for the United States and the Puget Sound Area. (See Appendix IV, Economic Environment.) Inasmuch as these projections are based primarily on past trends, they reflect the pattern of national economic efficiency as it has developed under the system of private enterprise and government. The economic efficiency objective is broad and, in achieving it, much progress will be made toward meeting the environmental quality objectives.

To meet the objective of maximizing net economic returns and satisfactions from the economic resources, each element of the plan was formulated to include only segments or increments which would provide benefits at least equal to their cost. Plan formulation was considered complete when: (1) each separable segment or purpose provided benefits at least equal to its costs, (2) development was sized to provide the maximum net benefits, and (3) there were no more economical means of accomplishing the same purposes that would be acceptable to the public.

Environmental Quality

The environmental quality objective of framework planning is the maintenance or improvement of the quality of the area's environment. This objective includes not only preservation, but perhaps more important, positive measures to create an improved living environment. The inclusion of this objective would insure that the effects of water and related land resource development on "human ecology," the relationship between man and his environment, are carefully defined and evaluated. The extent to which the environmental quality objective is attained cannot always be expressed in monetary terms.

Proper stewardship requires that certain areas be rehabilitated, that suitable lands be selected for the various required uses but protected and maintained under each condition of use to avoid preventable loss or deterioration of resource values. In addition to economic uses, areas of unique natural beauty, or historical and scientific value should be selected and preserved; other areas of open space, wild rivers, lakes, and mountains should be selected and maintained for aesthetic purposes and for enjoyment of the public.

The environmental quality objective may be met in large measure by the economic efficiency objective. However, in some instances, available resources were not sufficient to meet all needs. In these cases, alternatives were prepared and presented so that informed choices could be made.

Because all Federal, State or local environmental quality objectives have not been specifically defined, judgement of the planner, in consultation with appropriate disciplines, served as the primary basis of determining when projects or programs were in conflict with the environmental quality objectives. Public expressions with regard to sites, areas and general attitudes, were given careful consideration.

Regional Development

The regional development objective of planning is the attainment of a desired pattern of regional income or development induced through water and related land resources investments. This objective is attained to the extent that such investments provide specified patterns of regional development. Examples of regional development objectives are the desire to increase per capita income in an area, increase the total output, and to enhance and utilize the economic potential of an area. The regional development objective is generally considered when basic economic

problems of a local nature are present that result in a situation of long-term high unemployment or dearth of job opportunities. The regional development objective was not considered to be appropriate to the Puget Sound Area because of the prospects for an expanding economy and the excellent long-range potential for future growth. Consequently, this objective was not explicitly recognized in the formulation of a comprehensive plan for the Puget Sound Area. The Plan is flexible in that elements can be shifted in the time scale to meet changing needs and objectives.

METHODOLOGY OF PLANNING

General

The planning for the Puget Sound Area began with public hearings, an inventory of water and related land resources and projections of future economic growth. Projections of population, employment and industrial output were translated into needs which were compared to available resource opportunities. From this comparison a plan was developed to satisfy the needs after considering the viewpoints expressed by the public and alternative means to meet economic efficiency and environmental quality objectives. The planning procedures are covered in the following paragraphs.

Assessment of Local Viewpoints

Public hearings were held at Anacortes, Everett, and Olympia in the fall of 1964. The testimony presented endorsed the goals of the study, especially the concept for coordination of effort by various governmental entities and development of multiple-purpose use concepts for resource planning and development. Needs most frequently mentioned included municipal and industrial water supply, flood control, streambank stabilization and watershed protection and rehabilitation, navigation improvements and recreation needs, including small boat moorages. A digest of these public hearings is given in Appendix I, Digest of Public Hearings, Volume I.

Economic Evaluation of Present and Future Economy

Historical trends and economic activities were developed to a 1963 production base, utilizing studies made by Consulting Services Corporation, the Economic Research Service and Forest Service of the U.S. Department of Agriculture, and the Bureau of Mines of the U.S. Department of Interior and other sources. Projections were made for 1980, 2000, and 2020, recognizing the natural resources of the Area and factors influencing its competitive advantages. The findings of these economic studies are presented in Appendix IV, Economic Environment.

Examination of the Environment

The political framework under which resources are administered was established in detail. The natural environment was examined with respect to water and related land. The broad land resources of the area were inventoried and the prospects for development were established. Findings of these studies are given in Appendices II through V.

Analysis of Water and Related Land Resources

Detailed studies were made for each of the major water and related land resource uses of the Puget Sound Area. Future needs for each resource use were determined by correlations with parameters projected in the economic base study, followed by the development of single-purpose plans to meet these needs. The technical committees coordinated with local agencies during these studies.

The functional appendices contain single-purpose plans that were formulated to satisfy a particular need with minimal regard to the impact on other resource users. This was done in order to insure equal treatment and to obtain the maximum possible array of single-purpose alternatives. The results of these studies are given in Appendices V through XIV. Appendix XV, Plan Formulation, discussed alternatives and the resolution of conflicts in arriving at a comprehensive plan for the Area.

Development of the Comprehensive Plan and Alternatives

The Comprehensive Plan provides for an early action and long-range development with a program covering projects and management requirements for each. The Plan was formulated to guide the water and related land resources management and development through the year 2020, recognizing that revisions and adjustments would be necessary in the future to allow for changing conditions and desires of the public. Development of the Comprehensive Plan proceeded along the following sequence:

(a) The needs as contained in the functional appendices were summarized.

(b) Alternative means of resource use were examined to satisfy the needs. The opportunities

ranged from resource preservation and management to structural facilities development, including single-purpose and multiple-purpose solutions. Combinations of these solutions were utilized in developing a plan to meet the economic efficiency and environmental quality objectives of the study.

The Comprehensive Plan which was developed stemmed from the interplay of several basic concepts, some dictated mainly by consideration of the total Puget Sound Area, others derived from characteristics identified with individual river basins comprising the Area.

The expected industrial expansion and associated economic growth were utilized to estimate the future population of the Area by time periods. The population thus estimated was roughly allocated among the several river basins comprising the Area as a first approximation in the process of plan formulation. Factors used in this allocation were historical growth patterns and considerations of resource potentials by location, including apparent opportunities for commerce, navigation, and existing major avenues of transportation.

The distribution of population was used in estimating lands needed for urban occupancy and served to establish load centers for power, recreational demand, water supply, urban water management, navigation facilities, and the need for flood control.

Reservations of unique scenic, historical, and scientific areas for public use were made on the basis of fortunate occurrence and recognized public values.

Sources of water for municipal and industrial uses, fish and wildlife habitat, and recreational purposes; sites for power generation; and sites for water storage, were located by basin mainly on the basis of opportunity but strongly influenced by Area considerations.

Lands for agriculture, forestry, and other open uses are largely those remaining after reasonable densities were established and distribution of land for urban uses was made, and after reservations for various public uses. An effort was made to retain suitable lands devoted to these open uses in order to keep their economic, hydrologic, and aesthetic values in the Area and to distribute these values among the several basins.

The uses for the land thus established made possible a determination of required flood control measures, watershed treatment measures, irrigation, and measures for urban water management and for preservation of water quality. The plan selected is the result of successive approximations of land use patterns and uses of other resources. Various trade-offs of resource use to accommodate projected development and to conserve and develop desirable elements of the environment were made. Many multiple-judgment factors were involved, including expressions of public interest. A strong effort was made to retain the excellent alluvial bottom lands in agriculture. These lands constitute about six percent of the land area and are necessary in order to retain a healthy farm economy. Reserving flood plains largely for agriculture and other open uses serves to minimize the need for flood control measures. Selection of adapted lands for other specific purposes minimizes the need for specialized watershed rehabilitation and protection measures as well as for various water management measures. Adoption of the urban density shown under land use pattern C_2 allows retention of considerable areas of desirable open space and permits large economies in furnishing public services to communities.

(c) Further development of the plan led to the formulation and costing of programs and projects required for timely preparation for future population, and, at the same time, resulted in recommendations for zoning of land for critical uses and regulation of flood plain developments, as well as early acquisition of sites for various needed public purposes.

A plan was formulated with initial investment costs and annual costs and benefits estimated for the early action projects needed by 1980. Only investment costs in terms of 1968 prices were estimated for the long-range portion of the plan providing for satisfaction of needs projected to the years 2000 and 2020. When conflicts arose between the environmental quality and economic efficiency objectives, adjustments were made or alternative plan elements were prepared. (See Appendix XV, Plan Formulation, "Basis of Planning" and "Alternative Elements" for each basin.) The tentative projects and programs developed for each of the major river basins were presented to local planning and governmental authorities, including representatives of the counties and other interested groups, to determine their viewpoints. Every consideration was given to the local viewpoints and adjustments were made where appropriate.

CRITERIA FOR PLANNING

Legal Criteria

The Comprehensive Plan was developed in conformance with existing Federal and State laws,

treaties, and compacts, recognizing that existing laws and compacts and departmental policy would not always allow optimum use of the resources.

Economic Criteria

Price levels prevailing in 1968 were used for evaluating all present and future benefits and costs.

An interest rate of 4-5/8 percent per annum was used in plan formulation and evaluation for discounting future benefits and computing costs, or otherwise converting benefits and costs to a common time basis. This rate of interest is based upon the average yield during the preceding fiscal year on interest-bearing marketable securities of the United States with terms of 15 years or more remaining to maturity.

Period of Analysis and Life of Projects

A 100-year economic life was used in the analysis of projects proposed for development prior to 1980. Projects having economic lives less than 100 years included replacements at the end of their normal lives.

The Comprehensive Plan was formulated to meet needs to the year 2020. Needs are expected to grow after 2020, and many of the proposed projects and programs, by adding facilities, will have the capacity to meet some of these needs. The potential of the plan to meet needs that develop after 2020 has not been evaluated.

Basis for Comparison of Project Effects

Comparison and evaluation of the proposed projects and programs in the plan were made to determine the most effective use of water and related land resources. The value of the projects or programs included in the plan was determined on the basis of future conditions with the projects or programs as compared to future conditions without the projects or programs.

The future "with" conditions for individual project or program analysis include all economic development which would be expected to occur during the period of analysis with the project in existence.

The future "without" conditions include all projects that are existing or under construction as of 1968.

Average Annual Equivalent Values

Program or project benefits and costs, which are estimated to accrue at different times and over varying periods of time, were converted from capital values to average annual equivalent values over a 100-year life.

The average annual costs and benefits of multiple-purpose projects were estimated for a 100-year life. However, in order to provide a common basis for comparison of nonstorage with storage alternatives, an adjustment was made for projects that ordinarily have physical and economic lives of less than 100 years. This was accomplished by providing for major or complete replacement of these facilities at the end of their normal lives with an average annual equivalent replacement cost computed and included in the annual costs. Average annual equivalent costs for interest and amortization were computed with a capital recovery factor based on a 4-5/8 percent rate of interest. Average annual equivalent benefits were derived by projecting the benefits over a 100-year period. The present worth of future benefits was derived with discount factors based on a 4-5/8 percent rate of interest.

Benefits

The ultimate aim of resource projects and programs, in common with all other productive activity, is to satisfy human needs and desires. Goods and services produced or provided to achieve this end have values in accordance with demand and availability. Benefits attributable to projects contained in the Comprehensive Plan are classified as primary or secondary and may be tangible or intangible. Primary benefits are considered the increase in value of goods or services or their protection directly as the result of a project. Examples of primary benefits are flood damage prevention, water supply for industrial, municipal or agricultural use, outdoor recreation, land enhancement and hydropower. Secondary benefits are values that accrue indirectly from the operation of a project such as relocation or creation of industry, increase in retail sales, per capita income, improvement of community cash flows or reversing the migratory trend toward large metropolitan areas. Tangible benefits which may be primary or secondary are values that are readily derived by comparison with other marketable goods or services. An example of tangible benefits is the prevention of flood damages to land and improvements, personal property and

interruption of business. Intangible benefits, either primary or secondary, are values that are not readily subject to monetary evaluation except by assignment of arbitrary values or by assuming values equivalent to marketable goods and services. Intangible benefits include the saving of human life, maintenance or improvement of living conditions, alleviation of human suffering, and the safeguarding of wild and scenic rivers and of aesthetic conditions.

Primary Benefits

The primary tangible benefits, which are referred to as primary benefits, represent the estimated increase in the value of the actual goods, services, and satisfactions of a project or program expected for the period under study and from which any induced losses to other projects or programs have been deducted.

The benefits from domestic, municipal, and industrial water supply projects were assumed to be equal to the costs.

Primary benefits for irrigation projects were based upon income gains to farmers from increased crop production. Benefits for privately developed irrigation project systems were taken as equal to the costs.

Benefits of programs for vector (pest) control, solid-waste collection and disposal, air pollution and radiation monitoring, and pollution abatement, watershed rehabilitation and protection measures, except storage for augmenting low streamflows, are assumed equal to the cost of these programs.

Benefits of navigation are recognized as savings in shipping time, the reductions in operation and maintenance costs, the increased value of any filled land obtained through spoil disposal, and economies of scale gained by use of larger and more efficient ships. Deep draft navigation benefits computed for this study were based on operational savings to project users as a result of reductions in delays due to tides, and land value enhancement gained from project dredged fill. Pleasure boating benefits from small boat harbor projects were included with general recreation benefits for purposes of plan formulation.

The primary benefits from hydroelectric power were based on the alternative cost of equivalent power from thermal generating plants.

Primary benefits from control of overbank flood flows were derived from the differences in flood losses "with" and "without" protection.

The primary benefits from drainage and flood damage reduction, resulting from the upstream watershed projects, were derived from net values for expected changes in land use, the increased productivity of land, the reduction of direct damage to agricultural crops and fixed improvements, and reduction of management costs. For upstream watershed and local protection projects, enhancement and restoration benefits are also included where applicable.

Benefits used in the monetary evaluation of the recreation program consisted of the estimated value of increased user-days of recreational activity.

The primary benefits from the commercial fishery program were the estimated value of increased landings of commercial fish and shellfish.

Primary benefits from the sport fisheries and wildlife program were determined as the estimated value of projected increases in user-days of fishing and hunting.

Secondary Benefits

Secondary benefits occur as a result of the increased economic activity generated by a project or program. Project related recreational sport fishing, aesthetic, and wildlife development stimulate employment and monetary flows in the trade, service and transportation industries. These impacts particularly affect fishing camps, marinas, commercial boat docks, motels, sporting goods stores, service stations, boat dealers, restaurants, and many related businesses. The additional income generated in these activities represents secondary benefits where it can be shown that the gains are not offset by losses elsewhere.

Costs

Costs of proposed projects and programs include the initial investment which would be incurred in one or more stages of construction and the annual expenditures required for operation, maintenance, and replacements. Investment costs include the capital expenditures associated with constructing a project and carrying out a program. Where the period of construction was estimated to be more than 2 years, the investment included simple interest on one-half of the construction costs for the period of construction. Capital investment and operation and maintenance costs of multiple-purpose projects were given a preliminary allocation to the several purposes served.

In addition to costs directly related to the construction and operation of a project, economic

costs consisting of lost opportunities were considered. An example of an economic cost would be the loss of agricultural production from a valley that was flooded and used for reservoir purposes.

Intangible Costs

In evaluating resource projects and programs, many important effects cannot be adequately measured in monetary terms. Loss of aesthetic values is an example of an intangible cost frequently associated with resource development. Treatment of these intangible effects has been subjected to many of the requirements applicable to tangible effects. These included: (1) considering effects in terms of difference "with the project" and "without the project," and (2) considering intangible costs to the same degree or extent as intangible benefits.

Part Two
Puget Sound Area

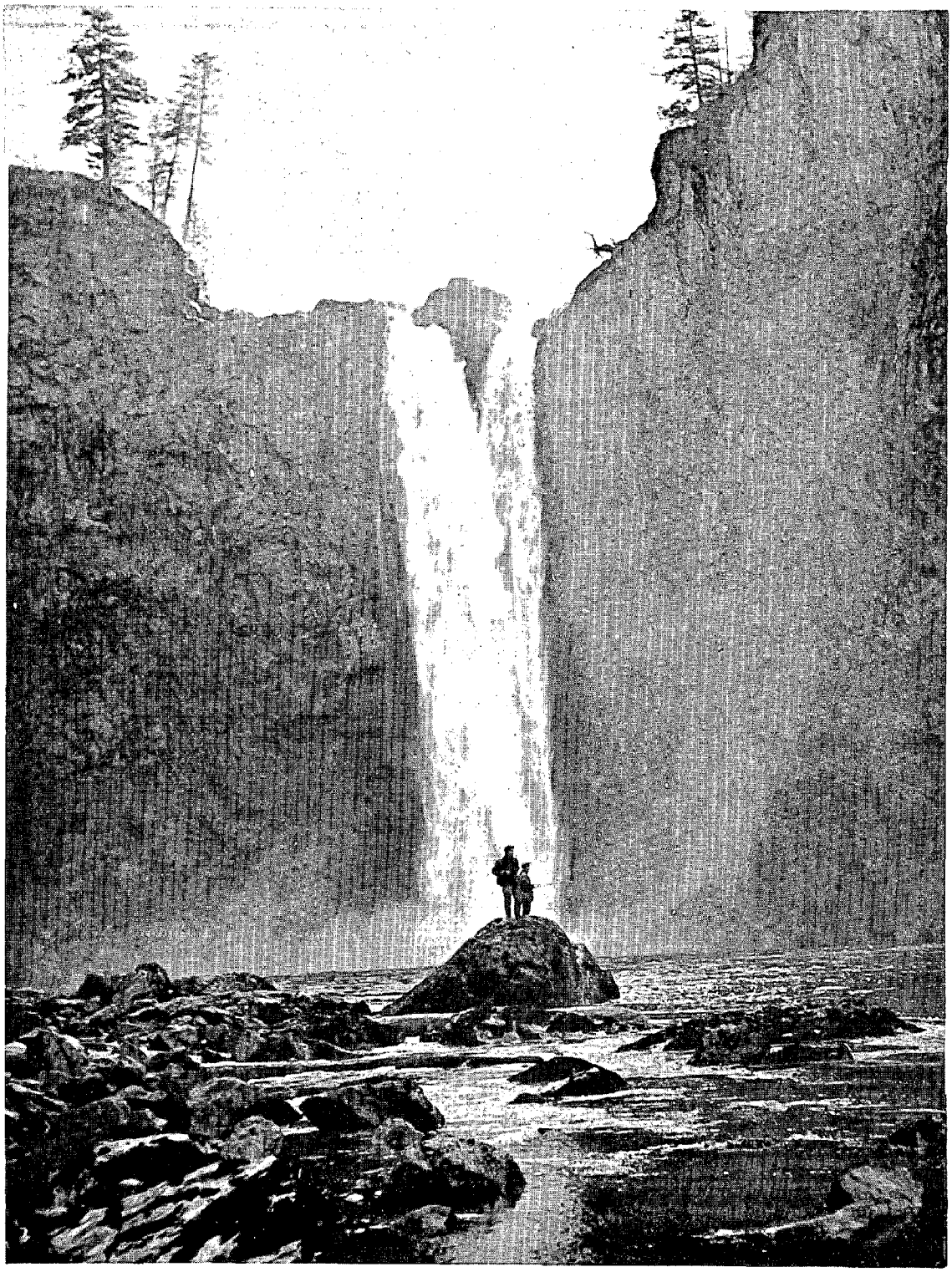


PHOTO 2-1. Snoqualmie River cascading 268 feet, then continuing its journey to join with the Skykomish to form the Snohomish River. Washington State Department of Game Photo

LOCATION, DESCRIPTION AND HISTORY

The Puget Sound Area lies in northwestern Washington, bounded on the north by Canada, on the east by the Cascade Range, on the west by the Olympic Mountains, and on the south by low hills as shown in Figure 2-1. In the center of the Area is Puget Sound, an inland sea of 2,500 square miles with saltwater beaches and sheltered inlets along interior waterways. The Sound is nationally recognized for its scenic and recreational values, water transportation and for the production of fish, shellfish, and other marine resources. Land areas in their natural state are located in the Cascade Range and on the Olympic Peninsula. The Area provides productive agricultural land, industrial sites, generally adequate water supplies, and extensive forests. Alluviated river valleys, bordered by bluffs and steep hills, constitute important physiographic features of the Puget Sound lowlands. The lowland valleys, with their mountain valley extensions, contain most of the population, industry, and agriculture in the Area. In the Cascade Range the principal rivers head at elevations where precipitation is abundant and large amounts of snow accumulate each winter. The higher ridges generally reach an elevation of about 8,000 feet in the north and 5,000 feet in the south.

The Olympic Mountains are generally lower in elevation than the Cascade Range. The sharp peaks and ridges that characterize this mountain range reach elevations in excess of 6,000 feet. A "rain shadow" created by the Olympics, extends eastward from Port Angeles, nearly to Everett, and northward into the San Juan Islands. This area receives an average of 15 to 30 inches of precipitation annually as compared to 35 to 50 inches in other lowland areas and over 200 inches on the wettest slopes of the Cascade and Olympic Mountains. Most of the winter precipitation in the Puget Sound Area falls as rain at altitudes below 1,500 feet, and as rain or snow above the 1,500-foot elevation. Most rainfall is usually of light to moderate intensity over a long period of time rather than heavy for brief intervals.

In slightly more than 100 years the Area has emerged from a status of discovery and exploration with complete dependence on natural resources, to a modern complex, technological society of the jet and nuclear age. Economic activity, including commercial fishing, transportation, agriculture, forestry, municipal and industrial development and outdoor recreation has evolved from modest beginnings. This transition from resource dependence to systematic resource management and development is recognized in the comprehensive planning for the Puget Sound Area.

WATER AND LAND RESOURCES

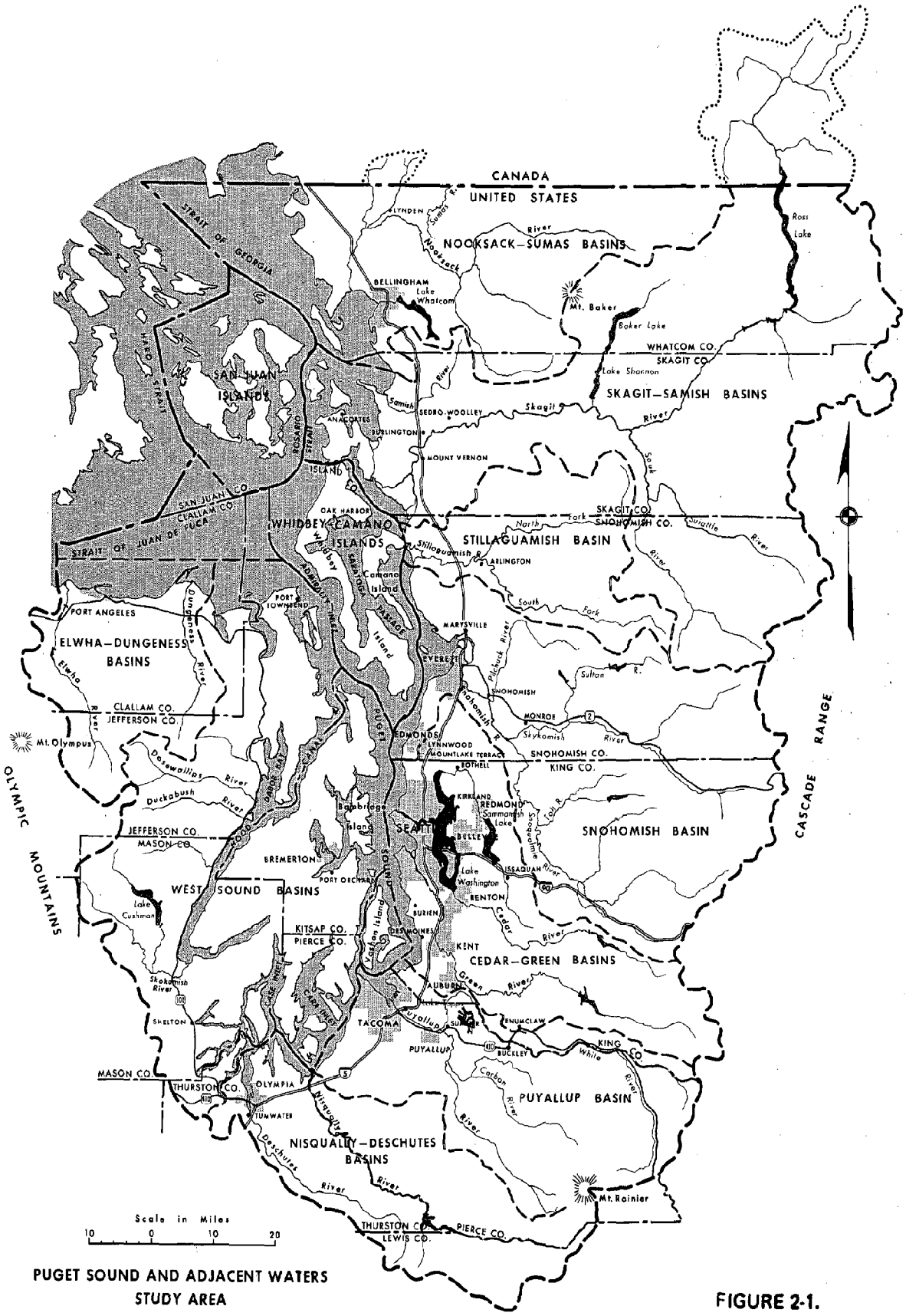
WATER

Streams

The rivers of the Puget Sound Area vary from a few miles to 135 miles in length. Glaciers, located at the higher elevations, are the source for many of these streams, imparting stabilizing influences to summertime low flows. The upper portions of most basins are characterized by narrow mountain valleys with steep gradients which drain forested areas. In the lowlands, rivers exhibit meandering courses across the flood plains.

Major floods in the Area occur during the months of October through March as a result of warm rain storms. Low streamflows occur during the summer months in all basins. The effect of low summer flows is most significant in the eastern basins where the demands for water are the highest. The total runoff for the Puget Sound Area during the period 1931-1960 averaged about 38,865,000 acre-feet per year. Average annual runoff ranges from less than 15 inches in some of the northern lowlands to as much as 140 inches in a few mountain areas.

The major rivers, in terms of largest average annual runoff, are the Skagit, Snohomish, Nooksack, Puyallup, Elwha, Nisqually, Green, Skokomish, Stillaguamish and Cedar Rivers. Discharge and runoff figures for various stations on these rivers are shown in Table 2-1.



PUGET SOUND AND ADJACENT WATERS STUDY AREA

FIGURE 2-1.

TABLE 2-1. Principal rivers, Puget Sound Area

Basin	River and Location	Drainage Area (sq. mi.)	Discharge (cfs) Minimum Daily Mean	Discharge (cfs) Momentary Maximum	Discharge (cfs) Average Annual	Average Annual Runoff (ac. ft.)
Nooksack-Sumas	Nooksack River nr. Lyndon	636	595	46,200	3,728	2,699,000
Skagit-Samish	Skagit River nr. Mt. Vernon	3,060[1]	2,740	144,000	16,340	11,830,000
Stillaguamish	South Fork, Stillaguamish River nr. Granite Falls	119	55	38,800	1,062	768,900
Snohomish	Snohomish River nr. Snohomish	1,720	—[2]	136,000	9,500	6,885,000
Cedar-Green	Cedar River nr. Renton	197	39	6,640	722	522,700
Cedar-Green	Green River nr. Auburn	382	81	28,100	1,334	965,800
Puyallup	Puyallup River at Puyallup	948	306	57,000	3,350	2,425,000
Nisqually-Deschutes	Nisqually River at McKenna	517	37	20,500	1,415	1,022,000
Nisqually-Deschutes	Deschutes River nr. Rainier	90	21	5,620	275	199,100
West Sound	Skokomish River nr. Potlatch	230	125	27,000	1,188	860,000
Elwha-Dungeness	Elwha River nr. Port Angeles	269	10	41,600	1,487	1,077,000
Elwha-Dungeness	Dungeness River nr. Sequim	156	77	6,820	371	268,600

1 Includes drainage area in Canada.

2 Flows less than 10,000 cfs not computed.

Source: Water Supply Bulletin No. 15, 1962 Washington Department of Conservation (Water Resources) and U.S. Department of the Interior, Geological Survey.

PHOTO 2-2. Howard A. Hanson Reservoir, a Corps of Engineers' multiple-purpose project located 32 miles upstream from Auburn in the Green River valley, provides storage for flood control and low flow augmentation to enhance downstream anadromous fish production. Corps of Engineers Photo

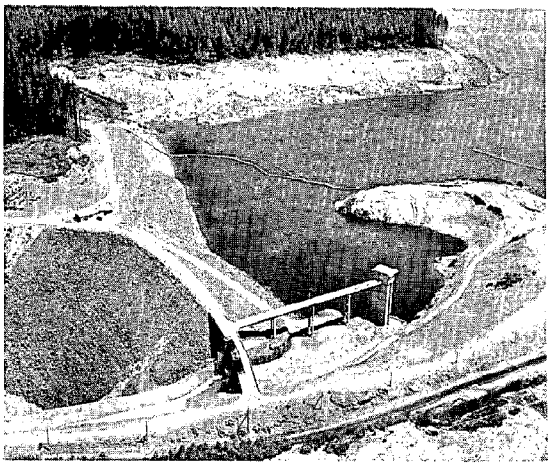
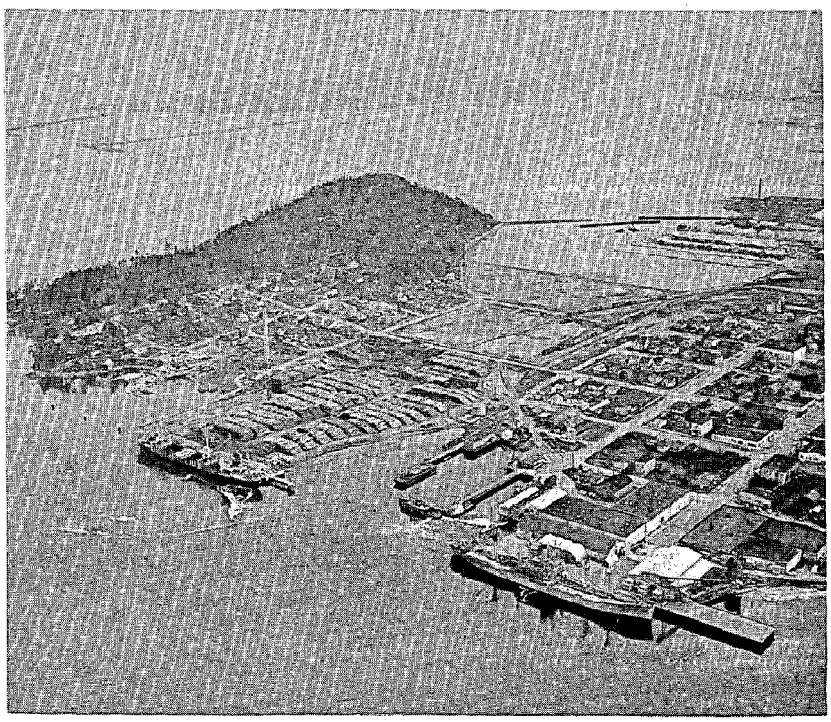


PHOTO 2-3. Seward Park, located in Seattle on the western shore of Lake Washington, provides excellent opportunities for urban enjoyment of outdoor recreation activity. Corps of Engineers Photo

PHOTO 2-4. Port of Anacortes, located at the north end of Fidalgo Island, 93 nautical miles from the Pacific Ocean, services deep draft vessels carrying bulk petroleum, forest products and general cargo. Port of Anacortes Photo



Streamflow characteristics and other data related to hydrology of the Area are discussed in Appendix III, Hydrology and Natural Environment.

Ground Water

High yields of ground water can frequently be obtained in the lower valley floor and adjacent to the delta of the rivers and tributaries in the Area. Ground water yields are relatively small in the mountainous areas. Aquifers occur in gravel and sand deposits of recessional (Fraser) glacial outwash and alluvium. These aquifers usually contain fresh water at depths of as much as a few hundred feet below sea level except in near-shore areas where aquifers less than 200 feet deep may contain sea water. The aquifers that contain fresh water receive recharge through infiltration of precipitation principally during winter months. The magnitude of recharge as well as the capacity of aquifers is not presently known.

Scattered ground water quality problem areas exist as a result of excessive concentrations of several constituents—notably iron, nitrate, and hardness elements and localized bacterial contamination and salt-water intrusion. Other than these scattered problems quality of the ground water is generally high.

Lakes and Reservoirs

The total amount of storage in the 2,808 lakes and reservoirs in the Puget Sound Area is not known. However, the surface area of these water bodies is at least 175 square miles. This area includes 24 major reservoirs having a surface area of about 70 square miles. Ross Reservoir on the Skagit River is the largest, having a total surface area of 11,820 acres. The largest lakes are Lake Washington (22,138 surface acres), which forms the eastern city limits of Seattle, and Lake Sammamish (4,897 surface acres), approximately five miles directly east of Lake Washington. Many of the other lakes are small and located in mountainous country above 2,500 feet in elevation. Most of these are high alpine lakes of exceptional beauty, lying in a wilderness of scenic grandeur. Lowland lakes are rapidly being developed for residential and recreational use and water quality problems associated with these uses are demanding increasing attention.

Estuaries

Estuaries are the transitional zones where rivers meet the sea. The mixing of fresh and salt waters results in a unique, variable and delicate environmental system. Salt marshes, bays, channels and inshore waters are part of the estuarine zone which is of importance to fish, shellfish and wildlife. It is through this zone that young anadromous migrants adjust to the new marine environment. The adjustment is a critical period, and good quality water is a requirement to accomplish a successful transition.

A rich and varied ecosystem of aquatic, mud flat and marsh habitats is supported by the estuaries with adjacent lowlands often providing habitat for wildlife. Some estuarial areas in Puget Sound approach a natural state and are unique outdoor laboratories for study and research of the complex interactions of living organisms. A few, like the Duwamish, Snohomish and Puyallup have been encroached upon by the expansion of cities and the growth of industries.

Marine Waters

The waters confined within the boundaries of Puget Sound are actually a small portion of a larger marine complex that includes the Strait of Georgia and the Strait of Juan de Fuca. The entire complex is composed of many interconnected inlets, bays, and channels with sea water entering from the west and fresh water entering at many points throughout the system. This large complex may be divided into nine major oceanographic areas which are interrelated: Strait of Juan de Fuca, Admiralty Inlet, Puget Sound Basin, Southern Puget Sound, Hood Canal, Possession Sound, Bellingham Bay, San Juan Archipelago, and Georgia Strait.

Basically, the Puget Sound-Georgia Strait-Juan de Fuca Strait complex is a two-layer system with fresher water moving seaward in a surface layer that overrides a more saline layer of inflowing oceanic water. The surface layer contains fresh water added locally from direct precipitation, river runoff, and other land drainage. The deeper, more saline layer moves landward in response to the forces associated with the difference in density between fresh water and sea water.

The Puget Sound Basin extends from the south end of the Admiralty Inlet to the north end of the Tacoma Narrows and is 50 miles long, averaging 5 miles in width. There are several suboceanographic areas which include Elliott Bay, Commencement Bay, Colvos Passage, and the waters west of Bainbridge Island. Each of these sub-areas is closely related to the main basin but with somewhat different surface

characteristics. The major differences are due to the source and amount of fresh water entering the sub-area.

Southern Puget Sound consists of all the waters south of the Tacoma Narrows. Currents are very strong in the Narrows, with speeds up to 7 miles (6.08 knots) an hour being common. The Narrows is a mixing zone similar to Admiralty Inlet on a smaller scale. In this case, waters from either side to depths of about 160 feet are mixed, depending upon the tide direction. Complete top to bottom mixing occurs during most of the tide cycle.

Hood Canal is a long, narrow inlet extending some 70 miles from Admiralty Inlet on its northern end to Lynch Cove to the south. The major fresh water sources for Hood Canal are the Skokomish, Hamma Hamma, Duckabush, and the Dosewallips Rivers. They exhibit a peak discharge in winter in response to local rainfall, but the largest runoff usually occurs in June because of snow melting in the mountains. A rather thick (15 feet) fresh surface layer is produced that overlies the main body of water.

The marine waters and estuaries of the Puget Sound Area are discussed in detail in Appendix XIII, Water Quality Control.

LAND

There are 13,200 square miles of land within the 15,800 square-mile Puget Sound Area with striking contrasts in types of terrain. The lowlands contrast markedly with the mountains of the Olympic and Cascade Ranges, which form the Area's western and eastern borders. The southern border is a low divide that separates the Puget Sound Area from the Chehalis River Basin.

The lowland valleys, with their mountain valley extensions, contain most of the population, industry and agriculture. The valleys are separated by uplands whose gently rolling surfaces are altered segments of a formerly continuous plain. Terraces, lakes, and marshy depressions diversify the terrain on the uplands. In much of the Area there is an abrupt transition from these broad, hilly uplands to mountains.

PRESENT SITUATION

ECONOMY

As of 1967, the 2.0 million people in the Puget Sound Study Area comprised nearly two-thirds of the total population of the State of Washington. Of this, about 86 percent lived in and around the rapidly growing Everett-Seattle-Tacoma metropolitan complex located in the Snohomish, Cedar-Green and Puyallup Basins. The northern basins, including the Nooksack-Sumas, Skagit-Samish, San Juan and Whidbey-Camano, and the western basins, including the Nisqually-Deschutes, West Sound and Elwha-Dungeness, are generally rural in nature and accommodate the remaining 14 percent of the population.

Table 2-2 compares the growth of population in various areas for the period of 1910 through 1967.

TABLE 2-2. Historical population trends, United States, Washington and Puget Sound Economic Area 1910-1967 (thousands)

	1910	1940	1960	1967
United States	92,228	132,164	179,323	200,100
Washington	1,142	1,736	2,853	3,203
Puget Sound Economic Area	607	1,007	1,768	2,033
North Division	(87)	(107)	(144)	(156)
Central Division	(482)	(820)	(1,513)	(1,751)
West Division	(38)	(80)	(111)	(126)

Source: Appendix IV, Economic Environment.

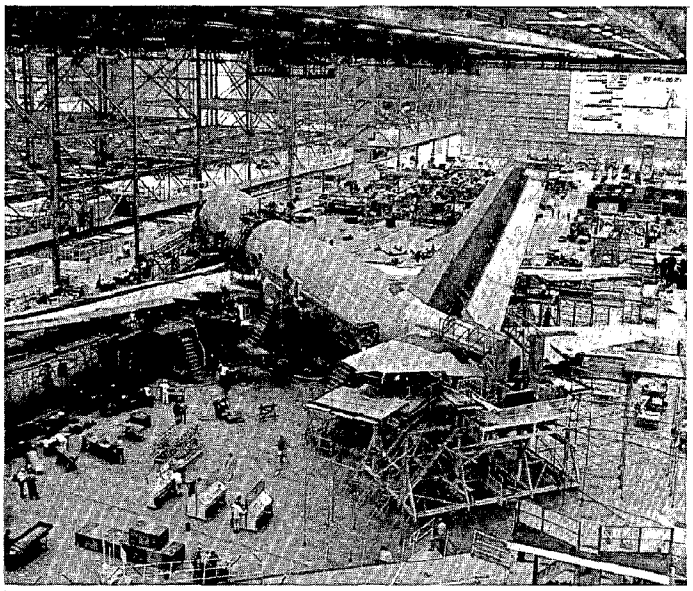


PHOTO 2-5. Production of Boeing 747 super transport jet airplane at Paine Field, near Everett. The aerospace industry has been a major contribution to the Area's economy with 95,000 persons employed by Boeing in the State of Washington in 1968. The Boeing Company Photo

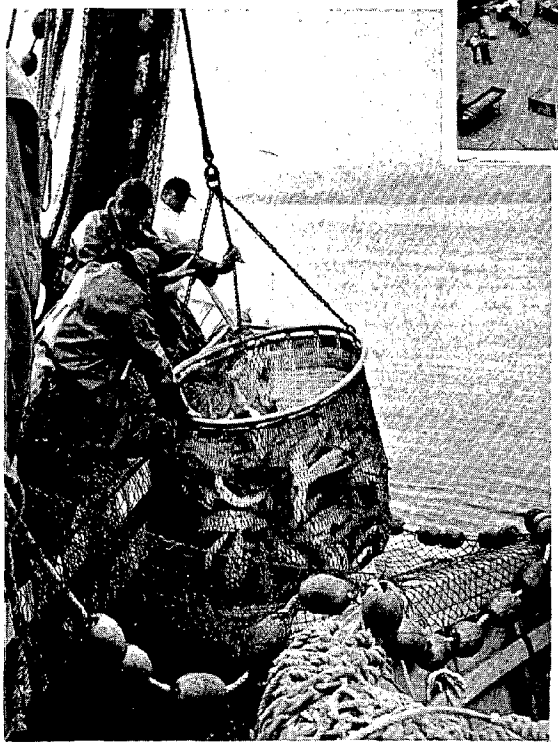


PHOTO 2-6. Sockeye salmon being bailed from net of purse seiner after successful set in Puget Sound. Approximately 250,000 sockeye salmon in 1969 returned to Cedar River via Lake Washington Ship Canal. Washington State Department of Fisheries Photo

PHOTO 2-7. Beef cattle grazing on improved clover-grass pasture in Sauk River Basin. The 1963 cattle and calf production in the Puget Sound Area was valued at in excess of $16,000,000. Soil Conservation Service Photo

The Puget Sound Economic Area, comprising all of the following counties, was divided into three divisions:

North Division	Central Division	West Division
Whatcom	Snohomish	Clallam
Skagit	King	Jefferson
Island	Kitsap	Mason
San Juan	Pierce	Thurston

This division was necessary to conform with availability of essential economic data. The difference in economic activity between the hydrologic area and the economic area is nominal due to the sparse population and large Federal land holdings in that portion of the economic area lying outside the hydrologic area.

The most intensive land use is concentrated in the Central Division, which includes the Seattle-Tacoma-Everett metropolitan and industrial areas, as well as numerous small cities and suburban residential developments that comprise approximately two-thirds of the total urban land. The Seattle-Tacoma-Everett metropolitan area functions as the major shipping, trading and manufacturing center in the Puget Sound Area and includes major seaports with some of the finest natural deep-water facilities in the world for ocean-going vessels. The Central Division supports a heavy industrial complex oriented toward aerospace, shipbuilding, trade, transportation, and diversified manufacturing. Defense facilities, such as Fort Lewis, McChord Air Force Base, and the military complex of the Bremerton Naval Shipyard are major sources of economic income to the Puget Sound Area.

In the West Division the waters of the Strait of Juan de Fuca support an abundance of marine-oriented recreation and fish and wildlife. Water-oriented commercial and recreational activities are important elements in the economy. Mountains, forests, lakes, and rivers are within a short distance for recreationists and tourists. As a result, trade and service industries are expanding in terms of employment, facilities and programs to meet the present and anticipated needs of outdoor recreation.

The North Division accounts for 30 percent of the Area's commercial forestland, most of which is in Skagit and Whatcom Counties, Agriculture, timber production, and fishing and related activities have long been important to the economy. Important factors in recent population growth may be attributed to the manufacture of food and kindred products, lumber, wood and chemical products, oil refining, and iron and steel manufacturing. Recreation, including boating, stream and lake fishing, and other water, forest and mountain activities are important activities.

In the six-year period (1960-1966) the average annual growth of employment of 3.7 percent made the Puget Sound Area one of the fastest growing areas in the United States. The national rate of growth during this period was 1.5 percent. The most significant upward trend was in the category of other durable manufacturing, which includes aerospace and shipbuilding. Table 2-3 shows employment in the Puget Sound Economic Area for 1960, 1963 and 1966 in 14 industrial sectors and by divisions.

TABLE 2-3. Employment by major industries, Puget Sound Economic Area and Divisions 1960, 1963 and 1966 (thousands)

	1960				1963				1966				Average Annual Increase	Central Division Percent of Total
	North	Central	West	Total	North	Central	West	Total	North	Central	West	Total		
Ag., For.,Fish., & Mining	7.3	15.3	2.4	25.0	7.1	14.0	2.6	23.7	7.0	12.3	2.7	22.0	-2.1	56
Construction	4.0	32.2	1.6	37.8	2.8	36.3	2.1	41.2	4.3	43.7	2.0	50.0	4.8	87
Food & Kindred	2.2	13.3	0.9	16.5	2.4	12.6	0.9	15.9	2.1	13.1	0.9	16.1	-0.4	81
Forest Products Ind.	3.3	20.3	7.3	30.9	3.2	19.9	5.9	29.0	3.4	21.1	7.6	32.2	0.7	66
Chemicals	0.0	2.2	0.1	2.3	0.0	22.2	0.1	2.3	0.2	2.2	0.1	2.4	0.7	92
Petroleum	1.2	0.2	0.0	1.4	1.0	0.2	0.0	1.2	0.9	0.2	0.0	1.2	-2.5	17
Stone, Clay & Glass	0.4	2.9	0.1	3.4	0.4	3.3	0.1	3.8	0.4	3.4	0.1	3.9	2.3	87
Primary Metals	0.0	3.8	0.0	3.8	0.0	4.1	0.0	4.1	0.4	4.8	0.0	5.2	5.4	92
Other Non-Durable	0.7	13.5	0.5	14.7	0.7	13.8	0.5	15.0	0.7	16.0	0.6	17.3	2.8	93
Other Durable	0.7	77.7	0.3	78.7	0.8	85.2	0.2	86.2	1.2	116.0	0.3	117.5	6.9	99
Trans. Comm. & Pub. Ut.	2.1	36.3	1.4	39.8	2.1	36.7	1.5	40.3	2.3	41.5	1.7	45.5	2.3	91
Trade	8.3	119.3	5.9	133.5	8.3	125.3	6.3	140.0	9.6	142.9	7.8	160.3	3.1	89
Service	8.6	115.9	6.1	130.6	8.4	128.3	7.3	144.0	9.3	149.9	8.0	167.2	4.2	90
Government	7.5	88.5	9.7	105.8	8.3	97.2	10.2	115.8	9.1	113.1	11.2	133.3	4.0	85
Total	46.5	541.0	36.3	623.9	45.6	578.5	38.8	663.1	51.1	680.3	43.2	774.5	3.7	88

Source: Appendix IV, Economic Environment.

Table 2-4 shows employment and sales of non-commodity industries in 1963.

TABLE 2-4. Employment and sales of non-commodity industries, Puget Sound Economic Area 1963 (1963 dollars)

Industry	Employment (1000's)	Output (millions of dollars)
Service[1]	144.0	$1,149.5
Wholesale & Retail Trade	140.0	1,250.3
Government	115.8	–
Construction	41.2	673.8
Transportation, Communication, & Public Utilities	40.2	615.6
Total	481.2	$3,689.2

[1] Includes finance, insurance, real estate, hotels, motels, etc.

Source: Exhibit D, Appendix IV, Economic Environment.

Following the national trend, growth in wholesale and retail trade was rapid with the utilization of consumer self-service and other labor saving devices. As a result, the volume of sales per employee increased greatly due to more efficient operating procedures. The service sector which includes restaurants, motels, finance, insurance and real estate, and other personal services has had a rapid growth due to increased personal incomes, growing population, and a rising demand for personal services.

Although recreation and tourism affect all types of industries, the service sector is the prime beneficiary. More people, higher incomes, an increase in leisure time, and greater mobility are among the pertinent reasons for growth. Outdoor recreation and tourism are particularly important to the Area. In 1959 almost six million out-of-state travelers had expenditures of almost one quarter billion dollars in the State of Washington. The 1962 Seattle World's Fair tourist expenditures were over $3 million. The unique combination of sea and mountains attracts many tourists and recreationists and provides for additional employment and sales.

Per capita income in the Puget Sound Economic Area was greater than the Pacific Northwest and the Nation in both the 1950-51 and 1960-61 periods. The Central Division held the lead over the Study Area, the Pacific Northwest, and the Nation in both the time periods. However, the North Division and the West Division had less per capita income when compared with the same major areas in the same time periods. Per capita income for the period 1960-61 was $2,526 for the Area compared to $2,227 for the Pacific Northwest and $2,249 for the United States. The per capita income for this same period was $1,941 for the North Division, $2,622 for the Central Division and $1,962 for the West Division.

The present economy has emerged from the age of discovery and settlement with abundant resources to a period requiring planned development along with management in order to properly use and conserve the resources of the Area. Foreseeable demands on all resources in the Area indicate a need for accelerated planning to properly coordinate land and water development.

WATER USE

The largest consumptive uses of water in the Puget Sound Area are for municipal and industrial purposes. Other water uses include diversion for irrigation, electric power generation, operation of fish hatcheries, recreation areas and forest product mills. The instream uses of water are important for fish, recreation, water quality and navigation.

The present municipal and industrial water use is approximately 660 million gallons of water per day. Nearly two-thirds of this consumption occurs in the Tacoma, Seattle, and Everett metropolitan areas. Although surface sources supply 85 percent of the municipal and industrial use, ground water is an important source in many basins.

The municipal use averages 220 million gallons daily or approximately 135 gallons per capita per day. Industrial water use averages about 430 mgd which represents about 65 percent of the total used by municipal and industrial consumers. Of this amount, about 95 percent is supplied from surface water sources.

Table 2-5 summarizes the present municipal and industrial water use.

A relatively small portion of the Area (about 91,700 acres) is presently irrigated. Due to the moist climate, irrigation is primarily used to prevent crop failure and to maintain plant growth rather than to produce optimum yields. The amount of water diverted for irrigating the 91,700 acres is estimated to

TABLE 2-5. Summary of Puget Sound Area Water uses (1965)

Basin and use	Surface Water: Estimated population served	Surface Water: Usage (mgd) Average daily	Surface Water: Usage (mgd) Maximum monthly	Ground Water: Estimated population served	Ground Water: Usage (mgd) Average daily	Ground Water: Usage (mgd) Maximum monthly	Total: Estimated population served	Total: Usage (mgd) Average daily	Total: Usage (mgd) Maximum monthly
Municipal	1,356,550	165	231	467,000	53	151	1,823,550	219	382
Rural Individual	14,450	1	1	134,700	8	12	149,150	9	13
Industrial	---	408	455	---	24	31	---	432	486
Total	1,371,000	575	687	601,700	85	194	1,972,700	660	881

Source: Appendix VI, Municipal and Industrial Water Supply.

be about 228,000 acre-feet annually of which 83,000 acre-feet or 33 percent is obtained from ground water sources.

The natural deep water channels of Puget Sound permit any size vessel to enter from the Pacific Ocean to the many ports located in the Area. This, plus the strategic location of the Sound with respect to Alaska and the Orient, has made waterborne commerce of major importance. Puget Sound is one of the few natural areas in the Nation which has the channel and port depths to handle the super-ships beginning to ply the waterways of the world. Nearly every river in the Area is by definition, navigable. However, only the lower sections, generally within the tidal range, are actually used for navigation. Total foreign and domestic coastwise and domestic internal waterborne commerce was about 40 million tons in 1966 with the annual growth from 1952 and 1966 averaging about 2.5 percent.

The rivers in the Puget Sound Area have been a source for obtaining electric energy since a small water power plant was placed in operation on a small unnamed stream at Tacoma in 1886. A total of 1.25 million kilowatts of capacity are presently installed in the Puget Sound Area in 22 hydroelectric power developments. The water diversions for the hydroelectric power plants range from 5 cfs for the smallest plant to 9,500 cfs for the largest.

There are several thermal-electric steam plants in the Puget Sound Area. These are located on Lake Union and Lake Washington, the Duwamish River, and directly on Puget Sound.

Local sources of power are inadequate to supply the present power demand and two-thirds of the peak demand is supplied from outside sources, primarily the Columbia River.

The physical features of the Puget Sound Area with its high mountain lakes, numerous rivers and streams and marine waterways make it an important water related recreation area. Pleasure boating opportunities in the San Juan Islands and the numerous marine waters of Puget Sound are outstanding. Swimming and water skiing are popular activities often associated with camping or picnicking.

The waters of Puget Sound are rich in nutrients and support a wide variety of marine fish and shellfish species. Many of the fish that reside or migrate through Puget Sound waters are of significant value to sport and commercial fishermen. An estimated 2,820 miles of stream throughout the Area are utilized by anadromous fish for spawning and rearing.

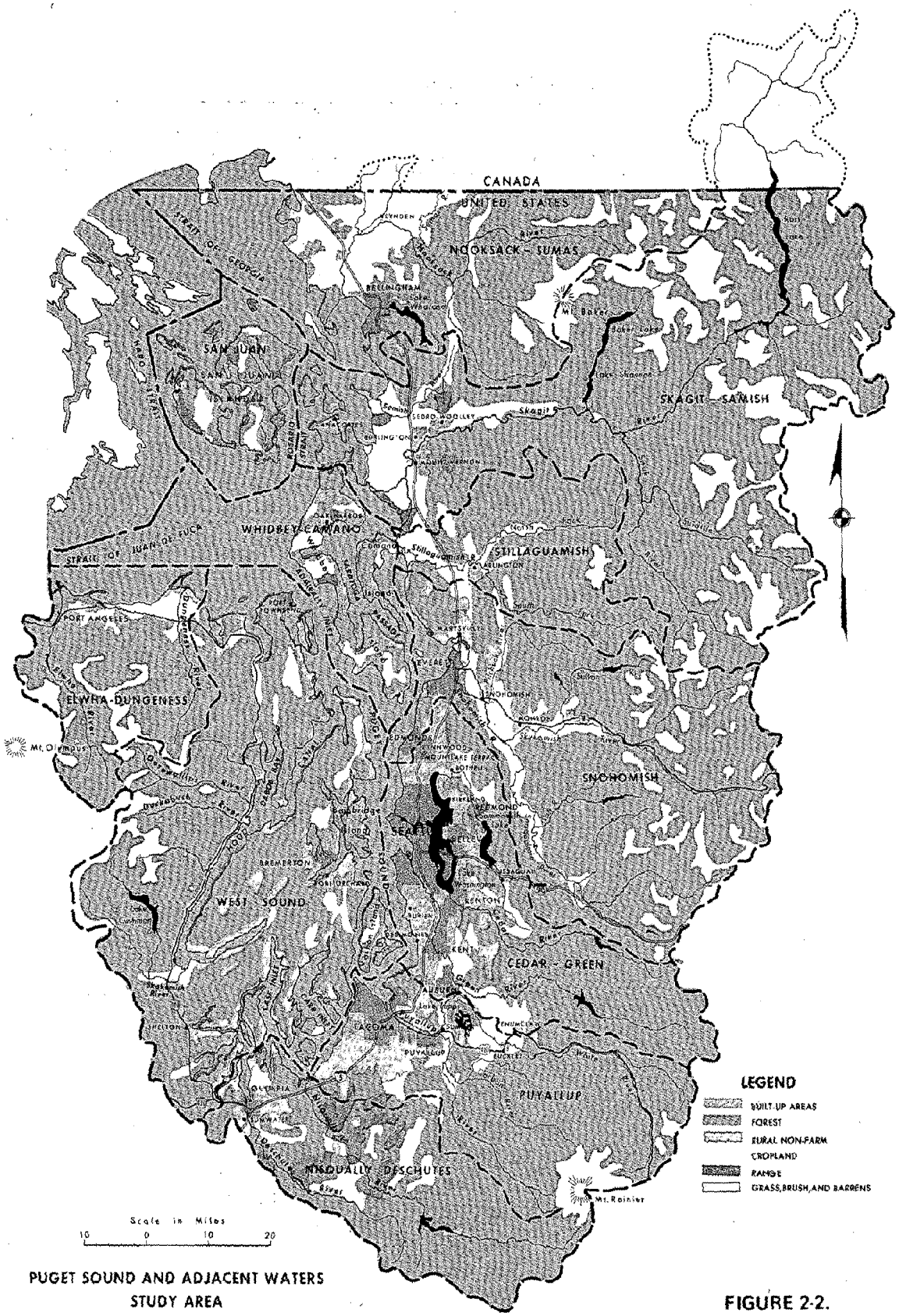
The anadromous fish of the Area include chinook, coho, sockeye, pink and chum salmon, and steelhead, searun cutthroat trout, and searun Dolly Varden. All of these fish spend a portion of their lives in the marine waters of Puget Sound and the Pacific Ocean before returning to streams of origin to spawn. The juveniles of these fish spend varying amounts of time in the estuarine waters of the Sound before moving to sea to grow to maturity.

In spite of the fact the Green and Puyallup Rivers are in the most heavily populated areas these streams and the Skagit and Stillaguamish are the most heavily fished for salmon and steelhead. Many of the lakes, ponds and reservoirs support resident fish as well as wildlife, including waterfowl.

An urgent need exists for additional hydrologic information to facilitate management of the Area's water resources. Appendix III, Hydrology and Natural Environment outlines the specific requirements for additional data gathering.

LAND USE

General land use is shown in Table 2-6 and Figure 2-2. Ownerships are shown in Table 2-7.



PUGET SOUND AND ADJACENT WATERS STUDY AREA

FIGURE 2-2.

Generalized Land Use

TABLE 2-6. Land use, Puget Sound Area 1967 (in acres)

Basin	Cropland	Rangeland	Forest Land[1]	Rural Non-Agricultural	Built-Up Areas	Fresh Water	Total Area Land and Fresh Water
Nooksack-Sumas	137,492	11,600	609,581	12,669	20,896	12,129	804,367
Skagit-Samish	100,465	19,748	1,753,445	20,092	18,804	35,409	1,947,963
Stillaguamish	34,531	1,016	385,450	5,932	6,698	4,721	438,348
Snohomish	71,752	2,424	1,054,699	29,360	36,355	23,861	1,218,451
Cedar	20,279	1,120	210,641	25,379	106,516	32,888	396,823
Green	33,103	2,232	236,047	8,966	59,885	5,950	346,183
Puyallup	36,853	5,683	593,339	25,729	97,446	11,297	770,347
Nisqually	29,254	34,008	379,675	6,368	5,481	7,468	462,254
Deschutes	16,248	9,480	127,123	13,541	14,416	2,597	183,405
San Juan	18,594	9,129	71,958	9,118	2,774	955	112,528
Whidbey-Camano	23,006	2,454	84,069	12,419	10,987	719	133,654
West Sound	46,215	5,137	1,123,666	64,208	42,161	12,606	1,293,993
Elwha-Dungeness	23,721	2,417	409,491	5,073	5,911	1,844	448,457
Puget Sound Area	591,513	106,448	7,039,184	238,854	428,330	152,444	8,556,773

[1] Includes open and barren land normally associated with forest areas.

Source: Appendix V, Water-Related Land Resources.

TABLE 2-7. Land ownership, Puget Sound Area (in percent of total area)

Basin	Public					Private
	Federal	State[1]	County	Municipal	All Public	
Nooksack-Sumas	34.3	10.7	0.3	0.6	45.9	54.1
Skagit-Samish	71.2	5.5	0.1	0.3	77.1	22.9
Stillaguamish	40.2	16.4	0.2	0.3	57.1	43.0
Whidbey-Camano	6.1	4.3	0.5	0.1	11.0	89.0
Snohomish	35.4	11.7	0.1	4.5	51.7	48.3
Cedar-Green	10.3	3.3	0.2	15.6	29.4	70.6
Puyallup	39.4	2.5	0.1	1.6	43.6	56.4
Nisqually-Deschutes	20.7	9.8	0.2	0.6	31.3	68.7
West Sound	28.5	9.4	0.1	1.4	39.4	60.6
Elwha-Dungeness	75.3	6.1	0.1	0.4	81.9	18.1
San Juan	1.1	8.3	0.8	0.0	10.2	89.8
Puget Sound Area	40.8	7.9	0.2	2.6	51.5	48.5

[1] Figures include country trust land administered by the State of Washington.

Source: Appendix V, Water-Related Land Resources.

Forests currently cover some 7.0 million acres, or about 80 percent of the total area. The Skagit-Samish, Snohomish and West Sound Basins contain the largest acreage of forest with about 55 percent of the Area's total. Forest land classification shows 13 percent of the acreage in noncommercial forest, 9 percent held in reserved status in parks, wilderness, or like units, and 78 percent in commercial forest land capable of and available for the production of forest products.

Cropland makes up 591,500 acres, or about 7 percent of the total area. Agriculture is largely confined to the fertile lowland and inland valley areas which are utilized for fruit, berry and vegetable growing, and for dairying and poultry raising operations. The basins containing the most intensive agricultural development include the Nooksack-Sumas, Skagit-Samish, and Snohomish, Cedar-Green, Puyallup and Elwha-Dungeness Basins.

Urban, industrial and other intensively developed land approximate eight percent of the Area, covering about 667,000 acres. This includes 239,000 acres of rural nonagricultural lands and 428,000 in built-up areas. Intensive development has occurred in the lowlands adjacent to Puget Sound and along the established transportation routes within the Area. Heavy industry is concentrated along the shorelines of bays and estuaries, particularly Commencement and Elliott Bays, Possession Sound, and the lower reaches of the Duwamish River. Other intensive development is occurring around the periphery of the established metropolitan areas, particularly in the lower reaches of the Snohomish, Cedar, Green and Puyallup River valleys. In many instances, such development has occurred on high value agricultural land in these basins.

The remaining acreage is made up of fresh water surface, rangeland, open and barren lands, and land not otherwise classified.

The overall ownership of land in the Puget Sound Area is almost evenly divided between public and private owners, ranging from extremes of 82 percent public in the Elwha-Dungeness Basins to 90 percent private in the San Juan Islands. Most public land is located in the mountainous areas under Federal jurisdiction, composed mainly of the national forests and national parks. Other significant blocks of public land include State ownerships in the Nooksack-Sumas, Stillaguamish and Snohomish Basins, and the city of Seattle ownership in the Cedar-Green Basins.

PROJECTED ECONOMY

Projections of the economy for the Puget Sound Area for the years 1980, 2000 and 2020 are detailed in Appendix IV, Economic Environment. The findings of this appendix form the basis for projecting the needs for water and related land resources. The major elements of these projections are summarized in the following paragraphs.

Population in the Puget Sound Area is projected to be 2.7 million persons by 1980 and 6.8 million by the year 2020 (See Figure 2-3). Population growth is expected to be greatest in the Seattle-Tacoma-Everett metropolitan complex. Table 2-8 shows the population projection for each of the eleven major basins of the Puget Sound Area.

The greatest population growth is projected to occur in the Cedar-Green, Puyallup, Snohomish and West Sound Basins. By 1980, these four basins are expected to have some 2.4 million people and account for 88 percent of the total population. Present trends point to a continued concentration of population in these basins, with over five million people expected by 2020.

Table 2-9 shows the Gross Regional Product and Employment projections by industry. Employment by 1980 is projected to approach one million jobs, with the Gross Regional Product almost doubling to 11.4 billion dollars (1963 dollars). Gross Regional Product per person is expected to increase some 34 percent over the 17-year period.

The large water-using industries (Food and kindred products, paper and allied products, chemical and petroleum, primary metals, stone, clay and glass, and lumber and wood products) are expected to experience substantial growth. Production for the major water-using industries is expected to realize an 82 percent increase from 1965 to 1980 in terms of value added. Food and kindred products, paper, and

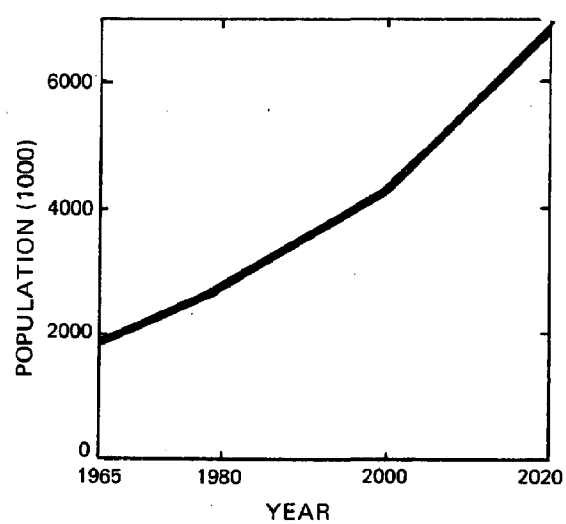


FIGURE 2-3. Projected population growth for the Puget Sound Area.

Source: Appendix IV, Economic Environment.

TABLE 2-8. Population projections by basins, Puget Sound Area (in thousands)

Basin	1963	1980	2000	2020
Nooksack-Sumas	74.6	91.6	123.5	168.7
Skagit-Samish	53.8	64.2	86.5	118.2
Stillaguamish	17.6	30.2	48.5	77.8
Whidbey-Camano Islands	19.9	56.0	80.9	115.0
Snohomish	178.2	297.8	467.8	761.4
Cedar-Green	976.9	1,454.8	2,270.0	3,619.9
Puyallup	324.5	449.8	700.0	1,107.5
Nisqually-Deschutes	69.6	74.9	104.5	146.5
West Sound	124.2	175.0	374.1	632.7
Elwha-Dungeness	28.3	29.8	41.0	56.6
San Juan Islands	2.6	2.8	3.7	5.1
Puget Sound Area	1,870.0	2,726.9	4,300.5	6,809.4

Source: Appendix IV, Economic Environment and Appendix V, Water-Related Land Resources.

allied and primary metals are projected to lead this growth. Relatively large increases also are projected for the chemicals and petroleum industries. On the declining growth side is the lumber and wood products industry.

Recreation and tourism are major industries. By 1980, over 109 million recreation days are forecast for the Puget Sound Area. Water-related activities are expected to account for over 45 percent of this total outdoor recreation demand in 1980. The most intensive demand for recreation is expected to occur in the Cedar-Green, Snohomish, West Sound, and Puyallup Basins. These four basins are projected to account for about 63 percent of the total outdoor recreation demand estimated for 1980.

TABLE 2-9. Present and projected output, value added, employment by industry and population, Puget Sound Area

Industry	1963			1980			2000			2020		
	Output[1]	Value Added[2]	Employment	Output[1]	Value Added[2]	Employment	Output[1]	Value Added[2]	Employment	Output[1]	Value Added[2]	Employment
	Millions of 1963 $			Millions of 1963 $			Millions of 1963 $			Millions of 1963 $		
Agri., Fish., For., Mining	196.7	99.5	23,700	261.1	139.0	18,200	360.0	190.0	13,500	516.0	268.0	11,000
Food & Kindred Prods.	698.5	223.3	15,900	1,240.9	405.3	19,500	2,333.4	900.2	22,900	4,088.7	1,906.6	25,600
Lumber & Wood Prods.	413.7	174.6	19,700	371.3	154.6	8,300	305.5	146.0	2,800	234.2	136.0	900
			(21,500)			(17,000)			(14,700)			(12,600)
Paper & Allied Prods.	349.2	168.1	9,400	683.1	334.9	14,700	1,009.4	561.0	15,900	1,101.5	705.1	12,400
			(9,800)			(10,300)			(10,900)			(9,300)
Chemicals	70.4	33.9	2,300	138.6	68.4	1,900	287.0	170.4	1,400	553.7	420.2	1,000
Petroleum Refining	255.9	61.5	1,200	511.8	123.0	1,300	1,080.2	301.4	1,400	2,124.7	729.1	1,300
Stone, Clay, Glass	92.4	37.9	3,800	172.5	71.1	5,000	337.1	161.2	6,500	614.0	361.1	8,000
Primary Metals	118.8	53.6	4,100	518.6	216.7	7,300	885.3	392.1	8,700	1,408.5	699.8	9,900
Other Non-Durable Mfgrs.	168.7	92.0	15,100	344.3	187.6	19,700	740.8	468.6	25,200	1,485.6	1,555.8	30,900
Other Durable Mfgrs.	1,816.9	959.6	86,200	5,460.7	2,408.6	175,700	18,707.1	7,707.4	380,700	58,086.5	24,349.1	787,400
Transportation	615.6	461.1	40,200	1,192.8	894.6	36,200	2,422.7	1,990.8	29,700	4,585.6	4,373.5	23,300
Wholesale & Retail Trade	1,250.3	1,011.3	140,000	2,269.4	1,835.4	202,600	4,267.4	4,006.3	292,300	7,477.7	8,634.1	402,400
Services	1,149.5	842.2	144,000	2,185.9	1,604.5	230,100	4,356.0	3,711.8	388,800	8,088.8	8,477.0	627,300
Construction	673.8	277.0	41,200	1,359.7	558.8	54,500	2,869.9	1,395.9	70,500	5,644.7	3,442.6	87,200
Government	---	734.0	115,800	---	1,565.1	178,100	---	4,140.9	275,100	---	10,816.5	405,800
Consumption	---	600.8	---	---	790.8	---	---	1,191.6	---	---	1,773.0	---
Total	$7,869.4	$5,830.4	662,600	$16,710.7	$11,358.4	973,100	$39,961.8	$27,435.6	1,535,400	$96,010.2	$68,247.5	2,434,500

[1] Output is equivalent to sales, except for those industries where "margin" entries are used. "Margin" represents "mark-up" costs as in case wholesale retail trade.

[2] Value added: A firm's sales less the purchase of goods and services from other firms. It is equivalent to the firm's contribution to gross regional product.

[3] Data in parenthesis is new data made available after the input-output study was completed.

Note: Figures may not add to totals due to rounding.
Source: Appendix IV, Economic Environment.

Future declines in the amount of farmland will be associated with urban-population growth and industrial expansion. Farming is expected to have its greatest decline in the Central Division as land is converted to more intensive use. The Northern Division is expected to contain the major share of farmland.

The total value of crop and livestock production is projected to increase due to improved agricultural technology from $128 million in 1963 to $165 million in 1980 and to $274 million by 2020.

In terms of percentages, the Northern Division is projected to show the largest increase in economic activity through 1980. Aluminum, petroleum refining, and education industries are expected to lead the way, especially in the Nooksack-Sumas Basins and Skagit-Samish Basins. The pulp and paper industry and the wood products industry also are expected to expand. As most of these industries require water access, development of additional deep-water port facilities is expected. Recreation and tourism are expected to provide economic stimuli to the San Juan and Whidbey-Camano Islands.

The present economic pattern in the Central Division is expected to continue, with the growth industries in the Cedar-Green, Snohomish, and Puyallup Basins, being transportation equipment, real estate, and services. However, noticeable declines in lumber and wood products economic activity is expected.

In the Western Division the forest products industries, particularly pulp and paper are expected to be high growth industries. In both areas, West Sound Basins and the Elwha-Dungeness Basins, tourism and recreation will continue to expand.

Future population and economic growth is expected to be the greatest in and adjacent to the existing urban centers with the basins. The greatest population changes are projected to occur in the Snohomish, Cedar-Green, and Puyallup Basins.

PROJECTED LAND USE

Future land use in the Puget Sound Area has been projected on the basis of five major land use categories. Alternative projections for cropland, rangeland, forest land, rural nonagricultural land and intensive or built-up lands were made, utilizing different population densities and other spatial distribution factors. The following alternatives were considered:

Pattern A.—Increase of population density to an average of 7.0 persons per acre in urban areas in 2020.

Pattern B.—Increase of population density to an average of 10.4 persons per acre in urban areas in 2020.

Pattern C_1—Increase of population density to an average of 6.7 persons per acre in urban areas in 2020 with cross sound bridges.

Pattern C_2—Increase of population density to an average of 9.9 persons per acre in urban areas in 2020 with cross sound bridges.

Each of the above alternatives imposes a different intensive land use requirement, particularly for the basins within the Central Division. Generally, there are adequate lands for all uses, yet the compatibility of uses requires good planning and adequate developmental control. Intensive land uses will continue to expand outward from the various urban and community centers and will continue to infringe upon existing agriculture and forest lands. Lands suitable for cropland are in short supply and must be protected from unplanned urban scatter if agriculture is to remain an important element in the economy. Selective processes for the development of intensive uses must be more critical than they have in the past if urban development is to be properly located, and not to the detriment of the other major uses. Recreational and industrial uses must be dealt with on an equal planning basis, especially those requiring waterfront locations with joint land use considered where possible.

Pattern A would result in intensive land use displacing 527,100 acres of forest (231,000), rural non-farm (142,600), crop (142,900) and range (10,600) lands as compared to only 225,400 acres of displacement by Pattern B. Patterns C_1 (588,400 acres displacement) and C_2 (264,100 acres displacement) are adaptations of Patterns A and B, respectively, with the advent of a cross-sound bridge and a bridge between the mainland and Whidbey Island. Only land use Patterns B and C_2 would satisfy the land needs for all uses to the year 2020 and result in about fifty percent less displacement of open space and green belt areas than Patterns A and C_1. Patterns

B and C_2 would also result in lower costs for the development of land to intensive uses, which then would result in a direct savings to the residents of the Area, or provide the possibilities of freeing more monies for amenities to improve the Area's living environment.

Land use Pattern C_2 was adopted for this study as the most reasonable means of satisfying the Area's land use requirements. The development of cross-sound bridges expands the current development pattern into the Kitsap Peninsula and island areas, and conforms with current State transportation concepts. An expanded ferry system, as an alternative, could perhaps accomplish the same result at some crossings. Additional details concerning this and the other land use patterns are in Appendix V, Water-Related Land Resources. A summary of intensive land use is given in Table 2-10 and a summary of projected land use is given in Table 2-11. The C_2 generalized land use pattern is shown in Figure 2-4.

TABLE 2-10. Intensive land use development in the year 2020, land use pattern C_2

	Present		2020		Acres of Land Displaced by Intensive use by Type					
Basins	Acres[1]	Density	Acres[1]	Density[2]	Forest	Rural Non-Farm	Crop land	Rangeland	Totals	Population 2020[1] (in 000's)
Nooksack-Sumas	20,900	3.6	29,800	5.7	5,000	600	3,300	0	8,900	168.7
Skagit-Samish	18,800	2.8	23,600	5.0	1,600	300	2,800	100	4,600	118.2
Stillaguamish	6,700	2.4	12,700	6.1	4,200	600	900	300	6,000	77.8
Snohomish	36,300	4.9	84,000	9.1	20,800	18,900	8,000	0	47,700	761.4[3]
Cedar-Green	166,400	5.85	222,900	16.2	25,300	13,100	17,600	500	56,500	3,619.9[3]
Puyallup	97,400	3.33	138,200	8.0	17,300	19,800	3,200	500	40,800	1,107.5[3]
Nisqually-Deschutes	19,900	3.0	23,500	6.2	1,000	2,200	200	200	3,600	146.5
West Sound	42,200	2.90	100,300	6.3	25,900	27,900	4,000	300	58,100	632.7[3]
Elwha-Dungeness	5,900	3.3	10,800	5.2	2,800	900	900	300	4,900	56.6
Whidbey-Camano	11,000	1.8	43,000	2.7	20,000	9,500	2,000	500	32,000	115.0[3]
San Juan	2,800	0.94	3,600	1.4	100	700	0	0	800	5.1
TOTAL	428,300	4.35	692,400	9.9	124,000	94,500	42,900	2,700	264,100	6,809.4

[1] Figures rounded to the nearest hundred.

[2] Persons per intensive land use acre.

[3] Population projections adjusted to meet a population shift with the advent of bridges being contructed between the mainland and the peninsula and between Whidbey Island and the mainland.

Source: Appendix V, Water-Related Land Resources.

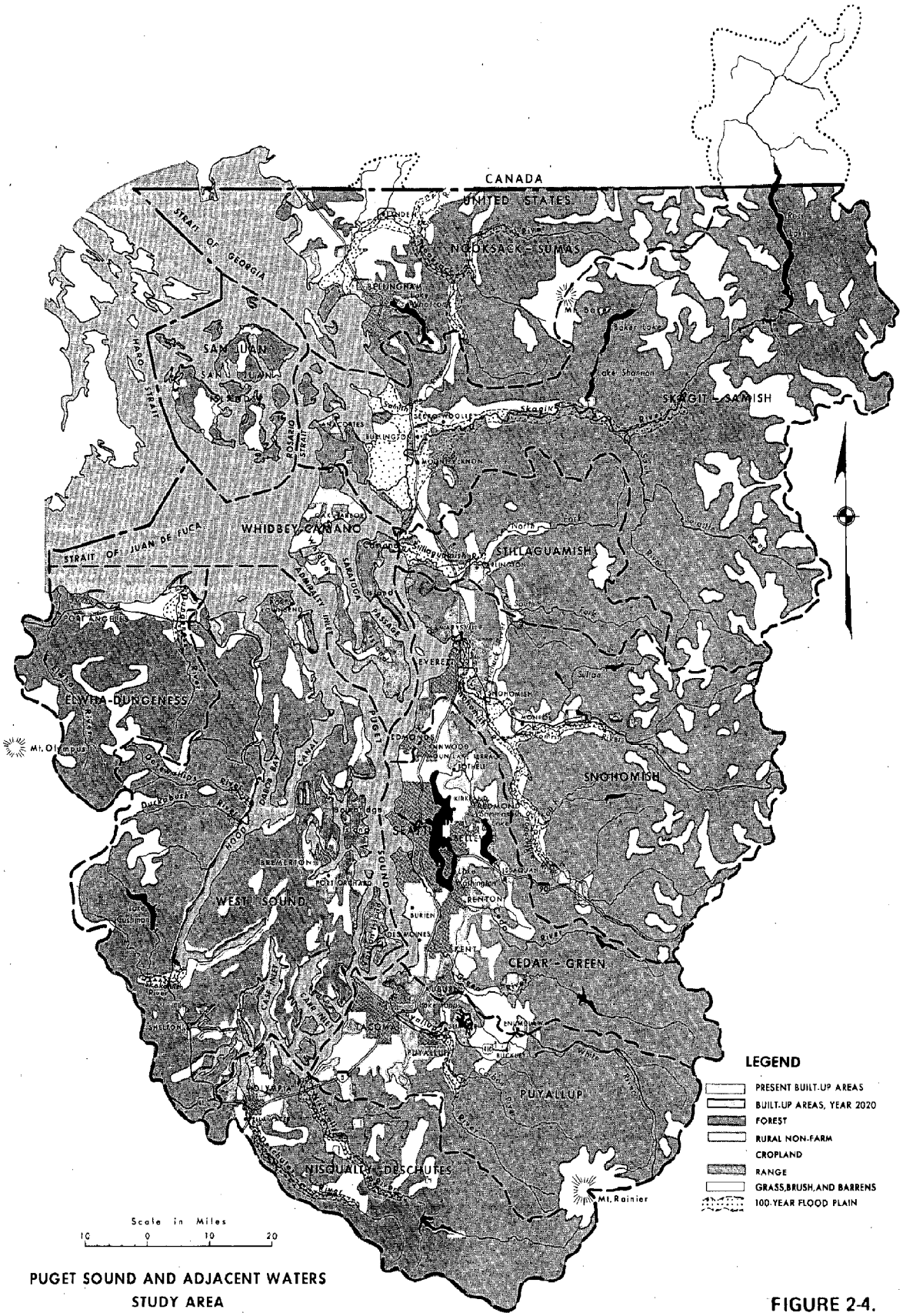
TABLE 2-11. Projected land use in the Puget Sound Area usage 2020 land use pattern C_2 (acres) [2]

Basin	Cropland	Rangeland	Forest Land[1]	Rural non-Agricultural Land	Intensive or Built-up Land	Fresh Water	Totals
Nooksack-Sumas	134,200	11,600	604,600	12,100	29,800	12,100	804,400
Skagit-Samish	97,700	19,700	1,751,800	19,800	23,600	35,400	1,948,000
Stillaguamish	33,600	700	381,300	5,300	12,700	4,700	438,300
Whidbey-Camano	21,000	2,000	64,100	2,900	43,000	700	133,700
Snohomish	63,800	2,400	1,033,900	10,400	84,000	23,900	1,218,400
Cedar-Green	35,800	2,900	421,400	21,200	222,900	38,800	743,000
Puyallup	33,700	5,200	576,000	5,900	138,200	11,300	770,300
Nisqually-Deschutes	45,300	43,300	505,800	17,700	23,500	10,100	645,700
West Sound	42,200	4,800	1,097,800	36,300	100,300	12,600	1,294,000
Elwha-Dungeness	22,800	2,100	406,700	4,200	10,800	1,800	448,500
San Juan	18,600	9,100	71,800	8,400	3,600	1,000	112,500
Total	548,600	103,800	6,915,200	144,400	692,400	152,400	8,556,800

[1] Figures include open and barren lands normally associated with forest areas.

[2] Figures rounded to the nearest hundred.

Source: Appendix V, Water-Related Land Resources.

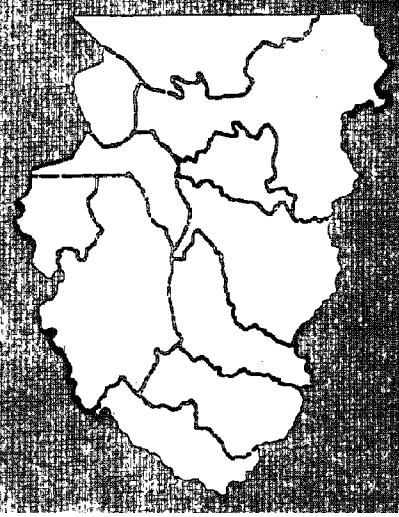


PUGET SOUND AND ADJACENT WATERS STUDY AREA

FIGURE 2-4.

Generalized Land Use
Alternative C2 –2020

Part Three
Water and Related Land Resource Needs



The single-purpose needs were developed in Appendices V through XIV. This section summarizes the results of the studies for the Area showing needs projected for each feature at the various time levels. The present status of each feature is also summarized to provide a brief introduction to the functional concept and describe current resource use.

MUNICIPAL AND INDUSTRIAL WATER SUPPLY

General

Municipal and industrial water is supplied through diversion and distribution of surface waters or through the development of ground water by numerous separate entities. Many of the industrial water supplies are provided by adjacent municipal systems. Some industries obtain water from independent surface or ground water sources as do many smaller communities and districts.

Surface waters are the sources of supply for major urban centers. Ground water sources, in addition to generally supplying outlying areas, also provide needed quantities during periods of turbidity in surface water sources.

Present and Future Needs

The future water needs are based on projected urban and industrial growth demands within each

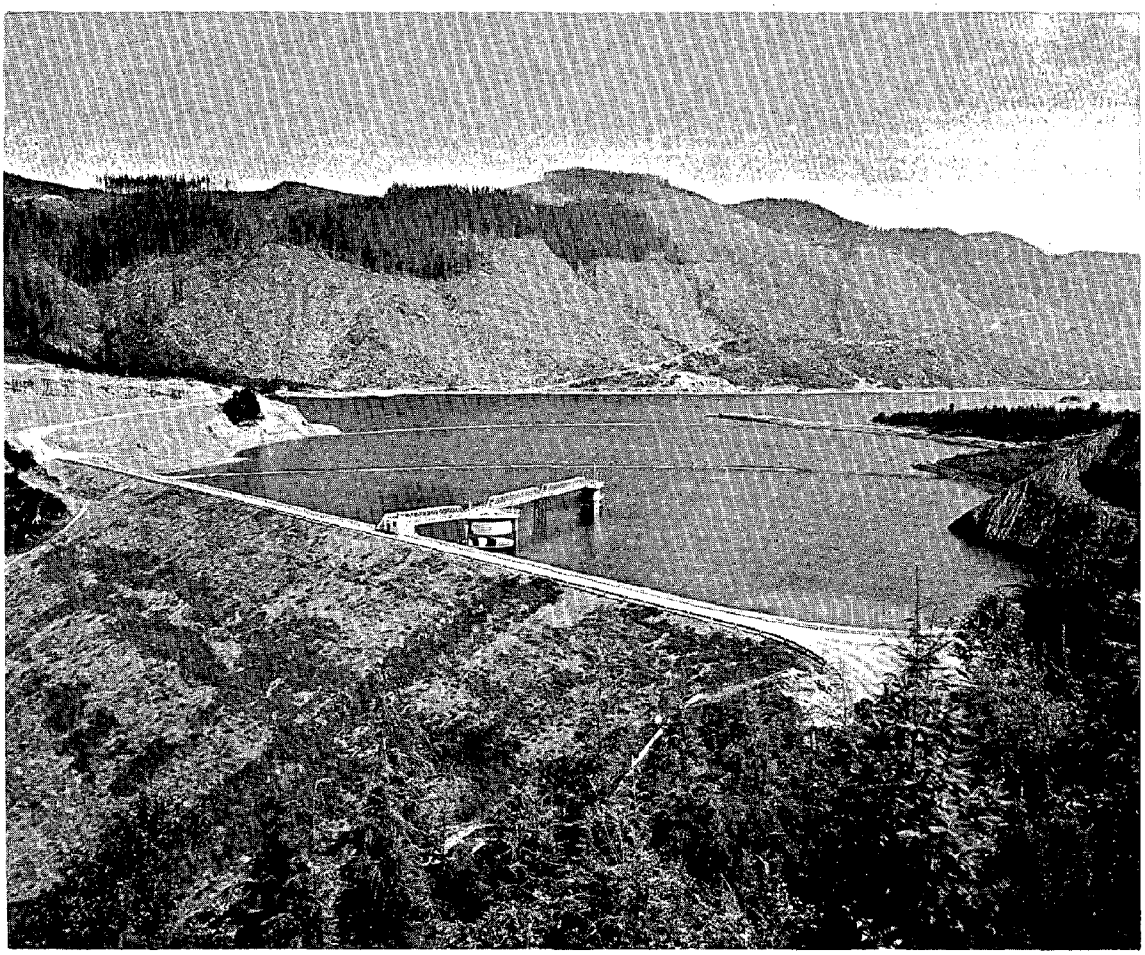


PHOTO 3-1. City of Seattle municipal and industrial water supply reservoir, South Fork of Tolt River. The Tolt is one of two surface water sources that the Seattle Water Department uses to supply approximately 120 million gallons per day to its service area. The other source is the Cedar River which the city has used since before 1900. Seattle Water Department Photo

basin. Certain areas have insufficient ground water supplies, and other areas have inadequate distribution and transmission facilities to meet private, municipal and industrial growth demands. Consolidation of servicing groups, updating systems, development of new storage and regional distribution systems, and use of water treatment plants is desirable.

The total Puget Sound Area municipal, industrial, and rural-individual water use for 1965 was estimated to average about 660 million gallons per day (mgd), or some 738,000 acre-feet per year. Projected annual water needs for 1980, 2000, and 2020 are estimated to be 1,278, 2,023, and 3,159 mgd, respectively. The projected needs are tabulated, by individual basins, in Table 3-1.

The design of new, or expansion of existing distribution facilities to meet the projected average annual needs should incorporate the increased delivery capacities necessary to meet desired state ratings for health, fire protection and other peak demands.

A detailed discussion of municipal and industrial water supply is contained in Appendix VI, Municipal and Industrial Water Supply.

TABLE 3-1. Municipal and industrial water supply, average annual present use and projected needs, Puget Sound Area

	1965 Use		1980		2000		2020	
Basin	MGD	1000 Ac.Ft.	MGD	1000 Ac.Ft.	MGD	1000 Ac.Ft.	MGD	1000 Ac.Ft.
Nooksack-Sumas	73	82	156	175	212	237	293	328
Skagit-Samish	28	31	49	55	77	87	116	130
Stillaguamish	2	2	5	5	9	10	17	19
Snohomish	165	185	266	298	419	470	540	605
Cedar-Green	165	185	354	396	584	654	1,122	1,257
Puyallup	100	112	186	208	329	368	547	613
Nisqually-Deschutes	8	9	16	18	25	27	41	46
West Sound	49	55	93	104	139	155	182	204
Elwha-Dungeness	64	72	140	156	209	235	271	303
San Juan Islands	0.6	0.7	0.6	0.7	0.8	0.9	1.2	1.3
Whidbey-Camano Is.	4	4	12	13	19	22	29	33
Totals-Area	658.6	737.7	1,277.6	1,438.7	2,022.8	2,265.9	3,159.2	3,539.3

Source: Appendix VI, Municipal and Industrial Water Supply.

IRRIGATION

General

Since 1945, irrigation in the Puget Sound Area has shown marked growth. Land classification surveys from 1963 to 1966 indicated that there were about 91,700 acres irrigated in the Area, as compared to 6,100 in 1919 and 10,300 in 1945.

The relatively uniform marine climate of the Puget Sound Area is suitable for growth of a variety of crops. Due to the moist climate, irrigation is primarily used to prevent crop failure and to maintain plant growth rather than to produce optimum yields.

Irrigated lands are generally in scattered small areas interspersed with larger areas of non-irrigated land. The suitability for irrigation is determined by soil characteristics, drainage, availability of water, and the type of system desired by the farm operator. There are abundant ground water and surface water sources in the Puget Sound Area, but in combining all of the factors involved there has not been widespread development of large tracts for irrigation. Most of the lands presently irrigated have been developed through private means.

Present and Future Needs

Arable lands in the Puget Sound Area total 516,000 acres, of which 91,700 are presently irrigated and 424,300 are potentially irrigable. Most of the potentially irrigable lands are located on the flood plains of the rivers which flow into Puget Sound and on the intermediate terraces and upland glacial hills

along the river valleys. Irrigated cropland needed by 2020, on the basis of development of land in the Area to retain the projected share of national production is 396,000 acres. However, the encroachment of the urban and suburban population and industrial sector onto the irrigable lands limits the number of acres which actually would be capable of sustaining economical irrigation in the year 2020. Projections based upon estimated needs for food and fiber, location and extent of potentially irrigable lands, and availability of adequate water supplies indicate that irrigated lands in the Puget Sound Area will amount to 138,100 acres in 1980, 185,600 acres in 2000 and 223,100 in 2020. The projected acreages to be irrigated are summarized for the Area in Table 3-2 and the corresponding irrigation water needs (from both surface and ground water sources) are shown in Table 3-3.

A complete discussion of irrigation including potentials and projections is contained in Appendix VII, Irrigation.

PHOTO 3-2. Irrigation through use of sprinkler systems enhances crop growth in the Puyallup River Basin. Bureau of Reclamation Photo

TABLE 3-2. Present and projected irrigation, Puget Sound Area

Basin	Present (acres)	1980 (acres)	2000 (acres)	2020 (acres)
Nooksack-Sumas	38,400	58,400	78,400	78,400
Skagit-Samish	6,200	16,200	26,200	51,200
Stillaguamish	2,500	6,500	10,500	10,500
Whidbey-Camano Islands	2,700	2,700	2,700	2,700
Snohomish	12,800	14,800	18,700	20,000
Cedar-Green	2,600	1,800	900	1,100
Puyallup	3,700	6,200	11,200	13,700
Nisqually-Deschutes	5,600	7,800	12,800	20,800
West Sound	1,200	1,600	2,100	2,600
Elwha-Dungeness	15,900	22,000	22,000	22,000
San Juan Islands	100	100	100	100
Puget Sound Area	91,700	138,100	185,600	223,100

Source: Appendix VII, Irrigation.

TABLE 3-3. Present and projected irrigation needs, Puget Sound Area

Basin	Present (1000 A.F.)	1980 (1000 A.F.)	2000 (1000 A.F.)	2020 (1000 A.F.)
Nooksack-Sumas	73.0	111.0	149.0	149.0
Skagit-Samish	12.0	31.1	50.3	98.3
Stillaguamish	4.8	12.5	20.2	20.2
Whidbey-Camano Islands	7.4	7.4	7.4	7.4
Snohomish	24.5	28.2	35.7	38.2
Cedar-Green	5.6	3.9	1.9	2.4
Puyallup	8.8	14.7	26.5	32.5
Nisqually-Deschutes	13.3	18.5	30.4	49.3
West Sound	3.1	4.1	5.4	6.6
Elwha-Dungeness	75.0	104.0	104.0	104.0
San Juan Islands	--	--	--	--
Puget Sound Area Total	227.5	335.4	430.8	507.9

Source: Appendix VII, Irrigation.

WATER QUALITY CONTROL

General

Water quality decline has occurred in a number of lower valley surface waters due to changes in land use and development and inadequately treated municipal and industrial waste discharges, especially in developed estuarial areas.

Wastes causing the degradation of water quality are contributed by municipalities, industries, agriculture, navigation, and outdoor recreation. An estimated 90 percent of wastes generated near marine waters in 1968 were untreated industrial wastes discharged from industrial sources. Municipal wastes are treated before discharge. Implementation of the present marine waters (interstate) quality standards will provide for the improvement of water quality.

Wastes discharged to fresh waters are receiving varying degrees of treatment. An estimated 34 percent of these are industrial wastes, discharged untreated to streams. More than three-fourths of the wastes generated in the Puget Sound Area are discharged into the Puyallup, Stillaguamish, Cedar-Green, and Skagit-Samish Basins and to related marine waters. Implementation of the adopted fresh water (intrastate) quality standards will provide for the improvement of water quality.

Present and Future Needs

State and Federal water quality standards provide the baseline from which present and future needs for water quality control are determined. Table 3-4 summarizes water quality standards for marine and fresh waters adopted by the State of Washington under the Water Quality Act of 1965.

The population equivalent of waste generated before treatment in the Puget Sound Area is projected to amount to 18,531,000 in 1980, 23,588,000 in 2000, and 28,944,000 in 2020. Projected waste-loadings by time and basin are shown in Table 3-5. These potential loadings provide our basis for detailed planning and cost estimation for waste treatment.

Minimum streamflows required to assimilate treated wastes are given in Table 3-6.

The success of water quality control measures depends upon (1) adequate collection, treatment and dispersal facilities for wastes discharged into marine waters and, (2) secondary treatment, where effluents are discharged into streams, and (3) advanced (or tertiary) treatment where necessary to preserve water quality in lakes and impoundments or headwater areas. All activities which discharge wastes into the waters or affect water quality must provide all known available and reasonable methods of treatment and control. Likewise, land use activities should be controlled to minimize the introduction of sediment or other pollutants into stream sources. The separation of storm and sanitary sewers and adequate treatment plant operation becomes increasingly important in reaching water quality goals. Sanitation requirements for commercial vessels, live aboard vessels, pleasure boats and moorages are also important in achieving compliance with standards. Areas having a high priority for waste collection and treatment facilities are located in the major urban-industrial complexes of Bellingham, Everett, Seattle and Tacoma.

A complete discussion of water quality is contained in Appendix XIII, Water Quality Control.

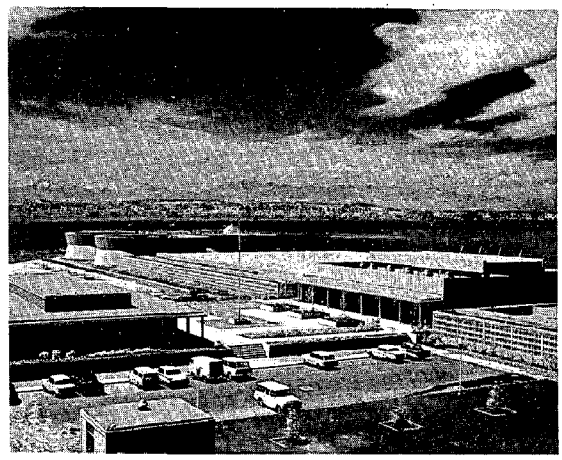


PHOTO 3-3. West Point treatment plant, Seattle. This plant, which discharges its effluent into Puget Sound, is the largest sewage treatment facility in the Northwest. Municipality of Metropolitan Seattle Photo

TABLE 3-4. Water quality classifications and criteria, Puget Sound Area

Water Quality Standards	Class AA Extraordinary		Class A Excellent		Class B Good		Class C Fair	
	Fresh	Marine	Fresh	Marine	Fresh	Marine	Fresh	Marine
Coliform	50 MPN	70 MPN	240 MPN	70 MPN	1,000 MPN	1,000 MPN	1,000 MPN	1,000 MPN
Dissolved Oxygen	9.5 mg/1	7.0 mg/1	8.0 mg/1	6.0 mg/1	6.5 mg/1	5.0 mg/1	5.0 mg/1	4.0 mg/1
Temperature	60°F	55°F	65°F	61°F	70°F	66°F	75°F	72°F
pH	6.5-8.5	7.8-8.5	6.5-8.5	7.8-8.5	6.5-8.5	7.8-8.5	6.0-9.0	7.0-9.0
Turbidity	5 JTU	5 JTU	5 JTU	5 JTU	10 JTU	10 JTU	10 JTU	10 JTU
Toxicity	Shall be below those of public health significance, or which may cause acute or chronic toxic conditions to the aquatic biota, or which may adversely affect any water use.							
Aesthetic Values	Shall not be impaired by the presence of materials or their effects, excluding those of natural origin, which offend the senses of sight, smell, touch, or taste.							

Source: Appendix XIII, Water Quality Control.

TABLE 3-5. Water quality control, projected before treatment raw wastes generated, Puget Sound Area (1000 population equivalents)

Basin	1965	1980	2000	2020
Nooksack-Sumas	2,031	3,102	3,624	4,087
Skagit-Samish	1,048	1,881	2,352	2,063
Stillaguamish	349	530	1,057	1,937
Whidbey-Camano Islands	24	89	141	186
Snohomish	7,169	5,886	6,079	6,057
Cedar-Green	1,348	2,359	3,986	6,658
Puyallup	839	1,226	2,173	3,182
Nisqually-Deschutes	139	189	338	584
West Sound	236	570	957	1,334
Elwha-Dungenesss	3,264	2,682	2,857	2,813
San Juan Islands	11	17	24	43
Puget Sound Area Total	16,458	18,531	23,588	28,944

Source: Appendix XIII, Water Quality Control.

TABLE 3-6. Minimum flow requirements, cfs, Puget Sound Area[1]

River and Location[2]	1980	2000	2020
Nooksack, Lynden	180	350	725
Skagit, Mount Vernon	240	435	650
Stillaguamish, Stanwood	140	270	415
Snoqualmie, North Bend-Snoqualmie	10	20	25
Skykomish, Monroe	150	285	335
Snohomish, Snohomish	400	750	890
Puyallup, Puyallup	105	245	270
White, Puyallup	45	120	135
Puyallup, Tacoma	140	210	240

[1]Minimum flow estimates based on wastes receiving secondary treatment.

[2]Minimum flow estimates for West Sound, Elwha-Dungeness, Whidbey-Camano, San Juan, Cedar-Green and Nisqually-Deschutes Basins have not been developed.

Source: Appendix XIII, Water Quality Control.

NAVIGATION

General

The navigation resources of the Puget Sound Area, combining deep water easily accessible from the Pacific Ocean with sheltered waterways is a significant heritage. The maintenance of this resource requires cooperative planning on a continuous basis to ensure that the needs for commercial developments are met in a manner which protects the unique environment. The navigation use of the Puget Sound Area has been one of the several reasons for its rapid economic growth. Seven major ports and a number of minor ports now serve the Area. The controlling depth at most harbor entrances is practically unlimited while at waterways and at berths alongside docks, the controlling depth varies from 25 to 70 feet. The Puget Sound Area ports are among the few natural harbors of the world which can handle "super bulk carriers," such as the "Manhattan" which has a draft of 51 feet fully loaded.

Most commercial navigation occurs on Puget Sound and adjacent marine waters with port facilities located along the shoreline of natural harbors. However, extensive use has been made of portions of river estuaries in the Snohomish and Cedar-Green Basins where channels have been dredged 7 and 5 miles, respectively, above the mouth of the Snohomish and Duwamish Rivers.

There are 32 active port districts in the Puget Sound Area, with the major ports located at Seattle, Tacoma, Olympia, Bellingham, Port Angeles, Port Townsend, Everett, and Anacortes. A full range of facilities required to handle both bulk and general cargo efficiently, including containerization facilities and back-up areas are available. Total foreign and domestic coastwise and domestic internal waterborne commerce of the Puget Sound Area increased from 31 million tons in 1952 to almost 42 million tons in 1966. The average annual rate of growth during this period was about 2.5 percent. In 1964, 48,000 persons were employed in work related to waterborne commerce, and the direct value of related goods and services was estimated to be 1.1 billion dollars.

There are 22 Federally authorized river and harbor projects in the Puget Sound Area, providing for construction of channels and breakwaters, annual maintenance dredging, and snagging and clearing of debris.

The waterfront terminal facilities in the Puget Sound Area serve an industrial complex which depends on waterborne commerce to enhance its competitive market position. Water transport-oriented industries had in use approximately 5,200 acres of land in 1963, while approximately 2,300 acres of land were used for terminal facilities.

Many of the ports provide small boat moorage facilities for recreation boating and accommodations for commercial fishing fleets. The registered pleasure boat ownership was about 62,000 in 1966, creating heavy demands on small boat facilities. A survey in 1966 of a representative sample of registered pleasure boat owners revealed a significant need for additional moorages above the 16,000 public rental moorages provided in that year. The Area has one of the highest per capita participation rates in pleasure boating of any major population center of the Nation.

Present and Future Needs

Significant growth in foreign and domestic coastwise and domestic internal commerce is projected over the 50-year study period with the total tonnage forecasted to rise from 42 million tons in 1966 to nearly 252 million tons by 2020. Additional lands will be required for terminal facilities to service these projected tonnages, as well as meeting the needs of water transport-oriented industry. The future land needs have been projected at 17,130 acres by 1980, 29,010 acres by 2000, and about 41,500 acres by the year 2020. Harbor and channel deepening projects would be required to insure that with a growing trend to deeper drafts all ships can be served in the waterways and berths of the Area. Channel depths of over 100 feet would be needed in some locations. Pleasure boating wet moorage demand is forecast at 43,790 moorages in 1980, 79,870 moorages in 2000, and 143,440 moorages by 2020. A large number of breakwater-protected marinas would be required to accommodate these demands. Table 3-7 summarizes the navigation needs for the Area.

Increased efficiency in cargo handling and land use would be necessary in order for the Area ports to remain competitive. Greater cooperation among ports and centralized planning are indicated as means of achieving these efficiencies.

Planning of the land transportation network, including warehousing, consolidation, and distribution facilities for integration with waterborne transportation is needed to take advantage of such

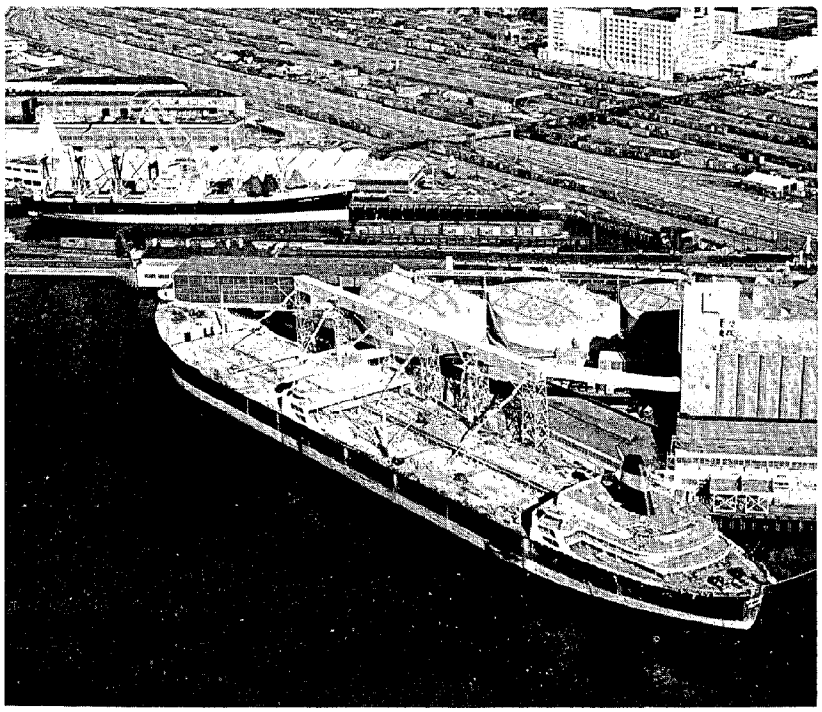


PHOTO 3-4. Manhattan, 51-foot draft bulk cargo vessel receiving grain from the Hanford Street terminal in Seattle. Port of Seattle Photo

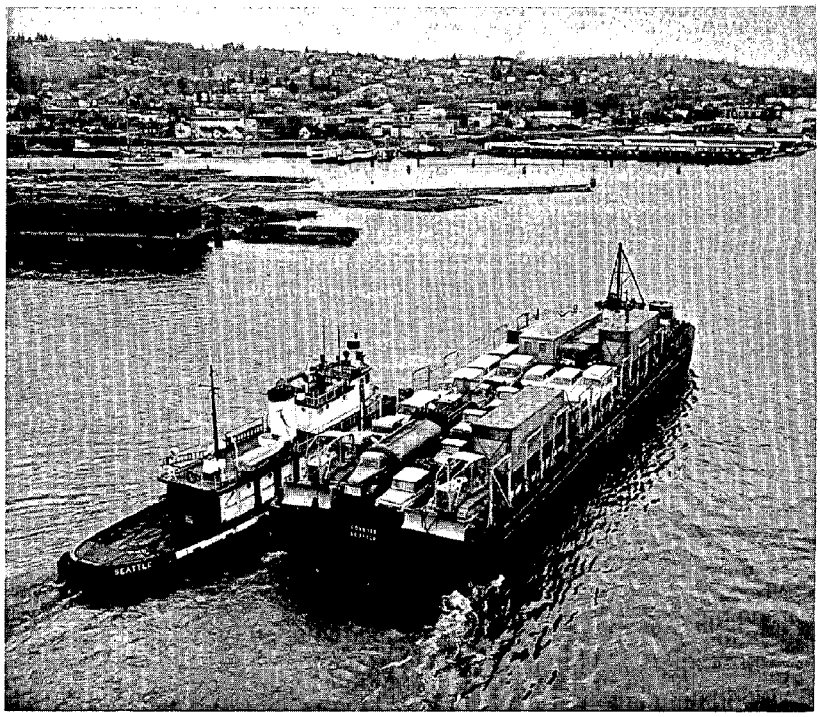


PHOTO 3-5. Tugboat towing barge through Lake Washington Ship Canal. Corps of Engineers Photo

TABLE 3-7. Gross navigation needs, Puget Sound Area

Basins	1980 Industrial & Terminal Lands (Acres)	1980 Sm. Boat Harbors (Moorages	1980 Waterborne Commerce (1,000 tons)	2000 Industrial & Terminal Lands (acres)	2000 Sm. Boat Harbors (Moorages)	2000 Waterborne Commerce (1,000 Tons)	2020 Industrial & Terminals Lands (Acres)	2020 Sm. Boat Harbors (Moorages)	2020 Waterborne Commerce (1,000 tons)
Nooksack-Sumas	2,040	990	4,700	3,480	1,620	12,700	5,870	2,700	30,100
Skagit-Samish	2,920	2,400	8,700	4,050	3,930	12,700	5,910	6,640	30,100
Stillaguamish	---	400	---	---[1]	770	---[2]	---[1]	1,500	---[2]
Whidbey-Camano	---[1]	3,770	---[2]	---	6,300	---	---	10,690	---
Snohomish	1,610	4,920	3,800	5,640	9,530	10,900	12,330	18,520	50,000
Cedar-Green	6,550	10,920	22,000	7,300	21,200	32,600	7,300	41,200	50,000
Puyallup	3,010	4,350	8,700	4,950	8,450	19,000	4,950	16,400	22,200
Nisqually-Deschutes	310	1,170	1,100	2,550	1,950	6,400	3,760	2,700	22,200
West Sound	---[1]	10,920	---[2]	---[1]	19,600	---[2]	---[1]	32,900	---[2]
Elwha-Dungeness	480	1,140	1 700	830	1,920	2,700	1,170	2,640	4,200
San Juan	---[1]	2,810	---[2]	---[1]	4,600	---[1]	---[1]	7,650	---[2]
Minor Ports	210	---	16,100	210	---	26,500	210	---	43,000
Puget Sound Total Area	17,130	43,790	66,800	29,010	79,870	123,500	41,500	143,440	251,900

[1] Industrial and terminal land needs in this basin are not forecasted as only minor development is anticipated

[2] Waterborne commerce projections for minor ports in this basin are included with total forecast for all minor ports in the Area.

Source: Appendix VIII, Navigation.

innovations as containerization and unit transport. Environmental, social, and aesthetic considerations should be incorporated into navigation developments to avoid degradation of the valued marine environment. The requirement exists for the proper disposal of dredged materials in order to minimize or eliminate possible adverse effects on the environment. Public demand for recreation boating facilities has reached significant proportions in the Area. Accelerated development of small boat facilities would be required to meet this need and permit full utilization of the recreation boating advantages of Puget Sound and adjacent waters. Means for proper waste collection from commercial vessels, live aboard vessels and pleasure craft should be provided. A complete discussion of navigation is contained in Appendix VIII, Navigation.

POWER

General

Development of power resources in the Puget Sound Area is an important factor in the physical and economic growth of the Pacific Northwest. Policies, plans and programs for the conservation and beneficial use of the Area's water, land and mineral resources are all affected by power development. Low-cost power, abundant and widely available is an important factor in expanding industry and the general economy of the Area.

Importation of power began in the early 1940's and now accounts for more than triple the energy produced in the Area. There are two diesel-electric generating plants on the San Juan Islands and five steam-electric plants in the Cedar-Green and Puyallup Basins. Installed capacity of these diesel and steam plants total about 200,000 kilowatts. In eight of the basins there are 22 hydroelectric plants with approximately 1,200,000 kilowatts of installed hydroelectric capacity. The San Juan Islands, Whidbey-Camano Islands and Stillaguamish Basin have no hydropower developments.

The Puget Sound Area as a producer and consumer of electric power is expected to continue to be an integral part of the Pacific Northwest power economy. The Area is served on a coordinated basis

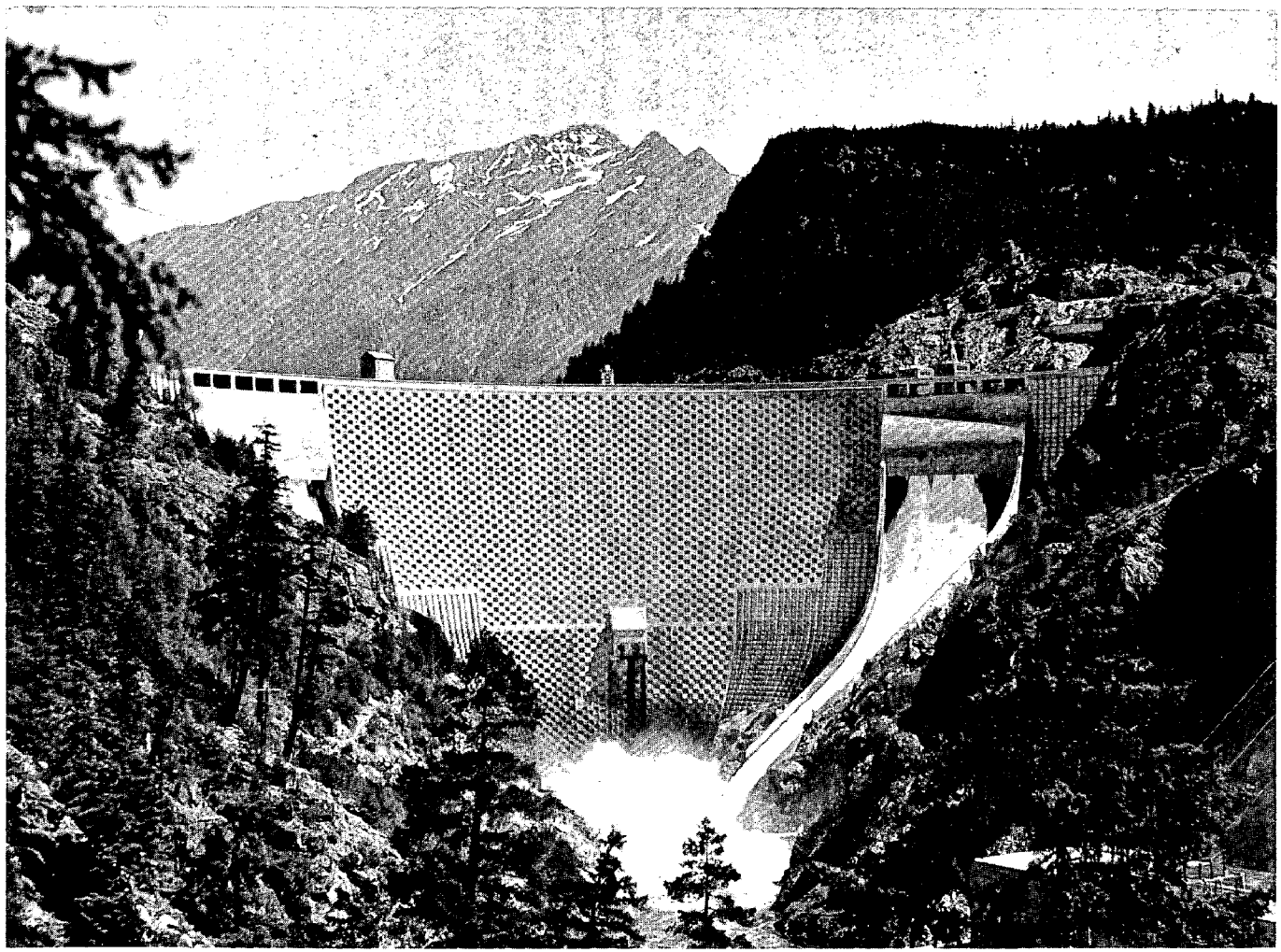


PHOTO 3-6. Seattle City Light's 540-foot Ross Dam during one of the few instances that water is going over the spillways. Ross Powerhouse generates up to 450,000 kw when the lake is full. Ross Lake has a total storage of 1,405,000 acre-feet and a usable storage of 1,023,000 acre-feet. The lake is kept at a reduced level from October 1 to March 15 each year to provide 120,000 acre-feet of storage for flood control. Seattle City Light Photo

through a number of interconnected generating and transmission systems which the Bonneville Power Administration system provides the backbone. At present the Northwest is almost entirely hydro supplied, but a shift to a mixed thermal-hydro system is expected to be well underway by 1980, when the bulk of the economical hydro energy will have been developed. Economic hydro peaking capacity may be under development for a considerable period after that time. The Puget Sound Area is deficient in electric power resources and is expected to continue to be a large importer of electrical energy from the rest of the Pacific Northwest, principally the Columbia Basin.

The seasonal pattern of peak and energy loads within the Area is characterized by low summer loads and a winter peak. The winter peak is created mostly by electric heating. The Area is generally characterized by cool summers and as a result there is very little summer air conditioning load. Three municipally-owned, one Federally-owned, one private utility and two industrial firms produce electrical energy within the Area.

Present and Future Needs

With the projected population expansion and industrial development, the Area's electric power requirements are projected to increase from the 17,407 million kwh in 1965 to 400,000 million kwh in year 2020. This represents an overall annual rate of growth of 5.9 percent for the 55-year period to 2020. The projected electrical energy needs of the Puget Sound Area are shown in Table 3-8.

A complete discussion of power is contained in Appendix IX, Power.

FLOOD CONTROL

General

A total of 747,000 acres of land in the Puget Sound Area are subject to floodwater damage at least once in every 100 years. About 276,800 acres are subject to overbank flooding along the mainstem of major streams. Flooding, other than mainstem overbank flooding, is discussed under Watershed Management.

Flooding by overbank flow of main-stem streams occurs on bottom-lands in nine of the eleven Puget Sound Area Basins. The San Juan and Whidbey-Camano Islands have relatively small watersheds, and because of light rainfall, overbank flow flooding is a minor problem. Average annual flood damages are estimated at $7,122,000 for the Puget Sound Area. About $6,200,000, or 87 percent of the flood damages occurs in the Skagit-Samish, Snohomish and Nooksack Basins.

Only portions of the Green and Puyallup River Basins have a level of flood protection to the standard required for urban areas. The lower Puyallup River Basin is protected against floods with recurrence intervals in excess of 100 years by Mud Mountain Dam and Reservoir and channel improvements. The Howard A. Hanson Dam and Reservoir has sufficient storage to provide in excess of 100-year control of Green River streamflow to a maximum of 12,000 cfs at Auburn.

Some agricultural lands are protected by levee systems. These levees are for the most part the result of efforts by local diking and drainage districts, constructed to prevent spring flooding. As a result, levee protected agricultural lands are still subject to winter flooding which occur on a frequency that varies from about once every two to eight years.

TABLE 3-8. Projected electric power requirements, Puget Sound Area

Year	Population (1000 People)	Per Capita Requirement (kwh)	Energy (Million kwh)	Loads[1] Average (1000 kw)	Loads[1] Peak (1000 kw)
1965	1,877	9,274	17,407	1,987	3,453
1980	2,727	17,700	48,300	5,530	9,730
2000	4,300	33,100	142,500	16,800	30,270
2020	6,809	58,700	400,000	47,700	89,400

[1] Includes reserve requirements.

Source: Appendix IX, Power.

PHOTO 3-7. Flooding of homes along Snohomish River during November 1959 flood which was result of intense winter storms. Damages occurred to cropland, buildings, equipment and transportation facilities. Corps of Engineers Photo

PHOTO 3-8. Flooded crop of broccoli which was not harvested because of flooding condition. Soil Conservation Service Photo

PHOTO 3-9. Flood plain of Snoqualmie Valley during 1965 winter flood of 2 to 5 year recurrence interval. Corps of Engineers Photo

Optimum development of agricultural lands is thus restricted.

The heavy sediment load of many rivers in the Puget Sound Area adds to flooding problems. Rivers deposit sediment where the stream gradient flattens from the steep mountainous area to the flat flood plain. The continued deposition of sediment adds to overbank flooding conditions by reducing channel carrying capacity. As a result the upper reaches of the flood plains are subject to frequent changes in river channel location and direction. Bank erosion and loss of valuable farmlands are typical occurrences.

Present and Future Needs

The degree of flood protection should be compatible with the present and projected future use of the flood plain lands. The objectives of flood protection established for this study vary according to the type and intensity of existing and anticipated developments. The objective for urban and industrial lands is at least a 100-year level of protection, for prime agricultural lands with a high density of farm buildings and residences, a 50-year level of protection is recommended, and for other agricultural lands, a 25-year level of protection. For recreation and related use lands, a 10-15 year protection is suggested.

Most of the flood plain lands along the principal rivers are in need of measures to prevent flood damages. These measures include a flood plain management program for each basin, as well as necessary and justifiable structures. Without additional protection, damages would increase with more intensive agricultural, urban and suburban development, expansion of transportation facilities and utilities, and construction of other facilities such as fish hatcheries. The projected damages are summarized by basin in Table 3-9.

A complete discussion of flood control is contained in Appendix XII, Flood Control.

TABLE 3-9. Average annual flood damages present and future conditions at existing levels of protection and at 1966 prices (in thousands of dollars)

	1966	1980	2000	2020
Nooksack-Sumas	853	1,210	1,970	3,350
Skagit-Samish	3,020	4,340	7,060	12,030
Stillaguamish	256	380	690	1,310
Snohomish	2,310	3,520	6,370	13,100
Cedar-Green	447	780	1,700	3,740
Puyallup	100	151	301	602
Nisqually-Deschutes	57	69	110	160
West Sound	51	68	100	158
Elwha-Dungeness	28	38	54	80
Total	$7,122	$10,556	$18,355	$34,530

Source: Appendix XII, Flood Control.

WATERSHED MANAGEMENT

General

Watershed management is concerned with the use and care of the land and vegetative cover that receives the precipitation, and with the management of the water that runs off the surface or percolates through the surface into the ground water resource. When watershed areas are in good condition the runoff is generally equitable and the water of good quality. Most of the watersheds in the Puget Sound Area are in relatively good condition at present. The activities of man or natural disasters often cause disruption of the natural hydrologic cycle and lead to changes in many aspects of the natural environment.

Urban expansion, logging, roadbuilding, and agriculture have increased the volume and intensity of surface runoff. The result has, in some areas, been a loss of soil stability, accelerated erosion, sedimentation, stream and lake pollution, swamping, and associated damages to property and to natural resources. These damages are widespread and cause injury and expense to the general public. In addition to a need for more care in the use of watersheds and corrective measures, many opportunities exist to enhance various elements of the environment through management of the water and related land resource for specific objectives.

PHOTO 3-10. Flooding small creek during excess winter rains due to inadequate culvert and drainage channel capacity. Soil Conservation Service Photo

PHOTO 3-11. Example of erosion and sediment transport resulting from development where forest cover and topsoil have been removed. Soil Conservation Service Photo

PHOTO 3-12. Interstate Highway 5, north of Seattle where established planting of a variety of ground cover beautify and help stabilize steep raw cut slopes and fills. Soil Conservation Service Photo

Present and Future Needs

There are 747,000 acres in the Puget Sound Area subject to floodwater damage at least once in every 100 years. About 276,800 acres are subject to overbank flooding from the mainstem of major streams and require mainstem control, previously described under Flood Control. However, these same areas are also subject to flooding from excess precipitation or other causes in the absence of mainstem overflow. Consequently these 276,800 acres, as well as 470,200 acres of upstream and tributary area, require flood prevention, drainage, and other water management measures within the scope of watershed management activities. Care has been taken to prevent double counting of development needs. Irrigation development requirements, while a facet of watershed management, are presented under Irrigation.

Projections of population and economic growth indicate accelerating demands on the Area's land and water resources. Urban and industrial use would require intensive development of additional land by the year 2020.[1] Production of food and fiber from the Area's forest and agricultural lands would be increased through improved management, utilization of waste products and improved technology, at the same time these lands are receiving mounting pressure for other uses, particularly outdoor recreation

These and other land use developments in the Puget Sound Area would require a greatly accelerated program of watershed management for the protection of land and water values. Currently the program is more than 50 percent deficient in meeting the optimum needs of the Area. In addition to making up the current deficit, future watershed management planning should be made an integral part of such development. Research and data collection are needed in the fields of hydraulic characteristics, sedimentation, beach erosion, channel erosion, and soil surveys.

Where watershed land is designated for a specific use; e.g., recreation, municipal and industrial water, or water quality control, management practices peculiar to that use would be needed. On lands which serve multiple uses, such as farming and recreation, forestry and recreation, forestry and water quality, and so on, management practices to prevent deterioration of the natural environment would be needed. For this category of practices, the needs would grow as population of the Area increased.

The upstream and tributary area subject to floodwater damage is approximately 25 percent forest and rangeland, 61 percent cropland, and 14 percent more intensively developed land. Damages are estimated at $8,822,000 annually. This is in addition to the overbank flood damage estimates presented in the section on Flood Control.

The area of forested land is not considered to require flood prevention or flood control measures under conditions of use in 1967, but would require such protection as use changes. Cropland should have protection from floodwater damage to enable higher yields. Intensively used land requires a 100-year level of protection. Some croplands and other lands are mingled with transportation and other improvements and require intermediate levels of protection that should be determined by individual, detailed analysis.

Soil erosion reduces the value of the land and contributes to streambed sediment loads, channel deterioration, and sedimentation of reservoirs and estuaries. Likewise, the deposition of stream sediment in lower channel areas reduces the flood-carrying capacity of streams and increases overland flooding, stream channel braiding and bank erosion. Sediment also has adverse affects upon quality of water for human consumption and industrial use, and for fish and wildlife. Nearly all of the land in the Puget Sound Area is periodically subject to erosion. The combined areas of agricultural, forest, and urban land requiring continued protection and rehabilitation measures, amounts to a total of 8,404,200 acres.

Streambank erosion and braiding conditions are heavy producers of channel sediment. Precise needs in this area are not known. However, about 1,000 miles of mainstem and tributary channel banks are estimated to need measures for rehabilitation and protection.

Forty-three percent of the lands covered by the soil survey in the Puget Sound Area is found to have drainage problems which affect their use for food and fiber production, urban development, and other purposes, including construction. Acreages requiring flood prevention, watershed protection and rehabilitation measures and other water management for agricultural and urban uses are shown by time periods in Table 3-10.

Beaches are the relatively unstable transition zone where the land mass and the tidal waters meet. Beaches in the Puget Sound Area are relatively

[1]See Table 2-1 and 2-23, Appendix XIV, Watershed Management.

TABLE 3-10. Principal watershed development needs, Puget Sound Area

Basin	1970 to 1980				1980 to 2000				2000 to 2020			
	Flood[1] Prevention	Watershed Protection & Rehabilitation	Water Management (agriculture)	Water Management (urban)	Flood[1] Prevention	Watershed Protection & Rehabilitation	Water Management (agriculture)	Water Management (urban)	Flood[1] Prevention	Watershed Protection & Rehabilitation	Water Management (agriculture)	Water Management (urban)
	1000 acres	1000 acres	1000 acres	1000 acres	1000 acres	1000 acres	1000 acres	1000 acres	1000 acres	1000 acres	1000 acres	1000 acres
Nooksack-Sumas	135.1	792.2	55.4	33.6	135.1	792.2	92.3	33.6	135.1	792.2	123.1	33.6
Skagit-Samish	155.4	1912.6	49.0	38.9	155.4	1912.6	81.7	38.9	155.4	1912.6	108.9	38.9
Stillaguamish	34.8	433.6	13.5	12.6	34.8	433.6	22.6	12.6	34.8	433.6	30.1	13.0
Whidbey-Camano	25.6	132.9	8.6	23.4	25.6	132.9	14.4	23.4	25.6	132.9	19.2	23.4
Snohomish	93.4	1194.6	25.7	65.7	93.4	1194.6	42.9	81.0	93.4	1194.6	57.2	130.1
Cedar-Green	63.9	704.1	10.6	264.9	63.9	704.1	17.8	317.3	63.9	704.1	23.7	433.7
Puyallup	66.2	759.0	12.0	123.2	66.2	759.0	19.9	123.6	66.2	759.0	26.6	198.5
Nisqually-Deschutes	68.4	635.6	5.3	39.8	68.4	635.6	9.0	39.8	68.4	635.6	11.9	39.8
West Sound	71.0	1281.4	17.1	106.4	71.0	1281.4	28.6	106.4	71.0	1281.4	38.1	106.4
Elwha-Dungeness	15.9	446.6	9.6	11.0	15.9	446.6	16.1	11.0	15.9	446.6	21.4	11.0
San Juan	17.3	111.6	9.9	11.9	17.3	111.6	16.4	11.9	17.3	111.6	21.9	11.9
Totals	747.0	8,404.2	216.7	731.4	747.0	8,404.2	361.7	799.5	747.0	8,404.2	482.1	1,040.3

[1] Needs include 276,800 acres discussed under "Flood Control," but do not include the main stem control measures discussed in that section. See text for further details.

Source: Appendix XIV, Watershed Management.

narrow except in the vicinity of major rivers and along certain coves and bays. In the Skagit and Nooksack Basins, among others, some tidal areas have been reclaimed by seawall dikes and used for farming. These dikes are subject to damage by wave action. A considerable portion of the wave-cut terrace along the eastern shore of the Puget Sound is occupied by railroad rights-of-way.

The Area has over 2,000 miles of marine shoreline, of which approximately 187 miles are considered to be in need of stabilization and/or rehabilitation. In some places the erosion is advancing at an average rate in excess of one foot per year. A study is required to fully evaluate needs for beach protective measures and for determining applicable means of beach erosion control. The estimated distribution of beach erosion is shown in Table 3-11.

The reader is referred to Appendix XIV, Watershed Management for further details.

TABLE 3-11. Erosion reduction needs, Puget Sound Area

Basins	Streambank Erosion			Beach Erosion (miles)
	Braiding (feet)	Severe (feet)	Moderate (feet)	
Nooksack-Sumas	191,000	89,800	93,600	5
Skagit-Samish	24,400	89,200	61,800	20
Stillaguamish	8,000	245,500	77,000	5
Snohomish	44,000	98,000	92,000	12
Cedar-Green	---	143,750	124,950	35
Puyallup	77,000	54,750	72,700	5
Nisqually-Deschutes	14,350	60,650	66,750	--
West Sound	5,150	10,650	11,250	39
Whidbey-Camano Islands	---	---	---	31
San Juan Islands	---	---	---	20
Elwha-Dungeness	---	2,700	12,550	15
Total measures	363,900	795,000	612,600	187

Source: Appendix XIV, Watershed Management.

RECREATION

General

The water and related lands of the Puget Sound Area are nationally and internationally recognized for their recreational use and potential. The outstanding physical features of the Area include extensive mountain ranges and forests, streams, lakes, and marine waterways which provide opportunities for many diverse forms of outdoor recreation activities.

The total use of recreation resources in the Area was estimated to be 58 million recreation days in 1960, of which about 25 million recreation days were for water-related activities. Demands for water-related activities are expected to reach 178,700,000 recreation days by the year 2020, representing a six-fold increase over 1960.

Present and Future Needs

Competing land and water uses impair and restrict the public use of these resources for recreation. For example, residential developments, shoreline roads and railroads, and private ownership of waterfront and tidal areas restrict the use of marine resources for public enjoyment. Increasing stretches of tideland and beach are being filled or dredged to accommodate residential and commercial uses. In several localized situations, pollution has reduced the value of water for recreational use.

The Area contains a wealth of outdoor resources and many of these resources are presently unusable or unavailable to the public and, therefore, do not contribute to the supply of outdoor recreation opportunities. The current demand for water related opportunities exceeds the existing supply of outdoor recreation facilities. Over 60 percent of outdoor recreation use occurs during the summer, and more than one-half of this use takes place on weekends. During heavy use periods recreation areas are overcrowded, especially those within or near urban areas.

PHOTO 3-13. Typical camping experience in National Forest Parks. U.S. Forest Service Photo

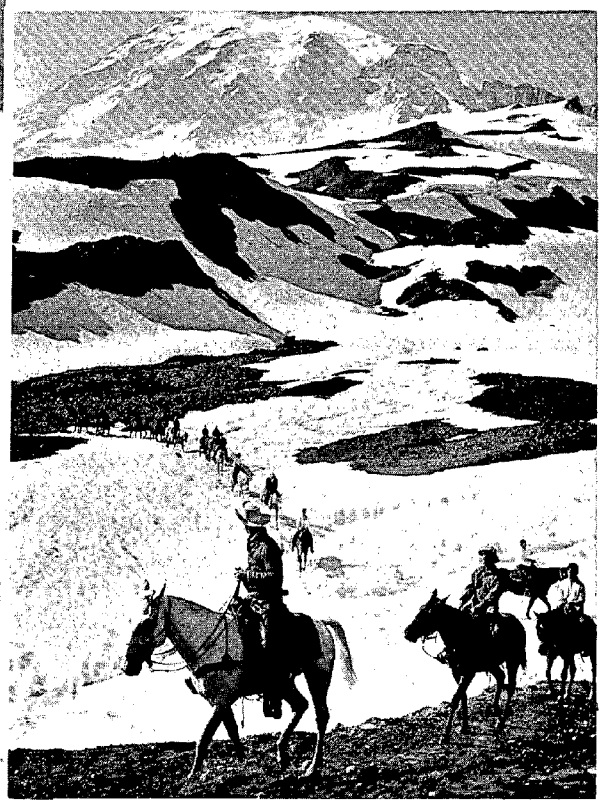


PHOTO 3-14. Outdoor recreational opportunities of the Puget Sound Area are many and varied. Horseback riding at base of Mount Rainier, 14,410 feet. Washington State Department of Commerce and Economic Development Photo

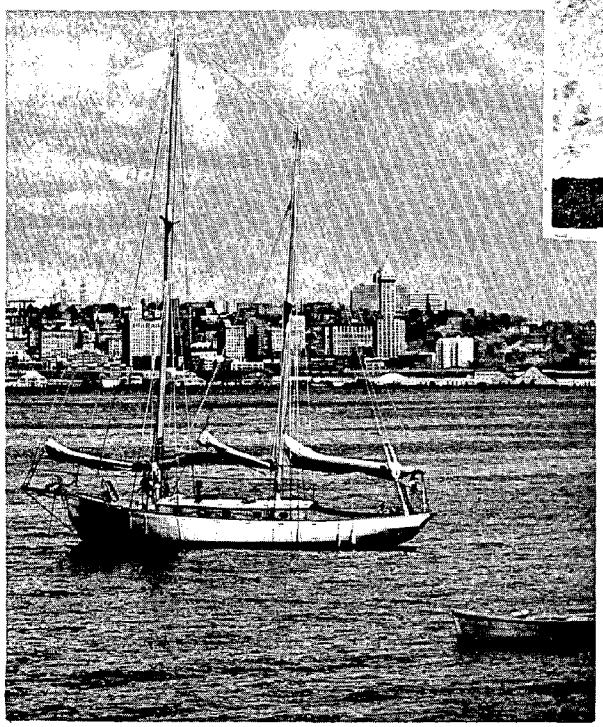


PHOTO 3-15. Pleasure boating is possible from the door steps of all major population centers in the Puget Sound Area. Elliott Bay with Seattle skyline as backdrop. Washington State Department of Commerce and Economic Development Photo

With the increasing concentration of population in metropolitan and suburban areas, the need to escape from man-made confines to outdoor recreation areas is expected to increase. About one-half of the future outdoor recreation demands and needs are anticipated to occur in and near the major metropolitan centers.

The project water-related recreational needs are summarized in Table 3-12.

TABLE 3-12. Present and future water-related recreation needs, Puget Sound Area

Basin	1000 Recreation-Days 1960	1980	2000	2020
Nooksack-Sumas	2,100	4,100	7,800	14,400
Skagit-Samish	2,200	4,300	8,300	15,200
Stillaguamish	830	1,600	3,000	5,500
Whidbey-Camano Island	1,500	3,000	5,800	10,800
Snohomish	3,600	7,200	15,000	26,000
Cedar-Green	4,700	9,400	18,100	33,600
Puyallup	2,500	5,000	9,700	18,000
Nisqually-Deschutes	2,100	4,200	8,000	14,900
West Sound	4,000	8,100	15,700	29,200
Elwha-Dungeness	650	1,300	2,500	4,600
San Juan Islands	1,000	1,900	3,500	6,500
Total for Area	25,180	50,100	96,400	178,700

Source: Appendix X, Recreation.

Only the water-oriented recreation needs were considered in this study. Such needs consist of swimming, boating, sailing, water-skiing, camping, picnicking, and hiking. Swimming is projected to be the most popular recreational activity followed closely by boating, camping, picnicking, and hiking.

Satisfaction of these demands would require land acquisition and facility developments interspersed throughout the Area, with emphasis on urban recreational development and salt water shoreline acquisition and development.

A complete discussion of recreation is contained in Appendix X, Recreation, including several studies and programs designed to protect significant salt and fresh water shorelines and recreation resources.

FISH AND WILDLIFE

General

The varied marine, forest, stream, and mountain environments in the Puget Sound Area support a wide and abundant variety of fish, shellfish and wildlife. Many of these resources are close to the metropolitan centers of the Area and offer a wide range of commercial and recreational opportunities that are unique.

In 1965, sport angler-use was estimated at 5,720,800 angler-days, of which approximately 35 percent involved anadromous fish, 61 percent resident fish, 1 percent marine fish and 2 percent shellfish. This amount of angler use was valued at $19,346,200. The commercial catch for 1965 amounted to 44,252,000 pounds, with a total value to the fishermen of $6,345,400. An estimated 847,000 hunter-days were spent in wildlife use pursuits. Such use is conservatively valued at $4,325,700. The fish production capabilities of various Area waters are considered good to excellent.

Wildlife is a product of the land and vegetative cover. The type or species, and number of animals or birds found in an area, is dependent upon the quantity and quality of the habitat. The basic elements of habitat, food, cover and water vary in type, quantity and quality as a result of existing climatic conditions, soil and topography. Each unit or area of habitat has a specific capacity to support wildlife. Wildlife cannot migrate to another area if a home territory is denuded of vegetation for some other use. The "other areas" are already supporting wildlife at the habitat carrying capacity. Human population demands for agricultural, urban and industrial uses occur almost exclusively at low elevations, the area of highest productivity for wildlife. Consequently, human competition is direct and critical to wildlife survival.

Present and Future Needs

Future demand for hunting and fishing is expected to increase substantially due to population growth, rising personal income, increased leisure time, ease of transportation and mobility, improved and reasonably priced equipment, and the continued assurance of access to the fish and wildlife resource.

The fish and wildlife needs projected in terms of user-days are shown in Table 3-13. In deriving the needs the assumption was made that present fishing and hunting success levels would be retained.

Numerous problems and conflicts resulting from population increases associated with industrial, urban, and suburban expansion would need to be resolved because they affect the overall demands for

PHOTO 3-16. Mountain goat, in Cascade Mountains which form Puget Sound Area's eastern border, provides object for energetic hunters. Washington State Department of Game Photo

PHOTO 3-17. Pheasant released from State game farms are hunted throughout the Puget Sound Area. Washington State Department of Game Photo

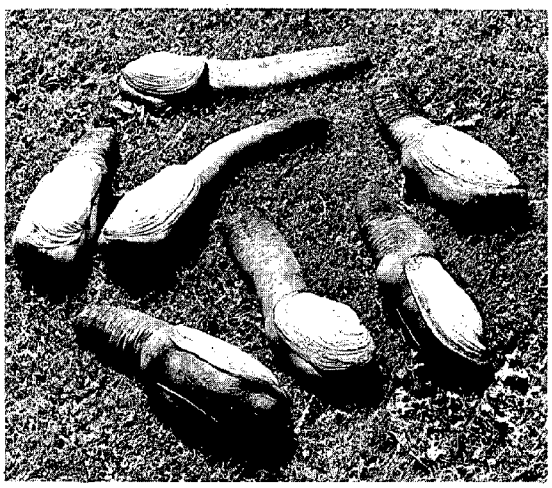


PHOTO 3-18. Geoducks, huge clams that are harvested from the shoreline of Puget Sound, weigh as much as 6 pounds. Washington State Department of Fisheries Photo

PHOTO 3-19. Excellent catch of rainbow trout from Bay Lake, located in West Sound Basin. Washington State Department of Game Photo

fish, shellfish, and wildlife. These developments tend to reduce the natural production capacities of essential environments. The major problems which affect fish production are listed in Table 3-14. Some of these limitations occur naturally, while others result from man-made activities. The most significant problems affecting wildlife are the direct and immediate conflicts with carrying capacity.

Supplemental legislation is needed to conserve and enhance fish and wildlife resources and habitats. Public awareness, improved technology, and management programs are essential to maintaining adequate levels of fish and wildlife under conditions of increased population. More detailed information is presented in Appendix XI, Fish and Wildlife.

TABLE 3-13. Summary of fish and wildlife needs, Puget Sound Area

	Units	1965	1980	2000	2020
Sport Fishing	1,000 User-Days	5,721	9,489	15,245	24,546
Hunting	1,000 User-Days	847	1,635	2,651	3,271
Commercial Fishing	1,000 Pounds	44,252	52,565	72,178	93,977

Source: Appendix XI, Fish and Wildlife.

TABLE 3-14. Major limiting factors on fish production in the Puget Sound Area[1]

	Limiting Factors[1]								Fish Life Affected			
Basin	Flooding	Low Summer Flows	Natural Barriers	Manmade Barriers	Erratic Streamflows	Unstable Streambed	Production Area Loss	Poor Water Quality	Anadromous Fish	Resident Fish	Marine Fish	Shellfish
Nooksack-Sumas	X	X	X		X	X	X	X	X	X	X	X
Skagit-Samish	X	X	X	X	X		X		X	X	X	X
Stillaguamish	X	X	X					X	X	X	X	
Whidbey-Camano		X							X	X		
Snohomish	X	X	X	X	X		X	X	X	X	X	X
Cedar-Green	X[2]	X		X			X	X	X	X	X	X
Puyallup	X	X		X	X	X	X	X	X	X	X	X
Nisqually-Deschutes	X[3]	X	X[3]	X[3]	X[3]		X		X	X		
West Sound	X	X	X			X	X	X	X	X	X	X
Elwha-Dungeness	X	X	X	X				X	X	X	X	X
San Juan		X							X	X		

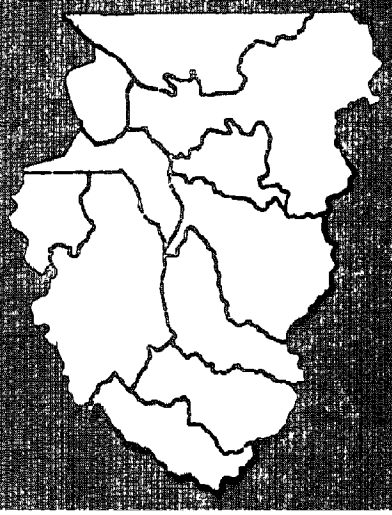
1 Further defined in each basin discussion.

2 Cedar Basin only.

3 Nisqually Basin only.

Source: Appendix XI, Fish and Wildlife.

Part Four
Comprehensive Plan



BASIS OF PLANNING

Desires of Local People

General. The views of local interests were gathered at three public hearings conducted at the beginning of the study in 1964. These views were an expression of problems and needs in each of the eleven major drainages comprising the Study Area. This public expression, together with the findings by the technical committees, provided the primary source of input for plan formulation. During the technical studies, as well as the formulation of the Comprehensive Plan, continuing liaison with local residents, organizations, and agencies was maintained. Formal and informal discussions were held with individuals and groups of residents in the various parts of the Area. Preliminary plans were presented to the county representatives for information and comment, as were the findings by the technical committees on the needs of the Puget Sound Area projected through the year 2020. The alternatives under consideration during the planning process also were discussed with planning organizations of the counties. Every consideration was given to the viewpoints expressed by individuals representing both public and private sectors.

Prior to the public hearings held in October 1964, extensive efforts were made to inform the public about the study. A conference to furnish information about State and Federal objectives was held 15 July 1964, with the governor of the State of Washington. The conference was attended by representatives of the participating Federal and State agencies and responsible bodies engaged in water resource planning and development from the twelve counties within the Study Area. Preceding the public hearings, separate meetings were held with the county commissioners of each of the twelve counties, other public officials, and the principal users and developers of water in the Puget Sound Area. The notice of public hearings and the information bulletin were mailed 25 September 1964, to Federal, State, county and local officials, to newspapers, radio and television stations, and to individuals representing a large cross-section of the general public. A pamphlet containing the statements of Federal and State agencies participating in the study was prepared to supplement the information bulletin, and was distributed to the public at the hearings.

Public Hearings

Initial Public Hearings. Three public hearings were held (Anacortes, Everett, and Olympia, Washington) on the Comprehensive Water Resource Study of Puget Sound and Adjacent Waters. The hearings were conducted by the Task Force for the Puget Sound and Adjacent Waters Study for the purpose of soliciting the views of interested persons concerning the need for programs and projects required within the next ten to fifteen years, and also as a basis for long-range framework plans. Information was sought on: (1) water needs and future requirements for domestic, municipal, irrigation, recreation, hydropower and industrial uses, (2) requirements for water quality and pollution control, (3) water and land treatment measures necessary to reduce erosion, siltation, and sedimentation, (4) specific requirements for flood control protection or planning, (5) information on immediate and long-range requirements for port facilities, (6) channel or other navigation needs for water movement and boating, both commercial and pleasure types, and (7) on development for fish and wildlife. The first hearing was held on the twelfth of October, the second on the twenty-second of October, and the third on the twenty-eighth of October 1964. A broad representation was present at all of the hearings with local, State, and Federal agencies present, as well as local citizens. There were 106 registered attendees at the Anacortes hearing, 146 attendees at the Everett meeting, and 97 at the Olympia meeting.

Summary of Views. Various Federal agencies participating in the study made presentations regarding their particular responsibilities as agencies, as well as those required in participation in the Comprehensive Study. The agencies emphasized that full consideration would be given to State and local policies on water resource development, social and economic factors, and local needs and desires. Some mention was made by the agencies, both State and Federal, of preliminary views as to existing needs in the Puget Sound Area.

Anacortes Hearing. The problems stemming from increased seasonal influx of recreationists in the San Juan Islands during the summer were indicated, with particular regard to the impacts on transportation, domestic water supply, pollution control, harbor development, fish, and recreation needs. Municipal and industrial water supply and an inadequate tax base to build facilities to accommodate the recreationists were indicated as primary problems in the San Juan Islands.

Control of the Skagit River floods in Skagit County was stated as being an urgent need. Multiple-purpose use of the Skagit River to satisfy power, recreation, and fish needs was indicated as being desirable. The flood threat was considered to be the number one hazard in the Skagit Valley. A strong support was indicated for development of water, land, and artificial spawning grounds to provide increased production of salmon.

Some opposition was expressed regarding the dredging of the Skagit River and construction of the Avon Bypass. A request was made that some rivers be preserved in their natural, free-flowing states. The dredging of Fidalgo Bay, which would facilitate a planned industrial park development by the city of Anacortes, was mentioned. Opposition was expressed to the construction of additional dams on the Skagit River or its tributaries.

Residents of Whatcom County expressed the desire for multiple-water-use development, including the impounding of waters of the Nooksack River system and an examination of the impact of any impoundments on water quality, water supply and fish resources. Increased flood control was indicated to be an important need along the Nooksack River. Contamination of Lake Whatcom, through recreation activity, was reported. Lake Whatcom is a source of municipal and industrial water for the city of Bellingham. The desire for more water-oriented recreation sites was also expressed, as well as the retention of streams, or segments thereof, in their natural state. The strong needs for adequate sewerage systems was indicated. Representatives of the city of Bellingham defined their water supply system and stated that a supplemental source under consideration was the South Fork of the Nooksack River, where the city owned water rights.

Everett Hearing. The principal need expressed for Island County was for increased water supply to meet the domestic requirements of Whidbey and Camano Islands. The Skagit, Stillaguamish, and Snohomish Rivers were suggested as possibilities for additional sources of water. The quality and quantity of ground water resources on the Islands was indicated as being very limited. There was strong support at the public hearings for comprehensive water and resource development. The need was indicated for small boat harbors and related facilities.

Comments as related to King County were, primarily, oriented toward the need for cooperation and coordination among the various agencies engaged in the Puget Sound Study. The Snoqualmie, Green, Cedar, Sammamish, Raging, Tolt, and Skykomish Rivers were indicated as presenting problems for flood control. Emphasis was indicated for the establishment of flood control zones and the need to provide for the removal of excess rainwater that falls on the Green River Valley floor. Concern was expressed for the economic and physical requirements for navigation and water-oriented industrial sites in King County. The lack of drainage and weed control were cited as problems. Opposition was expressed to the damming of remaining sport-navigable, free-flowing streams for the purpose of hydropower developments.

In Snohomish County the need was expressed for a balanced development of water resources to accommodate an expanding economy, with comprehensive planning including residential and industrial development, transportation, agriculture, recreation and flood control. Concern was indicated for the conservation and enhancement of fish resources. Flood control was requested with specific areas identified that needed protection. Control of waters and rivers in the watershed was recommended through the construction of flood control dams.

Olympia Hearing. Clallam County representatives expressed concern for the depletion of salmon spawning areas on the Elwha River due to the construction of dams. Support was given for fish ponds or farms at the mouth of the Elwha River and development of the Dungeness area to include a fish farm program. Physical improvements to the harbor at Port Angeles for small boat moorage needs was desired. The need for fish ladders for two dams on the Elwha River was stated.

In Jefferson County the needs were expressed for adequate water supply to satisfy the industrial needs of the Port Townsend area. The need for pipelines from major streams to provide additional water supply was indicated, as well as an integrated development of a boat haven for the Port Townsend area.

In Kitsap County a need was also expressed for additional municipal and industrial water supply to meet the need requirements of the city of Bremerton and other communities.

In Mason County, the need was indicated for watershed plans for a number of streams in that county. Concern for destruction of salmon and shellfish as a result of polluted waters was given. The need to remove the sources of pollution from industrial wastes, strong detergents, pesticides, and insecticides was indicated. Also, an additional hydroelectric plant on the South Fork of the Skokomish River was stated as being under study. The water pollution problems that could arise from recreation use in watersheds were suggested for further investigation. Data were submitted on drainage and flood control problems and land use for various small watersheds in the area.

In Thurston County support was given for further consideration of all future water needs in the Deschutes River Basin. Irrigation needs, as well as flood control and water storage for domestic water supplies, were stated. A recommendation was made for a study of navigation needs in connection with development of the Nisqually River delta and for the Deschutes River as a potential source of industrial water supply. Flood control needs were also described.

General Planning

The Puget Sound Area has an abundant supply of water and related land resources to meet most present and future needs projected for the Area over the next 50 years. However, considerable care in the use of these resources is necessary to insure that needs can be met in the most efficient manner possible, recognizing environmental and ecological concerns. A broad range of alternative measures for meeting the water and related land resource needs of the Area was viewed in the planning process, with a combination of measures found to be necessary to fully meet the needs. The following discussion summarizes the opportunities and various alternatives considered in formulation of the Comprehensive Plan.

Resource Opportunities. Ten major and twelve minor rivers flow into Puget Sound, providing the major source of 38,865,000 acre-feet of average annual fresh water runoff. This resource is compared to 5,705,200 acre-feet of average annual municipal and industrial water supply withdrawal and 272,200 acre-feet of irrigation diversion proposed from surface waters by the year 2020. However, a large amount of the water diverted for irrigation would be returned to the streams. The total withdrawal of 5,977,400 acre-feet represents about 15 percent of the average annual surface runoff. The remaining 85 percent represents water that would be available for instream uses, e.g., fish production, recreation, water quality control, aesthetics, etc.

The above of course is a simplification of the complex analysis required when a supply-demand study is made for consumptive water use. Minimum flows rather than averages, peak weekly and peak monthly demand, instream storage capability and local distribution system storage are all considered for specific system needs. However, the above comparison gives some illustration of the resource availability.

There are adequate flows within the river basins to satisfy the water supply requirements of major purveyors and other uses, provided these flows can be controlled and managed. Numerous sites are available for multiple-purpose storage in major river basins. Existing and potential storage sites are shown in Appendices III, Hydrology and Natural Environment, XII, Flood Control and XIV, Watershed Management.

Ground water supplies appear to be adequate to meet much of the present and future needs of small and rural communities and provide supplemental supplies for the larger cities, although further investigations are required in order to accurately determine the amount of usable ground water resources. This requirement, as well as the need for additional hydrologic information is discussed in detail in Appendix III, Hydrology and Natural Environment.

The land resource comprises about 8,404,000 acres with forests occupying 84 percent of the total area, cropland and ranges 8 percent, and rural nonagricultural use and built-up or intensively developed areas the remaining 8 percent. About 264,000 acres of land currently in non-intensive use are projected to be displaced by the year 2020 to meet the needs for residential, commercial and industrial development. Under pattern C_2 (see Projected Land Use), about 36 percent of displacement would be at the expense of rural nonfarmland, 47 by loss of forest land and only 17 percent from crop and range lands. Future residential and industrial growth projected in Appendix IV, Economic Environment, can be accommodated by the Area's land resource without significant displacement of the fertile river

valleys now in agricultural use nor complete utilization of the fresh water and marine shorelines. Land use pattern C_2 allows for this accommodation by more than doubling current population densities by the year 2020. Detailed land use planning and management criteria are required, however, to insure that changing land use is consistent with environmental and ecological needs.

The land resources within the Area, 10 percent of which are under State ownership, are sufficient to meet the future needs of outdoor recreation, including fishing and hunting. Municipal watersheds, currently closed to public use or allowing only restricted public access, are viewed as being potentially available for this purpose at such time as the need is commensurate with the associated costs of water treatment. These watersheds contain approximately 320,000 acres of land as compared to the total land area of 8,404,000 acres (approximately 4 percent of the total land is in municipal watershed). Many municipal water suppliers own all or a portion of their watersheds. Consequently, these property rights, as well as public health impacts of recreation activity on water quality, must be considered before the watersheds are made available for recreation use. In addition, the question of payment for expensive treatment facilities (required if the watersheds were opened) must be studied.

Alternatives Considered. Potential output from existing and under-construction projects were examined to determine net needs for present and future development. However, consideration was given to changing the operation of existing projects to gain greater net benefits when this appeared to be in the overall best interest of the Area.

Direct river pumping and treatment, desalinization, diversion, storage, increased ground water utilization, and improved water yield through various watershed management practices were considered as means for satisfying water supply needs of municipalities and industry. Desalinization of water is not considered to be economically competitive with other alternatives at this time. Consequently, diversion, storage, direct pumping and treatment of water from the larger streams and ground water use were viewed as the most feasible alternatives for satisfying future municipal and industrial requirements.

Surface and ground water supplies are adequate in most basins to satisfy irrigation and water supply needs through direct diversion. However, more efficient use of the water resources can, in some basins, provide opportunities for other competing uses as well as being the best alternative means for meeting the requirements for irrigation.

Water quality problems associated with organic wasteloadings exist in many of the rivers and lakes and localized marine waters in the Area. However, with construction of collection and treatment facilities, the water quality standards set forth in the Implementation and Enforcement Plan for Interstate Waters, 1967, and Intrastate Waters, 1969, of the State of Washington, can be met. Alternatives considered for satisfaction of water quality needs were sewage collection and treatment facilities, minimum streamflows for the assimilation of residual wastes after treatment, sewer outfall and dispersal facilities, sludge removal, and waste collection facilities on small boats used for pleasure purposes.

Navigation channel deepening in most basins appeared to be the only alternative for accommodating the growing vessel drafts. Land requirements for terminal and water transport-oriented industrial development can be met with retention and development of sites found in this study to be favorable for development. Alternatives to sites shown in Appendix VIII, Navigation, include Indian Reservations and other Federal lands. Lands suitable for terminal and/or water transport-oriented industry are located primarily along the eastern shoreline of Puget Sound in developed and undeveloped areas.

Ninety-seven sites along the Puget Sound shoreline are suitable for development as small boat harbors with the capability of accommodating over 115,000 wet moorages. Small boat harbor sites, inventoried in this study, are sufficient to meet public wet moorage development needs to the year 2020 in most basins, with some use of moorage opportunities in adjacent basins possible. In the more populated basins greater use of dry moorage may be required in the long-range period to satisfy total moorage needs than has been the case in the past or that has been indicated desirable by boaters. Selection of specific sites for early action development is facilitated by the number of alternatives available.

The Area has numerous sites that have a potential for hydroelectric power development as part of multiple-purpose storage projects, although only a few sites were included in the Comprehensive Plan for development. A number of pumped storage sites exist that could be used to satisfy peaking power requirements in a long-range period. Nuclear power production within the Area would require further

studies before final decisions as to plant locations could be made. The planning for the Puget Sound Area recognized the potential in those basins where active consideration had been given to development of the nuclear power plants. However, the Plan neither sets forth the specific sites for nuclear power plants nor schedules their development.

Considerable opportunity exists in the Area for accomplishing a reduction in the growth of flood damages through flood plain zoning and land use management. Other management alternatives including floodproofing, and warning and evacuation systems can provide some relief to existing as well as future developments located in the flood plain. Flood insurance, while reducing the financial burden to the property owners merely results in a transfer of costs from the individual to society. However, as provision of flood insurance requires flood plain zoning by local government, it serves as an inducement to regulate future development in the flood plain, thereby helping to stem the growth in flood damages. The construction of levees, channel improvements, stabilization and drainage facilities, small watershed projects and accompanying management practices are measures which provide opportunities to accomplish desired flood control objectives. In only a few basins is there adequate storage capability to satisfy flood control objectives by this means alone. Other structural measures, including levees and diversion channels, are required in addition to management of land use to provide adequate flood protection and damage reduction.

Watershed management alternatives considered for reducing erosion and sedimentation and providing water management included directing future intensive development to land areas suitable for such uses with minimal disruption of the natural environment, land treatment to stabilize soils and vegetative cover and construction of multiple-purpose small watershed projects.

The numerous sites found in the study to represent a potential for outdoor recreation activity are generally identified. Specific locations were avoided to reduce possible land speculation and provide greater flexibility for local and state recreation planners in programming future development of picnicking and camping facilities. The sites generally identified can be viewed as alternatives in a temporal sense.

Sport and commercial fish production enhancement alternatives considered included increasing the natural productivity of the existing resource through restoration of stream habitat, improvement of passage at man-made and natural barriers and construction of artificial propagation facilities. Wildlife propagation alternatives viewed included bird farms and habitat improvement. Access through easement or acquisition was emphasized as the basic means for increasing sport fishing and hunting opportunities.

A detailed discussion of specific alternatives considered in plan formulation for each river basin or island grouping is contained in Appendix XV, Plan Formulation.

SUMMARY OF COMPREHENSIVE PLAN

The Comprehensive Plan for the Puget Sound Area includes both programs and projects, categorized as early action or long-range depending upon the urgency of the needs to which they are responsive. The early action portion of the Plan provides for management and development of water and related land resources required to meet the Area's needs projected for the year 1980. The long-range portion of the Comprehensive Plan deals with programs and projects to be implemented after the year 1980 to meet foreseeable needs projected to the year 2020. The Plan is first discussed in general terms and summarized in tables, followed by a detailed description by features. Exhibit A contains individual basin discussions, including a listing of plan elements and figures showing project locations.

Planning was done with an overview of the Area's total needs and resources with each river basin provided for as part of the total Comprehensive Plan. In most basins a plan has been prepared that is responsive to the planning objectives and expressed desires of local residents. However, in two of the major basins the competing demands could not be resolved and alternative plans are presented.

Two alternative plans have been developed for the Skagit-Samish Basins and for the Nisqually-Deschutes Basins to aid in the determination of future development. In the Skagit-Samish Basins, Alternative A allows full use of storage opportunities to obtain maximum flood control in the Skagit River Basin. The assumption is made under this Alternative that no part of the Skagit River or its tributaries would be included in the National Wild and Scenic Rivers system. However, portions of the Skagit River system would be included for study under a State recreational river system. Alternative B is based on the assumption that the entire 165-mile river complex

cited in the Wild and Scenic Rivers Act (PL 90-542) would be designated in the National Wild and Scenic Rivers system. The assumption is also made that the entire complex would be given a "Recreational River" classification and that nonstorage developments would be compatible with this classification. Considerable portions of each alternative are the same and would not be affected by the river classifications.

In the Nisqually-Deschutes Basins, Alternative A would allow for a projected outdoor recreation-wildlife and biotic research use of the delta. Alternative B provides for the utilization of a portion of the delta as a navigation port and for related industrial development.

As planning is a dynamic process, the additional data that would be obtained from the studies recommended in the report and the various appendices, together with future technological innovations would provide a basis for updating the plan through periodic reviews. Future reviews would allow for changes in the Area's economy and include new economic forecasts to be used in updating projections of water and related land resource needs.

Early Action, 1970-1980

The early action portion of the Comprehensive Plan for the Puget Sound Area includes management programs for water quality control of rivers and marine waters, development and dissemination of flood plain information, watershed practices of land treatment, flood prevention, agricultural and urban water management, and fish and wildlife programs. Projects include such measures as diversion structures for municipal and industrial water supply, irrigation facilities, channel deepening and construction for navigation, levees and channel improvements for flood control, drainage control structures in small watersheds, recreation facilities, fish ladders, hatcheries, and game farms. Other projects include both small stream impoundments and large reservoirs to capture excess runoff for flood control and to provide storage for low flow augmentation for fish use, municipal and industrial water supply, water quality improvement and irrigation. Hydroelectric power is included where justified as a feature of a multiple-purpose storage project. Table 4-1 summarizes the early action portion of the Comprehensive Plan by management programs and nonstorage projects, showing the cumulative program costs for the period 1970-1980 and the average annual benefits and costs of projects, and costs of programs required prior to 1980. Also shown are the capital investment costs for this period. Multiple-purpose storage projects scheduled for early action are shown in Table 4-2. Four alternative combinations of basin plans are presented.

Other projects planned for early action include development of multiple-purpose storage on the South Fork of the Nooksack River at a site near Edfro Creek, on the North and Middle Forks of the Snoqualmie Rivers, on the Sultan River through second stage construction of Culmback Dam, and on the Cedar River near the outlet of Chester Morse Lake. These are multiple-purpose projects providing flood control storage and satisfying the needs of other purposes including municipal and industrial water supply, recreation, low flow augmentation for fish resource enhancement, and electric power production. Adjustments in power operation at several existing reservoirs are indicated in Table 4-2. These include the Upper Baker Dam in the Skagit-Samish Basins, with power production reduced in order to provide for flood control storage, and in the Nisqually-Deschutes Basins where the Alder Dam reservoir project would be operated to provide flood control on a firm basis with little or no reduction of power generation.

A coordinated sea coast resource management program is included in the Comprehensive Plan, which provides for an appraisal of the present and potential resource, a determination of opportunities for multiple use and preparation of guidelines for future use. Much of the data acquired as part of this study would be useful in implementing the seacoast resource management program.

Long-Range, 1980-2020

The long-range features of the Comprehensive Plan, including management programs and projects requiring implementation after 1980 and before the year 2020, are reflected in the cumulative program costs contained in Table 4-3 and capital investment costs shown in Table 4-4. The features are similar to those proposed for implementation during the early action period and represent additional measures designed to accommodate the subsequent growth in water and related land resource needs.

Additional multiple-purpose storage development proposed includes projects on the North Fork Nooksack, Sauk (Alternative A), South Fork Tolt, North Fork Snoqualmie, Cedar, Puyallup and Deschutes Rivers. In the Elwha-Dungeness Basins the existing dam below Lake Aldwell would be modified to increase utilization of existing storage.

PHOTO 4-1. Cucumber harvesting in Skagit River Basin. Soil Conservation Service Photo

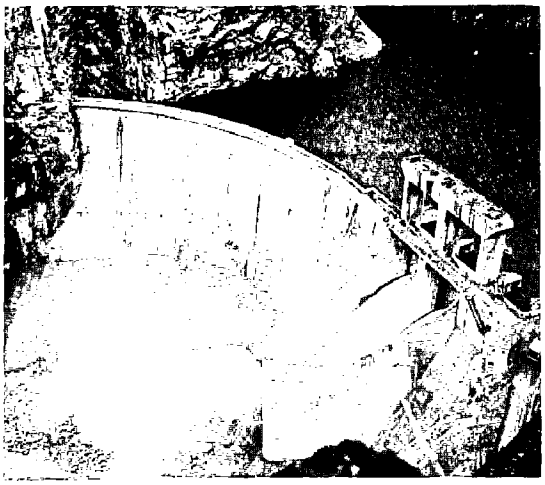


PHOTO 4-2. Gorge Dam on the Skagit River, part of Seattle City Light's hydroelectric development. Seattle City Light Photo

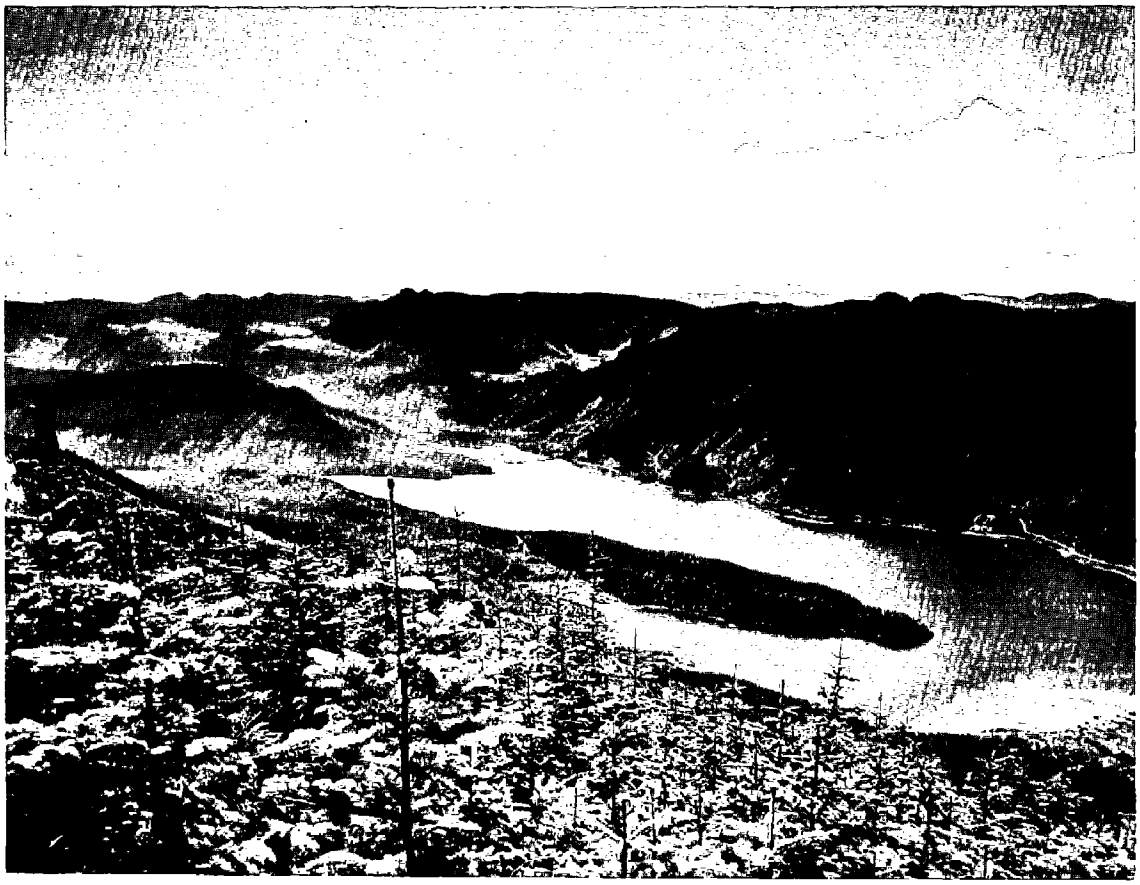


PHOTO 4-3. Chester Morse Lake, lying in Cedar River watershed, is proposed for increase in storage to provide flood control and additional conservation storage for municipal and industrial water supply and low stream flow augmentation. Seattle Water Department Photo

TABLE 4-1. Costs and benefits—early action (1970-1980) portion of Comprehensive Plan, Puget Sound Area ($1000)

Features	Basins													Puget Sound Area			
	Nooksack-Sumas	Skagit-Samish Alt. A	Skagit-Samish Alt. B	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes Alt. A	Nisqually-Deschutes Alt. B	West Sound	Elwha-Dungeness	San Juan Islands	Alt. A S.S. Alt. A—N.D.	Alt. A—S.S. Alt. B—N.D.	Alt. B—S.S. Alt. A—N.D.	Alt. B—S.S. Alt. B—N.D.
Management Programs[1]																	
Water Quality Monitoring, Evaluation and Control																	
Invest. Cost	840	490	490	160	250	2,400	3,400	2,600	350	350	750	350	340	11,930	11,930	11,930	11,930
Flood Plain Mgmt.																	
Invest. Cost	46	115	115	25	0	55	147	185	82	82	125	31	0	811	811	811	811
Watershed Mgmt. Programs[4]																	
Invest. Cost	60,532	87,556	87,556	28,693	16,266	108,504	225,954	135,672	40,710	40,710	97,404	17,852	11,897	831,040	831,040	831,040	831,040
Fish & Wildlife Programs																	
Invest. Cost	488	253	253	160	15	450	440	403	127	127	465	176	15	2,992	2,992	2,992	2,992
Total Management																	
Invest. Cost $1000	61,906	88,414	88,414	29,038	16,531	111,409	229,941	138,860	41,269	41,269	98,744	18,409	12,252	846,773	846,773	846,773	846,773
Nonstorage Projects																	
M&I Water Supply																	
Ground Water																	
Invest. Cost	1,663	0	0	564	216	180	2,400	13,154	1,290	1,290	2,470	24	670	22,631	22,631	22,631	22,631
Av. Ann. Cost	192	0	0	75	25	20	362	1,239	168	168	279	6	21				
Av. Ann. Benefits	192	0	0	75	25	20	362	1,239	168	168	279	6	21				
Net Ann. Benefits	0	0	0	0	0	0	0	0	0	0	0	0	0				
Surface Water																	
Invest. Cost	7,112	5,440	5,440	0	10,100	28,743	19,304	28,909	0	0	5,850	1,440	0	106,898	106,898	106,898	106,898
Ann. Cost	1,073	503	503	0	634	2,512	2,973	2,818	0	0	688	1,673	0				
Ann. Benefits	1,073	503	503	0	634	2,512	2,973	2,818	0	0	688	1,673	0				
Net Ann. Benefits	0	0	0	0	0	0	0	0	0	0	0	0	0				
Irrigation																	
Ground Water																	
Invest. Cost	2,230	1,072	1,072	270	0	135	0	136	273	273	0	0	0	4,116	4,116	4,116	4,116
Ann. Cost	311	179	179	45	0	22	0	17	32	32	0	0	0				
Ann. Benefits	311	179	179	45	0	22	0	17	32	32	0	0	0				
Net Ann. Benefits	0	0	0	0	0	0	0	0	0	0	0	0	0				
Surface Water																	
Invest. Cost	470	278	278	270	0	690	0	204	27	27	50	15,380	0	17,369	17,369	17,369	17,369
Ann. Cost	35	46	46	45	0	114	0	26	3	3	7	897	0				
Ann. Benefits	35	46	46	45	0	114	0	26	3	3	7	1,467	0				
Net Ann. Benefits	0	0	0	0	0	0	0	0	0	0	0	570	0				
Water Quality Control Treatment																	
Invest. Cost	15,800	4,880	4,880	1,860	3,187	97,390	113,850	34,000	5,375	5,375	10,900	13,595	1,824	302,661	302,661	302,661	302,661
Av. Ann. Costs	998	320	320	127	208	5,662	6,770	1,964	289	289	676	713	44				
Ann. Benefits	998	320	320	127	208	5,662	6,770	1,964	289	289	676	713	44				
Net Ann. Benefits	0	0	0	0	0	0	0	0	0	0	0	0	0				

Navigation																	
Invest. Cost	667	1,465	1,465	0	0	2,200	3,779	5,430	1,853	1,853	0	0	0	15,394	15,394	15,394	15,394
Av. Ann. Cost	36	81	81	0	0	120	191	318	92	92	0	0	0				
Av. Ann. Benefits	42	105	105	0	0	172	339	389	138	138	0	0	0				
Net Ann. Benefits	6	24	24	0	0	52	148	71	46	46	0	0	0				
Small Boat Harbors[2]																	
Invest. Cost	(1,766)	(1,714)	(1,714)	0	(4,648)	(6,306)	(4,139)	(3,120)	(459)	(459)	(8,685)	(1,434)	(2,951)	(35,222)	(35,222)	(35,222)	(35,222)
Av. Ann. Cost	(105)	(109)	(109)	0	(298)	(404)	(280)	(200)	(29)	(29)	(556)	(92)	(189)				
Av. Ann. Benefits	(164)	(159)	(159)	0	(431)	(585)	(391)	(290)	(43)	(43)	(806)	(133)	(274)				
Net Ann. Benefits	(59)	(50)	(50)	0	(133)	(181)	(111)	(90)	(14)	(14)	(250)	(41)	(85)				
Power	--	--	--	--	--	--	--	--	--	--	--	--	--				
Flood Control																	
Invest. Cost	2,500	37,800	45,800	7,700	0	31,950	12,000	1,600	0	0	150	0	0	93,700	93,700	101,700	101,700
Ann. Costs	125	2,116	2,536	454	0	1,545	601	86	0	0	11	0	0				
Ann. Benefits	141	3,450	3,778	500	0	4,130	723	103	0	0	12	0	0				
Net Ann. Benefits	16	1,334	1,242	46	0	2,585	122	17	0	0	1	0	0				
Watershed Management																	
Invest. Cost	10,973	10,637	10,637	1,645	0	2,503	2,180	4,972	0	0	1,079	0	0	33,989	33,989	33,989	33,989
Ann. Costs	614	594	594	92	0	142	119	271	0	0	59	0	0				
Ann. Benefits	2,269	2,242	2,242	288	0	397	242	382	0	0	150	0	0				
Net Ann. Benefits	1,655	1,648	1,648	196	0	255	123	111	0	0	91	0	0				
Recreation																	
Invest. Cost	25,680	35,814	35,814	20,420	28,450	60,900	54,425	35,389	21,951	21,951	62,212	8,259	15,224	368,724	368,724	368,724	368,724
Ann. Costs	1,743	2,555	2,555	1,256	2,257	4,039	3,792	2,339	1,697	1,697	5,405	698	1,112				
Ann. Benefits	3,156	3,600	3,600	1,484	2,715	5,720	4,560	3,255	2,590	2,590	6,000	1,125	2,700				
Net Ann. Benefits	1,413	1,045	1,045	228	458	1,681	768	916	893	893	595	427	1,588				
Fish & Wildlife																	
Invest. Cost	3,455	11,799	11,799	5,220	577	8,797	5,067	3,306	5,051	2,551	6,284	2,749	585	52,890	50,390	52,890	50,390
Av. Ann. Costs	271	1,420	1,420	521	42	987	438	366	494	347	583	282	47				
Av. Ann. Benefits	534	1,910	1,910	1,528	484	2,728	1,026	849	1,456	1,313	1,571	1,758	103				
Net Ann. Benefits	263	490	490	1,007	442	1,741	588	483	962	966	988	1,476	56				
Total Nonstorage																	
Invest. Cost	70,550	109,185	117,185	37,949	42,530	233,488	213,005	127,100	35,820	33,320	88,995	41,447	18,303	1,018,372	1,015,872	1,026,372	1,023,872
Av. Ann. Costs	5,398	7,911	8,331	2,615	3,166	11,017	15,246	9,444	2,775	2,628	7,708	4,269	1,224				
Av. Ann. Benefits	8,751	12,355	12,683	4,092	4,066	17,331	16,995	11,042	4,676	4,533	9,383	6,742	2,868				
Net Ann. Benefits	3,353	4,444	4,352	1,477	900	6,314	1,749	1,598	1,901	1,905	1,675	2,473	1,644				
Total Storage[3]																	
Invest. Cost	27,200	0	0	0	0	132,293	5,610	--	0	0	0	0	0	165,103	165,103	165,103	165,103
Av. Ann. Costs	1,540	133	133	0	0	7,008	312	--	0	0	0	0	0				
Av. Ann. Benefits	1,690	300	300	0	0	8,177	353	--	82	82	0	0	0				
Net Ann. Benefits	150	167	167	0	0	1,169	41	--	82	82	0	0	0				
Total Plan																	
Invest. Cost	$159,656	$197,599	$205,599	$66,987	$59,061	$404,690	$477,190	$265,960	$77,089	$74,589	$187,739	$59,856	$30,555	$2,030,248	$2,027,748	$2,038,248	$2,035,748

[1] Shown are cumulative annual program costs from 1970 to 1980.

[2] Included with Recreation.

[3] For feature data see Table 4-2, Storage Projects, Puget Sound Area.

[4] Does not include operation and maintenance costs or other program costs not distributed by basin.

TABLE 4-2. Costs and benefits—early action (1970-1980) storage projects, Puget Sound Area ($1000)

Features	Basins								
	Nooksack-Sumas (Edfro)	Skagit-Samish Upper Baker	Snohomish Culmback (Sultan)	Snohomish North Fork Snoqualmie	Snohomish Middle Fork Snoqualmie	Snohomish Total Snohomish	Cedar-Green Chester Morse Lake	Nisqually-Deschutes Alder Dam and Reservoir	Puget Sound Area
M&I Water Supply									
Investment Cost	2,414		6,798			6,798			9,212
Av. Ann. Cost	137		318			318			455
Av. Ann. Benefits	150		350			350			500
Net Ann. Benefits	13		32			32			45
Flood Control									
Investment Cost	22,935		8,642	12,138	25,088	45,868	4,740	0	73,543
Av. Ann. Cost	1,298	133	443	665	1,169	2,277	263	0	3,971
Av. Ann. Benefits	1,425	300	707	690	1,657	3,054	298	39	5,116
Net Ann. Benefits	127	167	264	25	488	777	35	39	1,145
Power									
Investment Cost				32,845		32,845			32,845
Av. Ann. Cost				1,798		1,798			1,798
Av. Ann. Benefits				1,867		1,867			1,867
Net Ann. Benefits				69		69			69
Recreation									
Investment Cost	1,609			16,959	19,683	36,642			38,251
Av. Ann. Cost	92			929	1,184	2,113			2,205
Av. Ann. Benefits	100			964	1,296	2,260			2,360
Net Ann. Benefits	8			35	112	147			155
Fish and Wildlife									
Investment Cost	242		7,604	1,618	918	10,140	870	0	11,252
Av. Ann. Cost	13		369	89	44	502	49	0	564
Av. Ann. Benefits	15		500	92	54	646	55	43	759
Net Ann. Benefits	2		131	3	10	144	6	43	195
Total Storage									
Investment Cost	27,200		23,044	63,560	45,689	132,293	5,610	0	165,103
Av. Ann. Cost	1,540	133	1,130	3,481	2,397	7,008	312	0	8,993
Av. Ann. Benefits	1,690	300	1,557	3,613	3,007	8,177	353	82	10,602
Net Ann. Benefits	150	167	427	132	610	1,169	41	82	1,609

TABLE 4-3. Total program investment costs, Puget Sound Area ($1000)

Feature and Period	Nooksack-Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha Dungeness	San Juan Islands	Puget Sound Area
Water Quality Control												
1970-1980	840	490	160	250	2,400	3,400	2,600	350	750	350	340	11,930
1980-2000	710	360	300	200	2,512	4,840	4,200	240	360	440	160	14,322
2000-2020	790	420	340	240	1,400	5,320	5,100	286	480	520	200	15,096
Total	2,340	1,270	800	690	6,312	13,560	11,900	876	1,590	1,310	700	41,348
Flood Control												
1970-1980	46	115	25	0	55	147	185	82	125	31	0	811
1980-2000	92	168	46	0	100	240	100	114	100	20	0	980
2000-2020	92	168	46	0	100	240	100	114	100	20	0	980
Total	230	451	117	0	255	627	385	310	325	71	0	2,771
Watershed Management												
1970-1980	60,532	87,556	28,693	16,266	108,504	225,954	135,672	40,710	97,404	17,852	11,897	831,040
1980-2000	70,389	99,226	29,480	18,412	134,227	230,301	94,123	68,131	121,702	23,229	13,989	903,209
2000-2020	65,373	109,318	28,547	19,642	135,540	230,044	138,264	34,506	120,616	24,437	13,720	920,007
Total	196,294	296,100	86,720	54,320	378,271	686,299	368,059	143,347	339,722	65,518	39,606	2,654,256[1]
Fish and Wildlife												
1970-1980	488	253	160	15	450	440	403	127	465	176	15	2,992[2]
1980-2000	430	200	320	15	750	602	630	478	800	309	0	4,534
2000-2020	435	200	320	15	750	776	630	470	800	300	0	4,696
Total	1,353	653	800	45	1,950	1,818	1,663	1,075	2,065	785	15	12,222[2]
Total All Programs												
1970-1980	61,906	88,414	29,038	16,531	111,409	229,941	138,860	41,269	98,744	18,409	12,252	846,773
1980-2000	71,621	99,954	30,146	18,627	137,589	235,983	99,053	68,963	122,962	23,998	14,149	923,045
2000-2020	66,690	110,106	29,253	19,897	137,790	236,380	144,094	35,376	121,996	25,277	13,920	940,779
Total	200,217	298,474	88,437	55,055	386,788	702,304	382,007	145,608	343,702	67,684	40,321	2,710,597

[1] Does not include $237,364,000 in program costs for beach erosion and sediment studies, soil surveys, etc., planned for the Puget Sound Area but not apportioned by basins.

[2] Does not include $388,000 for stream surveys planned for Puget Sound Area.

TABLE 4-4. Total project investment costs, Puget Sound Area ($1000)

Feature and Period	Nooksack-Sumas	Skagit-Samish Alt. A	Skagit-Samish Alt. B	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup
M&I Water Supply								
1970-1980	11,189	5,440	5,440	564	10,316	35,721	21,704	42,063
1980-2000	9,077	8,125	8,125	858	2,500	64,382	74,520	36,516
2000-2020	4,998	11,290	11,290	1,152	0	19,465	87,847	59,607
Total	25,264	24,855	24,855	2,574	12,816	119,568	184,071	138,186
Irrigation								
1970-1980	2,700	1,350	1,350	540	0	825	0	340
1980-2000	22,240	7,100	7,100	540	0	527	55	680
2000-2020	0	17,750	17,750	0	0	175	55	340
Total	24,940	26,200	26,200	1,080	0	1,527	110	1,360
Water Quality Control								
1970-1980	15,800	4,880	4,880	1,860	3,187	97,390	113,850	34,000
1980-2000	19,030	8,050	8,050	3,294	8,110	32,480	275,800	51,200
2000-2020	37,080	8,900	8,900	3,980	10,345	43,700	237,000	79,600
Total	71,910	21,830	21,830	9,134	21,642	173,570	626,650	164,800
Navigation								
1970-1980	667	1,465	1,465	0	0	2,200	3,779	5,430
1980-2000	1,343	9,417	9,417	0	0	7,696	0	4,488
2000-2020	0	2,989	2,989	0	0	0	0	0
Total	2,010	13,871	13,871	0	0	9,896	3,779	9,918
Power								
1970-1980	0	0	0	0	0	32,845	0	0
1980-2000	20,000	68,000	0	0	0	0	0	0
2000-2020	0	0	0	0	0	0	0	0
Total	20,000	68,000	0	0	0	32,845	0	0
Flood Control								
1970-1980	25,435	37,800	45,800	7,700	0	77,818	16,740	1,600
1980-2000	26,760	65,800	7,800	3,700	0	39,870	1,300	27,500
2000-2020	0	0	0	0	0	36,255	0	0
Total	52,195	103,600	53,600	11,400	0	153,943	18,040	29,100
Watershed Management								
1970-1980	10,973	10,637	10,637	1,645	0	2,503	2,180	4,972
1980-2000	5,950	1,850	1,850	5,620	3,245	12,387	5,510	4,167
2000-2020	936	1,460	1,460	1,310	0	100	200	0
Total	17,859	13,947	13,947	8,575	3,245	14,990	7,890	9,139
Recreation								
1970-1980	27,289	35,814	35,814	20,420	28,450	97,542	54,425	35,389
1980-2000	27,200	42,700	42,700	20,800	31,800	69,500	70,000	55,600
2000-2020	49,800	71,300	71,300	40,200	51,900	123,200	104,600	88,040
Total	104,289	149,814	149,814	81,420	112,150	290,242	229,025	179,029
Fish and Wildlife								
1970-1980	3,697	11,799	11,799	5,220	577	18,937	5,937	3,306
1980-2000	11,167	18,909	18,909	5,568	528	12,294	7,916	8,039
2000-2020	13,610	23,035	23,035	9,412	734	18,220	16,517	11,864
Total	28,474	53,743	53,743	20,200	1,839	49,451	30,370	23,209
Total (All Features)								
1970-1980	97,750	109,185	117,185	37,949	42,530	365,781	218,615	127,100
1980-2000	142,767	229,951	103,951	40,380	46,183	239,136	435,101	188,190
2000-2020	106,424	136,724	136,724	56,054	62,979	241,115	446,219	239,451
Total	346,941	475,860	357,860	134,383	151,692	846,032	1,099,935	554,741

[1] Alternative A—Skagit-Samish Basins.

[2] Alternative A—Nisqually-Deschutes Basins.

Nisqually-Deschutes Alt. A	Nisqually-Deschutes Alt. B	West Sound	Elwha-Dungeness	San Juan Islands	Puget Sound Area: Alt. A–S.S.[1] Alt. A–N.D.[2]	Alt. A–S.S. Alt. B–N.D.	Alt. B–S.S. Alt. A–N.D.	Alt. B–S.S. Alt. B–N.D.
1,290	1,290	8,320	1,464	670	138,741	138,741	138,741	138,741
435	435	18,190	2,678	10,200	227,481	227,481	227,481	227,481
1,167	1,167	5,360	848	0	191,734	191,734	191,734	191,734
2,892	2,892	31,870	4,990	10,870	557,956	557,956	557,956	557,956
300	300	50	15,380	0	21,485	21,485	21,485	21,485
680	680	70	0	0	31,892	31,892	31,892	31,892
1,080	1,080	70	0	0	19,470	19,470	19,470	19,470
2,060	2,060	190	15,380	0	72,847	72,847	72,847	72,847
5,375	5,375	10,900	13,595	1,824	302,661	302,661	302,661	302,661
6,760	6,760	25,300	9,760	2,968	442,752	442,752	442,752	442,752
10,200	10,200	37,300	21,300	3,600	493,005	493,005	493,005	493,005
22,335	22,335	73,500	44,655	8,392	1,238,418	1,238,418	1,238,418	1,238,418
1,853	1,853	0	0	0	15,394	15,394	15,394	15,394
3,713	6,113	0	0	0	26,657	29,057	26,657	29,057
0	0	0	0	0	2,989	2,989	2,989	2,989
5,566	7,966	0	0	0	45,040	47,440	45,040	47,440
0	0	0	0	0	32,845	32,845	32,845	82,845
0	0	0	0	0	88,000	88,000	20,000	20,000
0	0	0	0	0	0	0	0	0
0	0	0	0	0	120,845	120,845	52,845	52,845
0	0	150	0	0	167,243	167,243	175,243	175,243
0	3,000	1,140	0	0	166,070	169,070	108,070	111,070
3,500	3,500	0	2,750	0	42,505	42,505	42,505	42,505
3,500	6,500	1,290	2,750	0	375,818	378,818	325,818	328,818
0	0	1,079	0	0	33,989	33,989	33,989	33,989
4,340	4,340	8,055	2,962	2,736	56,822	56,822	56,822	56,822
100	100	970	300	0	5,376	5,376	5,376	5,376
4,440	4,440	10,104	3,262	2,736	96,187	96,187	96,187	96,187
21,951	21,951	62,212	8,259	15,224	406,975	406,975	406,975	406,975
30,200	30,200	82,100	12,700	16,200	458,800	458,800	458,800	458,800
53,700	53,700	133,700	19,800	28,200	764,440	764,440	764,440	764,440
105,851	105,851	278,012	40,759	59,624	1,630,215	1,630,215	1,630,215	1,630,215
5,051	2,551	6,284	2,749	585	64,142	61,642	64,142	61,642
5,612	5,612	13,389	3,474	580	87,476	87,476	87,476	87,476
7,437	7,437	14,854	1,998	676	118,357	118,357	118,357	118,357
18,100	15,600	34,527	8,221	1,841	269,975	267,475	269,975	267,475
35,820	33,320	88,995	41,447	18,303	1,183,475	1,180,975	1,191,475	1,188,975
51,740	57,140	148,244	31,457	32,684	1,585,950	1,591,350	1,459,950	1,465,350
77,184	77,184	192,254	46,996	32,476	1,637,876	1,637,876	1,637,876	1,637,876
164,744	167,644	429,493	120,017	83,463	4,407,201	4,410,201	4,289,301	4,292,201

FEATURES OF THE COMPREHENSIVE PLAN

The Comprehensive Plan summarized in Tables 4-1 through 4-4 is expanded in this section with a description of project and program features and an enumeration of investment costs required over the 50-year planning period.

Municipal and Industrial Water Supply

The Comprehensive Plan provides specific proposals for the satisfaction of municipal and industrial water supply needs for the various urban areas and rural communities through the utilization of both ground and surface water. Surface water derived from sources within each basin would be the main supply for eight of the eleven major river basins. Three of the basins would use or depend upon imported water from adjoining basins. These include the Whidbey-Camano Islands, Cedar-Green, and Puyallup Basins. The quantity and the quality of the water supplies are adequate for all requirements. The total supply, transmission and treatment cost estimated to satisfy the Puget Sound Area municipal and industrial water supply needs over the 50-year planning period is estimated at $557,956,000, which averages $11,159,000 per year.

The early action program requires an investment of $138,741,000 for construction of supply and transmission facilities prior to 1980 to meet the level of needs projected for that year. Major water purveyors in the Cedar-Green and Puyallup Basins, which presently depend on imported water, would draw additionally upon these sources to a much greater extent, consistent with projected population and industrial expansions. In many of the basins a major portion of the early action needs can be met through expansion of the existing systems. However, significant projects would be required in several of the basins in order to meet the 1980 level needs. These include development of surface water supplies on the South Fork Nooksack River by the city of Bellingham through water stored at the proposed Edfro Dam and interbasin transfer of additional water to serve Whidbey Island by purchasing water from the city of Anacortes to the north, with the southern portion of the Island satisfied by a pipeline connecting to the mainland and serviced by the city of Everett. In the Snohomish Basin, second stage construction of Culmback Dam on the Sultan River would meet the needs of Everett. Additional interbasin transfer of water is planned to supply Seattle, with a diversion structure constructed on the North Fork Tolt River. Further utilization of conservation storage at the Howard Hanson Dam project on the Green River is recommended to satisfy the needs of Tacoma. The Olympia service area in the Nisqually-Deschutes Basins could continue obtaining its water supply through further development of ground water resources. The least costly means of satisfying water supply needs in most cases involves the expansion of existing systems, as is the case in the West Sound Basins. A Ranney well system is planned near the Elwha River to supplement the existing Morse Creek supply to meet the needs of the city of Port Angeles.

Before 2020 major development would include pumping and treating water from the Snohomish River by Everett, additional storage on the North Fork Snoqualmie and Cedar Rivers by Seattle and use of Puyallup River water through a well system or direct diversion and treatment to meet Tacoma's needs. Utilization of Lake Aldwell in the Elwha Basin to supply industrial water and other uses is recommended through modification of the outlet works to increase the conservation storage capabilities of the reservoir. Satisfaction of water supply needs in the San Juan Islands would entail use of the collection and storage capability of Mountain Lake and construction of a submerged pipeline from Orcas Island to other islands. Camano Island could receive water supply through an interbasin transfer from the Stillaguamish River.

Development of water supply by major purveyors and the consolidation of smaller water districts into larger regional supply and transmission systems is recommended to obtain economies of scale and to minimize the possible adverse impacts on the environment and water resource which could occur if every water district developed its own supply.

A total investment of $419,215,000 is estimated to be required to satisfy the municipal and industrial water supply needs of the Area from 1980 to 2020.

Irrigation

Future irrigation development is projected to be accomplished primarily through private means. In most locations where the ground and surface water supplies are adequate this can be economically developed by the individual farmers. However, in some areas project-type developments are considered

to be the best means of bringing additional lands under irrigation. All the basins in the Area would have a net increase in land under irrigation except Whidbey-Camano and San Juan Islands, which are projected to remain at current levels of development, and the Cedar-Green Basins where a net reduction in irrigated land is projected due to industrial and urban growth onto presently irrigated lands. Total investment costs for irrigation facilities over the 50-year planning period is estimated at $72,847,000, averaging $1,457,000 annually.

The early action plan sets forth the development of individual farm and project irrigation facilities costing $21,485,000. This includes diversion facilities, conveyance pipe, pumps, elevated storage tanks and on-farm distribution systems necessary to deliver the irrigation water to the individual farms. An increase of 46,300 acres of land above the current amount being irrigated is projected by the year 1980. Principal irrigation expansion is expected to occur in the Nooksack-Sumas, Skagit-Samish and Elwha-Dungeness Basins. These lands would be served by direct diversion from ground and surface sources. Storage would be necessary in only the Nooksack-Sumas Basins to provide the projected irrigation water supplies.

During the early action period all irrigation development is expected to be by the individual farmer except for the Sequim area in the Elwha-Dungeness Basins. Here a project-type development is proposed which would update the existing open ditch irrigation system and serve 6,100 acres of additional lands. Water would be diverted from the Dungeness River and conveyed by gravity pipeline to elevated storage tanks from which it would be delivered to the farmlands with adequate pressure for sprinkler irrigation. The project is estimated to cost $14,610,000, with on-farm systems required by individual farmers amounting to $770,000, for a total project cost of $15,380,000.

The long-range plan projects an incremental increase in irrigated acreages of 85,000 acres between 1980 and 2020. Project-type developments are proposed for the Nooksack-Sumas Basins prior to 2000 and the Skagit-Samish between 1980 and 2020. Storage would be necessary in the Nooksack-Sumas Basins. A multiple-purpose storage project, on the North Fork of the Nooksack River would provide the needed irrigation water supplies. Water would be released from storage into the river, diverted at selected downstream locations, and conveyed to irrigable lands.

Adequate natural streamflows are available to meet the projected irrigation needs in the Skagit-Samish Basins. Here water would be diverted from the river and conveyed by project facilities to farm headgates with adequate pressure for sprinkler irrigation.

The other lands projected for irrigation in the long-range period are located in small scattered tracts suitable for economic development by individual farmers. Adequate ground and surface water supplies are available to meet these needs.

The projected irrigation diversions and depletions for each basin are shown in Table 4-5.

TABLE 4-5. Projected irrigation diversions and depletions (1000 acre-feet)

	Present				1980				2000				2020			
	Diversion		Depletion		Diversion		Depletion		Diversion		Depletion		Diversion		Depletion	
	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW	SW	GW
Nooksack-Sumas	29.0	44.0	20.0	30.0	33.0	78.0	23.0	53.0	71.0	78.0	49.0	53.0	71.0	78.0	49.0	53.0
Skagit-Samish	3.6	8.4	3.5	8.0	7.6	23.5	7.2	22.9	17.6	32.7	16.5	32.2	55.6	42.7	53.7	41.5
Stillaguamish	3.5	1.3	2.4	0.9	7.5	5.0	5.1	3.6	11.5	8.7	7.8	6.3	11.5	8.7	7.8	6.3
Whidbey-Camano Islands	1.9	5.5	1.9	5.5	1.9	5.5	1.9	5.5	1.9	5.5	1.9	5.5	1.9	5.5	1.9	5.5
Snohomish	11.9	12.6	8.9	8.3	20.9	7.3	10.4	9.1	26.4	9.3	14.2	10.4	28.9	9.3	15.9	10.4
Cedar-Green	4.5	1.1	3.0	0.8	3.1	0.8	2.1	0.5	1.5	0.4	1.0	0.3	2.0	0.4	1.3	0.3
Puyallup	5.0	3.8	3.4	2.3	9.0	5.7	5.7	3.9	17.0	9.5	10.8	6.5	21.0	11.5	13.4	7.7
Nisqually-Deschutes	8.1	5.2	5.3	3.4	8.6	9.9	5.6	6.5	11.0	19.4	7.1	12.7	15.0	34.3	9.7	22.5
West Sound	2.5	0.6	1.7	0.4	3.3	0.8	2.3	0.5	4.3	1.1	3.0	0.7	5.3	1.3	3.7	0.9
Elwha-Dungeness	*75.0*	---	*75.0*	---	*60.0*	---	*60.0*	---	*60.0*	---	*60.0*	---	*60.0*	---	*60.0*	---
San Juan Islands	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Total	145.0	82.5	125.1	59.6	154.9	136.5	123.3	105.5	222.2	164.6	171.3	127.6	272.2	191.7	216.4	148.1

SW—Surface Water
GW—Ground Water

Source: Appendix VII.

A total investment of $51,362,000 is estimated to be required to satisfy the long-range irrigation needs for the period 1980 to 2020.

Irrigation of forest lands is largely in the experimental stages and, while not yet economically justified, may become so in the future. The Puget Sound Area is expected to provide a significant share of the national wood fiber needs through 2020. The expected demand would require accelerated growth inducement and management techniques. Should irrigation prove feasible under these circumstances, there is an estimated 635,000 acres of forest land that may be affected.

Water Quality Control

The Comprehensive Plan provides for the satisfaction of water quality needs of the Puget Sound Area through water quality surveillance, construction of collection and treatment facilities, and provision of minimum dilution flows in streams. Satisfaction of Federal and State standards for receiving waters and as set forth in the Implementation and Enforcement Plan for Interstate Waters, 1967, and for Intrastate Waters, 1969, of the State of Washington, can be achieved by implementation of the Plan. The cost of water quality control and collection and treatment facilities proposed over the 50-year planning period is estimated at $1,279,766,000, averaging $25,595,000 per year.

The early action plan requires an investment of $302,661,000 to construct collection and treatment facilities prior to 1980 to meet water quality objectives. Water quality control programs, recommended for implementation prior to 1980, are estimated to cost $11,930,000, with water quality surveillance stations to be located in all eleven major river basins of the Puget Sound Area. A comprehensive sewerage plan would be developed for each basin. The major water quality problems existing within the Area are largely the result of inadequately treated waste discharges from the pulp and paper, and food and kindred products industries. Four bays in the Area have experienced significant water quality degradation due to discharges of these wastes. Provision of adequate treatment facilities by these industries represents the primary key to the solution of the major water quality problems. Discharges from pulp and paper plants are recommended for treatment including construction of sulphite removal facilities and adequate marine outfalls and diffusers. The pulp and paper products industry contributes a significant amount of the annual wasteload on receiving waters in the Puget Sound Area.

Major investments amounting to $113,850,000 for water quality control and improvement are planned prior to 1980 for the Cedar-Green Basins, where over 50 percent of the Area population resides. Much of this program is currently underway by the Municipality of Metropolitan Seattle. Significant investments for water quality control and treatment are also indicated for the Snohomish and Puyallup Basins where $97,390,000 and $34,000,000, respectively, are scheduled for projects to be started prior to 1980. Completion of the elements contained within the Comprehensive Plan for waste treatment and collection facilities and annual treatment costs would be at a fairly uniform annual level. Substantial investments would be required, however, for sewage collection facilities.

Streamflows in most basins are expected to be adequate in the future to assimilate residual waste discharges. Lake Washington would continue to require substantial fresh-water inflows to achieve and maintain adequate quality, with recovery from near eutrophication dependent upon these inflows. A minimum flow in the Cedar River would be required to insure that nutrients formerly discharged into the lake are eventually flushed out. Inflow from the Cedar River also is required to insure that a sufficient amount of water is available to maintain an adequate level of the lake during the summer months when peak use of the Hiram Chittenden Locks occurs, resulting in salt water intrusion into Lake Union and the Ship Canal.

The long-range program for satisfying water quality needs of the Puget Sound Area provides for further construction of collection and treatment facilities commensurate with the location and intensity of growing urban and industrial developments projected for the Area. During the long-range period expansion by industry, new developments and growth of urban and recreation areas correspondingly would require that new sewer systems be installed and treatment facilities enlarged and/or constructed. A total cost of $965,175,000 is estimated for the water quality improvement in the long-range period. This includes provision for a continuation of the control program initiated during the early action period.

Navigation

Future navigation needs of the Puget Sound Area would be met through retention of lands

having a potential for terminal and water transport-oriented industrial use and the scheduling of major river and harbor channel deepening projects to accommodate the growing draft of the world's fleet. Channel projects are proposed in six of the eleven basins; through the year 2000 in the Nooksack-Sumas, Snohomish, Cedar-Green, Puyallup, and Nisqually-Deschutes Basins; and through 2020 in the Skagit-Samish Basins. The channel improvements and the retention of land areas for terminal and water transport-oriented industry would be necessary to service the annual waterborne commerce of nearly 252,000,000 tons projected for the Area by the year 2020, compared to 40,000,000 tons currently handled annually by Puget Sound Area ports. The harbor and channel projects planned for the 50-year planning period are estimated to range from $45,040,000 to $47,440,000, averaging about $900,000 each year depending on the alternative plan selected.

Pleasure boating, although included as one aspect of outdoor recreation with total costs and benefits of moorage facilities covered under that function, was accorded special study as a facet of navigation. Small boat harbors required to satisfy a major portion of present and future moorage needs are viewed as important navigation projects. The Comprehensive Plan contains those small boat harbors that would probably be undertaken by the public sector to satisfy the wet moorage needs of Puget Sound boaters.

The early action portion of the Comprehensive Plan calls for investments of $15,394,000 to deepen thirteen existing navigation channels and dredge one new channel for a total of approximately 28 miles of channel improvements (see Table 4-6) to enable vessels expected by 1980 to call at Puget Sound Area ports. Deepening of the Whatcom Creek waterway in the Nooksack-Sumas Basins would be undertaken to accommodate the large freighters that would be calling at the Port of Bellingham. Oil tankers that service refineries at Anacortes in the Skagit-Samish Basins would be provided with deeper draft channels, up to 54 feet in depth. Major investments are planned for the Snohomish Basin with deepening of the Port of Everett's East Waterway and a portion of the shallow draft Snohomish River channel to accommodate deep draft vessels. The Duwamish River waterways in the Cedar-Green Basins are also proposed for deepening as are the Port of Tacoma's existing waterways in the Puyallup Basin, and the West Waterway of Olympia Harbor in the Nisqually-Deschutes Basins.

Navigation land requirements through 1980 generally would be satisfied by expansion of existing facilities and use of areas already partially or wholly developed. However, some development of new lands in the Snohomish River delta would be needed by 1980. The undeveloped areas cited in Appendix VIII, Navigation, as having a favorable potential for development as terminal and/or water transport-oriented industrial land should be retained for future navigation related use. This would insure that land does not become a constraint to that portion of the Area's economy related to commercial navigation. However, the reservation of these favorable sites need not preclude interim use for other purposes.

Approximately 27 small boat harbor projects, providing nearly 18,000 wet moorages are proposed for construction by the public sector prior to 1980 as shown in Table 4-6. Wet moorage needs for the Stillaguamish Basin would be satisfied through development in the Skagit-Samish Basins as no favorable sites were found in that basin.

During the early action period, a study would be undertaken to determine the requirements, size, and distribution of harbors of refuge needed to provide havens for small craft seeking shelter from sudden storms. The study would be conducted over a period of 3 years at an estimated cost of $500,000 (not shown in tables). A comprehensive plan of development for harbors of refuge would be developed by the study with preliminary site layouts made of suitable locations along the shoreline of Puget Sound and adjacent waters. A preliminary economic analysis would be performed of each site to determine project feasibility. The study would be undertaken on a joint Federal-State-local basis.

A management program should be prepared for the future use of Puget Sound and adjacent marine waters on the basis of a study evaluating the needs for commercial and recreational navigation. The problem of oil spills from tankers and conflicts in traffic between vessels carrying commerce and those involved in recreational activity requires that consideration be given to such alternatives as (1) use of shipping lanes and traffic control, and (2) designation of recreational waterways.

The long-range portion of the Comprehensive

Plan provides for the satisfaction of navigation needs through additional channel deepening, commensurate with the increasing vessel drafts expected. Channels of up to 106-foot in depth are proposed to accommodate the super bulk carriers projected for the future, with channels up to 46 feet deep proposed for freighters. A 46-foot channel is proposed through the Nooksack River delta prior to the year 2000 as a new development. Deepening of the existing shallow draft channel in the Snohomish River and an extension of this waterway approximately 3 miles upstream to the head of Ebey Slough is also proposed in the long-range plan prior to the year 2000. Further deepening of existing channels is planned in the long-range period in the Nooksack-Sumas, Skagit-Samish, Snohomish, Puyallup, and Nisqually-Deschutes Basins. Long-range navigation improvements, excluding development of the Nisqually River delta, are estimated to cost $29,646,000. A deep draft channel in the Nisqually delta, dredged to a 55-foot depth, would cost an estimated $2,400,000.

On a long-range basis all sites are needed that have been designated as being favorable for navigation related development, including the Nisqually delta. The Plan provides for a multidiscipline study of the Nisqually delta to be undertaken during the early action period to determine whether port development in the delta can be undertaken compatible with fish and wildlife and outdoor recreation use. If the Nisqually delta is not developed, an alternative site would be required to satisfy projected navigation land area needs. Lands now part of Indian Reservations or military reservations that were not considered as being available for development in this study would be reviewed and studied to determine possibilities for development as alternatives to the Nisqually Delta.

TABLE 4-6. Navigation projects, Puget Sound Area

	Navigation Channels						Small Boat Harbors					
	By 1980		1980-2000		2000-2020		By 1980		1980-2000		2000-2020	
Basins	Number of Projects	Miles	Number of Projects	Miles	Number of Projects	Miles	Number of Projects	Wet Moorages	Number of Projects	Wet Moorages	Number of Projects	Wet Moorages
Nooksack-Sumas	1	1.5	2	2.8			2	870	1	550	1	1,150
Skagit-Samish	2	5.7	3	9.4	2	4.8	2	850	2	1,900	3	3,340
Stillaguamish												
Whidbey-Camano Is.							3	2,300	2	2,660	6	9,390
Snohomish	2	4.2	3	11.3			2	3,130	4	5,940	8	13,680
Cedar-Green	5	7.4					3	2,100	5	10,020		
Puyallup	3	5.4	2	2.1			2	1,550	1	2,720		
Nisqually-Deschutes												
Alternative A	1	3.8	2	5.9			1	230	2	2,180	2	1,210
Alternative B	1	3.8	3	6.5			1	230	2	2,180	2	1,210
West Sound							6	4,310	9	8,710	8	13,220
Elwha-Dungeness							2	710	3	800	1	700
San Juan Islands							4	1,480	4	1,800	5	3,040
Puget Sound Area												
Alternative A	14	28.0	12	31.5	2	4.8	27	17,530	33	37,280	34	45,730
Alternative B	14	28.0	13	22.1	2	4.8	27	17,530	33	37,280	34	45,730

More intensive and efficient use of other lands also would be considered. However, present information indicates that the bulk cargo facilities proposed as part of the navigation development in the delta may not entirely be replaceable in other basins.

After 1980 the construction of 56 new small boat harbors and expansion of 11 existing facilities would provide additional wet moorages for pleasure boaters. All of the wet moorage needs projected for the Area cannot be satisfied at sites found to have a potential for development. Consequently, proportionately greater use of dry moorage is anticipated than currently is desired by boaters in order to meet moorage needs. In several of the basins, wet moorage needs, projected to the year 2000, can be satisfied in adjacent basins. However, needs projected to the year 2020 cannot be entirely-satisfied for the Cedar-Green and Puyallup Basins even with this means. Shown in Table 4-6 is a summary of navigation projects scheduled for construction after 1980.

Power

In the Pacific Northwest, planning for the satisfaction of electrical power needs is accom-

plished on a regional basis. The geographic and economic relationships between the Puget Sound Area and the surrounding region are inter-related. The region is served on a coordinated basis through a number of interconnected generating and transmission systems with the Federal regional transmission grid of the Bonneville Power Administration providing the major lines.

As the Puget Sound Area is one of two major load centers of the region, its needs would have a strong influence on the regional rate of development. Presently the major outside source of power is from the Upper and Middle Columbia River hydroelectric plants. These plants could reach ultimate installed capacity by the 1990's, which coincides with the time that the transmission corridor across the North Cascade Mountains would be filled to capacity.

The Puget Sound Area would have a peak demand of approximately 30,000 megawatts (mw) by the year 2000, almost ten times the present demand. Early in the period 1980-2000 the Area would begin developing nuclear-fueled steam-electric plants and pumped storage hydroelectric plants late in the period to meet the demand for power.

The Area has numerous potential nuclear-electric power sites utilizing various types of cooling, and many excellent pumped storage hydroelectric sites to meet the future power demands. Therefore, by the year 2020, when the electric power peak requirement is forecasted at almost 90,000 megawatts (nearly 30 times present demand) pumped storage and nuclear-electric generation is projected to dominate the scene.

Figure 4-1 illustrates the development of electric power resources in meeting energy and peak requirements from 1965 to 2020. The nuclear and miscellaneous portion includes geothermal or other unknown sources of generation. The pumped storage and fossil-fuel portion includes possible gas-turbine or steam-electric peaking plants.

Future new electric power developments within the Puget Sound Area would be determined by economies of location, and the impact on the natural environment. Some, or even all, of the base-load thermal nuclear generation could be located within the Area itself. Having the power plants located within the Area would result in minimizing transmission costs. However, due to environmental considerations, some thermal base-load plants may be near the ocean or east of the Cascade Mountains.

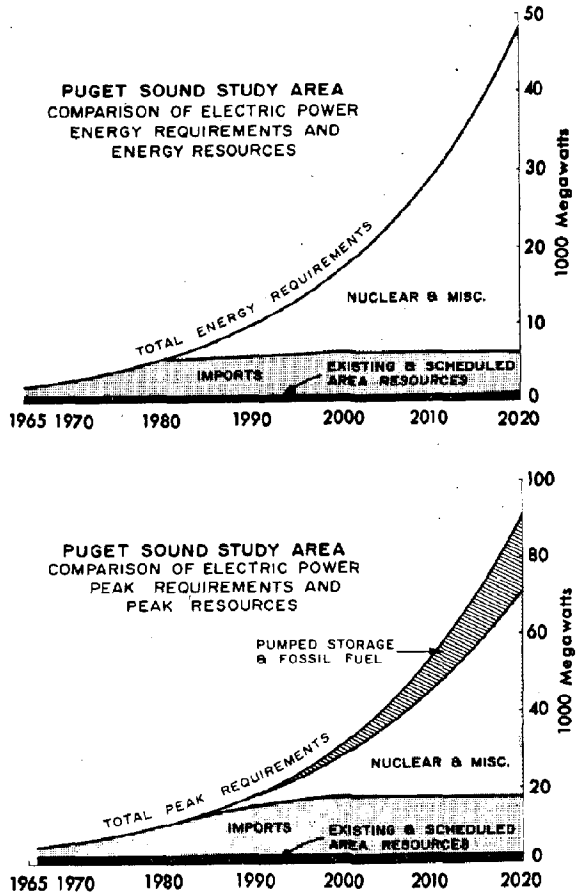


FIGURE 4-1. Electric power-energy and peaking requirements and resources, Puget Sound Area

Many existing hydroelectric power plants in the Puget Sound Area are now operating as peaking plants. Others, however, are too old or too small to justify additional units for peaking purposes. Thus, there probably would be no significant change in the operation of most existing Area hydroelectric plants. However, the Skagit River system does represent a potential source of additional peaking capacity. The existing power production of the Skagit River system can be increased by raising Ross Dam, installing additional generation units at Ross, Diablo and Gorge Dams and constructing a reregulating dam at Copper Creek.

Eighty-nine potential hydroelectric sites, with a total installed capacity of 3,390 mw, were investigated. The results of the investigation revealed that no site approaches economic justification from a single-purpose standpoint.

During the study, the potential of pumped-storage was investigated at more than 100 sites in the

Puget Sound Area. In the northern Cascade Mountains, there are an unusually large number of excellent pumped-storage sites. With off-peak thermal generation available for pumping energy, pumped storage is potentially the most economical source of peaking capacity once the conventional hydroelectric capability of the area are fully developed. Additional site investigation is required.

The Puget Sound Area, with a peak electric load of about 3,500 mw, presently imports about 2,000 mw. The importation of electric energy is at about the same ratio, two-thirds of requirements being met from outside sources. This importation is expected to continue as long as electrical generation is available from areas outside the Puget Sound Area.

Included in the early action portion of the Comprehensive Plan is hydroelectric power development as part of the North Fork Snoqualmie River project. Raising of Ross Dam on the Skagit River to provide increased power output from generating facilities at Ross power plant is recommended for further consideration to meet the Area's power needs. The importation of electric peaking capacity and energy from east of the Cascade Mountains would continue to increase through the 1990's until the Columbia River hydroelectric system is completely developed. Importation of 13,400 mw peaking capacity and 5,000 mw average energy would thereafter remain the same. The existing development under consideration would meet the 1980 demand projected for the Puget Sound Area. However, by the year 2000, the Puget Sound Area would need additional generation of 13,490 mw of peaking capacity and 10,380 average mw of energy. The means for satisfying this additional demand would primarily be base-load thermal installations. Nuclear power plants are scheduled to supply 12,100 mw peaking capacity with 10,300 mw of energy. Pumped-storage power plants that satisfactorily meet environmental considerations may be provided to assist in supplying peaking capacity. Some fossil-fuel plants in the form of gas turbines may also be installed in the future at locations near load centers to assist in meeting peak power demands.

Installation of about 52,000 mw of nuclear power generation would be required by the year 2020. The Puget Sound Area has many features advantageous to nuclear power plants siting, these include: (1) a plentiful supply of cold marine water for cooling purposes, (2) favorable tidal currents at many locations conducive to rapid dispersal of cooling water, (3) protected deep water, close to shore, providing good access by sea, and (4) proximity to major load centers and major transmission facilities. However, around Puget Sound there are some siting problems that stem from growing high density populations and in some cases restricted mixing in the waters of the Sound. Sites under active consideration by public utilities for nuclear power plant development are Kiket and Samish Islands, in the Skagit-Samish Basins, Cherry Point in the Nooksack-Sumas Basins, and Sequim in the Elwha-Dungeness Basins.

Power plants that would use once-through cooling systems, as envisioned for those in the Puget Sound Area, need a large water supply. The expected circulating water requirement for a 1,000 mw nuclear power plant would be about 1,600 cfs to limit the coolant temperature to maximum rise of 20 degrees F. This type of cooling system generally limits the potential thermal-nuclear plants to the use of salt water for cooling. With once-through cooling each nuclear plant requires about 350 acres. Hypothetically, the total land requirements of fifty-two 1,000 mw plants would, with once-through cooling, be 18,200 acres.

Capital and operating costs of nuclear plants determine whether they are economically competitive with other types of thermal power plants. Nuclear plants with the larger size units tend to cost less per kilowatt. In the period 1975-1980, new nuclear plants most likely would be composed of several units in the 750-1500 mw range and would cost in the range of $100 to $200 per kilowatt. At the rate of $200 per kilowatt (1968 price levels), a 1000 mw nuclear power plant would cost about $200,000,000.

In the decade between now and 1980, over billion dollars would be invested in electric power facilities in the Pacific Northwest. Of this total, about 2.7 billion dollars would be attributable to low voltage transmission and distribution, about 1.7 billion dollars to high-voltage transmission, about 1.6 billion dollars to hydro capacity, and, about 1.3 billion dollars to thermal generation. In the next 10 years, from 1980 to 1990, about 9 billion dollars would be invested in electric power facilities in the region, of which 3.2 billion dollars would be in low-voltage transmission distribution, 1.2 billion dollars would be in high-voltage transmission, 1.9 billion dollars in additional hydro capacity, and 2.6 billion dollars in thermal generation facilities. Under past and present trends, about one-third of the investment is expected to be in the Puget Sound Area.

Flood Control

The Comprehensive Plan provides for the reduction of future flood damages associated with main-stem overbank flooding of urban and rural communities and agricultural lands in the flood plains of each of nine major river basins. The two island groups, San Juan and Whidbey-Camano Islands, do not have serious overbank flooding. Complementary measures of flood prevention and control are discussed under Watershed Management.

The objectives of flood protection adopted for this study would generally be met by a combination of management programs and flood control projects. All urban and industrial lands would have at least a 100-year level of protection, with the exception of a relatively small amount of land in the Snohomish River Basin above the town of Snohomish along the Pilchuck River. Prime agricultural lands with a high density of farm buildings and residences would be provided a 50-year level of protection. Other agricultural lands in all but the Skykomish River Basin would be provided with a 25-year level of protection. In that basin levees or storage projects required to achieve a 25-year level of protection are neither economically justified at this time nor expected to be in the future. Flood plain management is an integral part of the Comprehensive Plan. Management and project costs to satisfy a significant amount of the Puget Sound Area flood control needs over the 50-year planning period are estimated to range from $328,589,000 to $381,589,000, averaging from $6,600,000 to $7,600,000 per year, depending on which alternative plan is selected.

The early action portion of the Comprehensive Plan requires an investment ranging from $168,054,000 to $176,054,000 to implement flood plain management programs, construct economically justified levees and channel improvements, and pay for the allocated flood control costs of multiple-purpose storage projects. In the Nooksack-Sumas Basins a storage project would be constructed at the Edfro site on the North Fork Nooksack River. In the Skagit-Samish Basins levees would be raised, the operation of Upper Baker Dam changed, and the Avon Bypass constructed. The size of the bypass would depend on the alternative plan selected. In the Stillaguamish Basin levee and channel improvements would be constructed. In the Snohomish Basin multiple-purpose storage projects on the North and Middle Forks Snoqualmie River would be constructed, Culmback Dam on the Sultan River raised, and levee and channel improvements made along the lower Snohomish River. In the Cedar-Green Basins additional storage would be obtained at Chester Morse Lake on the Cedar River through construction of a low dam at the lake outlet. In the Puyallup Basin levees would be constructed to protect the town of Orting. In the Nisqually-Deschutes Basins the plan includes using storage at Alder Lake on the Nisqually River by agreement with the city of Tacoma. In the West Sound Basins a levee would be constructed along the Dosewallips River to protect the State park.

Flood plain management, including land use zoning, floodproofing and other regulations necessary to protect existing structures and prevent unwarranted development in the flood plains is an essential

TABLE 4-7. Flood control projects for main-stem overbank flooding, Puget Sound Area

	Levees						Channel Improvements						Storage Projects					
	By 1980		1980-2000		2000-2020		By 1980		1980-2000		2000-2020		By 1980		1980-2000		2000-2020	
Basins	No. of Projects	Miles	No. of Projects	Miles	No. of Projects	Miles	No. of Projects	Miles	No. of Projects	Miles	No. of Projects	Miles	No. of Projects	Ac. Ft.	No. of Projects	Ac. Ft.	No. of Projects	Ac. Ft.
Nooksack-Sumas	1	6.0	3	20									1	63,000	1	21,000		
Skagit-Samish																		
Alternative A	2	39.5	2	7			2[1]	10.8					1	100,000	1	134,000		
Alternative B	2	39.5	2	7			2[1]	10.8					1	100,000	0	0		
Stillaguamish	1	13.0	1	11			1	6.2										
Snohomish			6	13			2	11.5	1	3.3	1	3.7	3	270,000	1	15,000		
Cedar-Green			1	13			1	16					1	50,000				
Puyallup	1	6.0	1	2											1	24,000		
Nisqually-Deschutes																		
Alternative A			0	0					0	0			1	55,000			1	15,000
Alternative B			1	2					1	1			1	55,000			1	15,000
West Sound	1	0.3	2	6.1														
Elwha-Dungeness					2	9.5												
Whidbey-Camano Is.																		
San Juan Is.																		
Puget Sound Area																		
Alternative A	6	64.8	16	72.1	2	9.5	6	44.5	1	3.3	1	3.7	7	538,000	4	194,000	1	15,000
Alternative B	6	64.8	17	75.1	2	9.5	6	44.5	2	4.3	1	3.7	7	538,000	3	60,000	1	15,000

[1] Avon Bypass (8 miles) has been included with channel improvements.

part of the Comprehensive Plan. Flood plain regulations would be utilized to establish and protect the required minimum channel for passage of flood flows and to control land use and development in those areas with less than 100-year level of flood protection. Flood plain zoning would also provide a means of retaining open space, if supported by land use zoning. As a condition for construction of Federal or Federally-assisted flood control projects the State and/or local governments should be required to regulate flood plain encroachments such that growth in flood damages from new developments is prevented.

Shown in Table 4-7 is a summary of flood control projects that would be implemented prior to 1980.

The long-range program for satisfying flood control needs includes development of additional storage in the Nooksack-Sumas Basins as part of the multiple-purpose North Fork project, and in the Skagit-Samish Basins with the Sauk River project, if found to be desirable after completion of the Wild and Scenic River Study in the Skagit Basin. Modification of the outlet works at the South Fork Tolt River project would provide additional flood control storage for the Snoqualmie River system in the Snohomish Basin. Storage projects are planned for construction on the Puyallup River prior to the year 2000 and on the Deschutes River after 2000. Additional channel and levee projects would be undertaken in many of the basins in the long-range period to provide increased levels of flood protection commensurate with the increase in urban and rural developments in the flood plains. Levees and channel improvements would be provided in the Nisqually River delta if port development is undertaken there. A change in operation of the existing dam on the Elwha River would be undertaken after 1980 to provide flood control protection in that basin. A total investment ranging from $152,535,000 to $213,535,000 is estimated to be required to provide the long-range flood control projects and flood plain management scheduled for the period 1980 to 2020, depending on which alternative plan is selected.

Watershed Management

The means provided in the Comprehensive Plan to achieve the objectives of watershed management include a wide spectrum of structural and nonstructural measures for development and improved use of the land and water resources. Structural measures are often the result of formal cost-sharing projects, while nonstructural land treatment and management measures are usually applied by the owner of the land under a planned program.

An important part of watershed management includes selection of watershed lands for specific development purposes in accordance with the capability of the land to sustain such use, coupled with adequate land treatment and water management based on the chosen use or combination of uses. The watershed area requiring management remains constant while the intensity of management increases with changed or more intense use of the land. Future development of the Area would require acceleration of management of land and water resources.

Nonstructural measures consist of land treatment and management operations for protection, rehabilitation, and improvement of watershed lands and water flows originating thereon. Examples of rehabilitation and protection measures are fire protection, special precautions in road building to reduce hazard of resource damage, and construction activity modifications to reduce stream pollution by sediment. Development activities may be on-farm or urban water management measures installed to achieve known potentials, often made possible by structural projects. Many of these measures are on-going at the present time and would be a part of the planned program. Some elements of existing management are good, while others need substantial improvement and redirection.

Projects, some of which are interrelated to mainstem overbank flooding projects discussed under Flood Control, are generally multiple-purpose and designed to reduce damages caused by floodwater and sediment.

The watershed management programs and projects contained in the Comprehensive Plan to satisfy the Area's needs over the 50-year planning period are estimated to cost $2,987,807,000 ($237,364,000 in program costs not shown in tables) averaging $59,800,000 per year. A large portion of this cost represents ongoing management and development costs, a portion of which would be redirected and accelerated. These costs, together with other costs of acquisition and development, represent the total given.

The early action program calls for the investment of $33,989,000 for projects planned under criteria similar to Public Law 566 for implementation prior to 1980, and $831,040,000 for complementary programs of land treatment, drainage, and erosion control. A five-year study of beach and shore erosion is planned for initiation and completion by 1980 at an estimated cost of $500,000. This study would identify and evaluate areas where significant erosion

TABLE 4-8. Early action watershed protection and management projects, Puget Sound Area

Basin and Watershed	Project Area (acres)	Channel Improvement (mi.)	Modification of Existing Protective Works (mi.)	Outlet Structures (no.)	Water Storage Facility (no.)	Debris Basin (no.)	Floodwater Protection (acres)	Drainage Improvement (acres)
NOOKSACK-SUMAS BASINS								
Middle Tribs. Nooksack	6,750	6.7	5.0	1			3,199	4,582
Fishtrap-Bertrand Cr.	23,914	37.0	6.0	2			13,159	13,508
Wiser Lake Area	38,305	29.0	10.1	4			14,791	18,832
Lower Nooksack Tribs.	19,835	18.9	9.3	5			10,499	12,559
Sumas River	33,079	22.0				1	14,509	14,692
Dakota Creek	20,314	18.0					593	3,118
California Creek	14,192	13.8			1		1,397	3,500
Silver Creek	10,855	16.0	5.0	1			2,736	4,999
Total	167,255	161.4	35.4	13	1	1	60,883	75,790
SKAGIT-SAMISH BASINS								
Gages Slough	14,419	17.0		1			9,520	7,087
South Mt. Vernon	32,132	21.5		4			9,619	10,501
Samish River	63,716	65.0		5			23,859	24,028
Skagit Flats	41,148	43.0	5.0	5			31,788	28,402
Total	151,415	146.5	5.0	15			74,786	70,018
STILLAGUAMISH BASIN								
Lower Stillaguamish	8,522	17.0	1.0	3			5,547	5,422
Church Creek	8,060	8.4	1.0	3			2,732	4,424
Total	16,582	25.4	2.0	6			8,279	9,846
SNOHOMISH BASIN								
Patterson Creek	12,451	8.0					667	1,426
Snohomish Estuary	29,759	15.0	11.0	3			12,321	10,222
Total	38,210	23.0	11.0	3			12,988	11,648
CEDAR BASIN								
Swamp, Bear, North Crs.	44,795	24.0		2			5,963	3,826
Evans Creek	29,800	16.0		2			3,348	3,620
Total	73,595	40.0		4			9,311	7,446
PUYALLUP BASIN								
Algona-Pacific	6,457	12.0					1,688	1,444
Clear Creek	8,060	21.0					2,364	6,587
Hylebos Creek	15,000	7.0		1			2,376	1,258
Wapato Creek	6,407	7.0		1			3,243	1,699
Clover Creek	58,092	14.0					4,990	805
Total	125,016	61.0		2			14,661	11,793
WEST SOUND BASINS								
Goldsborough Creek	38,501	5.0			1		3,388	261
Chimacum	22,326	16.0		8		1	3,375	2,717
Total	60,827	21.0		8	1	1	6,763	2,978
GRAND TOTAL	632,900	478.3	53.4	51	2	2	187,671	189,519

TABLE 4-9. Summary of principal measures for watershed protection and management on cropland, Puget Sound Area

Treatment Measures	Unit	Early Action Program Appl. Cum. Through 1966[2]	Early Action Program 1980	Proposed for Installation 2000	Proposed for Installation 2020	Total
Erosion Control Measures						
Conservation cropping system	Acre	210,600	58,000	115,700	115,700	500,000
Pasture and hay land planting[1]	Acre	10,000	5,000	10,000	10,000	33,000
Cover crop[1]	Acre	24,000	28,800	57,500	57,500	167,800
Flood Prevention Measures						
Dike and levee	Feet	1,443,790	154,810	309,500	309,500	2,217,600
Clearing and snagging	Feet	211,500	380,460	760,020	760,080	2,112,000
Streambank protection	Feet	892,500	143,580	287,160	287,160	1,610,400
Stream channel improvement	Feet	459,580	76,960	153,930	153,930	844,400
Stream channel stabilization	Feet	25,350	17,110	34,210	34,210	110,880
Drainage Measures						
Drainage main or lateral	Feet	7,042,420	1,391,520	2,783,030	2,783,030	14,000,000
Drainage field ditch	Feet	81,470	2,152,710	4,305,410	4,305,410	10,845,000
Tile drain	Feet	5,790,860	11,133,240	22,266,450	22,266,450	61,457,000
Recreation Measures						
Recreation access road	Feet	1,105,350	444,210	888,420	888,420	3,326,400
Wildlife habitat management	Acre	107,180	192,940	385,850	385,850	1,071,820
Farm pond	Number	1,010	390	800	800	3,000

[1] Conservation measures applied annually.

[2] This includes accomplishments that are part of Soil Conservation Service Records System.

is occurring, determine relevant factors for evaluation, describe justifiable remedial measures, and establish priorities for treatment.

Small multiple-purpose watershed projects shown in Table 4-8 would assist in reduction of floodwater and sediment damage to lands at the small watershed level (250,000 acres or less) and make possible improved management of these lands. Twenty-five such projects have feasibility for construction by 1980 and an additional 86 projects are projected as feasible by 2020. The Nooksack Basin contains eight of the proposed early action projects; the Puyallup Basin five such projects; the Skagit-Samish Basins four; and the remaining eight projects would be scattered in the Stillaguamish, Snohomish, Cedar, and West Sound Basins. These projects and programs are discussed in more detail in Appendix XIV, Watershed Management.

Additional studies are needed in land management and its impacts on various environmental factors, such as the production and effects of sediment. Cooperative studies involving long-term measurement and evaluation of sediment production, movement, and impacts on various economic and ecologic factors are estimated at $2,250,000 for the early action period and $150,000 annually in the long-range period.

Completion of cooperative soil surveys on Area lands, updating older inadequate surveys, and initiating surveys of greater intensity in areas expected to become part of metropolitan developments is proposed. These surveys would be accelerated for guidance of development. This survey work and reports, included for early action, are estimated to cost $3,000,000.

A summary of principal measures for cropland and natural forest land is given in Tables 4-9 and 4-10, respectively. The list of practices given in these tables serves to indicate the level of management needed on these lands, and it is expected the same level of management would be applied to State and corporate forest lands. Small private holdings would generally lag behind large ownerships in sophistication of management.

TABLE 4-10. Summary of principal measures for watershed protection and management on National Forests, Puget Sound Area

Treatment Measures	Unit	Early Action Program 1965-1980	Early Action Program Percent[1]	Proposed for Installation 1980-2000	Proposed for Installation 2000-2020
Managerial					
Surveys	Acres	8,875,970	95	5,048,170	0
Plans for watersheds	Numbers	87	100	41	0
Research studies[2]	Dollars	461,600	30	559,400	559,400
State and private programs[2]	Dollars	2,317,700	95	3,090,200	3,090,200
Protection					
Fire control	Acres	3,095,080	50	3,095,080	3,095,080
Insect and disease control[2,3]	Dollars	32,500	95	43,500	43,500
Road development[6]					
Permanent	Miles	2,429	75	3,770	2,460
Temporary	Miles	9,432	60	16,810	20,705
Land use development[6]					
Logging[5]	Acres	402,280	95	717,300	883,080
Grazing	Acres	11,720	75	33,020	64,600
Recreation[2]	Dollars	4,885,000	30	6,513,500	6,513,500
Restoration					
Reforestation	Acres	199,530	95	272,300	272,300
Gully stabilization	Miles	17.5	5	25	25
Erosion control	Acres	5,310	5	5,910	5,910
Channel clearance	Miles	83.7	10	150.3	150.3
Bank stabilization	Miles	143.4	5	156.5	156.5
Road and trail rehabilitation	Acres	150.2	5	206	206
Roadside stabilization	Acres	756	5	955	955
Water Yield Improvement[4]					
Cover-type conversion	Acres	0	0	40,750	40,450
Snowpack management facilities	Miles	0	0	810	798
Sediment basin construction	Acres	420	0	1,975	1,885
Flow regulation structures	Each	40	0	45	43
Water storage structures	Each	63	0	276	278
Wet land drainage structures	Each	2	0	8	0

[1] Approximate percentage of needs met by current funding levels.

[2] Based on allocation of the total State and private forestry program that is water related.

[3] Costs include detection only.

[4] Measures based on local determination of future off-site needs for water. These should be viewed as potential developments rather than specifically planned projects.

[5] Area includes thinnings and release cuttings as well as harvest cuts.

[6] Units shown are not wholly watershed protection and management items, costs, where presented, include that part needed for soil and water protection only.

TABLE 4-11. Watershed management projects 1980-2020, Puget Sound Area

1980-2000			2000-2020		
Basin	Number of Projects	Total Installation Cost (dollars)	Basin	Number of Projects	Total Installation Cost (dollars)
Nooksack-Sumas	7	5,950,000	Nooksack-Sumas	5	936,000
Skagit-Samish	3	1,850,000	Skagit-Samish	5	1,460,000
Stillaguamish	3	5,620,000	Stillaguamish	3	1,310,000
Whidbey-Camano Is.	4	3,245,000	Whidbey-Camano Is.	0	0
Snohomish [1]	8	12,387,000	Snohomish	1	100,000
Cedar	3	3,810,000	Cedar	1	100,000
Green	1	1,700,000	Green	1	100,000
Puyallup	4	4,167,000	Puyallup	0	0
Nisqually	4	2,930,000	Nisqually	1	100,000
Deschutes	3	1,410,000	Deschutes	0	0
West Sound	12	8,055,000	West Sound	7	970,000
Elwha-Dungeness	5	2,962,000	Elwha-Dungeness	2	300,000
San Juan Is.	3	2,736,000	San Juan Is.	0	0
Total	60	56,822,000	Total	26	5,376,000

[1] Includes Lake Stevens project installation cost of $147,000, not shown in Appendix XIV, Watershed Management.

TABLE 4-12. Summary of watershed management program and project costs. all lands (in thousands of dollars)[1]

Type of Cost	Time Periods			Total
	To 1980	1980-2000	2000-2020	
Federal				
Tech. Assistance[2 3]	127,010	203,649	201,073	531,732
Struc. Measures[3]	23,077	56,822	5,376	85,275
Accel. Tech. Assist.	3,424	7,599	3,205	14,228
Total	153,511	268,070	209,654	631,235
Federal & Cooperative				
Beach Erosion Study	500	0	0	500
Beach Stabiliz. (Constr.)		100,000	100,000	200,000
Cooper. Sedim. Monitoring	2,250	3,000	3,000	8,250
Cooper. Soil Surveys	3,000	0	0	3,000
Total	5,750	103,000	103,000	211,750
Non-Federal				
Technical Assistance	87,627	116,839	116,838	321,304
Structural Measures	3,984	[5]0	[5]0	3,984
Rights-of-Way	6,928	50	[5]0	6,928
OM&R, Structures[4]	7,648	16,353	1,613	25,614
Water Management	57,351	57,813	73,743	188,907
Urban Drainage	500,692	446,527	457,078	1,404,297
Land Treatment	54,936	70,782	68,070	193,788
Total	719,166	708,314	717,342	2,144,822
Grand Total	878,427	1,079,384	1,029,996	2,987,807

[1] Base: 1967 prices.

Source: Appendix XIV, Watershed Management.

[2] Does not include technical assistance and management costs for urban drainage.

[3] Costs of flood control not included.

[4] Base: 1967 adjusted normalized prices.

[5] Amounts not estimated for future time periods.

The long-range planning for satisfying watershed management needs provides for further small watershed projects for flood prevention and a continuation of rehabilitation and protection programs and activities associated with development of land and water. An investment of $2,091,414,000 is estimated to satisfy watershed management needs for the period 1980-2020. About 43 percent of this is for urban water management.

The long-range program features are shown in Tables 4-9 and 4-10 and projects are indicated in Table 4-11. A summary of the watershed management features for all lands is given in Table 4-12.

Recreation

In satisfying the future water-related recreation needs, the Comprehensive Plan sets forth a schedule of land acquisition and development providing for the timely construction of well-planned recreation facilities, the retention of public lands for recreational use, and the identification of natural areas which should be protected. Future recreation developments would be in accordance with the Washington Statewide Outdoor Recreation and Open Space Plan.

The plan of development calls for an investment of $1,630,215,000 to acquire lands and develop recreation facilities during the 50-year period, averaging $32,600,000 per year. The plan includes $406,975,000 investment during the early action period. The land requirements for developments including buffer zones are shown in the following tabulation:

	1980	2000	2020
Acres of development	9,500	12,200	21,800
Acres of buffer zones	8,200	10,500	18,700
Total acreage	17,700	22,700	40,500

The early action schedule proposes identifying, acquiring, and developing over 600 recreation areas. Priority is given to acquiring and developing salt water beaches, acquiring and providing access to public areas, designation of a state-wide system of scenic and recreation rivers, a program for setting aside unique, natural, archeological and historical sites, and the construction of facilities for campgrounds, picnic areas, beaches, swimming pools, boating areas and facilities including small boat harbors.

The early action needs can be met to a large degree by the expansion of existing facilities and development of public lands located within the Area. Emphasis should be given to the provision of access to waterfront lands adjacent to saltwater, lakes, and major rivers within one hour's drive of urban areas. Examples are the University of Washington Arboretum trail, acquisition and development of the Magnolia tideflats, Everett to Edmonds beach trail, and the development of street ends as access to water areas such as Lake Union. In urban areas, recreation lands must be acquired as soon as possible to insure their availability for future public use.

In the Skagit-Samish Basins, the Skagit River and some tributaries have high potential for inclusion in the National Wild and Scenic Rivers System. Prior to any determination of whether it should be included in the national system, future studies of its potential and expressions of national need must be made. These studies are scheduled for completion in 1973.

A major challenge to be met during the early action period is the provision of public access along the shorelines of fresh and marine waters where developments have, to a great extent, shut off the public in many locations. The railroad tracks located along the marine shoreline from Everett to Seattle and other locations restrict public use of the shoreline and access to the marine resource. Access easements with road access and pedestrian crossings should be acquired along the railroad right-of-way to provide for public use of the marine shoreline. Additional studies should be undertaken to determine the desirability and justification for opening the closed municipal watersheds for recreational use.

The Plan includes a network of scenic routes to provide travel links between recreation attractions used by a large segment of the population who enjoy driving for both pleasure and sightseeing. In addition, a network of trails is planned and scenic and recreation rivers are designated for possible inclusion as a part of a State-wide system.

The high country in the Cascades has a fragile ecological balance and while the apparent need is to increase capacity through a strong development program, care must be taken lest the resource itself be destroyed. A study is needed to find answers to the question of the proper level of human use in the high country, prior to initiation of development programs. Both winter and summer sport activities are involved. This concept also is applicable to most other areas receiving intense recreation use.

The long-range program for satisfying recreation needs provides for expansion and development of additional recreation facilities and acquisition of lands at 918 recreation areas. A total investment of $1,223,240,000 is estimated to be required to satisfy the long-range recreation needs for the period 1980 to 2020.

Fish and Wildlife

The Comprehensive Plan provides a schedule of project and facility developments concurrent with program and management proposals to increase production and harvest of the fish and wildlife resources of the Puget Sound Area. The development schedule initially sets forth specific measures to acquire additional natural spawning, rearing, nesting, and forage habitat areas for greater natural propagation. This would be followed by construction and development of artificial measures such as hatcheries, spawning channels, and rearing ponds. Concurrent with these developmental measures would be water control measures to decrease flood flows, provide low flow augmentation, and prevent water pollution. Low flow augmentation in many of the rivers is considered one of the most important and best means of increasing anadromous and game fish production.

To provide needed opportunities for fishing and hunting, streambank, lake, and salt water access areas would be acquired and developed. Boat launching ramps, waterfowl observation and hunting facilities would be included in the access area developments.

The fish and wildlife projects and programs contained in the Comprehensive Plan for the 50-year period are estimated to cost between $283,103,000 and $285,603,000 depending upon the alternative selected, including $3,018,000 for programs and projects on National Forest lands. This would average about $5,700,000 per year. The National Forest projects would involve stream clearance, debris removal from lakes, and lake fertilization and game habitat improvement. These are included with other fish and wildlife projects in the Area discussion.

The early action plan requires an investment ranging from $62,703,000 to $65,203,000 ($1,061,000–National Forests) for projects planned to meet the 1980 level of needs, and $3,380,000 for complementary fish and wildlife programs, including $388,000 for an Area-wide program of stream surveys. The minimum stream flows necessary to maintain present fish production levels are unknown and would be determined from the cross-sectional stream surveys. Tentative minimum flow data were provided in Appendix XI, Fish and Wildlife, for consideration in this study. However, these flows could not be supplied in any of the river basins on a sustained basis without significant carry-over storage. Consequently, planning proceeded on the basis of augmenting naturally occurring streamflows during critical low flow periods for fish to the extent possible, commensurate with other water resource needs. Further project studies would be required after the cross-sectional studies are completed.

Artificial propagation facilities for trout, steelhead and salmon are planned for implementation prior to 1980 throughout the Puget Sound Area. These include 1 new salmon and 14 new trout hatcheries, expansion of 3 existing trout and 4 existing salmon hatcheries, 2 miles of salmon egg incubation or spawning channels and 55 controlled rearing areas for steelhead and searun cutthroat. The Plan contains 9 artificial passage facilities at natural and man-made barriers. Approximately 510 miles of stream access, 87 access sites on fresh water and 62 on salt water would be acquired and developed. Seven lake enlargements are planned and surveys would be conducted on 530 miles of stream and 5,270 surface acres of lakes. Multiple-purpose storage projects in the Nooksack-Sumas, Snohomish and Cedar-Green Basins would provide for fish resource enhancement through low flow augmentation and control of floods that damage spawning beds through erosion and siltation.

Cross-sectional stream surveys are planned to determine minimum flows required to maintain current fish production levels and optimum flows for increased production. Also proposed for early action are fishing piers or jetties designed for use by sportsmen and located within or near the major metropolitan areas. The Plan contains proposals for increasing production of shellfish species for both commercial and sport use. Projects and programs are called for to protect the marine environment with particular emphasis on water quality, aquaculture, and the preservation of natural beach and intertidal zones to maintain and enhance shellfish production levels.

Wildlife projects for enhanced hunting opportunities include acquisition of 19,700 acres of waterfowl habitat and 3,000 acres of upland bird habitat. Expansion of pheasant propagation facilities are planned to allow increased production of 37,300 birds annually. Big game habitat improvements are scheduled for 10,500 acres of Area lands.

Programs also are contained in the Comprehensive Plan for increasing the supply of fish and

wildlife through basic research studies, especially those designed to develop new or improved management techniques. These include:

1. Development of lake and stream fertilization techniques which do not degrade water quality.
2. Development of new fish toxicants and lake and stream rehabilitation methods which do not degrade water quality.
3. Development of fish disease-control programs for lakes.
4. Analysis of fish and wildlife population and development of effective management programs.
5. Stimulation of interest in spiny-ray fishing.
6. Provision of fisherman and hunter access to closed watersheds.
7. Expansion of range surveys and development of new habitat improvement techniques.
8. Development of cooperative programs with landowners to maintain, develop and assure hunter access.

The rapid development of the Puget Sound Area, with increasing urban and rural land transformation from farming and timbered areas, is projected as having a significant impact on wildlife. Based on the current trends of purchasing hunting licenses, approximately 286,000 licensed hunters would reside in the Area by 1980. Meeting future hunting needs depends upon the ability and effort of the responsible management agencies, coupled with the mutually cooperative efforts of all entities interested in the protection and enhancement of wildlife habitat. Important elements of the wildlife program are those that deal with land management to improve the game carrying capacity of existing lands, with forest management playing an important role.

To maintain wildlife at the present level in the Area, a number of conditions must be met. These include the acquisition and development of suitable lands for public access, habitat improvement, artificial propagation for upland game, eventual use of the closed watersheds, and education of the public on the need for the conservation of the wildlife resource. To satisfy needs for 1980, either hunter success (game-kill per hunter-day) must be lowered, more sportsmen must hunt outside the Area, or program and projects to enhance hunter use must be expanded.

There are a number of sites which possess significant resource potential for waterfowl habitat development. These are: Padilla and Samish Bays (Skagit-Samish Basins), Port Susan (Stillaguamish and Snohomish Basins), Nisqually Delta (Nisqually-Deschutes Basins), Elk Marsh (Nooksack-Sumas Basins), Union Bay and Indian Island (West Sound Basins). There is a minimum of 4,000 acres that could serve as refuge areas.

The 3,000-acre Nisqually Delta is the last remaining significant river delta waterfowl habitat area between Skagit Bay and the Columbia River. Development of 1,300 acres of the delta for navigation and related purposes would require a reduction in the waterfowl-recreational development plan presently being undertaken by the State of Washington which includes the full 3,000 acres. If part of the delta is developed for navigational uses, the natural waterfowl-recreational potential may not be met. Although the Comprehensive Plan does not determine the best use or uses of the Nisqually Delta, the Plan does provide for a multi-discipline study to be undertaken during the early action period to determine whether port development in the delta can or should be undertaken, compatible with wildlife and recreational use.

The long-range program for satisfying the fish and wildlife needs in the Puget Sound Area provides for construction of 44 hatcheries, 18 miles of spawning channels, habitat improvement on 114 streams, fish passage over 22 barriers, development in excess of 670 acres of rearing ponds as well as land measures designed to increase wildlife production. A total investment of $217,020,000 ($1,957,000—National Forests) is estimated to be required to satisfy the long-range fish and wildlife needs for the period 1980 to 2020.

Estuaries and Coastal Zones

The management of the sea coast, estuaries and related shorelands of Puget Sound and adjacent waters is concerned with the conservation of natural resource values and maintenance of productivity. These waters and related land constitute one of the Puget Sound Area's most valuable geographic features.

The marine resource includes wide physical diversities ranging from rugged shorelands, with many indentations, islands and rocks to smooth coastlines with few offshore features. Sandy beaches, rocky headlands, marshlands and river estuarial areas are located here. Water depths may increase gradually from the shoreline or decline precipitously to depths of 800 feet or more.

Each of the shoreline areas and estuaries has a potential for satisfying various uses. Historically, the

estuaries have been the basis for social and economic development.

The pressures for shoreline space and water surface use have increased rapidly in recent years and are expected to accelerate. Coordinated efforts by Federal, State and local government and the private sector are required in order to provide for the best use of this resource. The estuaries of many of the rivers that flow into Puget Sound have been altered. The Sound itself remains relatively unaffected. The estuaries are important as they contribute to salmon, steelhead, marine fish and shellfish production and provide waterfowl and shorebird habitat. Collectively the many streams of the Puget Sound Area significantly contribute to the wealth of the Area in terms of fish and wildlife, recreation and aesthetics. Two large estuaries and adjoining tidelands, the Nisqually and Skagit River deltas, remain relatively undeveloped.

Details on the possible use of these areas and the other elements in the Comprehensive Plan for management and control of the estuaries and coastal zones are given in previous pages.

The Comprehensive Plan includes the following provisions for the management and control of the estuaries and coastal zones:

Water quality measures of waste treatment by municipalities and industry, and construction of marine outfalls and diffusers to properly disperse treated wastes; an expanded water quality surveillance program to insure compliance with State standards which protect the estuaries.

Recreational development along the marine shoreline to permit public access to the salt water with retention of all lands now in public ownership; priority for acquiring and developing salt water beaches and pedestrian crossings along the railroad right-of-way which follows the shoreline of Puget Sound from Seattle to Everett.

Preservation and protection of the marine estuaries and shorelines to sustain the fish, shellfish, waterfowl and wildlife species dependent on these specific natural habitats for their existence; and, to provide acquisition of marine shorelines for fish and wildlife habitat preserves, as well as fishing and hunting recreational access areas.

A study to identify specific erosion sites and determine correction measures, as erosion of the shoreline not only destroys developments and adjacent properties but contributes to silt deposition in the estuaries.

Finally, a coordinated program for future seacoast resource use to include:

1. Detailed appraisal of the present and potential resource.
2. Determination of opportunities for multiple use and enhancement of natural production.
3. Analysis of the significance of natural and man-caused environmental variations.
4. Identification for reservation of selected unique water and related land elements.
5. Development of management guidelines for future use of the coastal resource.
6. Identification of research needs, and development of units of measurement and prediction techniques.

INVESTMENT COSTS OF COMPREHENSIVE PLAN

A distribution of program and project investment costs for the Comprehensive Plan for the Puget Sound Area are shown in Tables 4-13 to 4-18. Cost distributions shown are only approximations. The largest investments shown in the Plan are for watershed management, recreation, water quality, and municipal and industrial water supply features.

The Federal watershed management costs on private lands are related to the project measures and programs which offer technical or other assistance, while the private and State costs are for program measures. All costs on public lands are borne by the management agency. Program measures refer to on-farm, forest management, and urban on-site practices which take advantage of improvements made possible by the structural works of improvement, as well as measures for watershed protection, erosion control, and water management. Estimated costs include on-going protection and management costs as well as necessary acceleration. These measures would include seeding of improved grasses and legumes, cover crops, cropland and urban drainage control works and facilities, and forest management practices.

The recreation costs include all of the costs for water-related recreational development to satisfy the projected recreational needs. The costs are borne by Federal, State, and local government, and private enterprise. The costs are for land acquisition and facility development at campgrounds and picnic areas, swimming pools, beach acquisition and development, small boat basins, and the planning and

design for these developments. The State costs are for recreational development at State Parks, and on State lands. The local government costs include county and municipal parks, playgrounds, swimming pools, hiking trails, access areas, boat launching ramps, scenic areas, and small boat basins. The private costs include fishing resorts, hunting areas, boat launching ramps, moorages, camping and picnic areas, etc. As the local and private recreational facilities are more numerous, and recreational use more widespread, they have been historically, and are, projected to provide the largest share of the investment.

The water quality costs include treatment facilities, sanitary sewers, monitoring, evaluation, control, and planning and design costs. The treatment facilities costs and sewers are generally borne by the local municipal governments and by private industry with additional funding provided by grants from the Federal and State governments.

The greatest future investment in water quality costs are for industrial and municipal treatment and sewage collection facilities. The largest costs would be for the State and local sectors. State costs are for grants to local governments and for surveillance programs. Industry costs for treatment are shown separately as private costs, with industrial sewers contained in the local costs since many industries discharge into municipal sewer systems. Local government costs shown would be reduced by Federal grants. The amount of these grants has not been estimated.

The municipal and industrial water supply costs include facilities for storing, diverting, and transmitting water by the purveyor. The costs do not include distribution systems within the municipality, rural community systems, or industry. As water supply systems costs are borne by the local government, water district, or individual, they have been nearly all assigned to the local sector. The Federal costs for grants in aid to the local sector for construction of municipal water supply systems have not been estimated.

Most irrigation development is expected to be accomplished through private development by the individual farmer and the costs have been distributed accordingly.

The navigation costs are for channel improvements. The cost-sharing between local and Federal varies according to the degree project benefits are general in nature. Port District costs are included in the local sector.

Flood control costs vary with the type of project and include as local costs for levee and channel improvements the acquisition of right-of-way, modification to transportation facilities, and relocation of utilities. Remaining costs are borne by the Federal Government, assuming the improvement is a Federal project. For multiple-purpose storage projects the Federal Government bears all costs allocated to flood control.

Fish and wildlife enhancement costs would be borne primarily by the State with some Federal contribution. Where anadromous fish benefits are part of a federally constructed multiple-purpose storage project, the allocated project cost to fishery enhancement would be borne by the Federal Government.

A more detailed determination of program and project cost-sharing would be made during authorization studies.

The costs summarized in the following tables represent the total estimated investment necessary to implement the programs and projects presented in the Comprehensive Plan. Although the total cost for programs and projects to the year 2020 (approximately $7 billion) appears staggering, it must be remembered that this represents investment costs over a period of one-half century. Additionally, as mentioned in the above discussion, many of these costs are ongoing investments that would have been made in the absence of this study. No attempt has been made to estimate the costs of the ongoing programs because any such breakdown would require a series of arbitrary judgments. Most of the $2 billion private investment along with significant portions of the $3 1/3 billion local-State costs and even some of the Federal share would fall in this category. The cost distribution by features is shown for the early action and long-range periods in Figures 4-2 and 4-3.

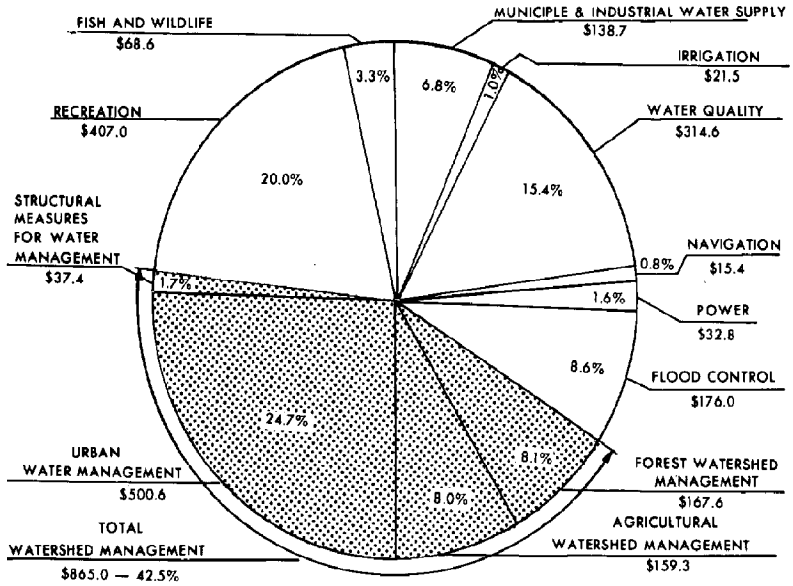


FIGURE 4-2. Distribution of program and project investment costs, Puget Sound Area, 1970—1980 ($ million)

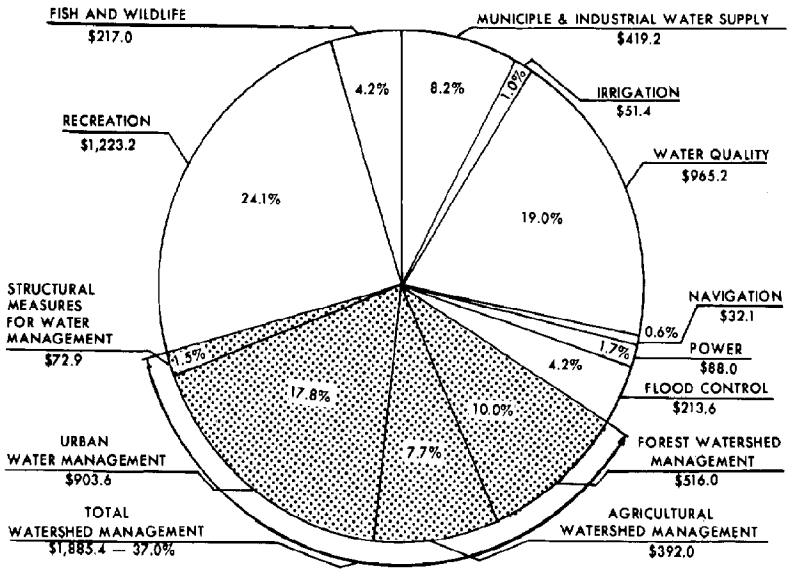


FIGURE 4-3. Distribution of program and project investment costs, Puget Sound Area, 1980—2020 ($ million)

TABLE 4-13. Distribution of program investment costs, Puget Sound Area 1970-1980 ($1000)

Feature	Nooksack-Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha-Dungeness	San Juan Islands	Puget Sound Area
Water Quality Control												
Private	140	83	28	45	486	580	420	55	95	55	55	2,042
Government												
Local	140	83	28	45	486	580	420	55	95	55	55	2,042
State	373	226	73	110	1,003	1,570	1,230	165	380	165	170	5,465
Federal	187	98	31	50	425	670	530	75	180	75	60	2,381
Total	840	490	160	250	2,400	3,400	2,600	350	750	350	340	11,930
Flood Control												
Private	0	0	0	0	0	0	0	0	0	0	0	0
Government												
Local	32	90	19	0	38	84	130	57	87	22	0	559
State	9	17	4	0	11	24	37	16	25	6	0	149
Federal	5	8	2	0	6	39	18	9	13	3	0	103
Total	46	115	25	0	55	147	185	82	125	31	0	811
Watershed Management [1]												
Private	41,455	42,685	14,709	9,050	54,351	113,160	71,177	23,024	45,563	6,205	6,107	427,486
Government												
Local	4,410	7,988	3,301	5,267	28,640	98,881	53,403	8,957	23,590	2,471	2,676	239,584
State	3,721	4,888	3,248	832	5,050	1,095	553	2,875	8,282	2,139	980	33,663
Federal	10,946	31,995	7,435	1,117	20,463	12,818	10,539	5,854	19,969	7,037	2,134	130,307
Total	60,532	87,556	28,693	16,266	108,504	225,954	135,672	40,710	97,404	17,852	11,897	831,040
Fish and Wildlife												
Private	0	0	0	0	0	0	0	0	0	0	0	0
Government												
Local	0	0	0	0	0	0	0	0	0	0	0	0
State	488	253	160	15	450	440	403	127	465	176	15	2,992
Federal	0	0	0	0	0	0	0	0	0	0	0	0
Total	488	253	160	15	450	440	403	127	465	176	15	2,992
TOTAL												
Private	41,595	42,768	14,737	9,095	54,837	113,740	71,597	23,079	45,658	6,260	6,162	429,528
Government												
Local	4,582	8,161	3,348	5,312	29,164	99,545	53,953	9,069	23,772	2,548	2,731	242,185
State	4,591	5,384	3,485	957	6,514	3,129	2,223	3,183	9,152	2,486	1,165	42,269
Federal	11,138	32,101	7,468	1,167	20,894	13,527	11,087	5,938	20,162	7,115	2,194	132,791
Total	61,906	88,414	29,038	16,531	111,409	229,941	138,860	41,269	98,744	18,409	12,252	846,773

[1] Does not include program costs and studies estimated on an Area basis only ($5,750,000)

TABLE 4-14. Distribution of program investment costs, Puget Sound Area 1980-2000 ($1000)

Feature	Nooksack-Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha-Dungeness	San Juan Islands	Puget Sound Area
Water Quality Control												
Private	171	64	42	32	920	812	660	48	60	68	24	2,901
Government												
Local	171	64	42	32	920	812	660	48	60	68	24	2,901
State	264	164	150	94	480	2,252	2,020	104	168	210	76	5,982
Federal	104	68	66	40	192	860	860	40	72	94	36	2,538
Total	710	360	300	200	2,512	4,840	4,200	240	360	440	160	14,322
Flood Control												
Private	0	0	0	0	0	0	0	0	0	0	0	0
Government												
Local	65	117	32	0	70	168	70	80	70	14	0	686
State	18	34	9	0	20	48	20	23	20	4	0	196
Federal	9	17	5	0	10	24	10	11	10	2	0	98
Total	92	168	46	0	100	240	100	114	100	20	0	980
Watershed Management [1]												
Private	47,794	43,765	14,339	10,629	58,564	112,147	47,186	35,578	53,392	6,258	7,125	436,777
Government												
Local	5,351	6,554	919	5,050	26,225	94,955	26,432	17,394	22,634	2,401	2,550	210,465
State	4,961	6,517	4,331	1,109	6,733	1,460	737	3,833	11,042	2,851	1,308	44,882
Federal	12,283	42,390	9,891	1,624	42,705	21,739	19,768	11,326	34,634	11,719	3,006	211,085
Total	70,389	99,226	29,480	18,412	134,227	230,301	94,123	68,131	121,702	23,229	13,989	903,209
Fish and Wildlife												
Private	0	0	0	0	0	0	0	0	0	0	0	0
Government												
Local	0	0	0	0	0	0	0	0	0	0	0	0
State	430	200	320	15	750	602	630	478	800	309	0	4,534
Federal	0	0	0	0	0	0	0	0	0	0	0	0
Total	430	200	320	15	750	602	630	478	800	309	0	4,534
TOTAL												
Private	47,965	43,829	14,381	10,661	59,484	112,959	47,846	35,626	53,452	6,326	7,149	439,678
Government												
Local	5,587	6,735	993	5,082	27,215	95,935	27,162	17,522	22,764	2,483	2,574	214,052
State	5,673	6,915	4,810	1,218	7,983	4,362	3,407	4,438	12,030	3,374	1,384	55,594
Federal	12,396	42,475	9,962	1,666	42,907	22,727	20,638	11,377	34,716	11,815	3,042	213,721
Total	71,621	99,954	30,146	18,627	137,589	235,983	99,053	68,963	122,962	23,998	14,149	923,045

[1] Does not include program costs and studies estimated on an Area basis only ($3,000,000).

TABLE 4-15. Distribution of program investment costs, Puget Sound Area 2000-2020 ($1000)

Feature	Nooksack-Sumas	Skagit-Samish	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup	Nisqually-Deschutes	West Sound	Elwha-Dungeness	San Juan Islands	Puget Sound Area
Water Quality Control												
Private	187	70	54	40	284	892	840	48	80	84	28	2,607
Government												
Local	187	70	54	40	284	892	840	48	80	84	28	2,607
State	298	196	162	112	600	2,476	2,460	132	224	244	100	7,004
Federal	118	84	70	48	232	1,060	960	58	96	108	44	2,878
Total	740	420	340	240	1,400	5,320	5,100	286	480	520	200	15,096
Flood Control												
Private	0	0	0	0	0	0	0	0	0	0	0	0
Government												
Local	65	117	32	0	70	168	70	80	70	14	0	686
State	18	34	9	0	20	48	20	23	20	4	0	196
Federal	9	17	5	0	10	24	10	11	10	2	0	98
Total	92	168	46	0	100	240	100	114	100	20	0	980
Watershed Management [1]												
Private	41,761	58,554	14,160	11,497	56,729	111,252	67,395	19,165	49,774	6,829	6,740	443,856
Government												
Local	7,538	7,244	1,948	5,483	29,236	96,548	50,568	586	22,526	2,543	2,801	227,021
State	4,961	6,517	4,331	1,109	6,733	1,460	737	3,833	11,042	2,851	1,308	44,882
Federal	11,113	37,003	8,108	1,553	42,842	20,784	19,564	10,922	37,274	12,214	2,871	204,248
Total	65,373	109,318	28,547	19,642	135,540	230,044	138,264	34,506	120,616	24,437	13,720	920,007
Fish and Wildlife												
Private	0	0	0	0	0	0	0	0	0	0	0	0
Government												
Local	0	0	0	0	0	0	0	0	0	0	0	0
State	435	200	320	15	750	776	630	470	800	300	0	4,696
Federal	0	0	0	0	0	0	0	0	0	0	0	0
Total	435	200	320	15	750	776	630	470	800	300	0	4,696
TOTAL												
Private	41,948	58,624	14,214	11,537	57,013	112,144	68,235	19,213	49,854	6,913	6,768	446,463
Government												
Local	7,790	7,431	2,034	5,523	29,590	97,608	51,478	714	22,676	2,641	2,829	230,314
State	5,712	6,947	4,822	1,236	8,103	4,760	3,847	4,458	12,086	3,399	1,408	56,778
Federal	11,240	37,104	8,183	1,601	43,084	21,868	20,534	10,991	37,380	12,324	2,915	207,224
Total	66,690	110,106	29,253	19,897	137,790	236,380	144,094	35,376	121,996	25,277	13,920	940,779
GRAND TOTAL												
Private	131,508	145,221	43,332	31,293	171,334	338,843	187,678	77,918	148,964	19,499	20,079	1,315,669
Government												
Local	17,959	22,327	6,375	15,917	85,969	293,088	132,593	27,305	69,212	7,672	8,134	686,551
State	15,976	19,246	13,117	3,411	22,600	12,251	9,477	12,079	33,268	9,259	3,957	154,641
Federal	34,774	111,680	25,613	4,434	106,885	58,122	52,259	28,306	92,258	31,254	8,151	553,736
Total	200,217	298,474	88,437	55,055	386,788	702,304	382,007	145,608	343,702	67,684	40,321	2,710,597

[1] Does not include program costs and studies estimated on an Areas basis only ($3,000,000).

TABLE 4-16. Distribution of project investment costs, Puget Sound Area 1970-1980 ($1000)

Feature	Nooksack-Sumas	Skagit-Samish Alt. A	Skagit-Samish Alt. B	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup
M&I Water Supply								
Private	2,730	0	0	0	0	900	2,704	660
Government								
Local	8,459	5,440	5,440	564	10,316	34,821	19,000	41,403
State	0	0	0	0	0	0	0	0
Federal	0	0	0	0	0	0	0	0
Total	11,189	5,440	5,440	564	10,316	35,721	21,704	42,063
Irrigation								
Private	2,700	1,350	1,350	540	0	825	0	340
Government								
Local	0	0	0	0	0	0	0	0
State	0	0	0	0	0	0	0	0
Federal	0	0	0	0	0	0	0	0
Total	2,700	1,350	1,350	540	0	825	0	340
Water Quality Control								
Private	10,260	2,400	2,400	670	0	85,230	0	5,600
Government								
Local	2,020	1,000	1,000	370	1,379	5,645	55,500	13,300
State	1,010	500	500	185	689	2,823	27,750	6,650
Federal	2,510	980	980	635	1,119	3,692	30,600	8,450
Total	15,800	4,880	4,880	1,860	3,187	97,390	113,850	34,000
Navigation								
Private	0	0	0	0	0	0	0	0
Government								
Local	210	426	426	0	0	1,043	2,212	2,084
State	0	0	0	0	0	0	0	0
Federal	457	1,039	1,039	0	0	1,157	1,567	3,346
Total	667	1,465	1,465	0	0	2,200	3,779	5,430
Power[3]								
Private	0	0	0	0	0	0	0	0
Government								
Local	0	0	0	0	0	0	0	0
State	0	0	0	0	0	0	0	0
Federal	0	0	0	0	0	32,845	0	0
Total	0	0	0	0	0	32,845	0	0
Flood Control								
Private	0	0	0	0	0	0	0	0
Government								
Local	250	5,660	7,060	800	0	3,195	1,200	160
State	0	0	0	0	0	0	0	0
Federal	25,185	32,140	38,740	6,900	0	74,623	15,540	1,440
Total	25,435	37,800	45,800	7,700	0	77,818	16,740	1,600
Watershed Management[4]								
Private	0	0	0	0	0	0	0	0
Government								
Local	3,292	3,412	3,412	496	0	621	654	1,947
State	0	0	0	0	0	0	0	0
Federal	7,681	7,225	7,225	1,149	0	1,882	1,526	3,025
Total	10,973	10,637	10,637	1,645	0	2,503	2,180	4,972
Recreation								
Private	5,458	7,163	7,163	3,063	7,100	12,180	16,328	8,847
Government								
Local	9,551	10,744	10,744	6,126	7,100	24,104	24,490	12,386
State	6,822	7,163	7,163	7,147	11,405	12,180	10,885	7,078
Federal	5,458	10,744	10,744	4,084	2,845	49,078	2,722	7,078
Total	27,289	35,814	35,814	20,420	28,450	97,542	54,425	35,389
Fish and Wildlife								
Private	0	0	0	0	0	0	0	0
Government								
Local	0	0	0	0	0	0	0	0
State	3,455	11,799	11,799	5,220	577	8,797	5,067	3,132
Federal	242	0	0	0	0	10,140	870	174
Total	3,697	11,799	11,799	5,220	577	18,937	5,937	3,306
TOTAL								
Private	21,148	10,913	10,913	4,273	7,100	26,635	19,032	15,447
Government								
Local	23,782	26,682	28,082	8,356	18,795	69,429	103,056	71,280
State	11,287	19,462	19,462	12,552	12,671	23,800	43,702	16,860
Federal	41,533	52,128	58,728	12,768	3,964	173,417	52,825	23,513
Total	$97,750	$109,185	$117,185	$37,949	$42,530	$365,781	$218,615	$127,100

[1] Alternative A—Skagit-Samish Basins.

[2] Alternative A—Nisqually-Deschutes Basins.

[3] Power investments represent hydroelectric costs only. Not shown are nuclear power and fossil fuel fired plant or pumped storage facilities costs.

[4] Does not include operation, maintenance and replacement ($7,648,000).

Nisqually-Deschutes Alt. A	Nisqually-Deschutes Alt. B	West Sound	Elwha-Dungeness	San Juan Islands	Puget Sound Area: Alt. A–S.S.[1] Alt. A–N.D.[2]	Puget Sound Area: Alt. A–S.S. Alt. B–N.D.	Puget Sound Area: Alt. B–S.S. Alt. A–N.D.	Puget Sound Area: Alt. B–S.S. Alt. B–N.D.
0	0	2,190	0	0	9,184	9,184	9,184	9,184
1,290	1,290	6,130	1,464	670	129,557	129,557	129,557	129,557
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1,290	1,290	8,320	1,464	670	138,741	138,741	138,741	138,741
300	300	50	770	0	6,875	6,875	6,875	6,875
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	14,610	0	14,610	14,610	14,610	14,610
300	300	50	15,380	0	21,485	21,485	21,485	21,485
775	775	2,300	9,870	225	117,330	117,330	117,330	117,330
1,850	1,850	3,700	1,600	186	86,550	86,550	86,550	86,550
925	925	1,850	800	94	43,276	43,276	43,276	43,276
1,825	1,825	3,050	1,325	1,319	55,505	55,505	55,505	55,505
5,375	5,375	10,900	13,595	1,824	302,661	302,661	302,661	302,661
0	0	0	0	0	0	0	0	0
891	891	0	0	0	6,866	6,866	6,866	6,866
0	0	0	0	0	0	0	0	0
962	962	0	0	0	8,528	8,528	8,528	8,528
1,853	1,853	0	0	0	15,394	15,394	15,394	15,394
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	32,845	32,845	32,845	32,845
0	0	0	0	0	32,845	32,845	32,845	32,845
0	0	0	0	0	0	0	0	0
0	0	15	0	0	11,280	11,280	12,680	12,680
0	0	0	0	0	0	0	0	0
0	0	135	0	0	155,963	155,963	162,563	162,563
0	0	150	0	0	167,243	167,243	175,243	175,243
0	0	0	0	0	0	0	0	0
0	0	343	0	0	10,765	10,765	10,765	10,765
0	0	0	0	0	0	0	0	0
0	0	736	0	0	23,224	23,224	23,224	23,224
0	0	1,079	0	0	33,989	33,989	33,989	33,989
4,400	4,400	15,553	1,652	3,806	85,550	85,550	85,550	85,550
7,680	7,680	18,664	2,066	3,045	125,956	125,956	125,956	125,956
5,471	5,471	21,774	2,889	7,612	100,426	100,426	100,426	100,426
4,400	4,400	6,221	1,652	761	95,043	95,043	95,043	95,043
21,951	21,951	62,212	8,259	15,224	406,975	406,975	406,975	406,975
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
5,051	2,551	6,284	2,749	585	52,716	50,216	52,716	50,216
0	0	0	0	0	11,426	11,426	11,426	11,426
5,051	2,551	6,284	2,749	585	64,142	61,642	64,142	61,642
5,475	5,475	20,093	12,292	4,031	218,939	218,939	218,939	218,939
11,711	11,711	28,852	5,130	3,901	370,974	370,974	370,974	370,974
11,447	8,947	29,908	6,438	8,291	196,418	193,918	196,418	193,918
7,187	7,187	10,142	17,587	2,080	397,144	397,144	403,744	403,744
$35,820	$33,320	$88,995	$41,447	$18,303	$1,183,475	$1,180,975	$1,191,475	$1,188,975

TABLE 4-17. Distribution of project investment costs, Puget Sound Area 1980-2000 ($1000)

Feature	Nooksack-Sumas	Skagit-Samish Alt. A	Skagit-Samish Alt. B	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup
M&I Water Supply								
Private	1,640	0	0	0	0	650	10,140	900
Government								
Local	7,437	8,125	8,125	858	2,500	63,732	64,380	35,616
State	0	0	0	0	0	0	0	0
Federal	0	0	0	0	0	0	0	0
Total	9,077	8,125	8,125	858	2,500	64,382	74,520	36,516
Irrigation								
Private	11,120	1,100	1,100	540	0	527	55	680
Government								
Local	0	0	0	0	0	0	0	0
State	0	0	0	0	0	0	0	0
Federal	11,120	6,000	6,000	0	0	0	0	0
Total	22,240	7,100	7,100	540	0	527	55	680
Water Quality Control								
Private	6,950	2,650	2,650	830	0	10,300	0	7,200
Government								
Local	5,040	2,250	2,250	772	3,555	9,790	135,000	20,800
State	2,520	1,125	1,125	386	1,778	4,895	67,500	10,400
Federal	4,520	2,025	2,025	1,306	2,777	7,495	73,300	12,800
Total	19,030	8,050	8,050	3,294	8,110	32,480	275,800	51,200
Navigation								
Private	0	0	0	0	0	0	0	0
Government								
Local	448	2,682	2,682	0	0	2,309	0	1,720
State	0	0	0	0	0	0	0	0
Federal	895	6,735	6,735	0	0	5,387	0	2,768
Total	1,343	9,417	9,417	0	0	7,696	0	4,488
Power								
Private	0	0	0	0	0	0	0	0
Government								
Local	0	0	0	0	0	0	0	0
State	0	0	0	0	0	0	0	0
Federal	20,000	68,000	0	0	0	0	0	0
Total	20,000	68,000	0	0	0	0	0	0
Flood Control								
Private	0	0	0	0	0	0	0	0
Government								
Local	1,000	580	780	400	0	3,787	130	100
State	0	0	0	0	0	0	0	0
Federal	25,760	65,220	7,020	3,300	0	36,083	1,170	27,400
Total	26,760	65,800	7,800	3,700	0	39,870	1,300	27,500
Watershed Management[3]								
Private	0	0	0	0	0	0	0	0
Government								
Local	1,785	592	592	1,694	1,136	3,051	1,653	1,625
State	0	0	0	0	0	0	0	0
Federal	4,165	1,258	1,258	3,926	2,109	9,336	3,857	2,542
Total	5,950	1,850	1,850	5,620	3,245	12,387	5,510	4,167
Recreation								
Private	5,440	8,540	8,540	3,120	7,950	13,900	21,000	13,900
Government								
Local	9,520	12,810	12,810	6,240	7,950	20,850	31,500	19,460
State	6,800	8,540	8,540	7,280	12,720	13,900	14,000	11,120
Federal	5,440	12,810	12,810	4,160	3,180	20,850	3,500	11,120
Total	27,200	42,700	42,700	20,800	31,800	69,500	70,000	55,600
Fish and Wildlife								
Private	0	0	0	0	0	0	0	0
Government								
Local	0	0	0	0	0	0	0	0
State	11,067	18,909	18,909	5,568	528	12,294	7,916	7,629
Federal	100	0	0	0	0	0	0	410
Total	11,167	18,909	18,909	5,568	528	12,294	7,916	8,039
TOTAL								
Private	25,150	12,290	12,290	4,490	7,950	25,377	31,195	22,680
Government								
Local	25,230	27,039	27,239	9,964	15,141	103,519	232,663	79,321
State	20,387	28,574	28,574	13,234	15,026	31,089	89,416	29,149
Federal	72,000	162,048	35,848	12,692	8,066	79,151	81,827	57,040
Total	$142,767	$229,951	$103,951	$40,380	$46,183	$239,136	$435,101	$188,190

[1] Alternative A—Skagit-Samish Basins.

2 Alternative A—Nisqually-Deschutes Basins.

[3] Does not include beach stabilization construction and other measures estimated in an Area basis only ($116,353,000).

Nisqually-Deschutes Alt. A	Nisqually-Deschutes Alt. B	West Sound	Elwha-Dungeness	San Juan Islands	Puget Sound Area: Alt. A–S.S.[1] Alt. A–N.D.[2]	Puget Sound Area: Alt. A–S.S. Alt. B–N.D.	Puget Sound Area: Alt. B–S.S. Alt. A–N.D.	Puget Sound Area: Alt. B–S.S. Alt. B–N.D.
0	0	1,280	0	0	14,610	14,610	14,610	14,610
435	435	16,910	2,678	10,200	212,871	212,871	212,871	212,871
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
435	435	18,190	2,678	10,200	227,481	227,481	227,481	227,481
680	680	70	0	0	14,772	14,772	14,772	14,772
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	17,120	17,120	17,120	17,120
680	680	70	0	0	31,892	31,892	31,892	31,892
1,960	1,960	4,400	7,340	0	41,630	41,630	41,630	41,630
1,550	1,550	8,300	560	134	187,751	187,751	187,751	187,751
775	775	4,150	280	67	93,876	93,876	93,876	93,876
2,475	2,475	8,450	1,580	2,767	119,495	119,495	119,495	119,495
6,760	6,760	25,300	9,760	2,968	442,752	442,752	442,752	442,752
0	0	0	0	0	0	0	0	0
1,784	2,984	0	0	0	8,943	10,143	8,943	10,143
0	0	0	0	0	0	0	0	0
1,929	3,129	0	0	0	17,714	18,914	17,714	18,914
3,713	6,113	0	0	0	26,657	29,057	26,657	29,057
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	88,000	88,000	20,000	20,000
0	0	0	0	0	88,000	88,000	20,000	20,000
0	0	0	0	0	0	0	0	0
0	300	114	0	0	6,111	6,411	6,311	6,611
0	0	0	0	0	0	0	0	0
0	2,700	1,026	0	0	159,959	162,659	101,759	104,459
0	3,000	1,140	0	0	166,070	169,070	108,070	111,070
0	0	0	0	0	0	0	0	0
1,519	1,519	2,416	1,037	958	17,466	17,466	17,466	17,466
0	0	0	0	0	0	0	0	0
2,821	2,821	5,639	1,925	1,778	39,356	39,356	39,356	39,356
4,340	4,340	8,055	2,962	2,736	56,822	56,822	56,822	56,822
6,040	6,040	20,525	2,540	4,050	107,005	107,005	107,005	107,005
10,570	10,570	24,630	3,180	3,240	149,950	149,950	149,950	149,950
7,550	7,550	28,735	4,440	8,100	123,185	123,185	123,185	123,185
6,040	6,040	8,210	2,540	810	78,660	78,660	78,660	78,660
30,200	30,200	82,100	12,700	16,200	458,800	458,800	458,800	458,800
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
5,612	5,612	13,389	3,474	580	86,966	86,966	86,966	86,966
0	0	0	0	0	510	510	510	510
5,612	5,612	13,389	3,474	580	87,476	87,476	87,476	87,476
8,680	8,680	26,275	9,880	4,050	178,017	178,017	178,017	178,017
15,858	17,358	52,370	7,455	14,532	583,092	584,592	583,292	584,792
13,937	13,937	46,274	8,194	8,747	303,527	303,527	303,527	303,527
13,265	17,165	23,325	6,045	5,355	520,814	524,714	394,614	398,514
$51,740	$57,140	$148,244	$31,574	$32,684	$1,585,950	$1,591,350	$1,459,950	$1,465,350

TABLE 4-18. Distribution of project investment costs, Puget Sound Area 2000-2020 ($1000)

Feature	Nooksack-Sumas	Skagit-Samish Alt. A	Skagit-Samish Alt. B	Stillaguamish	Whidbey-Camano Islands	Snohomish	Cedar-Green	Puyallup
M&I Water Supply								
Private	0	0	0	0	0	0	22,087	2,210
Government								
Local	4,998	11,290	11,290	1,152	0	19,465	65,760	57,397
State	0	0	0	0	0	0	0	0
Federal	0	0	0	0	0	0	0	0
Total	4,998	11,290	11,290	1,152	0	19,465	87,847	59,607
Irrigation								
Private	0	2,750	2,750	0	0	175	55	340
Government								
Local	0	0	0	0	0	0	0	0
State	0	0	0	0	0	0	0	0
Federal	0	15,000	15,000	0	0	0	0	0
Total	0	17,750	17,750	0	0	175	55	340
Water Quality Control								
Private	9,000	4,200	4,200	1,380	0	23,200	0	18,400
Government								
Local	13,040	1,850	1,850	840	4,673	8,000	117,000	29,400
State	6,520	925	925	420	2,336	4,000	58,500	14,700
Federal	8,520	1,925	1,925	1,340	3,336	8,500	61,500	17,100
Total	37,080	8,900	8,900	3,980	10,345	43,700	237,000	79,600
Navigation								
Private	0	0	0	0	0	0	0	0
Government								
Local	0	747	747	0	0	0	0	0
State	0	0	0	0	0	0	0	0
Federal	0	2,242	2,242	0	0	0	0	0
Total	0	2,989	2,989	0	0	0	0	0
Flood Control								
Private	0	0	0	0	0	0	0	0
Government								
Local	0	0	0	0	0	3,626	0	0
State	0	0	0	0	0	0	0	0
Federal	0	0	0	0	0	32,629	0	0
Total	0	0	0	0	0	36,255	0	0
Watershed Management[3]								
Private	0	0	0	0	0	0	0	0
Government								
Local	281	467	467	395	0	25	60	0
State	0	0	0	0	0	0	0	0
Federal	655	993	993	915	0	75	140	0
Total	936	1,460	1,460	1,310	0	100	200	0
Recreation								
Private	9,960	14,260	14,260	6,030	13,000	24,640	31,380	22,010
Government								
Local	17,430	21,390	21,390	12,060	13,000	36,960	47,070	30,814
State	12,450	14,260	14,260	14,070	20,710	24,640	20,920	17,608
Federal	9,960	21,390	21,390	8,040	5,190	36,960	5,230	17,608
Total	49,800	71,300	71,300	40,200	51,900	123,200	104,600	88,040
Fish and Wildlife								
Private	0	0	0	0	0	0	0	0
Government								
Local	0	0	0	0	0	0	0	0
State	13,610	23,035	23,035	9,412	734	18,220	16,517	11,517
Federal	0	0	0	0	0	0	0	347
Total	13,610	23,035	23,035	9,412	734	18,220	16,517	11,864
TOTAL								
Private	18,960	21,210	21,210	7,410	13,000	48,015	53,522	42,960
Government								
Local	35,749	35,744	35,744	14,447	17,673	68,076	229,890	117,611
State	32,580	38,220	38,220	23,902	23,780	46,860	95,937	43,825
Federal	19,135	41,550	41,550	10,295	8,526	78,164	66,870	35,055
Total	106,424	136,724	136,724	56,054	62,979	241,115	446,219	239,451
GRAND TOTAL								
Private	65,258	44,413	44,413	16,173	28,050	100,027	103,749	81,087
Government								
Local	84,761	89,465	90,070	32,767	51,609	241,024	565,609	268,212
State	64,254	86,256	86,256	49,688	51,477	101,749	229,055	89,834
Federal	132,668	256,721	137,121	35,755	20,556	330,732	201,522	115,608
Total	$346,941	$475,860	$357,860	$134,383	$151,692	$773,532	$1,099,935	$554,741

[1] Alternative A—Skagit-Samish Basins.

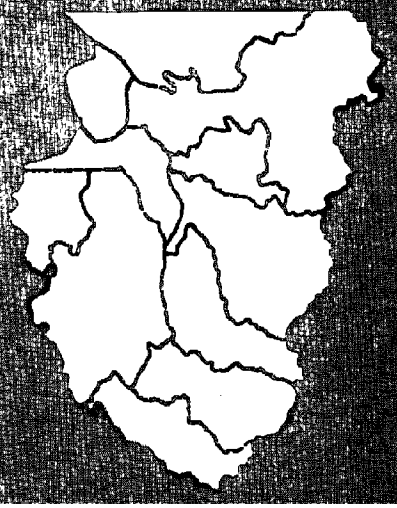
[2] Alternative A—Nisqually-Deschutes Basins.

[3] Does not include beach stabilization construction and other measures estimated on an Area basis only ($101,613,000)

Nisqually-Deschutes Alt. A	Nisqually-Deschutes Alt. B	West Sound	Elwha-Dungeness	San Juan Islands	Puget Sound Area: Alt. A–S.S.[1] Alt. A–N.D.[2]	Puget Sound Area: Alt. A–S.S. Alt. B–N.D.	Puget Sound Area: Alt. B–S.S. Alt. A–N.D.	Puget Sound Area: Alt. B–S.S. Alt. B–N.D.
0	0	0	0	0	24,297	24,297	24,297	24,297
1,167	1,167	5,360	848	0	167,437	167,437	167,437	167,437
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
1,167	1,167	5,360	848	0	191,734	191,734	191,734	191,734
1,080	1,080	70	0	0	4,470	4,470	4,470	4,470
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
0	0	0	0	0	15,000	15,000	15,000	15,000
1,080	1,080	70	0	0	19,470	19,470	19,470	19,470
3,000	3,000	8,000	16,000	0	83,180	83,180	83,180	83,180
2,500	2,500	12,250	1,650	100	191,303	191,303	191,303	191,303
1,250	1,250	6,125	825	50	95,651	95,651	95,651	95,651
3,450	3,450	10,925	2,825	3,450	122,871	122,871	122,871	122,871
10,200	10,200	37,300	21,300	3,600	493,005	493,005	493,005	493,005
0	0	0	0	0	0	0	0	0
0	0	0	0	0	747	747	747	747
0	0	0	0	0	0	0	0	0
0	0	0	0	0	2,242	2,242	2,242	2,242
0	0	0	0	0	2,989	2,989	2,989	2,989
0	0	0	0	0	0	0	0	0
350	350	0	275	0	4,251	4,251	4,251	4,251
0	0	0	0	0	0	0	0	0
3,150	3,150	0	2,475	0	38,254	38,254	38,254	38,254
3,500	3,500	0	2,750	0	42,505	42,505	42,505	42,505
0	0	0	0	0	0	0	0	0
35	35	291	105	0	1,659	1,659	1,659	1,659
0	0	0	0	0	0	0	0	0
65	65	679	195	0	3,717	3,717	3,717	3,717
100	100	970	300	0	5,376	5,376	5,376	5,376
10,730	10,730	33,425	3,960	7,050	176,445	176,445	176,445	176,445
18,820	18,820	40,110	4,955	5,640	248,249	248,249	248,249	248,249
13,420	13,420	46,795	6,925	14,100	205,898	205,898	205,898	205,898
10,730	10,730	13,370	3,960	1,410	133,848	133,848	133,848	133,848
53,700	53,700	133,700	19,800	28,200	764,440	764,440	764,440	764,440
0	0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0	0
7,437	7,437	14,854	1,998	676	118,010	118,010	118,010	118,010
0	0	0	0	0	347	347	347	347
7,437	7,437	14,854	1,998	676	118,357	118,357	118,357	118,357
14,810	14,810	41,495	19,960	7,050	288,392	288,392	288,392	288,392
22,872	22,872	58,011	7,833	5,740	613,646	613,646	613,646	613,646
22,107	22,107	67,774	9,748	14,826	419,559	419,559	419,559	419,559
17,395	17,395	24,974	9,455	4,860	316,279	316,279	316,279	316,279
77,184	77,184	192,254	46,996	32,476	1,637,876	1,637,876	1,637,876	1,637,876
28,965	28,965	87,863	42,132	15,131	685,348	685,348	685,348	685,348
50,441	51,941	139,233	20,418	24,173	1,567,712	1,569,212	1,569,312	1,570,812
47,491	44,991	143,956	24,320	31,864	920,004	917,504	920,004	917,504
37,847	41,747	58,441	33,087	12,295	1,234,237	1,238,137	1,114,637	1,118,537
$164,744	$167,644	$429,493	$120,017	$83,463	$4,407,301	$4,410,201	$4,289,301	$4,292,201

PHOTO 4-4. Typical summer weekend activity at Hiram M. Chittenden Locks where over 1 million visitors come each year to view the activity of the 50-year-old locks. The locks, primarily used by pleasure craft, make possible deep draft ship movement through the heart of Seattle from Puget Sound to Lake Washington. Corps of Engineers Photo

Part Five
Effects of the Plan



GENERAL

The Puget Sound Area has a heritage of a high quality environment with coordinated planning for the future being necessary to retain and improve this environment. The basic objective in the formulation of plans was to provide the best use, or combination of uses, of water and related land resources to meet all foreseeable short and long-term needs. In pursuit of this basic conservation objective, full consideration was given to preservation, development opportunities and the well-being of the people. The overriding determinant was the well-being of the people. The following chapter evaluates the effects of plan implementation on the Puget Sound Area. Exhibit B contains an evaluation of the Plan based on the use of alternative economic projections (OBE-ERS).

PRESERVATION OF WATER AND RELATED LAND

The future withdrawal of water from rivers is planned to be consistent with continued fish production in all streams. In many instances projects would result in increased production through low flow augmentation. Detailed stream surveys planned for implementation prior to 1980 would provide a basis for refined planning and determination of optimum flow requirements in major rivers.

Conflicting demands are being made on the marine waters and coastal shoreline to satisfy economic development needs and to meet requirements for preservation of the natural environment. The Comprehensive Plan attempts to accommodate as much of the future demands for this resource as possible by providing for balanced use of the marine shoreline as well as abating water pollution that hampers and limits production of shellfish and other fauna that inhabit these areas.

The land-use planning, undertaken on a broad basis, sought to continue as much as possible the current forest, cropland and other open space uses to meet future needs. To accomplish this objective, an urban density of 9.9 persons per acre compared with the existing average density of 4.35 persons per acre was employed in planning for the Puget Sound Area population expected by the year 2020. The Plan also provides for watershed management measures that would rehabilitate and protect watershed resources and provide for more efficient use of these lands in the future.

PRESERVATION OF FREE-FLOWING RIVERS

A large number of streams have been designated for possible inclusion in a proposed State system of recreational rivers. These streams, listed below, are recommended for further study for preservation in a natural free-flowing state in their entirety or portions thereof, with stream access retained for public use.

Nooksack-Sumas Basins
Mainstem, North, Middle, and South Forks of Nooksack River

Skagit-Samish Basins
Cascade, Suiattle, Whitechuck and portions of the Sauk and Skagit Rivers

Stillaguamish Basin
North and South Forks of Stillaguamish River, and Deer, Boulder, Squire, Jim and Canyon Creeks

Snohomish Basin
South Fork of Snoqualmie River, and portions of the North and Middle Forks of Snoqualmie, Skykomish, Wallace, Beckler, Miller, Foss, Tyee and Pilchuck Rivers

Cedar-Green Basins
Sammamish River, portions of Cedar and Green Rivers

Puyallup Basin
Carbon River, and portions of White and Puyallup Rivers

Nisqually-Deschutes Basins
Nisqually River

West Sound Basins
Skokomish, and its North and South

Forks, Hamma Hamma, Duckabush, Dosewallips and Big Quilcene Rivers

Elwha-Dungeness Basins
Elwha and Dungeness Rivers and Morse Creek

A 165-mile portion of the Skagit River and several of its tributaries have been designated in an alternative plan for the Skagit-Samish Basins for inclusion in the National Wild and Scenic River system. This complex is currently under study by the Departments of Agriculture and Interior for recommendations to Congress.

PRESERVATION OF ESTUARIES AND COASTAL ZONES

The management of the sea coast, estuaries and related shorelands of Puget Sound Area is concerned with the use and care of natural resource values and productivity. These waters and related land constitute one of the Puget Sound Area's most valuable geographic features. The pressures for shoreline space and water surface use have increased rapidly in recent years and are expected to accelerate. The Comprehensive Plan includes the following provisions for management and control and preservation of estuaries and coastal zones:

Institution of water quality measures, including waste treatment by municipalities and industry, construction of marine outfalls and diffusers to properly disperse treated wastes; and expansion of water quality surveillance program to insure compliance with State water quality standards which protect the estuaries.

Retention of all shorelands now in public ownership with emphasis on additional acquisition and development of salt water beaches and pedestrian crossings along the railroad right-of-way which follows the shoreline of Puget Sound from Seattle to Everett.

Preservation and protection of the marine estuaries and shorelines to sustain the fish, shellfish, waterfowl and wildlife species dependent on these specific natural habitats for their existence; and, to provide acquisition of marine shorelines for fish and wildlife habitat preserves, as well as fishing and hunting recreational access areas.

Identification of specific erosion sites and determination of correction measures, as erosion of the shoreline not only destroys developments and adjacent properties but contributes to deposition of silt in the estuaries.

Finally, development of a coordinated State program for future sea coast resource use.

PRESERVATION OF UNIQUE AND HISTORICAL AREAS

Numerous archeological, historical, outstanding natural and underwater marine areas have been identified in the study. The Plan includes the more significant and interesting features to be classified, protected and properly developed for public enjoyment and scientific purposes. These areas are identified in Appendix X, Recreation. Also see Appendix XV, Plan Formulation.

WELFARE OF PEOPLE

The socio-economic environment of the Puget Sound Area has been considered to be one of the best in the Nation and has accounted for substantial immigration to the Area. The population has grown from 1.7 million to 2.0 million within the past ten years. The people of the Area have combined their skills with the natural resources to develop an industrial complex heavily oriented toward aerospace, forest products, shipbuilding, trade, transportation and diversified manufacturing. In addition, commercial fisheries and recreation activities, agriculture, and timber production have long been important to the economy. The contrasts and variations that occur in the economic conditions in various parts of the Area are a result of the urbanization of the eastern shoreline of Puget Sound, with natural resources and transportation influencing the pattern of economic development in other parts of the Area. The Area is primarily split into three economic areas with the Central Division containing the industrial complex and 80 percent of the Area's population. The North Division accounts for 30 percent of the Area's commercial forest land with the agriculture, timber production and fishing and related activities the main factors of the economy. In the West Division the waters of the Strait of Juan de Fuca support an abundance of marine-oriented recreation and fish and wildlife associated activities. Trade and service industries have been expanding to meet the present and anticipated needs for outdoor recreation.

The welfare of the people was the overriding consideration in the study which sought to provide opportunities for an improved living environment. The basic needs of particular groups such as those having a special interest in water and related land resources for either economic development or environmental preservation and enhancement purposes were considered. However, the overall welfare of the general public was viewed as being paramount and care was taken to avoid resource use and development for the benefit of a few or the disadvantage of many. The depletion of a resource for a single purpose was not considered to be in the interest of the public. The Comprehensive Plan was designed to provide for balanced use of Puget Sound Area resources. Minimum streamflows for fish, water quality and aesthetic purposes were considered in the study for all of the major streams in the Area with provision made for reconsideration of plan elements after the stream survey planned for early action is completed.

The living environment would be improved by the provisions for adequate water supply, recreation facilities, restoration and maintenance of the quality of streams and estuaries, development of access to water areas for public use and enjoyment, the provisions for preservation of selected natural stream reaches in a free-flowing state, and retention of sites of historical significance and areas of unique natural beauty. The reduction of flooding would help to alleviate health problems associated with floodflows and provide for improvement of the welfare of those residing in the flood plain. The flood protection obtained by plan elements would, together with flood plain zoning, allow for continued economic farming of croplands in the flood plain thereby satisfying the needs for food and fiber as well as providing open space and greenbelts for the enjoyment of sightseeing urban dwellers. Irrigation would also help maintain a stable economy and at the same time maintain open space and green areas. The recreation facilities planned for the Area, in urban and rural areas, including the small boat harbors, and the fish and wildlife enhancement projects are designed to enhance the social environment.

The production of food and fiber would be enhanced by projects designed to increase yields through irrigation, drainage improvement and better land-use management. The planning undertaken in this study attempts to direct urban growth in such a manner that it would be related to and integrated with the natural environment, providing for an ecological improvement.

Regional systems of water supply and sewerage collection and treatment are planned to provide a more efficient use of the resources thereby allowing more of the natural resources to be retained for recreation and aesthetic enjoyment than would otherwise occur if the numerous utility districts and community systems continued to develop haphazardly.

The study sought to provide a good inventory of soil characteristics which can be used for detailed land use planning and zoning to encourage urban development on those lands that are suitable for this purpose. The Comprehensive Plan in its entirety supports the retention of flood plains for agricultural production in those areas that are considered to be uniquely suited for this purpose. Large expanses of open space land are planned for retention near urban areas. Developing access to public areas along the marine shoreline within the urban areas is viewed as a high priority element. Rural considerations involve the drainage and flood damage reduction projects and would provide an improved environment for those choosing to live in rural areas.

The Comprehensive Plan is designed to accommodate the projected economy for the Puget Sound Area through the year 2020. The economic projections were translated into needs for food and fiber, water supply and power. The Plan provides that these necessary inputs to the economic well-being of the people of the Area would be available in accordance with the projections. Comprehensive Plan elements would play an important role in enabling economic growth of the Puget Sound Area to continue. The provisions for improved navigation channels would facilitate waterborne commerce which is a growing factor in the local economy. Puget Sound is a unique harbor with deep waters capable of accommodating the largest of present and planned ocean-going vessels. The retention of sufficient back-up lands for terminal and water transport-oriented industry also is an important measure which would contribute to the economy of the Puget Sound Area. Water supply has been planned to satisfy industrial needs with industry expected to account for 60 percent of the total water consumed within the Puget Sound Area by the year 2020. Adequate quantity and quality of water are necessary for continued industrial development in the Area. Irrigation and watershed management measures would enable increased production of food and fiber supporting those industries related to agriculture and forestry and wood products.

The projection of future acreage requirements for cropland, forests, and rangeland provides important information for use in guiding future intensive land use development to enable sufficient acreages of the foregoing categories to be relegated to satisfying the projected share of Area and national needs for food and fiber and in retaining favorable hydrologic and other related conditions on such lands.

ACCOMPLISHMENTS

A detailed discussion of the accomplishments of the Comprehensive Plan is presented for each of the eleven basins in Appendix XV, Plan Formulation. Generally, all quantifiable water and related land resource needs of the Puget Sound Area, projected for the year 2020, would be met by the Comprehensive Plan except flood damage reduction to the extent desired and wet moorages for pleasure craft. Approximately 92 percent of flood damages projected for the year 2020 would be prevented by the management and structural measures of the Plan. About 83 percent of the additional permanent wet moorages required by 2020 would be provided. Urban water management needs would be met by 2020, although in preceding time periods a residual need is indicated as a minimum population density is required in order to facilitate project undertakings. Sport and commercial fishery needs would be satisfied by plan elements. However, satisfaction of future hunting needs requires that hunters accept a lower success ratio or use resources located outside the Area.

RELATIONSHIP TO NATIONAL ENVIRONMENTAL POLICY ACT OF 1969

The Comprehensive Plan has as one of its primary objectives that of environmental preservation and enhancement. Although the National Policy Act of 1969 was not in force during the course of the study its purposes were adhered to by conformance with existing State and Federal laws, regulations and policies.

In response to increasing citizen concern, Public Law 91-190 known as the National Environmental Policy Act of 1969 was signed into law on January 1, 1970. The stated purposes of the Act are:

> "To declare a national policy which will encourage production and enjoyable harmony between man and his environment; to promote efforts which will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of man; to enrich the understanding of the ecological systems and natural resources important to the Nation; and to establish a Council on Environmental Quality."

Section 101 of the Act declares the policies and goals to be:

> "The Congress, recognizing the profound impact of man's activity on the interrelations of all components of the natural environment, particularly the profound influences of population growth, high-density urbanization, industrial expansion, resource exploitation, and new and expanding technological advances and recognizing further the critical importance of restoring and maintaining environmental quality to the overall welfare and development of man, declares that it is the continuing policy of the Federal Government, in cooperation with State and local governments, and other concerned public and private organizations, to use all practicable means and measures, including financial and technical assistance, in a manner calculated to foster and promote the general welfare, to create and maintain conditions under which man and nature can exist in productive harmony, and fulfill the social, economic, and other requirements of present and future generations of Americans.
>
> (b) In order to carry out the policy set forth in this Act, it is the continuing responsibility of the Federal Government to use all practicable means, consistent with other essential considerations of national policy, to improve and coordinate Federal plans, functions, programs, and resources to the end that the Nation may–
>
> (1) fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
>
> (2) assure for all Americans safe, healthful, productive, and esthetically and culturally pleasing surroundings;
>
> (3) attain the widest range of beneficial uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences;

(4) preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment which supports diversity and variety of individual choice;

(5) achieve a balance between population and resource use which will permit high standards of living and a wide sharing of life's amenities; and

(6) enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

(c) The Congress recognizes that each person should enjoy a healthful environment and that each person has a responsibility to contribute to the preservation and enhancement of the environment."

Prior to implementation of any portion of the Puget Sound and Adjacent Waters Comprehensive Plan and as part of detailed project authorization studies all Federal agencies must conform with Section 102 of the Act which states:

"The Congress authorizes and directs that, to the fullest extent possible: (1) the policies, regulations, and public laws of the United States shall be interpreted and administered in accordance with the policies set forth in this Act, and (2) all agencies of the Federal Government shall–

(A) utilize a systematic, interdisciplinary approach which will insure the integrated use of the natural and social sciences and the environmental design arts in planning and in decisionmaking which may have an impact on man's environment;

(B) identify and develop methods and procedures, in consultation with the Council on Environmental Quality established by Title II of this Act, which will insure that presently unquantified environmental amenities and values may be given appropriate consideration in decisionmaking along with economic and technical considerations;

(C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on–

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action,

(iv) the relationship between local short-term uses of man's environment and the maintenance and enhancement of long-term productivity, and

(v) any irreversible and irretrievable commitments of resources which would be involved in the proposed action should it be implemented.

Prior to making any detailed statement, the responsible Federal official shall consult with and obtain the comments of any Federal agency which has jurisdiction by law or special expertise with respect to any environmental impact involved. Copies of such statement and the comments and views of the appropriate Federal, State, and local agencies, which are authorized to develop and enforce environmental standards, shall be made available to the President, the Council on Environmental Quality and to the public as provided by section 552 of Title 5, United States Code, and shall accompany the proposal through the existing agency review processes;

(D) study, develop, and describe appropriate alternatives to recommended courses of action in any proposal which involves unresolved conflicts concerning alternative uses of available resources;

(E) recognize the worldwide and long-range character of environmental problems and, where consistent with the foreign policy of the United States, lend appropriate support to initiatives, resolutions, and programs designed to maximize international cooperation in anticipating and preventing a decline in the quality of mankind's world environment;

(F) make available to States, counties, municipalities, institutions, and individuals, advice and information useful in restoring, maintaining, and enhancing the quality of the environment;

(G) initiate and utilize ecological information in the planning and development of resource-oriented projects; and

(H) assist the Council on Environmental Quality established by Title II of this Act."

The planning undertaken in this study was in full agreement with the sense of the National Environmental Policy Act with a balance sought in satisfying economic needs, resource preservation and restoration and enhancement of the natural environment. Recommendations or reports on individual proposals for Federal legislation, for which this study acts as a guide, will be accompanied by detailed statements required by Section 102 of the Act. Adherence to the principles of the Act also should be sought in implementing non-Federal elements of the Comprehensive Plan.

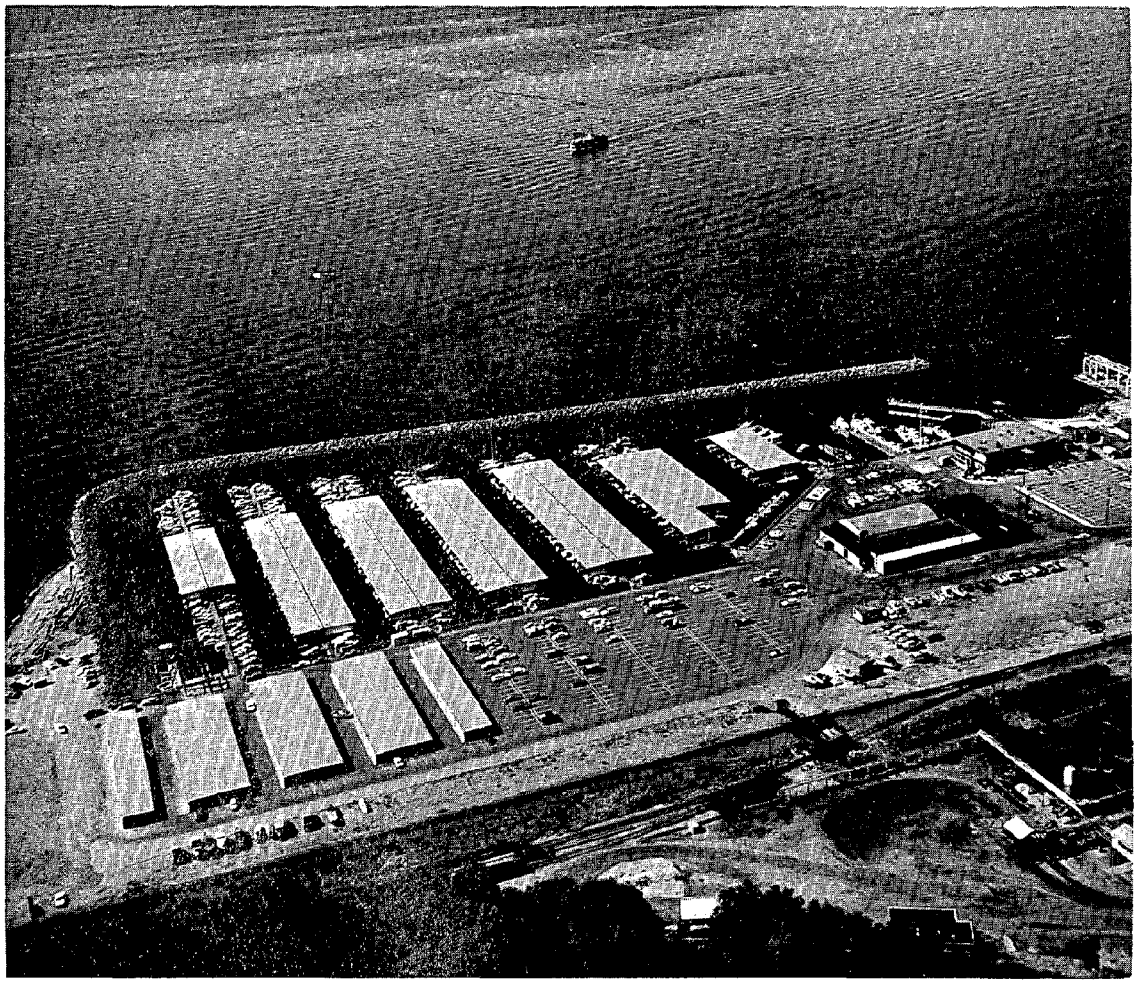
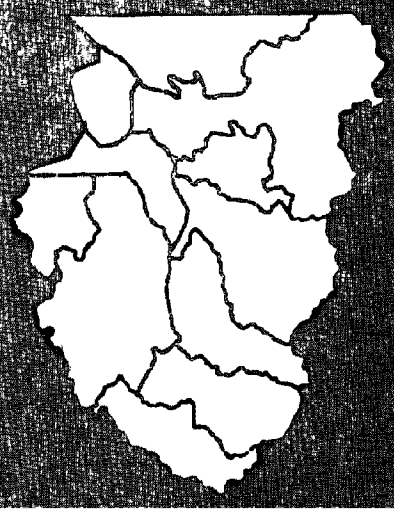


PHOTO 5-1. Puget Sound Area has a significant shortage of wet moorages. Implementation of the Comprehensive Plan would provide additional marinas to reduce this shortage, such as the well-designed complex constructed by the Port of Edmonds on the shore of Puget Sound. Corps of Engineers Photo

Part Six
Comprehensive Plan Implementation



GENERAL

Implementation of the Comprehensive Plan will require the active participation and cooperation of all Federal, State and local government, and private interests in defining goals and objectives and in sharing the legal, financial and environmental responsibilities and obligations. Many of the expenditures called for by the Plan are already part of on-going programs. An entity representing various levels of government is required to coordinate future development within the framework of the Plan consistent with the capabilities and limitations of the natural environment. The existing Puget Sound and Adjacent Waters Task Force or some similar entity could be the logical body to provide future leadership and guidance in performing this task.

Provision must also be made for periodic review and updating to maintain the viability of the Plan. Projects and programs not now part of the Plan may become evident in future studies, which reflect changed economic conditions as well as possible changes in the goals, objectives and desires of the people.

It must be recognized that the United States Government is trustee for all Indian natural resources including land in the Puget Sound Area. The Indian natural resources are private property held in trust for the Indian. All federal, state and local agencies and other planning groups should be aware that the prior immemorial rights of the Indian (land, water, fishery) must be recognized and the Indian Tribes should be a part of any plan formulation. The Bureau of Indian Affairs is exploring ways and means, including funds, to inventory all Indian natural resources to insure that the unique character of these paramount rights is recognized and protected and preserved. Any action by any planning group—federal, state, or local—must be in contemplation of the unique and distinct Indian interest. These interests must not be confused with public rights or interests, which could impair and invade the Indians' rights.

RESPONSIBILITY

The State of Washington, other legal entities, and local interests have the responsibility for initiating and coordinating many of the projects and programs included in the Plan. The impetus for activities in which a Federal agency normally performs the detailed planning and construction should be originated by a coordinating entity to direct future development within the framework of the Comprehensive Plan.

The Comprehensive Plan is intended as a guide for future water and related land development in the Puget Sound Area with further refined and more detailed studies required for specific programs and projects that have been identified as elements of the Plan. The criteria prevailing at the time of individual project studies will determine project feasibility. This includes the interest rate used in economic analysis.

The non-development alternative will also be reexamined at that time. The public should be given an active role initially and throughout the project studies. See Exhibit C for public involvement guidelines.

LEAD AGENCY

The Puget Sound Task Force (or a successor arrangement), under the leadership of the State of Washington, should continue to coordinate planning, implementation, research, communications, financing and periodic review as required to realize full benefits of the Comprehensive Plan. Citizens advisory groups, responsible for arranging continuous and broad public participation in all future studies and actions leading to implementation of the Plan, are recommended as important adjuncts to the follow-on coordination entity.

The Task Force, having responsibilities in comprehensive water-related resource planning, would assist in Plan implementation in accordance with defined policies, goals and objectives by:

1. Documenting a State viewpoint including priorities.
2. Establishing procedures for adding new elements to the Plan and modifying elements now included.
3. Assisting local organizations in coordinating, planning, financing, implementation, maintenance and operation of interrelated facilities and services in water-related development.
4. Developing a program of fiscal coordination including project expenditures and repayments, establishing formulas for grants and incentives to encourage Federal, State, and local participation in planning and development by drainage areas and as integral parts of the Comprehensive Plan.
5. Preparing annual reports, coordinating 5-year revision and updating of the Comprehensive Plan and preparing public information releases.

6. Coordinating the following:
   (a) Information gathering systems.
   (b) Establishment of ecological definitions and standards.
   (c) Establishment of prototype and demonstration programs.
   (d) Basic and applied research and technology in water and related land resources.

NEW LEGISLATION AND ZONING

The following State legislative action is needed:

1. Passage of Coastal Zone legislation to authorize multiple-purpose use and to control dredging, filling and spoils disposal in accordance with defined environmental criteria.

2. Passage of small boat act to provide for the control of wastes from water craft, ports and marinas, and for a Safe Boating Law referenced to pertinent elements of the Federal Recreation Boating Act of 1958.

3. Passage of land use and surface water zoning laws, with provision for State action if local governments do not implement adequate controls. Special attention is needed to use and protection of riverbanks and streambeds, marine waters and shorelands and to flood plain zoning, industrial and urban development, land drainage, agricultural lands, public access and open space and greenbelts and requirements for urban renewal projects.

4. Passage of legislation to improve participation in comprehensive planning at the local level.

5. Establishment of procedural arrangements to finance State and local participation investigations associated with program and project implementation studies.

The following Federal legislative action is required:

1. Passage of legislation that would provide for technical assistance, training, research and development, standards and grants to state and local government for public water supply.

2. Statutes relative to the location and clearance of bridges and causeways in the navigable waters of the Unite; States, contained in Title 33, U.S. Code, should be enlarged to provide that the Rivers and Harbors Act be amended to include funding of necessary alterations of bridges and causeways in way of proposed waterway modifications.

3. Passage of legislation establishing an emergency fund to permit timely rehabilitation of watershed resources following a natural disaster.

4. Revise legislation to allow acquisition of surplus Federal lands by State and local public agencies at minimal or no costs for use as recreation lands.

5. Provide authority to allow funding as part of Federal studies of essential review and coordination by local government.

6. Consideration should be given to changes in legislation and policy governing Indian trust or restricted lands to facilitate and permit inclusion in, and assessment for operation and maintenance, betterment, and construction by any diking and drainage district, flood control district, flood control zone district, or other improvement district that may be formed under the laws of the State of Washington.

Further discussion of Comprehensive Plan implementation and the above legislative needs is contained in Appendix II, Political and Legislative Environment.

PLAN FEATURES

Plan implementation responsibilities by major features follows:

Municipal and Industrial Water Supply

Municipalities and private interests would have primary responsibility for providing an adequate and potable water supply, including development of regional type supply and transmission systems.

A Federal-State cost-sharing program is proposed as a basis for enabling water purveyors to comply with Federal-State criteria for supply and quality control, and for participation in the State Water Plan. Communities with large seasonal populations would require special considerations.

Irrigation

Private interests would be primarily responsible for most future irrigation development in the Puget Sound Area. The project-type developments anticipated between 1980 and 2020 would use Federal and State technical and financial assistance.

Water Quality Control

Municipalities and private interests would be primarily responsible for implementation of water quality control programs, in compliance with Federal

and State water quality standards. County governments would be responsible for preparation and adoption of comprehensive sewage drainage basin plans for waste collection, treatment and control and for environmental quality management for sedimentation, solid waste disposal, land management practices and small boat sanitation, with appropriate Federal and State support.

Navigation

The Federal Government together with the State and local port authorities would have the primary responsibility for maintenance and development of commercial and recreational navigational facilities.

Terminal and water transport-oriented developments in the Puget Sound Area and construction of small boat harbor projects planned for early action should be coordinated on a regional basis.

Power

Public utilities now serving the Area have the continuing primary responsibility for satisfaction of power requirements. This will be met by development of thermal-electric plants (nuclear and fossil-fueled), utilization and expansion of existing systems, and importation from other areas. The Federal role in this expansion is to provide the backbone transmission grid for integration of new power plants and for coordination with the Pacific Southwest, to provide additional hydroelectric peaking capability to supplement the new thermal-electric energy, and to provide on occasion secondary hydroelectric energy for fuel displacement. Additional hydropower and numerous pumped storage sites will, in time, be evaluated as a part of multiple-purpose use. Selected sites are to be reserved for future use.

Flood Control

Primary responsibilities for flood control improvements rests with the Federal, State and local government for the development of flood control plans including storage, stream channel maintenance and diversions and management of flood plain use consistent with the degree of protection provided.

Watershed Management

Primary responsibilities rest with the Federal, local and private interests for programs of erosion control, water management, and management of forest and agricultural lands. However, matching funds and program incentives are needed for additional Federal and State support to attain unified action at an accelerated pace.

Programs of the U.S. Department of Agriculture provide substantial technical and financial assistance for installation of watershed measures on private lands and for installation of similar measures on national forest land; and for intensive cooperation with various State and Federal agencies in areas of mutual responsibility. Ongoing programs of the Department are expected to continue with such redirection as is required to meet the needs of the times. Twenty-five projects are described in the Comprehensive Plan as feasible for installation by 1980, and are discussed in more detail in Appendix XIV, Watershed Management, under Department of Agriculture Early Action and Other Programs. These projects and programs have interrelated aspects with projects proposed by various State and Federal agencies. Because of the interrelated nature, the Secretary of Agriculture is urged to consider requesting Area-wide authorization for planning of projects and related programs contained in the early action program.

Recreation

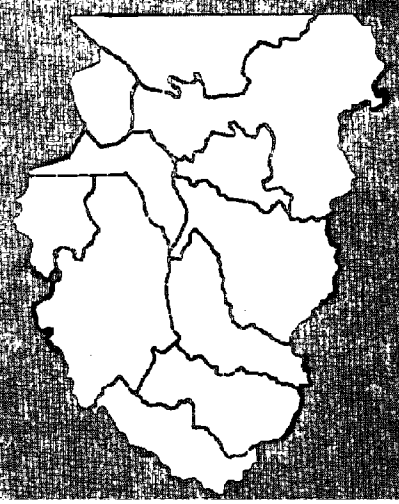
The Plan is intended to be compatible with the Comprehensive Outdoor Recreation and Open Space Plan of the State of Washington. The responsibilities for providing recreation opportunities rest with the Federal, State and local governments and commercial interests with the Federal Government providing facilities on Federal lands and grants to the State and local governments for developments on other public lands.

Fish and Wildlife

Primary responsibilities for providing fish and wildlife recreational opportunities rest with the State government.

Flow management requirements and policies are to be defined and management programs activated by the State during the first half of the early action phase of the Comprehensive Plan for the streams and lakes of the Area. The Federal Government would be responsible for carrying out fish and wildlife enhancement projects on Federal lands and assisting the State where opportunities arise through multiple-purpose projects.

Part Seven
Conclusions and Recommendations



CONCLUSIONS

In view of the information in this report it is concluded that the Plan formulated would generally meet the projected water and related land resource needs of the basin through the year 1980 and act as a framework for resource preservation and development to 2020. The Plan, to be effective, must be implemented in the form of actual projects and programs. However, because the Plan is based on long-range assumptions and projections, and because it must be sufficiently flexible to be adjusted to conform to future unforeseen changes in national, state, and local conditions, it will need periodic reviews to insure that it is properly responsive to changing times and conditions.

The public review of the Plan, undertaken prior to hearings conducted in May and June 1970 and during county workshops held from November 1970 through early April 1971, revealed that some elements of the Plan may be modified or other alternatives selected during detailed implementation studies. However, the Plan as presented provides a reasonable basis for future planning. (See Exhibit C for a summary of the public workshops and how issues raised at the workshops were responded to by the Task Force. Additions and changes were made to the Summary Report to reflect comments received from the workshop participants. A brief summary of the final hearings is presented in Exhibit D. Also see Appendix I, Digest of Public Hearings, Volumes II and III for a more detailed presentation of the hearings and workshops.)

RECOMMENDATIONS

The Puget Sound Task Force recommends that:

1. The Comprehensive Plan, as presented and discussed in this report, be used as a guide for the development and beneficial use of the water and related land resources of the Area;

2. The projects and programs in the early action (before 1980) phase of the Plan be implemented through the appropriate agency or interest;

3. This report be a supporting document for the individual Federal agency reports that would be the basis for authorization of the various parts of the Plan;

4. Each of the affected and concerned Federal, State and local agencies make periodic review of the segments of the Plan for which it may have responsibility;

5. The additional studies and other actions discussed in this report be undertaken as soon as practicable (see Syllabus for a summary listing of proposed studies);

6. An entity of local, State and Federal Governments be established in the Puget Sound Area under State leadership to (a) provide guidance in coordinating future development within the framework of the Comprehensive Plan, (b) establish priorities, (c) maintain the Plan's viability through data collection and periodic updating, and (d) report annually on progress and activity to the Northwest River Basins Commission and the Governor of the State of Washington;

7. Citizen advisory groups be formed to arrange continuous and broad public participation in all future studies and actions leading to implementation of the Comprehensive Plan;

8. The first review and updating of the Plan be accomplished within five years, including reexamination of economic projections with local governments and lay citizens participating;

9. Prototype developments be undertaken to provide information for guiding resource use in a manner that is harmonious with the natural environment, e.g., nuclear power plant siting, Indian reservation development;

10. Basic research and data gathering in follow-up studies be undertaken on a coordinated basis;

11. Land use policies and goals be determined by methods that assure public participation;

12. Federal, State and local governments reexamine current policies with regard to taxation to determine if desirable changes in resource use can be induced through modification of tax policy;

13. A single port planning entity be established for guiding future development for waterborne commerce;

14. Concerted action be undertaken by all responsible agencies to regulate vessel movements on Puget Sound and Adjacent Waters to minimize the potential for pollution resulting from collision and accidents;

15. Federal and state legislative needs identified herein and in Appendix II, Political and Legislative Environment, by reference be acted upon by the appropriate legislative body.

Exhibit A
Basin Summaries

Nooksack-Sumas

Skagit-Samish

Stillaguamish

Whidbey-Camano

Snohomish

Cedar-Green

Puyallup

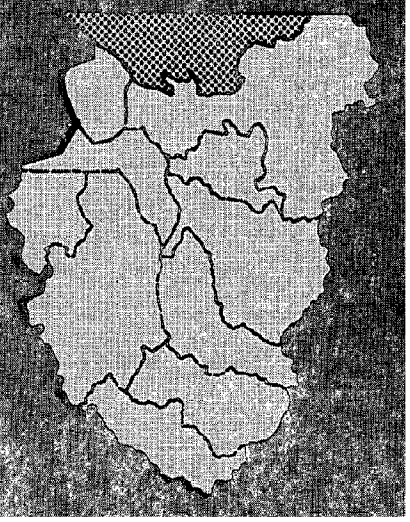
Nisqually-Deschutes

West Sound

Elwha-Dungeness

San Juan

Nooksack-Sumas Basins



COUNTIES AFFECTED:

Whatcom

Skagit

NOOKSACK–SUMAS BASINS

SUMMARY OF PLAN

Early Action 1970-1980

The projected 1980 level of municipal and industrial water needs of the city of Bellingham and its service area could be satisfied through the construction of the Edfro Dam on the South Fork of the Nooksack River. Lynden would continue to obtain its water from surface sources while Ferndale, Blaine, Sumas, Emerson and other small communities would use ground water sources. Industrial water would also be developed from surface water sources.

An additional 20,000 acres of cropland would be placed under irrigation with water being supplied from both ground and surface sources. All of the development would be by individual farmers utilizing the most economical means available.

Compliance with Washington State water quality standards would be obtained through installation of adequate collection and treatment by the communities within the Basins. Pulp and paper mills would remove settleable solids from mill effluents prior to discharge, install adequate outfalls and diffusers to achieve maximum dilution and dispersion and removal of existing sludge deposits in Whatcom Waterway to land disposal. A water quality surveillance program would be expanded in order to provide an adequate monitoring system with a sampling station on marine and fresh waters. A comprehensive sewerage plan would be developed in the Basins.

Navigation needs would be met through channel deepening of the Whatcom Waterway. Increased depth is required to accommodate bulk carriers and freighters. Lands found suitable for terminal or water transport-oriented industrial development would be retained for this purpose to insure future availability. Wet moorage would be provided for pleasure boats through the construction of two small boat harbors with 1,766 moorage spaces.

Power needs for the Basin would be satisfied by the Northwest Regional system which is discussed under Power in the Area portion of this Report.

A multiple-purpose storage project on the South Fork of the Nooksack River would provide significant flood control for the Nooksack River flood plain. This project would provide 100-year protection to 15,000 acres downstream and a lesser degree of protection to an additional 34,000 acres of land. A levee project is programmed for construction during this period. Approximately 6,200 acres of agricultural land would receive 25-year protection. In connection with the Edfro project the protection would increase to 75 years. Flood plain management would provide an effective means of reducing future flood damages through land use zoning of lands in the flood plain consistent with the levels of flood protection provided. Floodproofing and warning systems also would be implemented.

Eight small watershed multiple-purpose projects are planned for implementation during this period to achieve floodwater damage reduction and improved water management. These projects consist of improved channels, dikes, small reservoirs and outlet control structures. Important complements to the watershed management projects are the programs of technical assistance and management and land treatment and drainage.

Campgrounds, picnic areas, beaches, and boat launching ramps would be developed on existing public lands, together with the acquisition of additional land and water areas to satisfy recreational needs. Recreation sites would be developed as part of the multiple-purpose Edfro storage project. Additional land and water areas would be acquired along the Puget Sound shoreline to provide badly needed marine parks. Over 40 recreation areas would be expanded or developed before 1980.

Land acquisition and fish and wildlife enhancement projects would be undertaken to increase the opportunities for this form of outdoor recreation. Additional fish hatcheries would be constructed for both resident and migratory fish together with rearing ponds and spawning channels. Low flow augmentation would be provided from the South Fork of the Nooksack multiple-purpose storage project. The important cross-sectional stream surveys would be undertaken during this period in order to determine the minimum and optimum streamflows required for fish production. Subsequent to these cross-sectional surveys further studies of new projects may be required, as well as reconsideration of the operation of existing projects.

Long-Range, 1980-2020

Expansion of the transmission system from the Edfro Project to the distribution works would be necessary to satisfy the Bellingham service area water supply needs through the year 2020. The small and rural communities as well as industry would be supplied from combinations of ground and surface waters to the year 2020.

An additional 20,000 acres of land would be placed under irrigation during this period with water supplied primarily from the Nooksack River. The North Fork multiple-purpose storage would assist in meeting peak irrigation demands.

Existing treatment and collection facilities would be expanded commensurate with the growth in population and industrial development to insure that the State water quality standards are continually met. The water quality program would be maintained.

Navigation needs during this period require that the Whatcom Waterway again be expanded to accommodate deep draft vessels. In addition, a new channel would be constructed in the Nooksack River delta to meet the expected increase in navigation in the area. Approximately 1,700 wet moorages would be provided through the Hale Passage small boat harbor project, proposed between 1980 and the year 2020. During this period all lands that were indicated in Appendix VIII, Navigation, as being suitable for terminal or water transport-oriented industrial development would be utilized for this purpose.

Power development would probably include pumped-storage at a number of the potential sites within the Basins. The North Fork multiple-purpose storage project would also assist in meeting the power demands. Oil or gas-fueled steam electric plants may also be located during this period to meet short-term peaking requirements. Development of nuclear electric generating plants may occur, but specific sites have not been determined and would be dependent upon future studies that consider shoreline characteristics, nearness to major load centers and impacts on the environment.

Flood control needs would be satisfied by the North Fork multiple-purpose storage project and by levees in the lower valley. Levees would be constructed on the right bank between Lynden to above Everson and on the left bank opposite Lynden. A ring dike to protect the community of Sumas is also programmed. These measures would provide 100-year level of protection to 3,000 acres and 25 to 50 year protection to an additional 7,000 acres of land. Flood plain management would also be continued. Implementation of land use zoning would preclude the necessity of further structural measures within the Basins.

Further programs and projects would be undertaken to satisfy watershed management needs. These would include 12 projects and a significant program of technical assistance, land treatment, and urban and rural water management.

Additional development of campgrounds, picnic areas, and other recreation facilities would be undertaken after 1980 at over 100 sites throughout the Basins, on public lands as well as on private lands, with both public and private sectors participating in the providing of recreation facilities. Recreation facilities provided at the North Fork project would be expanded commensurate with the growth in recreation use of the reservoir. Segments of the North, Middle and South Forks may be included in a State system of scenic and recreational rivers for retention in a free-flowing state for public use.

Additional fishing opportunities would be provided through anadromous and resident fish resource enhancement measures. A number of fish passage improvements are planned during the long-range period as well as additional spawning habitat development. Wildlife preservation and enhancement programs begun prior to 1980 would be continued.

Table 1 summarizes the Nooksack-Sumas Basins elements of the Comprehensive Plan, showing the benefits and costs for the early action portion of the Plan, and provides a summary of investment costs by water resource functions for the entire 50-year period ending in 2020. The early action portion of the Plan includes programs amounting to $61,906,000 and projects costing $97,750,000, for a total investment of $159,656,000. Program and project investment costs for the 1980-2000 period amount to $214,388,000 and for the 2000-2020 period, $173,114,000, for a total 50-year investment of $547,158,000.

TABLE 1. Comprehensive Plan, Nooksack-Sumas Basins

Feature	Item	1970–1980 Investment[1] Costs ($1000)	1970–1980 Average Annual Costs ($1000)	1970–1980 Average Annual Benefits Gross ($1000)	1970–1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000–2020 Investment Costs ($1000)	1970–2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation, and Control Programs	840	--	--	--	710	790	2,340
Flood Control	Flood Plain Management	46	--	--	--	92	92	230
Watershed Management	Programs	60,532	--	--	--	70,389	65,373	196,294
Fish & Wildlife	Programs	488	--	--	--	430	435	1,353
Total Programs		$ 61,906				$ 71,621	$ 66,690	$200,217
Non-Storage Projects								
M&I Water Supply	Ground Water Use	1,663	192	192[4]	0	1,144	456	3,263
	Surface Water Use	7,112	1,073	1,073[4]	0	7,933	4,542	19,587
Irrigation Water	Ground Water Use	2,230	311	311[4]	0	---	---	2,230
Supply	Surface Water Use	470	35	35[4]	0	22,200	0	22,670
Water Quality Control	Sewerage Treatment & Collection Facilities	15,800	998	998[4]	0	19,030	37,080	71,910
Navigation	Channels	667	36	42	6	1,343	---	2,010
	Small Boat Harbors	(1,766)[3]	(105)[3]	(164)[3]	(59)	(1,108)	(2,326)	(5,200)
Power[2]								
Flood Control	Channels & Levees	2,500	125	141	16	10,000		12,500
Watershed Management	Flood water damage reduction, protection and rehabilitation, and water management	10,973	614	2,269	1,655	5,950	936	17,859
Recreation	Land Acquisition, Access & Recreation Facilities	25,680	1,743	3,156	1,413	27,100	49,800	102,580
Fish and Wildlife	Land Acquisition, Access & Enhancement Facilities	3,455	271	534	263	11,067	13,610	28,132
Total Non-Storage		$ 70,550	$ 5,398	$ 8,751	$ 3,353	$105,767	$106,424	$282,741
Storage Projects								
	Edfro							
M&I Water Supply		2,414	137	150	13	0	0	2,414
Flood Control		22,935	1,298	1,425	127	0	0	22,935
Recreation		1,609	92	100	8	0	0	1,609
Fish & Wildlife		242	13	15	2	0	0	242
Total Project		27,200	1,540	1,690	150	0	0	27,200
	North Fork							
Power		0	0	0	0	20,000	0	20,000
Flood Control		0	0	0	0	16,760	0	16,760
Recreation		0	0	0	0	100	0	100
Irrigation		0	0	0	0	40	0	40
Fish & Wildlife		0	0	0	0	100	0	100
Total Project		0	0	0	0	37,000	0	37,000
Total Storage		$27,200	$1,540	$1,690	$150	$37,000	0	$64,200
Total Program and Projects		$159,656	$6,938	$10,441	$3,503	$214,388	$173,114	$547,158

[1] Include cumulative annual program costs for the period for management featrues and capital costs for non-storage and storage projects.

[2] Power facilities not included in basin plan.

[3] General Navigation facilities cost and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

[4] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT

The projects and programs of the Comprehensive Plan are summarized in Table 2 by period. The project numbers identify features on Figure 1.

TABLE 2. Future projects and programs, Nooksack-Sumas Basins

Projects Prior to 1980

Project No.	
	Municipal and Industrial Water Supply
1.	Expansion of existing water supply and transmission systems at Ferndale, Lynden, Sumas, Blaine and other rural communities.
2.*	Increase capacity of self-supplied industrial surface water system.
3.	Provide water supply storage from Edfro multiple-purpose project, South Fork Nooksack River and transmission system—Bellingham.
	Irrigation
4.*	Installation of individual farm irrigation pumping and sprinkler systems (private).
	Water Quality Control
5.	Construction of secondary treatment and disinfection facilities at Ferndale, Lynden food processing plants and Birch Bay area.
6.	Construction of secondary treatment, disinfection, and sewage interception facilities at Everson, Nooksack and Sumas.
7.	Installation of interception facilities for septic tank effluent at Lake Whatcom.
8.*	Improvement of collection and treatment of waste discharges and submarine outfall at Bellingham.
9.	Improvement of collection and treatment of waste discharges and submarine outfall at Bellingham.
	Navigation
10.	Small boat harbor development at Bellingham and Blaine.
11.	Channel improvement at Bellingham.
	Flood Control
3.	Construction of flood control storage at Edfro multiple-purpose project—South Fork Nooksack River.
12.	Construction of levee—Ferndale.
	Watershed Management
13.	Small watershed multiple-purpose project—Middle Nooksack tributaries.
14.	Small watershed multiple-purpose project—Fishtrap and Bertrand Creeks.
15.	Small watershed multiple-purpose project—Lower Nooksack tributaries.
16.	Small watershed multiple-purpose project—Sumas River.
17.	Small watershed multiple-purpose project—Dakota Creek.
18.	Small watershed multiple-purpose project—California Creek.
19.	Small watershed multiple-purpose project—Silver (Marietta) Creek.
20.	Small watershed multiple-purpose project—Wiser Lake.
	Recreation
21.	Development of one recreation site at Point Roberts.
22.	Development of two recreation sites along saltwater shoreline from Birch Bay to Blaine.
23.	Development of one recreation site along saltwater shoreline from Lummi Bay to Birch Bay.
24.	Development of one recreation site in this vicinity.
25.	Development of two recreation sites along the saltwater shoreline of Lummi Island and Hale Passage.
26.	Development of two recreation sites along the saltwater shoreline of Bellingham Bay and south.
27.	Development of two recreation sites in this vicinity.
28.	Development of two recreation sites along Nooksack River from Lynden to junction with South Fork of Nooksack.
29.	Development of two recreation sites along Nooksack River from junction with South fork to National Forest.
30.	Development of two recreation sites along Middle Fork Nooksack River to National Forest.
31.	Development of three recreation sites along South Fork Nooksack River to National Forest.
32.	Development of 15 recreation sites in National Forest and Nation Park.
3.	Installation of recreation facilities at Edfro multiple-purpose project—South Fork Nooksack River.
	Fish and Wildlife
33.*	Acquisition and development of 12 lake access areas.
34.	Enlargement of Barrett Lake.
35.*	Construction of fish hatchery for game fish.
36.	Development of fishing piers and habitat at Lake Whatcom.
37.*	Acquisition and development of 50 miles of stream access.
38.*	Acquisition and development of 20 salt water access areas.
39.*	Acquisition and development of 1,900 acres of waterfowl and fur animal habitat.
40.*	Acquisition and development of 200 acres of band-tailed pigeon area.
41.*	Acquisition of salt water access area for waterfowl hunting.

*Projects not shown on Figure 1

TABLE 2. Future projects and programs, Nooksack-Sumas Basins (Cont'd)

42.* Development of propagation sites for rearing anadromous game fish.

43.* Construction of steelhead rearing pond.

44.* Expansion of game farm to produce 3,000 pheasants annually.

45. Improvement of lake and stream on Skookum Creek and Musto Marsh Ponds.

3. Low flow augmentation from Edfro multiple-purpose project—South Fork Nooksack River.

Programs Prior to 1980

Water Quality Control

a. Establish and operate water quality surveillance stations at key salt and fresh water locations and prepare comprehensive sewerage plan for the Basins.

Flood Control

b. Establish and administer county-wide flood plain zoning measures under flood plain management program.

Watershed Management

c. Provide technical assistance and management for State and Federal lands.

d. Provide technical assistance for onfarm and other private practices.

Fish and Wildlife

e. Develop lake fertilization techniques.

f. Make wildlife population analysis and timberland management practices studies, develop habitat improvement techniques and an education program on proper game hunting concepts, and begin a program with land owners for game habitat retention and hunter access.

g. Develop fish disease controls and new toxicants.

h. Conduct cross-sectional stream surveys to determine minimum and optimum streamflows for fish.

i. Locate, survey, and mark boundaries of all State-owned second class tidelands in the Basins. Take steps to reserve all such lands for public use except as required for specific circumstances.

j. Perform an inventory of shellfish stocks and recreational use of tidelands.

Projects 1980—2000

Municipal and Industrial Water Supply

46. Expansion of existing surface water supply and transmission facilities—Bellingham.

47. Expansion of existing water supply and transmission systems at Ferndale, Sumas, Blaine, Lynden and other rural communities.

48.* Additional development of self-supplied industrial surface water system.

Irrigation

49. Provide irrigation water supply to serve cropland at Lake Terrell and northeast of Lynden from North Fork multiple-purpose project—North Fork Nooksack River.

Water Quality Control

50.* Expansion of waste treatment and interception facilities for municipalities, industry and recreation.

Navigation

51. Small boat harbor development—Hale Passage, East Side.

52. Channel improvement at Bellingham.

53. Navigation channel dredging in Nooksack River delta.

Power

49. Installation of hydroelectric facilities at North Fork multiple-purpose project—North Fork Nooksack River.

Flood Control

49. Flood control storage at North Fork multiple-purpose project—North Fork Nooksack River.

54. Construction of levee on the left bank (10 miles)—opposite Lynden.

55. Construction of levee to protect Sumas.

56. Construction of levee between Lynden and Everson.

Watershed Management

57. Small watershed multiple-purpose project—South Fork Nooksack.

58.* Small watershed multiple-purpose project—Middle tributaries Nooksack.

59. Small watershed multiple-purpose project—Anderson Creek.

60.* Small watershed multiple-purpose project—Coastal Creeks.

61. Small watershed multiple-purpose project—Terrell Creek.

62. Small watershed multiple-purpose project—Squalicum Creek.

63. Small watershed multiple-purpose project—Lummi Island.

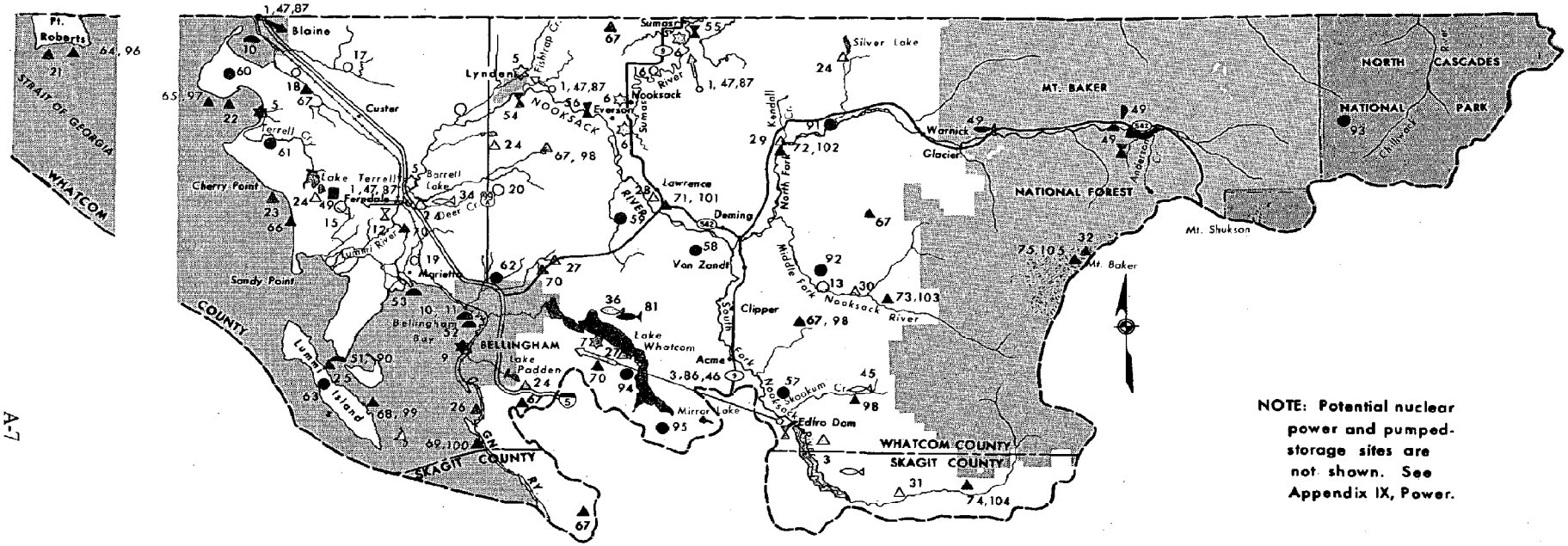
Recreation

64. Development of one recreation site at Point Roberts.

65. Development of three recreation sites along saltwater shoreline from Birch Bay to Blaine.

66. Development of two recreation sites along saltwater shoreline from Lummi Bay to Birch Bay.

*Projects not shown on Figure 1



NOTE: Potential nuclear power and pumped-storage sites are not shown. See Appendix IX, Power.

LEGEND

Proposed early-action projects	FEATURE	Proposed long-range projects
	M & I Water Supply	
	Irrigation	
	Water Quality Control	
	Navigation	
	Power	
	Flood Control	
	Watershed Management	
	Recreation	
	Fish & Wildlife	
	Dams & Reservoir	

Scale in Miles

5 0 5 10

NOOKSACK-SUMAS BASINS

ITEMS NOT SHOWN ON MAP

Rural and small community water supply projects

Irrigable land and private irrigation developments ●

Terminal and water-transport oriented industrial lands ●

Small watershed boundaries ●

Scenic highway and potential recreation river segments

Fish and wildlife projects yet to be sited

● *See functional appendix for location maps*

FIGURE 1. Comprehensive Plan Elements

TABLE 2. Future projects and programs, Nooksack-Sumas Basins (Cont'd)

67. Development of one recreation site in this vicinity.
68. Development of two recreation sites along the saltwater shoreline of Lummi Island and Hale Passage.
69. Development of three recreation sites along the saltwater shoreline of Bellingham Bay and south.
70. Development of two recreation sites in this vicinity.
71. Development of three recreation sites along Nooksack River from Lynden to junction with South Fork of Nooksack.
72. Development of three recreation sites along Nooksack River from junction with South Fork to National Forest.
73. Development of two recreation sites along Middle Fork Nooksack River to National Forest.
74. Development of four recreation sites along South Fork Nooksack River to National Forest.
75. Development of 20 recreation sites in National Forest and Nation Park.
49. Installation of recreation facilities at North Fork multiple-purpose storage project—North Fork Nooksack River.

Fish and Wildlife

76.* Construction of fish passage facilities.
77.* Improvement of salmon habitat on 14 streams.
78.* Construction of one salmon hatchery.
79.* Construction of one mile of spawning channel for salmon.
49. Low flow augmentation from North Fork multiple-purpose project—North Fork Nooksack River.
80.* Construction of fish hatcheries for game fish.
81.* Construction of fishing piers on Lake Whatcom.
82.* Continue acquisition of wildlife areas.
83.* Development of access and parking to all State-owned beaches.
84.* Development of one subtidal park for skin divers.
85.* Acquisition of five miles of tideland for public use.

Programs 1980–2000

Water Quality Control

k. Continuation of water quality monitoring, evaluation and control programs.

Flood Control

l. Continuation of flood plain management programs.

Watershed Management

m. Provide technical assistance and management for State and Federal lands.
n. Provide technical assistance for onfarm and other private practices.

Fish and Wildlife

o. Continuation of fish and wildlife programs.
p. Improvement of public beaches for clam culture.

Projects 2000–2020

Municipal and Industrial Water Supply

86. Expansion of existing surface water supply and transmission facilities—Bellingham.
Expansion of existing water supply and transmission systems at Ferndale, Sumas, Blaine, Lynden and other rural communities.
88.* Additional development of self-supplied industrial surface water system.

Water Quality Control

89.* Expansion of waste treatment and interception facilities for municipalities, industry and recreation.

Navigation

90. Small boat harbor expansion—Hale Passage—East Side.

Watershed Management

91. Small watershed multiple-purpose project—North Fork Nooksack.
92. Small watershed multiple-purpose project—Middle Fork Nooksack.
93.* Small watershed multiple-purpose project—Upper South tributaries of Chilliwack.
94. Small watershed multiple-purpose project—Lake Whatcom.
95. Small watershed multiple-purpose project—Chuckanut Mountain.

Recreation

96. Development of one recreation site at Point Roberts.
97. Development of two recreation sites along saltwater shoreline
98. Development of one recreation site in this vicinity.
99. Development of one recreation site along the saltwater shoreline of Lummi Island and Hale Passage.
100. Development of one recreation site along the saltwater shoreline of Bellingham Bay and south.
101. Development of four recreation sites along Nooksack River from Lynden to junction with South Fork of Nooksack.
102. Development of five recreation sites along Nooksack River from junction with Sourth Fork to National Forest.
103. Development of three recreation sites along Middle Fork Nooksack River to National Forest.
104. Development of six recreation sites along South Fork Nooksack River to National Forest.
105. Development of 20 recreation sites in National Forest and National Park.

*Projects not shown on Figure 1

TABLE 2. Future projects and programs, Nooksack-Sumas Basins (Cont'd)

Fish and Wildlife

106.* Construction of three new salmon hatcheries and development of 100 acres of rearing facilities.

Programs 2000–2020

Water Quality Control

q. Continuation of water quality monitoring, evaluation and control programs.

Flood Control

r. Continuation of flood plain management programs.

Watershed Management

s. Provide technical assistance and management for State and Federal lands.

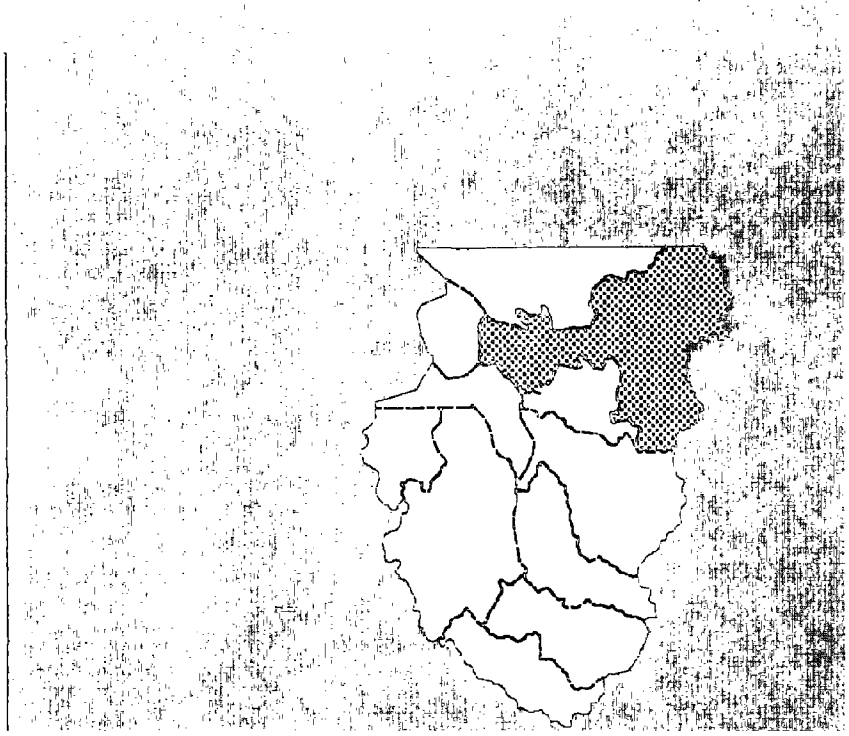
t. Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

u. Continuation of fish and wildlife programs.

*Projects not shown on Figure 1

Skagit-Samish Basins



COUNTIES AFFECTED:

Whatcom

Skagit

Snohomish

SKAGIT–SAMISH BASINS

SUMMARY OF PLAN

A major consideration in planning for the Skagit-Samish Basins was the possible future inclusion of portions of the Skagit River and its tributaries in the National Wild and Scenic Rivers system in accordance with the National Wild and Scenic Rivers Act. Under the Act, the classifications "wild," "scenic," and "recreation" would impose different restrictions upon future improvements along the stream. Because of the possibility of parts of the Skagit River system being classified under the national system, two alternatives, A and B, are presented herein for consideration.

Alternative A allows full use of storage opportunities to obtain maximum flood control in the Skagit River Basin. The assumption is made under this Alternative no part of the Skagit River or its tributaries would be included in the National Wild and Scenic Rivers system. However, portions of the Skagit River system would be included for study under a State recreational river system.

Alternative B is based on the assumption that the entire 165-mile river complex cited in the Act would be designated in the National Wild and Scenic Rivers system. Also, the assumption is made that the entire complex would be given a "Recreational River" classification and that nonstorage developments would be compatible with this classification.

The elements of the alternative plans are the same for all features except for flood control, power and recreation. The latter only differs as to the inclusion of the designated portions of the Skagit River and tributaries in a National Wild and Scenic Rivers system.

Stream reaches assumed to be designated under Alternative B for the National Wild and Scenic Rivers system are identified in the tabulation below:

Alternative B
Segments of the Skagit River and its Tributaries in the National Wild and Scenic Rivers System

		Miles
Skagit	Mount Vernon to and including the mouth of Bacon Creek	70
Cascade	Mouth to junction of its North and South Forks	17
Cascade, North Fork	Mouth to Glacier Peak Wilderness Area	2
Suiattle	Mouth to Glacier Peak Wilderness Area at Milk Creek	28
Sauk	Mouth to junction with Elliott Creek	38
Sauk, North Fork	Mouth to Glacier Peak Wilderness Area	10
		165

Alternative A is presented first in the subsequent discussion in its entirety with a discussion of Alternative B following, limited to those features which differ with Alternative A.

ALTERNATIVE A

Early Action, 1970-1980

During this period municipal and industrial water supply needs of the city of Anacortes and the Skagit County PUD No. 1 would be satisfied by pumping and treating water from the Skagit River for the city and further withdrawal of water from the Cultus Mountain Watershed for the PUD. Ground water resources would continue to supply small and rural communities and industry.

About 10,000 acres of cropland would be placed under irrigation with water supplied by individual farmers from both surface and ground sources.

Compliance with Washington State water quality standards would be obtained through installation of adequate collection and treatment facilities by a number of communities and cities and by food processors. The paper mill at Anacortes would remove settleable solids from mill effluents prior to discharge and would install adequate outfalls and diffusers to achieve maximum dilution and dispersion into Puget Sound. A water quality surveillance program would be expanded in order to provide an adequate monitoring system with sampling stations on marine and fresh water. A comprehensive sewerage plan would be developed for the Basins.

Navigation needs would be met through deepening of Guemes Channel and by providing a deep draft channel in Fidalgo Bay. These channels would be deepened to accommodate bulk petroleum vessels and freighters respectively. Lands found to be suitable for terminal or water transport-oriented industrial development would be retained for this purpose to insure future availability. Development of existing and new areas of the Port of Anacortes would begin during this period in order to provide a basis for future port expansion. Wet moorage would be provided for pleasure boaters through the construction of two small boat harbors with 850 moorage slips.

Power needs for the Basin would be satisfied by the Northwest Regional system which is discussed under Power in the Area portion of this Report. Additional power production is recommended for further consideration at Ross power plant with the raising of Ross Dam. Also recommended for further consideration is (1) a reregulation project on the Skagit River at Copper Creek which would make possible the addition of further capacity at each of the Ross, Diablo, and Gorge plants; (2) the Thunder Creek diversion project to divert water into Ross Lake from the Thunder Creek Basin; and (3) nuclear power development sites on the salt-water shoreline.

During this period 100,000 acre-feet of flood control storage would be obtained by changing the operation of the Upper Baker project. The Avon Bypass also would be constructed in conjunction with downstream levee and channel improvements. The Bypass would be sized for a flow of 60,000 cfs. A levee would be constructed at Nookachamps Creek before 1980. Flood plain management by land use zoning of lands would control development in the flood plain consistent with the levels of flood protection. Floodproofing and warning systems also would be implemented. These measures would contribute significantly to the reduction of future flood damages.

Small watershed multiple-purpose projects at Gages Slough, South Mount Vernon, the Samish River and at the Skagit Flats watersheds are planned for implementation during this period to achieve floodwater damage reduction, protection and rehabilitation of lands, and water management. The projects include stabilized channels and outlet control structures. Programs of technical assistance, water management, land treatment and drainage, would complement structural measures.

Campgrounds, picnic areas, beaches, and boat launching ramps would be developed on existing public lands. Additional land and water areas would be acquired to satisfy recreational needs. Acquisition would include additional land along the Puget Sound shoreline to provide badly needed marine parks. Over 60 recreation areas would be expanded or developed before 1980.

Fish and wildlife enhancement projects including acquisition of access would be undertaken to increase the opportunities for this form of outdoor recreation. Additional fish hatcheries would be constructed for both resident and migratory fish together with rearing ponds, spawning channels and fish passage improvements including a collection and transportation facility to provide migratory fish access above Cascade Falls and on the North Fork of the Cascade River. Cross-sectional stream surveys would be undertaken during this period to determine the minimum and optimum streamflows required for fish production. These cross-sectional surveys may result in further studies of new projects as well as reconsideration of the operation of existing projects.

Long-Range, 1980-2020

Existing water supply systems would be expanded to meet elements of population and industrial growth. The projected water supply needs of municipalities, small and rural communities and industry would be satisfied.

An additional 45,000 acres of land would be placed under irrigation during this period with water supplied from surface and ground water. A project type development is planned by the year 2000.

Existing treatment and collection facilities would be expanded commensurate with the growth in population and industrial development. State water quality standards would be met and the water quality surveillance program would be maintained.

Further terminal and water transport-oriented industrial development is envisioned during this period to meet the navigation needs of the Basins. Lands would be developed in Padilla Bay through dredge fill as a deep-draft channel would ultimately be provided having a depth of 54 feet. Further channel dredging is planned in Fidalgo Bay. The Guemes channel would be deepened to accommodate bulk petroleum vessels.

Power development could include pumped-storage at a number of the potential sites within the Basins. Oil or gas-fueled steam electric plants also may be located during this period to meet short-time peaking requirements. Development of nuclear electric generating plants may occur but definite scheduling of facilities and exact siting have not been completed and would be dependent upon future studies of shoreline characteristics, major load centers and impacts on the environment. Power facilities would be provided as part of the Lower Sauk storage project.

After 1980 levees would provide 100-year winter flood protection for the communities of Hamilton and Sedro Woolley. These projects, generally would be a matter of raising existing structures to heights sufficient to provide the 100-year protection. Flood plain management would be continued with zoning being required to guide future development and prevent unwarranted development in the flood plain. Under Alternative A, 134,000 acre-feet of flood control storage would be provided by the Lower Sauk project.

Eight additional multiple-purpose projects would be undertaken to satisfy watershed management needs in this time period. In addition to the structural measures included in these projects, a program of technical assistance, land treatment, and water management would be continued and enlarged.

Additional development of campgrounds, picnic areas, and other recreation facilities would be undertaken after 1980 at nearly 170 sites throughout the Basins, on public lands as well as on private lands, with both public and private sectors participating in providing facilities. The recreation facilities at the Avon Bypass project would be expanded commensurate with demand. Portions of the Skagit River system would be included in a State system of scenic and recreational rivers for retention in a free-flowing state for public use.

Additional fish and wildlife opportunities would be provided through anadromous and resident fish enhancement measures. A number of fish passage improvements are planned during the long-range period as well as additional spawning habitat development.

Table 3 summarizes the Skagit-Samish Basins elements of the Comprehensive Plan, showing the benefits and costs for the early action portion of the Plan, and provides a summary of investment costs by water resource functions for the entire 50-year period ending in 2020. The early action portion of the Plan includes programs amounting to $88,414,000 and projects costing $109,185,000; for a total investment of $197,599,000. Program and project investment costs for the 1980-2000 period amount to $329,905,000 and for the 2000-2020 period program and project costs would be $246,830,000. A total 50-year investment would amount to $774,334,000.

TABLE 3. Comprehensive Plan, Alternative A, Skagit-Samish Basins

Feature	Item	1970-1980 Investment[1] Costs ($1000)	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control	490	--	--	--	360	420	1,270
Flood Control	Flood Control Management	115	--	--	--	168	168	451
Watershed Management	Programs	87,556	--	--	--	99,226	109,318	296,100
Fish and Wildlife	Programs	253	--	--	--	200	200	653
Total Programs		$88,414				$99,954	$110,106	$298,474
Nonstorage Projects								
M&I Water Supply	Ground Water Use	0	0	0	0	565	905	1,470
	Surface Water Use	5,440	503	503[4]	0	7,560	10,385	23,385
Irrigation Water Supply	Ground Water Use	1,072	179	179[4]	0	3,400	3,750	8,222
	Surface Water Use	278	46	46[4]	0	3,700	14,000	17,978
Water Quality Control	Sewerage Treatment and Collection Facilities	4,880	320	320[4]	0	8,050	8,900	21,830
Navigation	Channels	1,465	81	105	24	9,417	2,989	13,871
	Small Boat Harbors[3]	(1,714)[3]	(109)[3]	(159)[3]	(50)[3]	(3,831)[3]	(3,830)[3]	(9,375)[3]
Power[2]								
Flood Control	Levee and Channels	37,800	1,983	3,150	1,167	5,800	0	43,600
Watershed Management	Floodwater Damage Reduction, Water Management, and Protection and Rehabilitation	10,637	594	2,242	1,648	1,850	1,460	13,947
Recreation	Land Acquisition, Access and Enhancement Facilities	35,814	2,555	3,600	1,045	42,700	71,300	149,814
Fish and Wildlife	Land Acquisition, Access and Enhancement Facilities	11,799	1,420	1,910	490	18,909	23,035	53,243
Total Nonstorage		$109,185	$7,681	$12,055	$4,374	$101,951	$136,724	$347,860
Storage Projects								
Flood Control	Upper Baker		133	300	167			
	Lower Sauk							
Power						68,000		68,000
Flood Control						60,000		60,000
Total Projects						$128,000		$128,000
Total Programs and Projects		$197,599	$7,814	$12,355	$4,541	$329,905	$246,830	$774,334

[1] Includes cumulative annual program costs for the period for management features and capital costs for nonstorage projects.

[2] Nonstorage power development not included in the Plan.

[3] General navigation facilities costs and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

[4] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT
ALTERNATIVES A AND B

The projects and programs of the Comprehensive Plan are summarized in Table 4 by time period. Elements listed are the same for both Alternatives A and B unless otherwise noted. Project numbers identify features on Figure 2.

TABLE 4. Future projects and programs, Skagit-Samish Basins

PROJECTS PRIOR TO 1980

Municipal and Industrial Water Supply

1. Expansion of Skagit River intake and treatment plant–Anacortes.
2. Expansion of Cultus Mountain water supply system–Skagit County PUD No. 1.
3.* Increase capacity of self-supplied industrial water system.

Irrigation

4.* Installation of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

5.* Installation of adequate secondary treatment facilities by food processors and wood products industries.
6. Installation of facilities to remove all settleable solids from mill effluents prior to discharge with adequate outfall and diffuser–paper mill at Anacortes.
7. Installation of adequate secondary treatment facilities with disinfection by Mount Vernon, Sedro Woolley, Concrete, LaConner, Skagit County Sanitary District No. 1, and the properties of Seattle City Light.
8. Expansion of domestic system by Burlington.

Navigation

9. Deepen Guemes channel.
10. Dredge deep draft navigation channel in Fidalgo Bay.
11. Construction of small boat harbor development–LaConner, Indian Bay.
12. Enlargement of small boat harbor–Anacortes.

Flood Control

13. Construction of levee–Skagit River at Nookachamps Creek
14. Improvement of levee and channel–Skagit River downstream from Burlington.
15. Purchase flood control storage in Upper Baker River.
16. Construction of Avon Bypass including levee from bypass entrance upstream to Sedro Woolley (size varies with Alternatives A and B).

Watershed Management

17. Small watershed multiple-purpose project–Gages Slough.
18. Small watershed multiple-purpose project–South Mount Vernon.
19. Small watershed multiple-purpose project–Samish River.
20. Small watershed multiple-purpose project–Skagit Flats.

Recreation

16. Installation of recreation facilities as part of Avon Bypass project.
21. Development of four recreation sites along the salt water shoreline of Fidalgo Island.
22. Development of three recreation sites, total, on Cypress and Guemes Islands.
23. Development of two recreation sites along the salt water shoreline of Padilla Bay.
24. Development of one recreation site in this vicinity.
25. Development of four recreation sites along Skagit River from mouth to confluence with the Sauk River.
26. Development of two recreation sites along Sauk River from mouth to head waters.
27. Development of 40 recreation sites in the National Forest and National Park.

Fish and Wildlife

28.* Enlargement of existing fish hatcheries.
29. Construction of fish passage facilities at Cascade Falls.
30.
30.* Acquisition and development of access to eight lakes.
31. Construction of fishing piers at Samish Lake.
32.* Construction of two trout hatcheries.
33.* Construction of one rearing pond for summer steelhead.
34.* Construction of one rearing pond for winter steelhead.
35.* Acquisition and development of 75 miles of streambank access.
36* Acquisition and development of six salt water access areas.
37.* Acquisition and development of 12,000 acres of waterfowl and fur animal habitat.
38.* Acquisiton of access to 500 acres of band-tailed pigeon areas.
39.* Enlargement of game farm to produce 5,000 additional pheasants.
40. Construction of fish passage facilities on North Fork Cascade River.

*Projects not shown on Figure 2

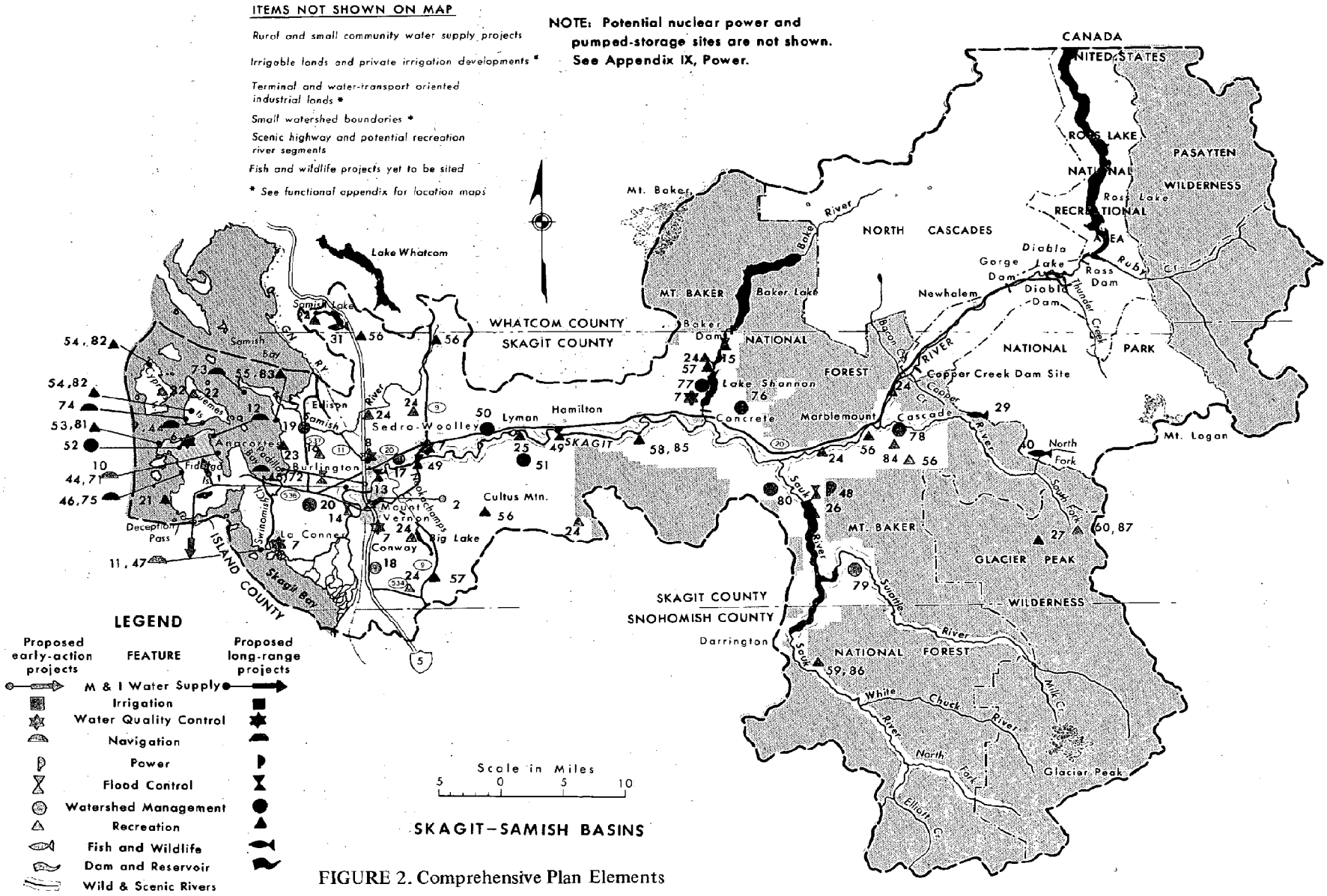


FIGURE 2. Comprehensive Plan Elements

TABLE 4. Future projects and programs, Skagit-Samish Basins (Cont'd)

PROGRAMS PRIOR TO 1980

Water Quality Control

a. Establish and operate water quality surveillance stations at key salt and fresh water locations and prepare comprehensive sewerage plan for the Basins.

Flood Control

b. Establish and administer county-wide flood plain zoning measures under flood plain management program.

Watershed Management

c. Provide technical assistance and management for State and Federal lands.

d. Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

e. Develop lake fertilization techniques.

f. Make wildlife population analysis and timberland management practices studies, develop habitat improvement techniques and an education program on proper game hunting concepts, and begin a program with land owners for game habitat retention and hunter access.

g. Develop fish disease controls and new toxicants.

h. Conduct cross-sectional stream surveys to determine minimum and optimum streamflows for fish.

i. Locate, survey, and mark boundaries of all State-owned second class tidelands in the Basins. Take steps to reserve all such lands for public use except as required for specific circumstances.

j. Perform an inventory of shellfish stocks and recreational use of tidelands.

Projects 1980-2000

Municipal and Industrial Water Supply

41.* Expand existing water supply systems.

Irrigation

42.* Construction of project-type irrigation supply system with individual farm installation or sprinkler systems.

Water Quality Control

43.* Expansion of waste treatment and interception facilities for municipalities, industry, and recreation development.

Navigation

44. Deepen Guemes and Fidalgo Bay channels.

45. Dredge channel for deep draft navigation and construct terminal and transfer facilities and develop waterfront industrial land in Padilla Bay.

46. Development of small boat harbor—Fidalgo Island.

47. Enlargement of small boat harbor—LaConner, Indian Bay.

Power

48. Installation of power facilities at Lower Sauk multiple-purpose project—Sauk River (Alternative A only).

Flood Control

48. Flood control storage at Lower Sauk multiple-purpose project—Sauk River (Alternative A only).

49. Construction of levee—Sedro Woolley and Hamilton.

Watershed Management

50. Small watershed multiple-purpose project—North Skagit tributaries.

51. Small watershed multiple-purpose project—South Skagit tributaries.

52. Small watershed multiple-purpose project—Fidalgo Island group.

Recreation

53. Development of four recreation sites along the salt water shoreline of Fidalgo Island.

54. Development of three recreation sites, total, on Cypress and Guemes Islands.

55. Development of two recreation sites along the salt water shorelines of Padilla Bay.

56. Development of one recreation site.

57. Development of two recreation sites.

58. Development of five recreation sites along Skagit River from mouth to confluence with the Sauk River.

59. Development of three recreation sites along Sauk River from mouth to head waters.

60. Development of 50 recreation sites on National Forest and National Park lands.

Fish and Wildlife

61.* Improvement of fish habitat on 38 miles of stream.

62.* Channel clearance on 38 miles of stream.

63.* Construction of two salmon hatcheries.

64.* Construction of 2 miles of salmon spawning channel.

65.* Develop access and parking facilities at all State-owned beaches.

66.* Develop one sub-tidal park for skin divers.

67.* Improve public beaches for clam culture.

Programs 1980-2000

Water Quality Control

k. Continue water quality surveillance program.

Flood Control

l. Continue flood plain management program.

Watershed Management

m. Provide technical assistance for on-farm and other private practices.

n. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

o. Continue fish and wildlife programs.

*Projects not shown on Figure 2

TABLE 4. Future projects and programs, Skagit-Samish Basins (Cont'd)

Projects 2000-2020

Municipal and Industrial Water Supply

68.* Expand existing water supply systems.

Irrigation

69.* Installation of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

70.* Expansion of waste treatment and interception facilities for municipalities, industry and recreation.

Navigation

71. Deepen Fidalgo Bay channel.
72. Deepen Padilla Bay channel.
73. Development of small boat harbor—Padilla Bay—Williams Point.
74. Development of small boat harbor—Guemes Island Southwest.
75. Expansion of small boat harbor—Fidalgo Island West.

Flood Control

(No further projects planned)

Watershed Management

76. Small watershed project multiple-purpose—Upper Skagit River.
77. Small watershed multiple-purpose project—Baker River.
78. Small watershed multiple-purpose project—Cascade River.
79. Small watershed multiple-purpose project—Suiattle River.
80. Small watershed multiple-purpose project—Sauk River.

Recreation

81. Development of five recreation sites along the salt water shoreline of Fidalgo Island.
82. Development of four recreation sites, total, on Cypress and Guemes Islands.
83. Development of one recreation site along the salt water shoreline of Padilla Bay.
84. Development of one recreation site.
85. Development of six recreation sites along Skagit River from mouth to confluence with the Sauk River.
86. Development of five recreation sites along Sauk River from mouth to head waters.
87. Development of 70 recreation sites on National Forest and National Park lands.

Fish and Wildlife

88.* Construction of six salmon hatcheries or equivalent.
89.* Development of 130 acres of rearing facilities.
90.* Development of 2 miles of spawning channel.

Programs 2000-2020

Water Quality Control

p. Continue water quality surveillance program.

Flood Control

q. Continue flood plain management program.

Watershed Management

r. Provide technical assistance for on-farm and other private practices.
s. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

t. Continue fish and wildlife programs.

*Projects not shown on Figure 2

ALTERNATIVE B

Alternative B is the same as Alternative A except for flood control, power and recreation features. Flood control features differ in both the early action and long-range phases of the Plan, with the Lower Sauk storage project omitted from long-range consideration in Alternative B. Hydroelectric power development as a purpose of the Lower Sauk project also is excluded. Recreation features only differ with regard to the inclusion in Alternative B of designated portions of the Skagit River and tributaries in a National Wild and Scenic Rivers system. Only the flood control and recreation features of Alternative B are discussed in the following section.

Early Action, 1970-1980

During this period 100,000 acre-feet of flood control storage would be obtained by changing the operation of the Upper Baker project. The Avon Bypass also would be constructed in conjunction with downstream levee and channel improvements. The Bypass would be sized for a flow of 100,000 cfs under Alternative B. A levee would be constructed at Nookachamps Creek before 1980. Flood plain management by land use zoning of lands would control development in the flood plain consistent with the levels of flood protection. Floodproofing and warning systems also would be implemented. These measures would contribute significantly to the reduction of future flood damages and are relied upon to large measure in Alternative B to reduce future flood damages above Sedro Woolley.

About 165 miles of the Skagit River and tributaries would be classified as "Recreational Rivers" in the National Wild and Scenic Rivers sys tem.

Table 5 summarizes all the elements of Alternative B, showing the benefits and costs for the early action portion of the Plan, and provides a summary of investment costs by water resource functions for the entire 50-year period ending in 2020. The early action portion of the Plan includes programs amounting to $88,414,000 and projects costing $117,185,000 for a total investment of $205,599,000. Program and project investment costs for the 1980-2000 period amount to $203,905,000 and for the 2000-2020 period $246,830,000. A total 50-year investment amounts to $656,334,000 for Alternative B.

SEQUENCE OF DEVELOPMENT ALTERNATIVE B

The projects and programs of Alternative B are shown in Table 4 with projects identified on Figure 2. Elements differing with Alternative A are noted.

TABLE 5. Comprehensive Plan, Alternative B, Skagit-Samish Basins

Feature	Items	1970-1980 Investment[1] Costs ($1000)	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control	490	--	--	--	360	420	1,270
Flood Control	Flood Control Management	115	--	--	--	168	168	451
Watershed Management	Programs	87,556	--	--	--	99,226	109,318	296,100
Fish and Wildlife	Programs	253	--	--	--	200	200	653
Total Programs		$ 88,414				$ 99,954	$110,106	$298,474
Nonstorage Projects								
M&I Water Supply	Ground Water Use	0	0	0	0	565	905	1,470
	Surface Water Use	5,440	503	503[4]	0	7,560	10,385	23,385
Irrigation Water Supply	Ground Water Use	1,072	179	179[4]	0	3,400	3,750	8,222
	Surface Water Use	278	46	46[4]	0	3,700	14,000	17,978
Water Quality Control	Sewerage Treatment and Collection Facilities	4,880	320	320[4]	0	8,050	8,900	21,830
Navigation	Channels	1,465	81	105	24	9,417	2,989	13,871
	Small Boat Harbors[3]	(1,714)[3]	(109)[3]	(159)[3]	(50)[3]	(3,831)[3]	(3,830)[3]	(9,375)[3]
Power[2]								
Flood Control	Levee and Channels	45,800	2,403	3,478	1,075	7,800	0	53,600
Watershed Management	Floodwater Damage Reduction, Water Management, and Protection and Rehabilitation	10,637	594	2,242	1,648	1,850	1,460	13,947
Recreation	Land Acquisition, Access and Enhancement Facilities	35,814	2,555	3,600	1,045	42,700	71,300	149,814
Fish and Wildlife	Land Acquisition, Access and Enhancement Facilities	11,799	1,420	1,910	490	18,909	23,035	53,243
Total Nonstorage		$117,185	$8,101	$12,383	$4,282	$103,951	$136,724	$357,860
Storage Project								
Flood Control	Upper Baker		133	300	167			
Total Programs and Projects		$205,599	$8,234	$12,683	$4,449	$203,905	$246,830	$656,334

1 Includes cumulative annual program costs for the period for management features and capital costs for nonstorage projects.

2 Nonstorage power development not included in the Plan.

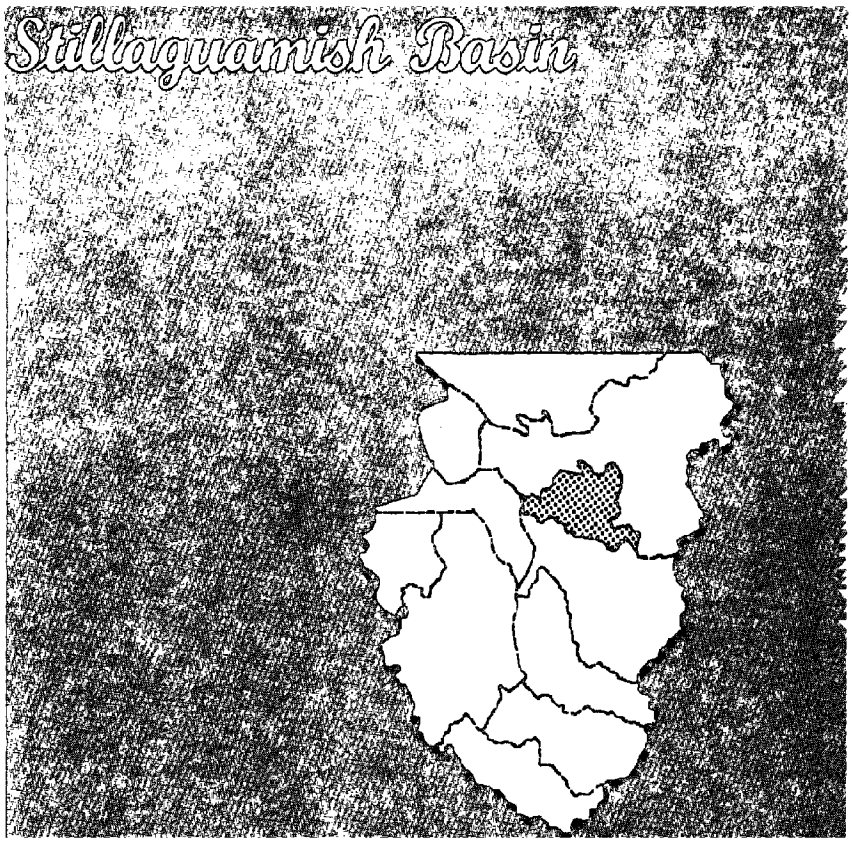
3 General navigation facilities costs and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

4 Average annual benefits assumed equal to average annual costs.

COUNTIES AFFECTED:

Skagit

Snohomish



STILLAGUAMISH BASIN

SUMMARY OF PLAN

Early Action, 1970-1980

During this period ground water resources would continue to supply Arlington, Stanwood, and rural communities. Minor use of surface waters for rural and individual system is expected.

About 4,000 acres of cropland would be placed under irrigation with water supplied by individual farmers from both surface and ground sources. All development would be by individuals utilizing the most economical means available.

Compliance with Washington State water quality standards would be obtained through installation of adequate collection and treatment facilities by a number of communities and cities in the Basin. The food processing industry would provide adequate means of waste disposal either through use of municipal facilities or land disposal. A water quality surveillance program would be expanded in order to provide an adequate monitoring system with sampling stations on marine and fresh water.

No commercial navigation needs are projected for the Stillaguamish Basin. The extensive tidelands in Port Susan and the shoaled condition of the Stillaguamish River at Stanwood make development of small boat basins within the Basin impracticable under present conditions. Accordingly, small boat moorage needs of the Stillaguamish Basin would be met in the Skagit-Samish Basins.

Power needs for the Basin would be satisfied by the Northwest Regional system which is discussed under Power in the Area portion of this Report.

A flood control project to straighten and enlarge the Stillaguamish-Hat Slough channel below Silvana in connection with levees is planned. A levee north of Stanwood is recommended to provide protection from flooding in the Skagit Basin. These improvements would provide 100-year protection for 7,300 acres of land. Flood plain management would provide an effective means of reducing future flood damages through land use zoning of lands in the flood plain consistent with the levels of flood protection provided. Floodproofing and warning systems also would be implemented. These measures would contribute significantly to the reduction of future flood damages.

Two small watershed multiple-purpose projects are planned for implementation during this period to achieve floodwater damage reduction and install water management measures, together with protection and rehabilitation of watershed lands. These projects contain structural measures such as stabilized channels, dikes on the Stillaguamish, and outlet control structures. Upgrading of existing facilities and more intensive application of recurring and nonrecurring land treatment practices would be required throughout the Basin. Soil and water conservation programs which offer technical assistance and financial participation would be continued.

Campgrounds, picnic areas, beaches, and boat launching ramps would be developed on existing public lands together with the acquisition of additional land and water areas to satisfy recreational needs. Additional land and water areas would be acquired along the Puget Sound shoreline to provide marine parks. About 40 recreation sites are planned for expansion or development before 1980.

Land acquisition, access easements and fish and wildlife enhancement projects would be undertaken to increase the opportunities for this form of outdoor recreation. Additional fish hatcheries would be constructed for both resident and migratory fish together with rearing ponds, spawning channels and fish passage improvements on the South Fork of the Stillaguamish River. Cross-sections of the streams would be surveyed during this period to determine the minimum and optimum streamflows required for fish production. These cross-sectional surveys may show further studies of new projects to be warranted.

Long-Range, 1980-2020

Arlington, Stanwood and other small rural communities within the Basin would continue to develop ground water to satisfy their needs to 2020. A limited amount of surface water would be utilized by rural consumers.

An additional 4,000 acres of land would be placed under irrigation with water supplied by individual farmers from both ground and surface sources.

Existing sewerage treatment and collection facilities would be expanded commensurate with the growth in population and industrial development to insure that the State water quality standards are continually met. The water quality surveillance program would be maintained.

As in the early action program, no commercial navigation needs have been projected for the Basin. Shorelands are unsuitable for small boat harbors. This need would be fulfilled in the Skagit-Samish Basins.

Power development would probably include pumped-storage at a number of the potential sites within the Basin. Oil or gas-fueled steam electric plants also may be located during this period to meet short-time peaking requirements. Development of nuclear electric generating plants may occur but specific sites have not been determined and would be dependent upon future studies that considered shoreline characteristics, nearness to major load centers and impacts on the environment.

The only additional flood control structures envisioned after 1980 would be a construction of levees to provide 25-year flood protection for 4,000 acres of land between Arlington and Silvana. Flood plain management would be continued with zoning being required to guide future development and prevent unwarranted development in the flood plain.

Six additional multiple-purpose projects would be undertaken to satisfy watershed management needs in this time period. In addition to the structural measures provided by these projects, a significant program of technical assistance, land treatment, and water management would be continued and enlarged.

Additional development of campgrounds, picnic areas, and other recreation facilities would be undertaken after 1980 at nearly 100 sites throughout the Basin, on public lands as well as private lands with both public and private sectors participating in the providing of recreational facilities. The South and North Forks of the Stillaguamish River may be included in a State system of scenic and recreational rivers for public use.

Further fishing opportunities would be provided through anadromous and resident fish enhancement measures. A number of fish passage improvements are planned during the long-range period as well as additional spawning habitat development. Wildlife preservation and enhancement programs begun prior to 1980 would be continued.

Table 6 summarizes the Stillaguamish Basin elements of the Comprehensive Plan, showing the benefits and costs for the early action portion of the Plan, and provides a summary of investment costs by water resource functions for the entire 50-year period ending in 2020. The early action portion of the Plan includes programs amounting to $29,038,000 and projects costing $37,949,000 for a total investment of $66,987,000. Program and project investment costs for the 1980-2000 period amount to $70,526,000 and for the 2000-2020 period, $85,307,000; for a total 50-year investment of $222,820,000.

TABLE 6. Comprehensive Plan, Stillaguamish Basin

Feature	Items	1970-1980 Investment Costs ($1000)[1]	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control Programs	160	--	--	--	300	340	800
Flood Control	Flood Plain Management	25	--	--	--	46	46	1,117
Watershed Management	Programs	28,693	--	--	--	29,480	28,547	86,720
Fish & Wildlife	Programs	160	--	--	--	320	320	800
Total Programs		$29,038				$30,146	$29,253	$ 88,437
Nonstorage Projects								
M&I Water Supply	Ground Water Use	564	75	75[3]	0	858	1,152	2,574
Irrigation Water Supply	Ground Water Use	270	45	45[3]	0	270	0	540
	Surface Water Use	270	45	45[3]	0	270	0	540
Water Quality Control	Sewerage Treatment and Collection Facilities	1,860	127	127[3]	0	3,294	3,980	9,134
Navigation[2]		--	--	--	--	--	--	--
Power[2]		--	--	--	--	--	--	--
Flood Control	Channels and Levees	7,700	454	500	46	3,700	0	11,400
Watershed Management	Floodwater Damage Reduction, Water Management and Rehabilitation and Protection of Watershed Lands	1,645	92	288	196	5,620	1,310	8,575
Recreation	Land Acquisition, Access and Recreation Facilities	20,420	1,256	1,484	228	20,800	40,200	81,420
Fish & Wildlife	Projects	5,220	521	1,528	1,007	5,568	9,412	20,200
Total Nonstorage		$37,949	$2,615	$4,092	$1,477	$40,380	$56,054	$134,383
Total Programs and Projects		$66,987	$2,615	$4,092	$1,477	$70,526	$85,307	$222,820

[1] Includes cumulative annual program costs for the period for management features and capital costs for nonstorage projects.

[2] Power and Navigation facilities not included in Basin Plan.

[3] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT

The projects and programs are summarized in Table 7 by time periods. The project numbers identify features on Figure 3.

TABLE 7. Future projects and programs, Stillaguamish Basin

PROJECTS PRIOR TO 1980

Municipal and Industrial Water Supply

1. Increase of transmission capacity of Arlington, Stanwood, Granite Falls and rural communities.

Irrigation

2.* Installation of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

3. Expansion of treatment, disinfection and sewage interception facilities—Stanwood, Arlington and Granite Falls.

Flood Control

4. Construction of levees—Stanwood.

Watershed Management

5. Small watershed multiple-purpose project—Lower Stillaguamish.
6. Small watershed multiple-purpose project—Church Creek.

Recreation

7. Development of one recreation site at mouth of Stillaguamish River.
8. Development of one recreation site in this vicinity.
9. Development of three recreation sites along Stillaguamish River from mouth to Arlington.
10. Development of two recreation sites along Pilchuck Creek from mouth to Cavanaugh Lake.
11. Development of four recreation sites along North Fork of Stillaguamish River from Arlington to National Forest.
12. Development of four recreation sites along the South Fork of the Stillaguamish River from Arlington to the National Forest.
13. Development of 20 recreation sites in the National Forest.

Fish and Wildlife

14.* Acquisition and development of access to four lakes.
15.* Acquisition of 50 miles of streambank access.
16.* Acquisition and development of four salt water access areas.
17. Enlargement of Little and Twin Lakes.
18.* Construction of a trout hatchery to stock lakes.
19.* Construction of addition to existing steelhead and searun cutthroat trout rearing complex.
20.* Construction of a game fish hatchery.
21. Acquisition and development of waterfowl habitat on Hat Slough.
22.* Enlargement of existing pheasant game farm.
23. Construction of modifications to existing fish passage facility at Granite Falls.
24. Correction of clay slides in North and South Forks of Stillaguamish River.

PROGRAMS PRIOR TO 1980

Water Quality Control

a. Establish and operate water quality surveillance stations at key salt and fresh water locations and prepare comprehensive sewerage plan for the Basin.

Flood Control

b. Establish and administer county-wide flood plain zoning measures under flood plain management program (county-city responsibility under State law using Federal flood plain information).

Watershed Management

c. Provide technical assistance and management for State and Federal lands.
d. Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

e. Develop fish disease controls and new toxicants.
f. Develop lake fertilization techniques.
g. Perform cross-section surveys of streams.

*Not shown on Figure 3

TABLE 7. Future projects and programs, Stillaguamish Basin (Cont'd)

h. Make wildlife population analysis and timberland management practices studies, develop habitat improvement techniques and an education program on proper game hunting concepts and begin a program with land owners for game habitat retention and hunter access.

i. Locate, survey, and mark boundaries of all State-owned second class tidelands in the Basin. Take steps to reserve all such lands for public use except as required for specific circumstances.

j. Perform an inventory of shellfish stocks and recreational use of tidelands.

PROJECTS 1980-2000

Municipal and Industrial Water Supply

25. Increase of transmission capacity of Arlington, Stanwood, Granite Falls and rural communities.

Irrigation

26.* Construction of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

27.* Expansion of treatment, disinfection and sewage interception facilities—Stanwood, Arlington and Granite Falls.

Flood Control

28. Improvement of levee—Silvana to Arlington.
29. Improvement of floodway—Silvana to Arlington.

Watershed Management

30. Small watershed multiple-purpose project—Pilchuck Creek.
31. Small watershed multiple-purpose project—Lower Stillaguamish River.
32. Small watershed multiple-purpose project—Church Creek.

Recreation

33. Development of one recreation site at mouth of Stillaguamish River.
34. Development of one recreation site at Cavanaugh Lake.
35. Development of two recreation sites along Pilchuck Creek from mouth to Cavanaugh Lake.
36. Development of three recreation sites along the Stillaguamish River from mouth to Arlington.
37. Development of five recreation sites along the North Fork of the Stillaguamish River from Arlington to National Forest.
38. Development of four recreation sites along the South Fork of the Stillaguamish River from Arlington to National Forest.
39. Development of one recreation site in this vicinity.
40. Development of 25 recreation sites in the National Forest.

Fish and Wildlife

41. Construction of a fish passage facility on Pilchuck Creek.
42. Construction of a fish passage facility on Canyon Creek.
43.* Construction of 10 acres of rearing ponds.
44.* Construction of a salmon hatchery.
45.* Construction of one salmon spawning channel.
46.* Develop access and parking facilities to all State-owned beaches.

PROGRAMS 1980-2000

Water Quality Control

k. Continue water quality monitoring, evaluation and control program.

Flood Control

l. Continue flood plain management program.

Watershed Management

m. Provide technical assistance to on-farm and other private practices.

n. Provide technical assistance and management for State and Federal lands.

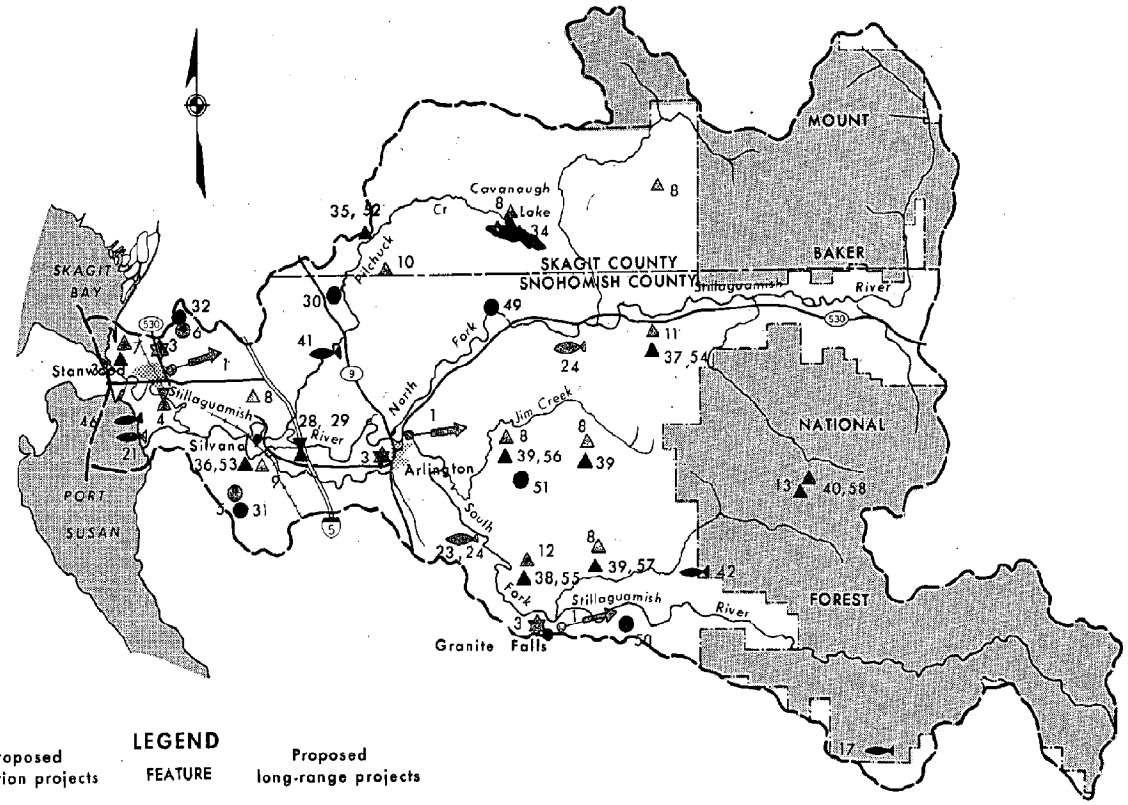
Fish and Wildlife

o. Continue fish and wildlife programs.

p. Improve beaches for clam culture.

*Not shown on Figure 3

NOTE: Potential nuclear power and pumped-storage sites are not shown. See Appendix IX, Power.



LEGEND

Proposed early-action projects	FEATURE	Proposed long-range projects
	M & I Water Supply	
	Irrigation	
	Water Quality Control	
	Navigation	
	Power	
	Flood Control	
	Watershed Management	
	Recreation	
	Fish & Wildlife	
	Dam and Reservoir	

Scale in Miles

5 0 5 10

STILLAGUAMISH BASIN

ITEMS NOT SHOWN ON MAP

Rural and small community water supply projects

Irrigable lands and private irrigation developments *

Terminal and water-transport oriented industrial lands *

Small watershed boundaries *

Scenic highway and potential recreation river segments

Fish and wildlife projects yet to be sited

* *See functional appendix for location maps*

FIGURE 3. Comprehensive Plan Elements

TABLE 7. Future projects and programs, Stillagumaish Basin (Cont'd)

PROJECTS 2000-2020

Municipal and Industrial Water Supply

47. Expansion of water supply transmission lines at Arlington, Stanwood, Granite Falls and rural communities.

Water Quality Control

48.* Expansion of treatment, disinfection and sewage interception facilities—Stanwood, Arlington and Granite Falls.

Watershed Management

49. Small watershed multiple-purpose project—North Fork Stillaguamish River.
50. Small watershed multiple-purpose project—South Fork Stillaguamish River.
51. Small watershed multiple-purpose project—Jim Creek.

Recreation

52. Development of two recreation sites along Pilchuck Creek from mouth to Cavanaugh Lake.
53. Development of three recreation sites along Stillaguamish River from mouth to Arlington.
54. Development of seven recreation sites along North Fork of Stillaguamish River from Arlington to National Forest.
55. Development of five recreation sites along South Fork of Stillaguamish River from Arlington to National Forest.
56. Development of two recreation sites in this vicinity.
57. Development of one recreation site in this vicinity.
58. Development of 35 recreation sites in National Forest.

Fish and Wildlife

59.* Construction of three salmon hatcheries.
60.* Construction of 15 acres of salmon rearing facilities.
61.* Construction of 1 mile of salmon spawning channel.

*Not shown on Figure 3

PROGRAMS 2000-2020

Water Quality Control

q. Continue water quality monitoring, evaluation and control program.

Flood Control

r. Continue flood plain management program.

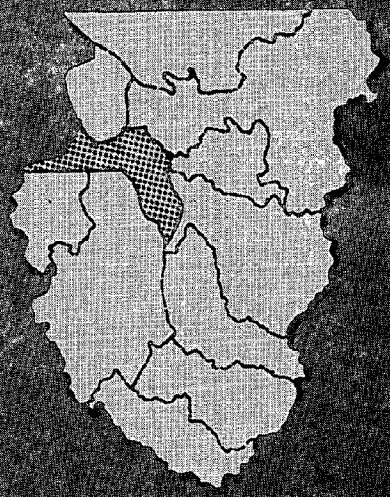
Watershed Management

s. Provide technical assistance to on-farm and other private practices.
t. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

u. Continue fish and wildlife programs.

Whidbey-Camano Islands



COUNTY AFFECTED:

Island

WHIDBEY–CAMANO ISLANDS

SUMMARY OF PLAN

1970-2020

The early action program emphasizes construction of water supply facilities for Whidbey Island, additional treatment and sewers for both Islands, acquisition of land and construction of recreation facilities, new boat harbors and moorages, and obtaining access to areas for fishing and hunting uses.

To meet the future water supply needs for Whidbey Island, treated water would be purchased from the city of Anacortes for north Whidbey Island, and from the city of Everett for the southern part of the Island. The water for north Whidbey would be obtained near Deans Corner on Fidalgo Island and conveyed by pipeline to Whidbey Island by crossing on Deception Pass Bridge. The water would be piped to distribution centers at Oak Harbor, Coupeville, and Greenbank. The water from Everett would cross Possession Sound via the new bridge and piped to distribution centers at Clinton and Bay View.

Individual municipal distribution systems would connect to the transmission line or at the distribution centers. The distribution system costs are not included in the plan for Whidbey Island.

Camano Island's future water supply, which would be needed after 1980, would be diverted from the Stillaguamish River near Silvana and conveyed to a distribution reservoir near Kristoferson Lake on Camano Island. A water treatment plant would be included as a part of the water supply plan for Camano Island.

To comply with the Washington State water quality standards, the cities of Oak Harbor, Coupeville, Langley, and Penn Cove should provide secondary treatment facilities, disinfection facilities, and adequate marine discharge outfalls for optimum dispersion. Sewer districts would need to be established and sewers constructed throughout the Islands to intercept septic tank effluent and prevent beach and marine water contamination. Water quality surveillance is an essential element of the water quality program. Stations should be established on Camano Head, Port Susan, Gedney Island, Holmes Harbor, Crescent Harbor, Strawberry Point and Skagit Island.

There should be nine new small boat harbors established to 2020 providing over 14,300 wet moorages and 140 boat launching lanes. Three harbors with 2,300 wet moorages should be constructed prior to 1980. These facilities would meet the needs of Whidbey and Camano Islands in addition to part of the needs of the Stillaguamish and Cedar-Green Basins.

The early action plan for watershed management includes upgrading of existing facilities and more intensive application of recurring and nonrecurring land treatment practices. Ongoing watershed management programs which provide some degree of technical assistance and financial participation would be continued. After 1980, four small watershed projects for floodwater damage prevention, rehabilitation and protection of watershed lands, and water management, would be installed, while programs would be continued and in many cases accelerated.

The recreational plan envisions facilities provided on 365 acres of lands by 1980, 1,210 acres by 2000, and 2,580 acres by 2020. To meet the needs of the 1980 recreationists would require large investments of which over one-third would be for purchasing land, principally salt water beach areas and beach access. A coordinated development plan would be established between Federal, State and local governmental bodies to acquire land and develop facilities in an orderly arrangement to meet the demands after 1980.

To meet the early action objectives of fish and wildlife would require acquisition of additional land locations throughout the Islands for public access. These lands would be in addition to those needed by recreation. Miller Lake would be enlarged for public fishing, Whidbey Island game farm would be increased in size, and a 5-acre controlled rearing impoundment would be developed for salmon production. Fish and wildlife programs to enhance shellfish production, develop marine water rearing areas, and acquire additional lands for waterfowl and upland game habitat are included.

The possibilities of a nuclear power site being located on Whidbey Island are good since it is located near the present and projected main load centers and has an abundance of offshore cooling waters. Four potential sites on Whidbey Island, each capable of supporting several power complexes, were studied. One of the areas on Whidbey Island could support at least three 2,000 mw nuclear-electric plants by the

year 2000. Further studies are required that consider shoreline characteristics, nearness to major load centers and impacts on the natural environment before a final decision can be made on plant locations.

The early action plan includes programs amounting to $16,531,000 and projects costing $42,530,000 for a total investment of $59,061,000. Program and project investment costs for the 1980-2000 period amount to $64,810,000 and for the 2000-2020 period $82,876,000 for a total 50-year investment of $206,747,000.

Table 8 shows all elements and the attendant costs. The output of the programs are complementary to the listed project facilities.

TABLE 8. Comprehensive Plan, Whidbey-Camano Islands

Feature	Item	1970-1980 Investment[1] Costs ($1000)	Average Annual Costs ($1000)	Average Annual Benefits Gross ($1000)	Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control Programs	250				200	240	690
Watershed Management	Programs	16,266				18,412	19,642	54,320
Fish & Wildlife	Programs	15				15	15	45
Total Programs		$16,531				$18,627	$19,897	$ 55,055
Nonstorage Projects								
M&I Water Supply	Ground Water Use	216	25[3]	25	0	0	0	216
	Surface Water Use	10,100	634[3]	634	0	2,500	0	12,600
Water Quality Control	Waste Treatment and Collection Facilities	3,187	208[3]	208	0	8,110	10,345	21,642
Navigation	Small Boat Harbors[2]	(4,648)	(298)	(431)	(133)	(5,355)	(18,910)	(28,913)
Watershed Management	Floodwater Damage Reduction, Water Management, Protection and Rehabilitation	0	0	0	0	3,245	0	3,245
Recreation	Land Acquisition, Access and Facilities	28,450	2,257	2,715	458	31,800	51,900	112,150
Fish & Wildlife	Production Enhancement Facilites, Access and Acquisition	577	42	484	442	528	734	1,839
Total Nonstorage		$42,530	$3,166	$4,066	$900	$46,183	$62,979	$151,692
Total Programs and Projects		$59,061				$64,810	$82,876	$206,747

1 Includes cumulative annual program costs for the period for management features and capital costs for nonstorage projects.

2 General Navigation facilities cost and benefits for small boat harbors only. Total pleasure boat facilities, costs and benefits included with Recreation.

3 Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT

The projects and programs of the Comprehensive Plan are summarized in Table 9 by time period. The project numbers identify features on Figure 4.

TABLE 9. Future projects and programs, Whidbey-Camano Islands

PROJECTS PRIOR TO 1980

Project No.

Municipal and Industrial Water Supply

1. Construct water supply pipeline for north Whidbey Island from Deans Corner to Greenbank.
2. Construct water supply pipeline for south Whidbey Island from the city of Everett to Bay View.
3.* Enlarge the small and rural community municipal and water supply transmission systems.

Water Quality Control

4. Provide secondary treatment facilities with disinfection, and an adequate outfall at Oak Harbor.
5. Provide secondary treatment and disinfection facilities with adequate outfall at the Seaplane Base near Oak Harbor.
6. Provide secondary treatment and disinfection facilities with adequate outfall at Coupeville, Langley and the Penn Cove Sewer District.
7.* Improvement of waste collection facilities for recreation developments including small boat harbors.

Navigation

8. Small boat harbor development—Oak Harbor, Phase I.
9. Small boat harbor development—Point Partridge.
9a. Small boat harbor development—Langley.

Recreation

10. Development of a beach recreation site north of Dugvalla Bay.
11. Development of an urban recreation area at Oak Harbor.
12. Development of two recreation areas in Penn Cove.
13. Development of a beach recreation area south of Coupeville.
14. Development of a beach recreation area in Admiralty Bay.
15. Development of a beach recreation area near Greenbank.
16. Development of a beach recreation area near Brush Point.
17. Development of a beach recreation area in Mutiny Bay.
18. Development of two beach recreation areas near Langley.
19. Development of a recreational area near Lone Lake.
20. Development of a recreational area near Deer Lake.
21. Development of a recreational area at Cultus Bay.
22. Development of a recreation area near Utsaladdy, Camano Island.
23. Development of a beach recreation site near Triangle Cove, Camano Island.
24. Development of a beach recreation site near Elger Bay, Camano Island.
25. Development of a beach recreation site near Camano Head, Camano Island.

Fish and Wildlife

26. Acquire and develop saltwater access near Greenbank Beach.
27. Acquire and develop saltwater access near Bush Point.
28. Acquire and develop saltwater access near Lagoon Point.
29. Acquire and develop saltwater access near Land Point Manor.
30. Acquire and develop fresh water access at Silver Lake.
31. Enlarge Miller Lake.
32.* Develop a salt water rearing area.
33.* Increase size of Whidbey Island Game Farm.

PROGRAMS PRIOR TO 1980

Water Quality Control

a.* Establish and operate water quality surveillance stations at key salt and fresh water locations and prepare comprehensive sewerage plan for the Islands.

Watershed Management

b.* Provide technical assistance and management for State and Federal lands.
c.* Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

d.* Conduct lake fertilization studies.
e.* Educational programs on the use of wildlife resources.
f.* Perform an inventory of shellfish stocks and recreational use of tidelands.
g.* Acquire title or easements to land for wildlife habitat development and hunter access.

*Project or program not shown on Figure 4

TABLE 9. Future projects and programs, Whidbey-Camano Islands (Cont'd)

PROJECTS 1980-2000

Municipal and Industrial Water Supply

34. Construct the water supply pipeline from Stillaguamish River to Camano Island.

Water Quality Control

35. Enlarge and expand waste treatment and sewer facilities at Oak Harbor, Coupeville, Langley, Greenbank and Clinton.
36.* Provide waste treatment facilities at recreation developments and small boat harbors.

Navigation

37. Enlargement of small boat harbor development at Oak Harbor.
38. Construct small boat harbor development at Utsalady.

Watershed Management

39. Small watershed multiple-purpose project—North Whidbey Island.
40. Small watershed multiple-purpose project—Central Whidbey Island.
41. Small watershed multiple-purpose project—South Whidbey Island.
42. Small watershed multiple-purpose project—Camano Island.

Recreation

43. Development of a recreation area near Silver Lake.
44. Development of two recreation areas near Crescent Harbor.
45. Development of a beach recreation area near Penn Cove.
46. Development of a beach recreation area near Race Lagoon.
47. Development of two beach recreation areas near Greenbank.
48. Development of a beach recreation area near Bush Point.
49. Development of a beach recreation area near Mutiny Bay.
50. Development of a beach recreation area near Lone Lake.
51. Development of two beach recreation areas on east side Camano Island.
52. Development of one beach recreation area near Triangle Cove—Camano Island.
53. Development of one beach recreation area on Camano Island.
54. Development of two beach recreation areas on east side Camano Island.

Fish and Wildlife

55.* Develop additional access areas and habitat areas.

PROGRAMS 1980-2000

Water Quality Control

h. Continue water quality monitoring, evaluation and control programs.

Watershed Management

i. Provide technical assistance for on-farm and other private practices.
j. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

k. Continue fish and wildlife programs.

PROJECTS 2000-2020

Water Quality Control

56. Enlarge and expand waste treatment facilities at Oak Harbor, Coupeville, Greenbank, Langley and Clinton.
57.* Provide waste treatment facilities at recreation developments and small boat facilities.

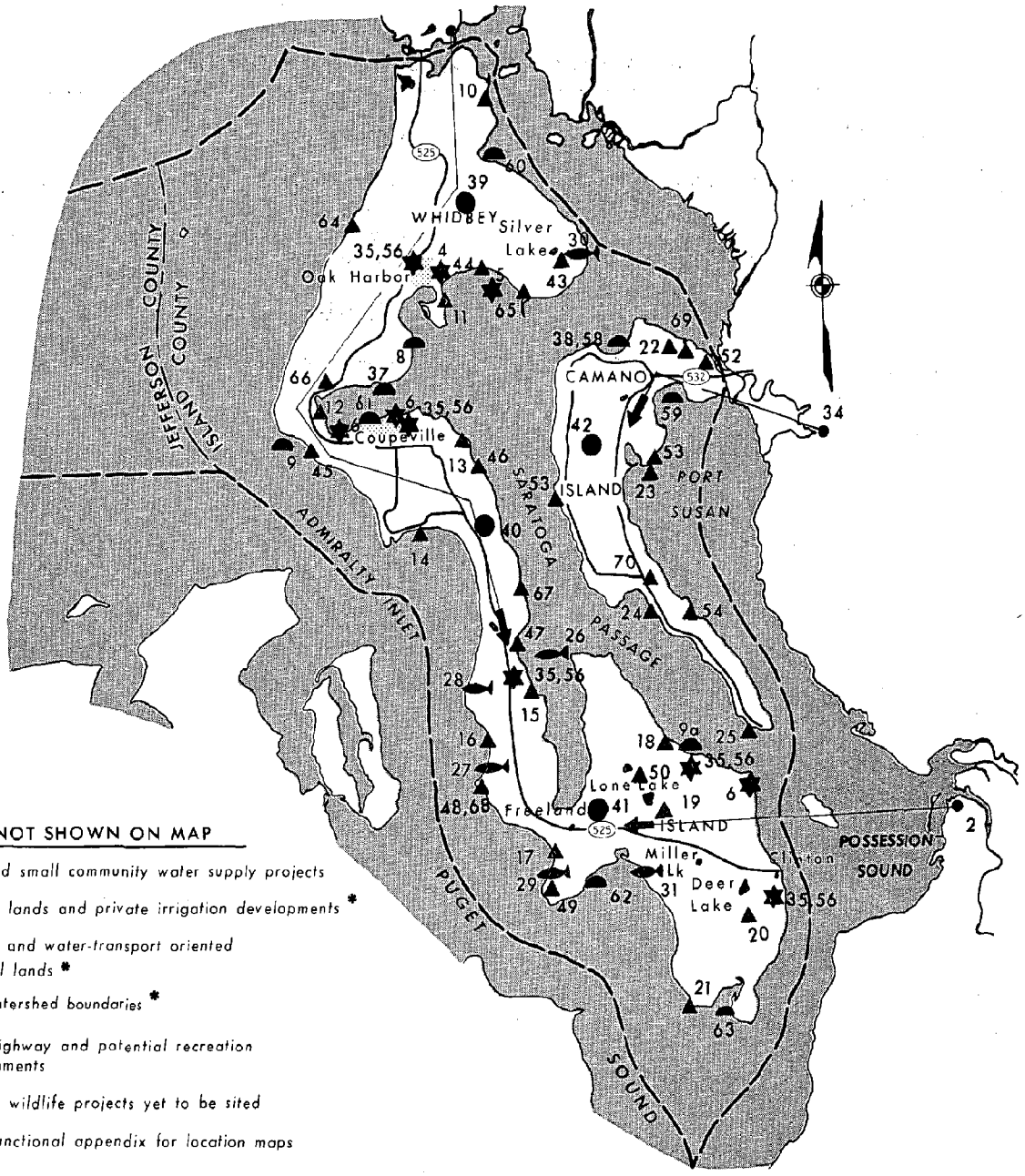
Navigation

58. Enlargement of the small boat harbor development—Utsalady.
59. Development of a small boat harbor—Camanols.
60. Development of a small boat harbor—Dugualla Bay.
61. Development of a small boat harbor—Coupeville.
62. Development of a small boat harbor—Useless Bay.
63. Development of a small boat harbor—Cultus Bay.

Recreation

64. Development of three beach recreation sites south of Ault Field.
65. Development of three beach recreation sites near Crescent Harbor.
66. Development of three beach recreation sites near Penn Cove.
67. Development of three beach recreation sites near North Bluff.
68. Development of three beach recreation sites near Lagoon Point.
69. Development of three beach recreation sites near Stanwood.
70. Development of three beach recreation sites near Elger Bay.

*Project or program not shown on Figure 4



ITEMS NOT SHOWN ON MAP

Rural and small community water supply projects

Irrigable lands and private irrigation developments *

Terminal and water-transport oriented industrial lands *

Small watershed boundaries *

Scenic highway and potential recreation river segments

Fish and wildlife projects yet to be sited

* *See functional appendix for location maps*

LEGEND

Proposed early-action projects	FEATURE	Proposed long-range projects
	M & I Water Supply	
	Irrigation	
	Water Quality Control	
	Navigation	
	Power	
	Flood Control	
	Watershed Management	
	Recreation	
	Fish & Wildlife	
	Dam and Reservoir	

Scale in Miles

5 0 5 10

WHIDBEY—CAMANO ISLANDS

NOTE: Potential nuclear power and pumped-storage sites are not shown. See Appendix IX, Power.

FIGURE 4. Comprehensive Plan Elements

TABLE 9. Future projects and programs, Whidbey-Camano Islands (Cont')

Fish and Wildlife

71.* Continue developing access, marine fish facilities and habitat areas.

PROGRAMS 2000-2020

Water Quality Control

l. Continue water quality monitoring, evaluation and control programs.

Watershed Management

m. Provide technical assistance for on-farm and other private practices.

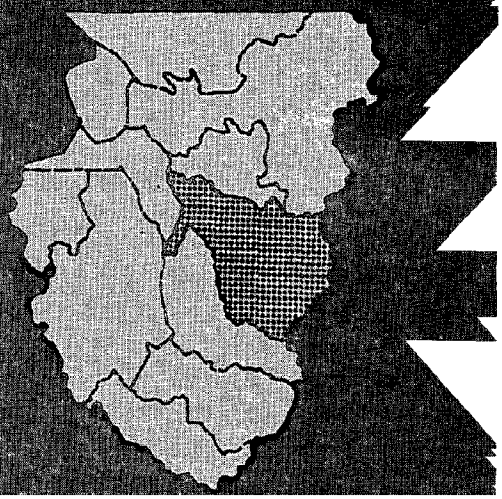
n. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

o. Continue fish and wildlife programs.

*Project or program not shown on Figure 4

Snohomish Basin



COUNTIES AFFECTED:

Snohomish

King

SNOHOMISH BASIN

SUMMARY OF PLAN

Early Action 1970-1980

During this period municipal and industrial water supply needs of the city of Everett and its service area would be satisfied through raising of Culmback Dam on the Sultan River. Ground water resources would continue to supply small and rural communities with industry also continuing to meet a portion of its water requirements by pumping from the Snohomish River or one of its sloughs.

About 6,100 acres of cropland would be placed under irrigation with water supplied by individual farmers from both surface and ground sources. This increase would be offset somewhat by 4,100 acres of land which would be taken out of crop production and put to higher more intensive use.

Compliance with Washington State water quality standards would be obtained through installation of adequate collection and treatment facilities by a number of communities and cities in the Basin. Pulp mills would remove settleable solids from mill effluents prior to discharge and would install adequate outfalls and diffusers to achieve maximum dilution and dispersion into Puget Sound. A water quality surveillance program would be expanded in order to provide an adequate monitoring system with sampling stations on marine and fresh water. A comprehensive sewerage plan would be developed for the Basin.

Navigation needs would be met through channel deepening projects on the East Waterway and on the Lower Snohomish River, below the Highway 99 Bridge. These channels would be deepened to accommodate bulk carriers and freighters. Lands found to be suitable for terminal or water transport-oriented industrial development would be retained for this purpose to insure future availability. Development of the Snohomish River delta and a dredge fill in Everett Harbor would begin during this period in order to provide a basis for future port expansion. Concurrent with development of the delta open spaces and recreation areas would be set aside to meet environmental needs. Wet moorage would be provided for pleasure boaters through the construction of two small boat harbors with 3,130 moorage slips.

Power needs for the Basin would be satisfied by the Northwest Regional system which is discussed under Power in the Area portion of this Report. Power facilities at a multiple-purpose storage project and downstream reregulating dam on the North Fork of the Snoqualmie River would have an installed capacity of 60,000 kilowatts and an estimated average annual energy output of about 32,000 kilowatts. These projects are included in the early action portion of the Plan.

Multiple-purpose storage projects on the North and Middle Forks of the Snoqualmie River would provide significant flood control for the Snoqualmie River flood plain. The projects would provide a 100-year level of flood protection along the Snoqualmie River from North Bend to Snoqualmie Falls, and approximately 25-year protection from Snoqualmie Falls to the confluence of the Skykomish River. Flood control storage provided from second stage construction of Culmback Dam on the Sultan River would enable a 100-year level of flood protection along the lower Sultan River. In the lower Snohomish River significant contributions to flood damage reduction would result from both the Snoqualmie and Sultan River projects. These projects, together with the setting back of levees at French Creek and Marshland drainage districts would reduce the frequency of winter flooding of the districts at a current reoccurrence interval of once every 2 to 4 years to once every 25 years. As the Snohomish River delta is developed the existing natural floodways would be adjusted by enlarging the channel capacity of the Snohomish River and its sloughs as it enters into Possession Sound to insure 100-year level of flood protection for these industrial developments. Flood plain management would provide an effective means of reducing future flood damages through land use zoning of lands in the flood plain consistent with the levels of protection provided and aid in the retention of open spaces and greenbelts. Floodproofing and warning systems would also be implemented. These measures would contribute significantly to the reduction of future flood damages and are relied upon to a large measure in the Skykomish River Basin.

Two small watershed multiple-purpose projects are planned for implementation during this period to achieve floodwater damage reduction and water management. One project is located in the Patterson Creek drainage and the other in the Snohomish Estuary. These projects consist of stabilized channels and outlet control structures. Important comple-

ments to the watershed management projects are the programs of technical assistance and management and land treatment and drainage.

Campgrounds, picnic areas, beaches, and boat launching ramps would be developed on existing public lands together with the acquisition of additional land and water areas to satisfy recreational needs. Recreation sites would be developed as part of the multiple-purpose storage projects on the North and Middle Forks of the Snoqualmie River. Additional land and water areas would be acquired along the Puget Sound shoreline to provide badly needed marine parks. Over 100 recreation areas would be expanded or developed before 1980.

Land acquisition including public access and fish and wildlife enhancement projects would be undertaken to increase the opportunities for this form of outdoor recreation. Additional fish hatcheries would be constructed for both resident and migratory fish together with rearing ponds, spawning channels and fish passage improvements including a collection and transportation facility to provide migratory fish access upstream from the 268-foot high Snoqualmie Falls. Low flow augmentation would be provided from the North and Middle Fork Snoqualmie multiple-purpose storage projects and from the Sultan River project. Important cross-sectional stream surveys would be undertaken during this period in order to determine the minimum and optimum stream flows required for fish production. Subsequent to these cross-sectional surveys further studies of new projects may be required as well as reconsideration of the operation of existing projects.

Long-Range, 1980-2020

Expansion of the transmission sys tem from Lake Chaplain to the distribution works would be necessary as well as the development of an additional water supply source to satisfy the Everett service area water supply needs through the year 2020. The new source would be the Snohomish River with a pumping and treatment plant located near the river upstream from tidal influences. The plant together with the Sultan system would provide an adequate source of water to meet Everett's needs. The small and rural communities would be supplied from Everett and the Seattle water systems with some further development of surface water in the lower Snohomish River by industry expected up to the year 2000.

An additional 5,200 acres of land would be placed under irrigation during this period with water supplied primarily from the Snoqualmie, Skykomish, Snohomish and Pilchuck Rivers as well as some ground water development in the Snohomish subbasin.

Existing treatment and collection facilities would be expanded commensurate with the growth in population and industrial development to insure that the State water quality standards are continually met. The water quality monitoring, evaluation and control program would be maintained.

Further development of the Snohomish Delta is envisioned during this period as terminal and water transport-oriented industrial sites would be required to meet the navigation needs of the Basin. A continuous dredge operation would be undertaken to develop new lands through dredge fill as the ship channels are maintained. Continuous dredging would be required in order to maintain these channels as the silt load of the Snohomish River is extremely high. Before the year 2020 the ultimate development pf the Snohomish Delta would occur with a self-maintaining floodway connecting the Possession Bay and Ebey Slough where the slough leaves the Snohomish River at about river mile 11. At this point a control structure would be constructed and the Snohomish River channel from river mile 11 to its mouth would no longer have the silt load as the river would be diverted through the floodway. This channel would be deepened to 20 feet from the Highway 99 Bridge to river mile 10 and from the mouth of the river to the Highway 99 Bridge the channel would be deepened to 46 feet. A large number of wet moorages would be provided through public small boat harbor projects with over 11 of these projects planned between 1980 and the year 2020 to supply 19,620 moorages. During this period all lands that were indicated in the navigation study as being suitable for terminal or water transport-oriented industrial development would be utilized for this purpose.

Power development would probably include pumped-storage at a number of the potential sites within the Basin. Oil or gas-fueled steam electric plants may also be located during this period to meet short-time peaking requirements. Development of nuclear electric generating plants may occur but specific sites have not been determined and would be dependent upon future studies that considered shoreline characteristics, nearness to major load centers and impacts on the environment.

The only additional flood control structures

envisioned after 1980 would be levees to provide 100-year winter flood protection for the communities of Carnation, Gold Bar, Skykomish, Sultan, Monroe, and Snohomish. These projects, generally would be a matter of raising existing structures to heights sufficient to provide the 100-year protection. Flood plain management would be continued with zoning by the two counties which divide the Basin being required to guide future development and prevent unwarranted development in the flood plain. Additional floodway improvement would occur in the Snohomish Delta which would culminate in a self-maintaining flood channel from approximately river mile 11 near the head of Ebey Slough to the mouth of the river. The channel would be straightened and gradually widen as it approached Puget Sound. Modification of the outlet works at the South Fork of the Tolt River storage project would be undertaken to gain some incremental flood control at the Snoqualmie system.

Further programs and projects would be undertaken to satisfy watershed management needs. These would include nine projects and a significant program of technical assistance and land treatment and water management.

Additional development of campgrounds, picnic areas, and other recreation facilities would be undertaken after 1980 at over 270 sites throughout the Basin, on public lands as well as on private lands, with both public and private sectors participating in the providing of recreation facilities. The recreation facilities provided at the North and Middle Fork Snoqualmie projects would be expanded commensurate with the growth in recreation use of these reservoirs. The tributaries of the Skykomish River may be included in a State system of scenic and recreational rivers for retention in a free-flowing state for public use. Also, the South Fork of the Snoqualmie and the Pilchuck Rivers could be included in the sy stem.

Additional fishing opportunities would be provided through anadromous and resident fish enhancement measures. A number of fish passage improvements are planned during the long-range period as well as additional spawning habitat development. Wildlife preservation and enhancement programs begun prior to 1980 would be continued.

Table 10 summarizes the Snohomish Basin elements of the Comprehensive Plan, showing the benefits and costs for the early action portion of the Plan, and provides a summary of investment costs by water resource features for the entire 50-year period ending in 2020. The early action portion of the Plan includes programs amounting to $111,409,000 and projects costing $365,781,000 for a total investment of $477,190,000. Program and project investment costs for the 1980-2000 period amount to $376,725,000 and for the 2000-2020 period, $378,905,000; for a total 50-year investment of $1,232,820,000.

TABLE 10. Comprehensive Plan, Snohomish Basin

Feature	Items	1970-1980 Investment[1] Costs ($1000)	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control Programs	2,400	--	--	--	2,512	1,400	6,312
Flood Control	Flood Plain Management	55	--	--	--	100	100	255
Watershed Management	Programs	108,504	--	--	--	134,227	135,540	378,271
Fish & Wildlife	Programs	450	--	--	--	750	750	1,950
Total Programs		$111,409				$137,589	$137,790	$ 386,788
Nonstorage Projects								
M&I Water Supply	Ground Water Use	180	20	20[6]	0	0	0	180
	Surface Water Use	28,743[4]	2,512[4]	2,512[6]	0	64,382	19,465	112,590
Irrigation Water Supply	Ground Water Use	135	22	22[6]	0	135	0	270
	Surface Water Use	690	114	114[6]	0	392	175	1,257
Water Quality Control	Sewerage Treatment and Collection Facilities	97,390	4,588	4,588	0	32,480	43,700	173,570
Navigation	Channels	2,200	120	172	52	7,696	0	9,896
	Small Boat Harbors[3]	(6,306)[3]	(404)[3]	(585)[3]	(181)[3]	(9,725)[3]	(29,909)[3]	(45,940)[3]
Power[2]								
Flood Control	Channels and Levees	31,950	1,545	4,130	2,585	39,870[5]	36,255	108,075
Watershed Management	Floodwater Damage Reduction, Rehabilitation and Protection, and Water Management	2,503	142	397	255	12,387	100	14,990
Recreation	Land Acquisition, Access and Recreation Facilities	60,900	4,039	5,720	1,681	69,500	123,200	253,600
Fish & Wildlife	Land Acquisition, Access and Enhancement Facilities	8,797	987	2,728	1,741	12,294	18,220	39,311
Total Nonstorage		$ 233,488	$11,017	$17,331	$6,314	$239,136	$241,115	$ 713,739
Storage Projects								
	Culmback Dam (Sultan River)							
M&I Water Supply		6,798	318	350	32	0	0	6,798
Flood Control		8,642	443	707	264	0	0	8,642
Fish Enhancement		7,604	369	500	131	0	0	7,604
	Total Project	$ 23,044	$ 1,130	$ 1,557	$ 427	$ 0	$ 0	$ 23,044
	North Fork Snoqualmie							
Power		32,845	1,798	1,867	69	0	0	32,845
Flood Control		12,138	665	690	25	0	0	12,138
Recreation		16,959	929	964	35	0	0	16,959
Fish Enhancement		1,618	89	92	3	0	0	1,618
	Total Project	$ 63,560	$ 3,481	$ 3,613	$ 132	$ 0	$ 0	$ 63,560
	Middle Fork Snoqualmie							
Flood Control		25,088	1,169	1,657	488	0	0	25,081
Recreation		19,683	1,184	1,296	112	0	0	19,683
Fish Enhancement		918	44	54	10	0	0	918
	Total Project	$ 45,689	$ 2,397	$ 3,007	$ 610	$ 0	$ 0	$ 45,689
Total Storage		$132,293	$ 7,008	$ 8,177	$1,169	$ 0	$ 0	$ 132,293
Total Program and Projects		$477,190	$18,025	$25,508	$7,483	$376,725	$378,905	$1,232,820

[1] Includes cumulative annual program costs for the period for management features and capital costs for nonstorage and storage projects.

[2] Power facilities not included in basin plan.

[3] General Navigation facilities cost and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

[4] Includes costs for additions to Everett's Sultan River transmission system.

[5] Includes cost of modifying existing South Fork Tolt River project.

[6] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT

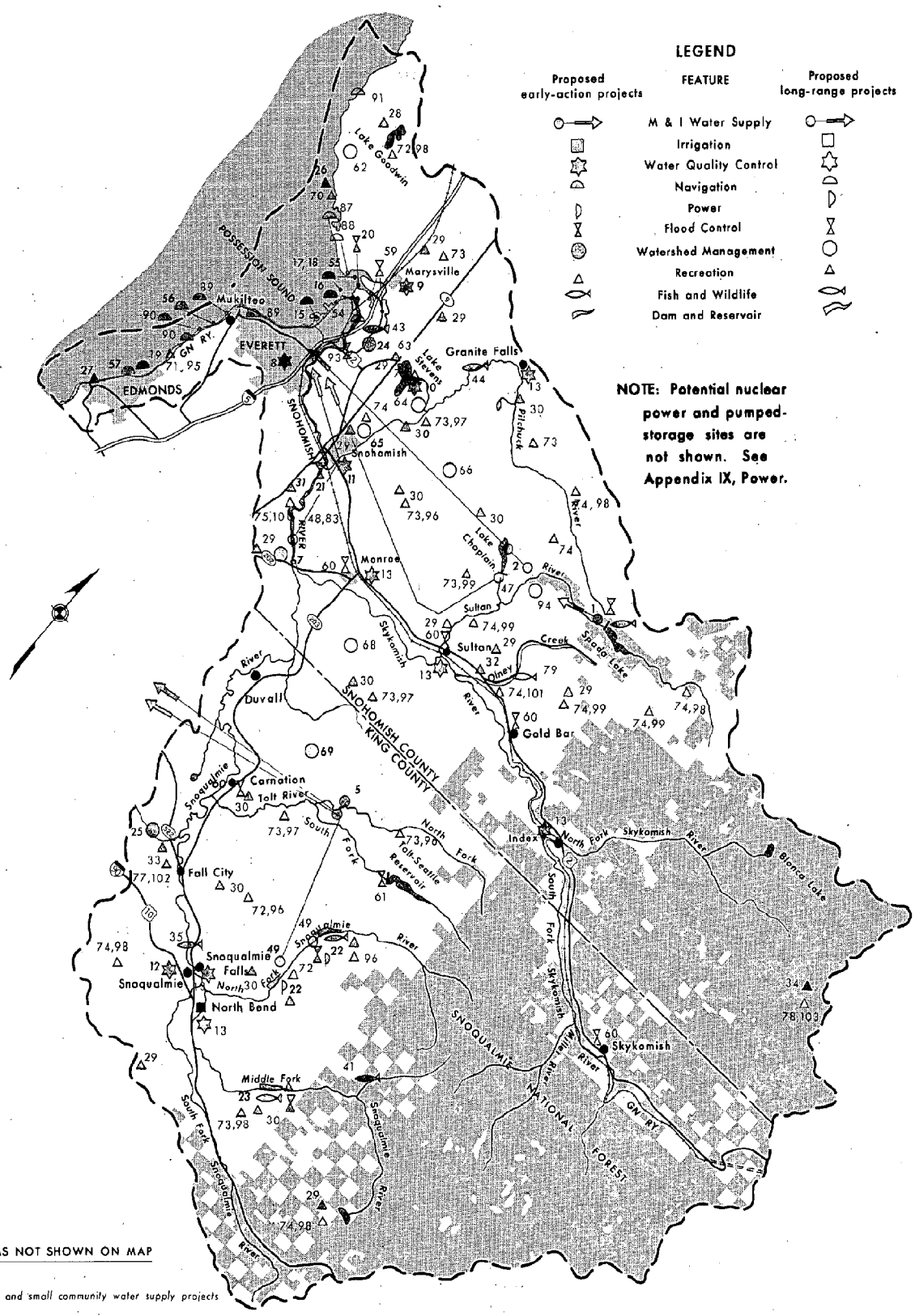
The projects and programs of the Comprehensive Plan are summarized in Table 11 by period. The project numbers identify features on Figure 5.

TABLE 11. Future projects and programs, Snohomish Basin

Projects Prior to 1980

Project No.	
	Municipal and Industrial Water Supply
1.	Water supply storage for Everett—second stage of Sultan River multiple-purpose project (Culmback Dam).
2.	Improvement of water supply transmission system by constructing second tunnel between Sultan River and Lake Chaplain and installing additional pipelines—Everett.
3.*	Expansion of small and rural community municipal and industrial water supply and transmission systems.
4.*	Increase capacity of self-supplied industrial surface water system.
5.	Construction of diversion dam and transmission facilities on North Fork Tolt River—Seattle (for Cedar-Green Basins).
	Irrigation
6.*	Installation of individual farm irrigation pumping and sprinkler systems (private).
	Water Quality Control
7.	Installation of facilities to remove all settleable solids from mill effluents prior to discharge with adequate outfall and diffuser—pulp mills at Everett.
8.	Expansion of secondary treatment, disinfection, and sewage interception facilities at Everett.
9.	Expansion of disinfection facilities at Marysville.
10.	Installation of collection and treatment facilities at Lake Stevens.
11.	Expansion of secondary treatment and disinfection facilities at Snohomish.
12.	Installation of sewage interception at Snoqualmie.
13.	Installation of secondary treatment facilities: Monroe, Sultan, Index, North Bend, Snoqualmie Falls, and Granite Falls.
14.*	Improvement of waste collection facilities for recreation developments including small boat harbors.
	Navigation
15.	Channel improvement—East Waterway.
16.	Channel improvement—Snohomish River Mile 0.0 to Highway 99 bridge crossing.
17.	Dredge-fill of Tract Q and portions of Smith Island for terminal and water-transport-oriented industrial development.
18.	Small boat harbor development—Tract Q.
19.	Small boat harbor development—Meadowdale.
	Power
22.	Hydroelectric power installation—North Fork Snoqualmie multiple-purpose project.
	Flood Control
1.	Flood control storage—second stage of Sultan River multiple-purpose project.
20.	Modification of Snohomish River floodway at mouth of river.
21.	Setting back existing levees from River Mile 10.0 to River Mile 18.5 of Marsh Land and French Creek Drainage Districts.
22.	Flood control storage—North Fork Snoqualmie multiple-purpose project.
23.	Flood control storage—Middle Fork Snoqualmie multiple-purpose project.
	Watershed Management
24.	Small watershed multiple-purpose project—Snohomish River Estuary.
25.	Small watershed multiple-purpose project—Patterson Creek.
	Recreation
22.	Installation of recreation facilities as part of North Fork Snoqualmie multiple-purpose project.
23.	Installation of recreation facilities as part of Middle Fork Snoqualmie multiple-purpose project.
26.	Development of two recreation sites along saltwater shoreline from northern boundary of Basin to mouth of Snohomish River.
27.	Development of four recreation sites along saltwater shoreline from southern boundary of Basin to mouth of Snohomish River.
28.	Development of three recreation sites.
29.	Development of one recreation site.
30.	Development of two recreation sites.
31.	Development of three recreation sites along Snohomish River from mouth to confluence of Skykomish and Snoqualmie Rivers.

*Projects not shown on Figure 5



ITEMS NOT SHOWN ON MAP

Rural and small community water supply projects

Irrigable lands and private irrigation developments *

Terminal and water-transport oriented industrial lands *

Small watershed boundaries *

Scenic highway and potential recreation river segments

Fish and wildlife projects yet to be sited

* *See functional appendix for location maps*

SNOHOMISH BASIN

FIGURE 5. Comprehensive Plan Elements

TABLE 11. Future projects and programs, Snohomish Basin (Cont'd)

Project No.	
	Recreation (Cont'd)
32.	Development of three recreation sites along Skykomish River from mouth to National Forest.
33.	Development of four recreation sites along Snoqualmie River from mouth to National Forest.
34.	Development of 60 recreation sites in the National Forest.
	Fish and Wildlife
I.	Low flow augmentation and flood control—second stage construction of Sultan River multiple-purpose project.
22.	Low flow augmentation and flood control—North Fork Snoqualmie multiple-purpose storage project.
23.	Low flow augmentation and flood control—Middle Fork Snoqualmie multiple-purpose storage project.
35.	Construction of fish trapping facilities to collect and haul salmon above Snoqualmie Falls.
36.*	Construction of two spawning channels, each 1 mile in length.
37.*	Acquisition of 50 miles of streambank access, development of boat access at 13 lakes and enlargement of one lake.
38.*	Construction of trout hatchery for stocking lakes.
39.*	Correction of gravel compaction problems in streams.
40.*	Construction of steelhead trout rearing ponds.
41.	Correction of clay slides in Taylor and Snoqualmie Rivers.
42.*	Construction of trout hatchery for stocking streams.
43.	Acquisition and development of 600 acres of estuarine habitat on Ebey Island.
44.	Acquisition and development of 640 acres of band-tailed pigeon habitat in Pilchuck River drainage.
45.*	Acquisition and development of upland bird habitat.
46.*	Construction of addition to existing game farm to rear 8,000 pheasants annually.
	PROGRAMS PRIOR TO 1980
	Water Quality Control
a.	Establish and operate water quality surveillance stations at key salt and fresh water locations and prepare comprehensive sewerage plan for the Basin.
	Flood Control
b.	Establish and administer county-wide flood plain zoning measures under flood plain management program.
	Watershed Management
c.	Provide technical assistance and management for State and Federal lands.
d.	Provide technical assistance for on-farm and other private practices.
	Fish and Wildlife
e.	Develop lake fertilization techniques.
f.	Make wildlife population analysis and timberland management practices studies, develop habitat improvement techniques and an education program on proper game hunting concepts, and begin a program with land owners for game habitat retention and hunter access.
g.	Develop fish disease controls and new toxicants.
h.	Conduct cross-sectional stream surveys to determine minimum and optimum streamflows for fish.
i.	Locate, survey, and mark boundaries of all State-owned second class tidelands in the Basin. Take steps to reserve all such lands for public use except as required for specific circumstances.
j.	Perform an inventory of shellfish stocks and recreational use of tidelands.
	Projects 1980 to 2000
	Municipal and Industrial Water Supply
47.	Increase of transmission capacity of Everett water system.
48.	Construction of water supply pumping and treatment plant off Snohomish River—Everett.
49.	Increase storage capacity of North Fork Snoqualmie River project and install transmission lines—Seattle (for Cedar-Green Basins).
50.*	Installation of small and rural community municipal and industrial water supply transmission lines from Everett and Seattle systems.
51.*	Increase of capacity of self-supplied industrial surface water system.
	Irrigation
52.*	Construction of individual farm irrigation pumping and sprinkler systems (private).
	Water Quality Control
53.*	Expansion of waste treatment and interception facilities for municipalities, industry, and recreation development.
	Navigation
54.	Improvement of shallow draft channel—Highway 99 bridge to River Mile 10.0.
55.	Small boat harbor expansion—Tract Q.
56.	Small boat harbor development—Big Gulch.
57.	Small boat harbor development—Edmonds North.
58.*	Development of additional water transport-oriented industrial lands in the Snohomish River Delta.

*Projects not shown on Figure 5

TABLE 11. Future projects and programs, Snohomish Basin (Cont'd)

Project No.	
	Flood Control
59.	Improvement of floodway—Snohomish River, River Mile 3 to River Mile 6.3.
60.	Improvement of levee; Carnation, Gold Bar, Skykomish, Sultan and Monroe.
61.	Modification of outlet works for flood control storage—South Fork Tolt River.
	Watershed Management
62.	Small watershed multiple-purpose project—Tulalip-Warm Beach.
63.	Small watershed multiple-purpose project—Snohomish Estuary.
64.	Small watershed multiple-purpose project—Lake Stevens.
65.	Small watershed multiple-purpose project—Pilchuck River.
66.	Small watershed multiple-purpose project—Woods Creek.
67.	Small watershed multiple-purpose project—Catheart area.
68.	Small watershed multiple-purpose project—Skykomish River.
69.	Small watershed multiple-purpose project—Snoqualmie River.
	Recreation
70.	Development of three recreation sites along saltwater shoreline from the northern boundary of the Basin to the mouth of the Snohomish River.
71.	Development of three recreation sites along saltwater shoreline from southern boundary to the Basin to the mouth of the Snohomish River.
72.	Development of three recreation sites in this vicinity.
73.	Development of two recreation sites in this vicinity.
74.	Development of one recreation site in this vicinity.
75.	Development of three recreation sites along Snohomish River from mouth to confluence of Skykomish and Snoqualmie Rivers.
76.	Development of four recreation sites along Skykomish River from mouth to National Forest.
77.	Development of five recreation sites along Snoqualmie River from mouth to National Forest.
78.	Development of 70 recreation sites in the National Forest.
	Fish and Wildlife.
79.	Construction of a fish passage facility on Olney Creek.
80.*	Construction of fish passage facilities or removal of obstructions on four tributaries.
81.*	Improvement of fish habitat on 24 streams.
82.*	Construction of two salmon hatcheries.

Project No.	
	PROGRAMS 1980 to 2000
	Water Quality Control
k.	Continue water quality, monitoring, evaluation and control programs.
	Flood Control
l.	Continue flood plain management program.
	Watershed Management
m.	Provide technical assistance for on-farm and other private practices.
n.	Provide technical assistance and management for State and Federal lands.
	Fish and Wildlife
p.	Continue fish and wildlife programs.
	PROJECTS 2000 to 2020
	Municipal and Industrial Water Supply
83.	Expansion of Snohomish River water supply pumping and treatment plant—Everett.
84.*	Installation of small and rural community municipal and industrial water supply transmission lines from Everett.
	Irrigation
85.*	Construction and expansion of individual farm irrigation pumping and sprinkler systems.
	Water Quality Control
86.*	Expansion of waste treatment and interception facilities for municipalities, industry, and recreation.
	Navigation
87.	Small boat harbor development—Tulalip Bay, First Phase and Second Phase.
88.	Small boat harbor development—Priest Point West.
89.	Small boat harbor development—Mukilteo and Mukilteo South.
90.	Small boat harbor development—Picnic Point North and Norma Beach North.
91.	Small boat harbor development—Port Susan-Warm Beach.
92.*	Development of additional water transport-oriented industrial lands in Snohomish River Delta.
	Flood Control
93.	Improvement of floodway—Snohomish River, River Mile 6.3 to River Mile 10.0.

*Projects not shown on Figure 5

TABLE 11. Future projects and programs, Snohomish Basin (Cont'd)

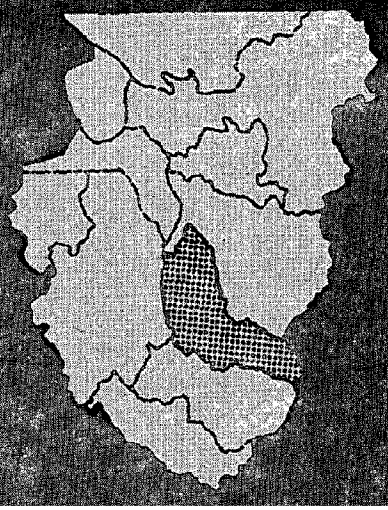
Project No.	
	Watershed Management
94.	Small watershed multiple-purpose project—Sultan River.
	Recreation
95.	Development of one recreation site along saltwater shoreline from the southern boundary of the basin to the mouth of the Snohomish River.
96.	Development of four recreation sites in this vicinity.
97.	Development of three recreation sites in this vicinity.
98.	Development of two recreation sites in this vicinity.
99.	Development of one recreation site in this vicinity.
100.	Development of one recreation site along Snohomish River from mouth to confluence of Skykomish and Snoqualmie Rivers.
101.	Development of five recreation sites along Skykomish River from mouth to National Forest.
102.	Development of six recreation sites along Snoqualmie River from mouth to National Forest.
103.	Development of 100 recreation sites in the National Forest.
	Fish and Wildlife
104.*	Construction of four hatchery equivalent stations and development of 80 acres of rearing facilities and 1 mile of spawning channel.

PROGRAMS 2000 to 2020

	Water Quality Control
q.	Continue water quality monitoring, evaluation and control programs.
	Flood Control
r.	Continue flood plain management program.
	Watershed Management
s.	Provide technical assistance for on-farm and other private practices.
t.	Provide technical assistance and management for State and Federal lands.
	Fish and Wildlife
u.	Continue fish and wildlife programs.

*Projects not shown on Figure 5

Cedar-Green Basins



COUNTIES AFFECTED:

Snohomish

King

CEDAR–GREEN BASINS

SUMMARY OF PLAN

Early Action 1970-1980

During this period municipal and industrial water supply needs of the city of Seattle and its service area, which includes Bellevue, would be satisfied through construction of a diversion facility on the North Fork of the Tolt River in the Snohomish River Basin. Ground water resources would continue to supply small and rural communities with industry meeting a portion of its future growth in water supply requirements by pumping from nearby surface waters.

No new crop land is expected to be placed under irrigation during this period with a continual decrease of irrigated land anticipated due to expansion of residential housing and industry into farming areas.

Compliance with Washington State water quality standards would be obtained through installation of adequate collection and treatment facilities by a number of communities and cities in the Basins. Continued expansion of the Metro waste collection and treatment system is planned. Several outfall facilities located along the Puget Sound shoreline would be improved to assure adequate disposal of treated wastes. Further monitoring, evaluation and information collection for control purposes would be undertaken to insure compliance with the State standards. A comprehensive sewerage plan would be developed for the Basins, and a comprehensive investigation would be made of the Cedar River-Lake Washington system to insure maintenance of water quality.

Navigation needs would be met through channel deepening projects on the Duwamish River waterways and through retention of lands found to be suitable for terminal or water transport-oriented industrial development. Pleasure boating needs would be met through full development of potential sites for small boat harbors in the Basins. Moorages would be provided for pleasure boaters through the construction of three small boat harbors with 2,100 moorage slips.

Power needs for the Basins would be satisfied by a Northwest Regional System which is discussed under Power in the Area portion of this Report. Additional hydro-electric power production may be possible as part of the multiple-purpose storage project planned on the Cedar River at Chester Morse Lake.

A multiple-purpose storage project on the Cedar River at Chester Morse Lake would provide 50,000 acre-feet of flood control storage which, together with additional levees and channel work planned after 1980, would provide the Cedar River flood plain with protection against floods with an occurrence interval in excess of 100 years. In the Green River flood plain sixteen miles of levees and channel work along the Green River below Auburn are planned to provide a channel capacity capable of accommodating the 12,000 cfs of controlled flow release by Howard A. Hanson Dam at Auburn and the additional water pumped into the river by the valley drainage projects located on either side of the river. These projects provide for removal of valley drainage through pumping plants and collection channels. The flood plain of the Green River Valley would have protection in excess of 100 years as a result of this project. Flood plain management is relied upon to retain the open space and green belts remaining in the Sammamish River drainage and to guide future use of the Cedar and Green River flood plains consistent with the degree of flood protection provided.

Two small watershed flood prevention and water management projects are planned for installation prior to 1980 to achieve damage reduction and drainage improvement. One project is located in the Swamp, Bear, North Creek watershed and the other in the Evans Creek watershed, both tributary to the Sammamish River. These structural improvements would be complemented by ongoing and accelerated land treatment measures.

Campgrounds, picnic areas, beaches, and boat launching ramps would be developed on existing public lands together with the acquisition of additional land and water areas to satisfy recreational needs. Additional land and water areas would be acquired along the Puget Sound shoreline to provide badly needed marine parks. Over 50 recreation sites are planned for improvement or development before 1980 with many sites located within the urban areas. The plan calls for the preservation and the public accessibility of the many natural attractions in the Basins including the shoreline of Puget Sound, Lake Washington, Lake Sammamish and a 12-mile section of the Green River Gorge from the town of Kanasket to the Kummer Bridge.

Land acquisition including access and fish and wildlife enhancement projects would be undertaken

to increase the opportunities for this form of outdoor recreation. Additional trout hatcheries, artificial propagation for salmon and steelhead, including rearing ponds and spawning channels, would be constructed. Low flow augmentation would be provided through additional conservation storage from Howard Hanson Dam on the Green River and through releases from the proposed Chester Morse Lake multiple-purpose project on the Cedar River. Modification of the salt water drain outlet and the fish ladder at the Hiram M. Chittenden Locks, at the entrance to the Lake Washington Ship Canal, would provide improvements in fish passage at that facility. Important cross-sectional stream surveys would be taken during this period in order to determine the minimum and optimum stream flows required to fish production. Subsequent to these cross-sectional surveys further studies of the new projects may be required as well as reconsideration of the operation procedures of existing projects.

Long-Range, 1980-2020

Expansion of the Seattle water system to partially satisfy the 2000 level demand may require construction of additional storage in the Cedar River watershed on the Rex River or on the main stem upstream from Chester Morse Lake. Some of this water could be provided from the conservation pool made possible by increased storage at Chester Morse Lake, proposed as an early action project to meet flood control and low flow augmentation needs of fish. A third pipeline would be constructed from the Cedar River during this period. Additional water supply would be needed to meet the 2000 level of demand generated by the Seattle service area. This water would be obtained from the North Fork of the Snoqualmie River with releases from water stored by the North Fork multiple-purpose project planned for implementation prior to 1980. Ultimate water supply needs of the city of Seattle could be met through development of the North Fork of the Skykomish River although this source is considered to be tentative due to the technological changes that are expected prior to the time when this project would be needed. Recycling of water by industry and other innovations would probably preclude the necessity of this project allowing the retention of the North Fork in a free flowing state. The small communities would continue to be supplied from their existing sources of ground water until such time as these resources become exhausted or are used to their ultimate limit. Provisions have been made for the small water purveyors to be supplied from Tacoma and Seattle water systems when needed. Industry currently using nearby surface waters are expected to continue doing so primarily for washing purposes. These flows are normally returned to the river a short distance from the point from which they were diverted.

An additional 800 acres is expected to be placed under irrigation during this period with water supplied primarily from the Green River as these lands are located in the upper Green River Valley above Auburn. A net decrease in the total number of acres irrigated in the Cedar-Green Basins is expected from the 2,600 acres irrigated in 1966 to a projected 1,100 acres by the year 2020.

Existing treatment in collection facilities would be expanded commensurate with the growth of population and industrial development to insure the State water quality standards are continually complied with. A water quality monitoring evaluation and control program would be maintained.

Significant increases in small boat harbor development are forecast for this period with over 10,000 wet moorages to be provided by the development of five small boat harbors. All lands that have been designated as having a favorable potential for terminal water transport-oriented industrial development in the Cedar-Green Basins are expected to have been developed by this period. Joint development of navigation facilities may occur with authorities in adjacent basins. The Snohomish Basin is viewed as having an excellent potential for a large port development.

No power development is anticipated in these Basins in a long-range period with importation of power viewed as being the means for satisfying power needs. The Northwest Regional Power System has been planned with consideration given to the load requirements of the highly populated Cedar-Green Basins.

The only additional flood control structures visioned after 1980 would be construction of levees and channel improvements along the Cedar River from River Mile 4.5 to about 17.5 near Maple Valley. This work in conjunction with the storage from the Chester Morse Lake project would provide protection in excess of 100 years for the Cedar River flood plain downstream from Maple Valley. Remaining portions of the Cedar flood plain are recommended for flood plain management, namely, zoning to insure that developments are consistent with the degree of protection provided.

Further programs and projects would be undertaken to satisfy watershed management needs. These include six projects and a program of technical assistance, land treatment and water management.

Additional development of campgrounds, picnic areas and additional recreational facilities would be undertaken after 1980, on public lands as well as on private lands with both public and private sectors providing recreation facilities. In the long-range period development of recreation facilities in the municipal watersheds may be required to satisfy recreation needs. Detailed studies are required which adequately demonstrate this need as well as evaluate the economic feasibility of recreation use, taking into account treatment plant construction costs, if warranted. About 70 recreation sites are planned for improvement or development during the long-range period. Portions of the Cedar and Green Rivers and tributaries may be included in a State system of scenic and recreation rivers for retention in a free-flowing state for public use.

Additional fish and wildlife opportunities would be provided through anadromous and resident fish enhancement measures. A facility may be constructed on the Green River to provide passage up and downstream from Howard Hanson Dam. Details and actual feasibility of this project would be determined in studies undertaken prior to 1980. Clearance improvement of 2 miles of Burns and Crisp Creeks and six miles of channel on three other streams would be undertaken during this period together with construction of spawning channels to provide opportunities for enhancement of anadromous fish runs. Artificial propagation measures including hatcheries or their equivalent also would be provided to meet growth in both the sport and commercial fisheries.

Table 12 summarizes the Cedar-Green Basins elements of the Comprehensive Plan, showing benefits and costs for the early action of the Plan, and provides a summary of investment costs by water resource features for the entire 50-year period ending in 2020. The early action of the plan includes programs amounting to $229,941,000 and projects costing $218,615,000 for a total investment of $448,556,000. Program and project investment cost for the 1980-2000 period amount to $671,084,000 and for the 2000-2020 period $682,599,000, for a total 50-year investment of $1,802,239,000.

TABLE 12. Comprehensive Plan, Cedar-Green Basins

Feature	Item	1970-1980 Investment[1] Costs ($1000)	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control	3,400				4,840	5,320	13,560
Flood Control	Flood Plain Management	147				240	240	627
Watershed Management	Programs	225,954				230,301	230,044	686,299
Fish & Wildlife	Programs	440				602	776	1,818
Total Programs		$ 229,941				$ 235,983	$ 236,380	$ 702,304
Non-storage Projects								
M&I Water Supply	Ground Water Use	2,400	362	362[7]	0	3,780	5,760	111,940
	Surface Water Use	19,304	2,973	2,973[7]	0	10,140	22,087	51,531
Irrigation Water Supply	Ground Water Use	0	0	0	0			0
	Surface Water Use	0	0	0	0	55	55	110
Water Quality Control	Sewerage Treatment & Collection Fac.	113,850	6,770	6,770[7]	0	275,800	237,000	626,650
Navigation	Channels	3,779	191	339	148	0	0	3,779
	Small Boat Harbors[1]	(4,139)[3]	(280)[3]	(391)[3]	(111)[3]	(20,196)[3]	(0)	(24,335)
Power[2]								
Flood Control	Channel and Levees	12,000	601	723	122	1,300	0	13,300
Watershed Management	Floodwater Damage Reduction, Water Management and Rehabilitation and Protection of Watershed Lands	2,180	119	242	123	5,510	200	7,890
Recreation	Land Acquisition, Access & Recreation Fac.	54,425	3,792	4,560	768	70,000	104,600	229,025
Fish & Wildlife	Land Acquisition, Access & Enhancement Facilities	5,067	438	1,026	588	7,916	16,517	29,500
Total Non-Storage		$ 213,005	$15,246	$16,995	$1,749	$ 374,501	$ 386,219	$ 973,725
Storage Projects								
	Chester Morse Lake[4]							
Flood Control		4,740	263	298	35			4,740
Fish & Wildlife		870	49	55	6			870
	Total Project	5,610	312	353	41			5,610
	Howard Hanson							
Water Quality Control		(Not evaluated)						
Fish & Wildlife		(Not evaluated)						
M&I Water Supply	N. Fork Snoqualmie[6]					47,600[5]		47,600[5]
M&I Water Supply	Cedar River					13,000[5]		13,000[5]
M&I Water Supply	N. Fork Skykomish[6]						60,000[5]	60,000[5]
Total Storage		$ 5,610	$ 312	$ 353	$ 41	$ 60,600	$ 60,000	$ 126,210
Total Program and Projects		$448,556	$15,558	$17,348	$1,790	$671,084	$682,599	$1,802,239

[1] Includes cumulative annual program costs for the period for management features and capital costs for non-storage and storage projects.

[2] Power facilities not included in basin plan.

[3] General Navigation facilities costs and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

[4] Power and municipal, and industrial water supply benefits from increased storage at Chester Morse Lake not evaluated.

[5] Includes total costs for municipal and industrial water supply and transmission lines.

[6] Located in Snohomish Basin.

[7] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT

The projects and programs of the Comprehensive Plan are summarized in Table 13 by period. The project numbers identify features on Figure 6.

TABLE 13. Future projects and programs, Cedar-Green Basins

PROJECTS PRIOR TO 1980

Municipal and Industrial Water Supply

1.* Small and rural community ground water development.
2.* Self-supplied industry surface water development.
3. Construction of diversion and transmission facilities at North Fork Tolt River–Seattle.
4. Expansion of existing system–Renton.
5. Expansion of existing system–Kent.
6. Expansion of existing system–Auburn.
6a. Expansion of transmission facilities from Green River–Tacoma (for Puyallup Basin).

Water Quality Control

7.* Expansion of Metro waste collection and treatment system.
8. Improvement of outfall at Alki sewerage treatment plant.
9. Improvement of outfall at Southwest Suburban Sewer District, Salmon Creek plant.
10. Improvement of outfall at Sylvia Pines Sewer District.

Navigation

11. Channel improvement–West Waterway.
12. Channel improvement–East Waterway.
13. Channel improvement–Duwamish Channel to 1st Avenue South.
14. Channel improvement–Duwamish 1st Avenue South to 8th Avenue South.
15. Channel improvement–Duwamish 8th Avenue South to head of navigation.
16. Small boat harbor development–Elliott–Pier 54.
17. Small boat harbor development–Des Moines.
18. Small boat harbor expansion–Seacrest Marina addition.

Flood Control

19. Flood control storage at Chester Morse Lake multiple-purpose project–Cedar River.
20. Levee and channel improvements downstream from Auburn–Green River.

Watershed Management

21. Small watershed multiple-purpose project–Swamp, Bear, and North Creeks.
22. Small watershed multiple-purpose project–Evans Creek.

Recreation

23. Development of six recreation sites along saltwater shoreline.
24. Development of one recreation site.
25. Development of two recreation sites.
26. Development of four recreation sites.
27. Development of three recreation sites along Lake Union and Lake Washington Ship Canal.
28. Development of three recreation sites along Sammamish River.
29. Development of seven recreation sites along shoreline of Lake Washington.
30. Development of three recreation sites along Cedar River from mouth to Landsburg Dam.
31. Development of five recreation sites along Green River from mouth to city of Tacoma water supply diversion dam.

Fish and Wildlife

32.* Lease and development of 10 sites for pheasant releases and hunting.
33.* Acquisition of band-tailed pigeon concentration areas.
34.* Expansion of existing game farm facilities to produce 5,000 more pheasants.
35.* Acquisition and development of public access to 21 lakes.
36.* Construction of trout hatchery.
37.* Construction of spawning channel–Cedar River.
38.* Construction of steelhead rearing pond–Green River.
39.* Acquisition and development of access on 50 miles of main river and 10 miles of tributaries–Green River.
40.* Acquisition and development of five saltwater access areas.
41. Operate Howard Hanson project to provide additional low flow augmentation for fish–Green River.
19. Low flow augmentation and flood control from Chester Morse Lake multiple-purpose project–Cedar River.
42. Modification of salt water drain and construction of fish ladder at H.M. Chittenden Locks–Lake Washington Ship Canal.

PROGRAMS PRIOR TO 1980

Water Quality Control

a. Expand water quality surveillance stations at salt and fresh water locations monitor, and control treatment, evaluate and prepare comprehensive sewerage plan for the Basins.
b. Perform in-depth comprehensive investigation of Cedar River-Lake Washington system to analyze interrelationships of hydrology, nutrient concentrations, salinity concentrations, and diversion from the system for water supply to determine the basis for management of the system for maintenance of water quality.

Flood Control

c. Establish and administer county-wide flood plain zoning measures under flood plain management program.

*Project not shown on Figure 6

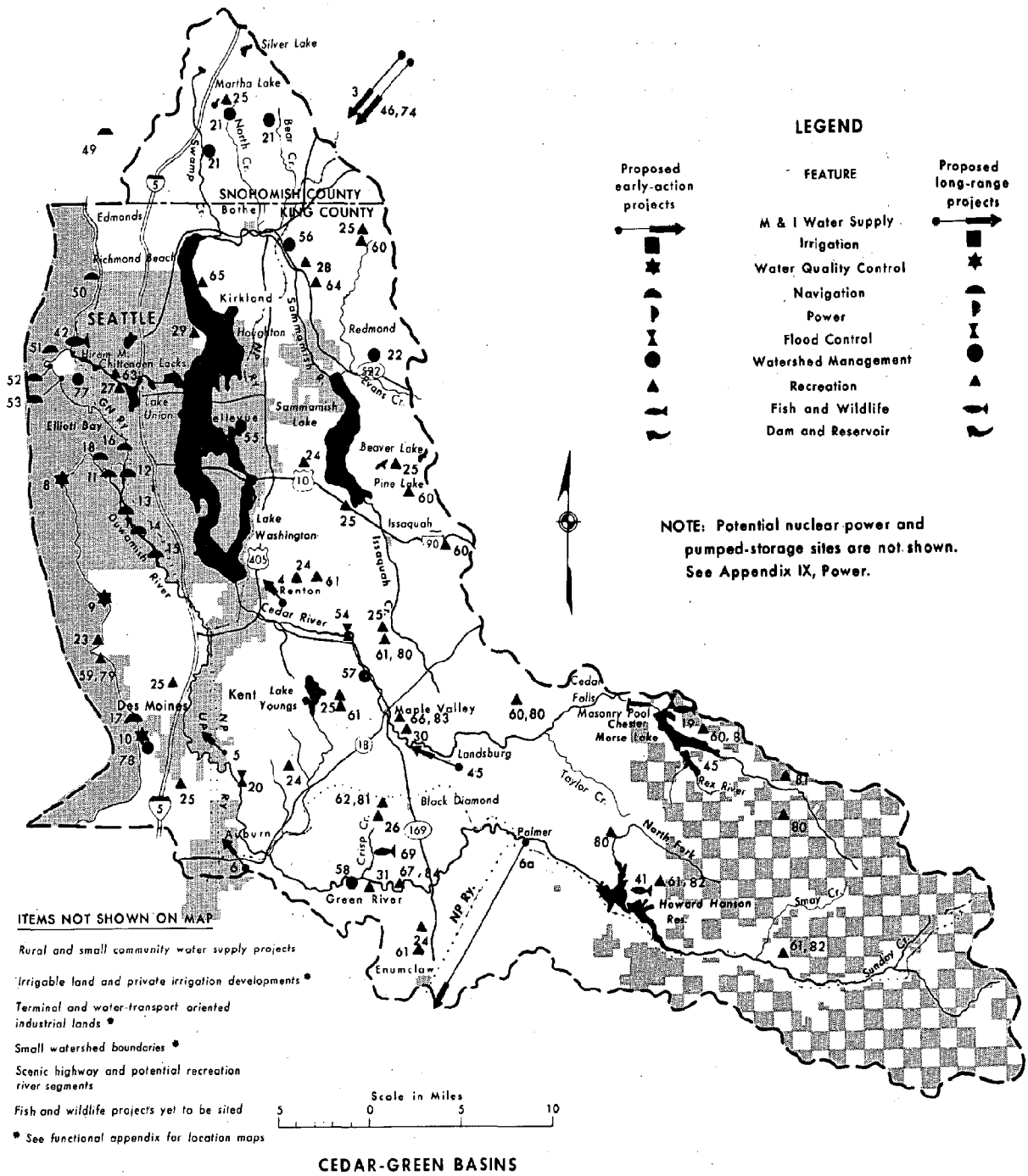


FIGURE 6. Comprehensive Plan Elements

TABLE 13. Future projects and programs, Cedar-Green Basins (Cont'd)

Watershed Management

d. Provide technical assistance and management for State and Federal lands.

e. Provide technical assistance for on-farm and other practices.

Fish and Wildlife

f. Develop lake fertilization techniques.

g. Make wildlife population analysis and timberland management practices studies, develop habitat improvement techniques and an education program on proper game hunting concepts, and begin a program with land owners for game habitat retention and hunter access.

h. Develop fish disease controls and new toxicants.

i. Conduct cross-sectional stream surveys to determine minimum and optimum streamflows for fish.

j. Locate, survey, and mark boundaries of all State-owned second class tidelands in the Basins. Take steps to reserve all such lands for public use except as required for specific circumstances.

k. Perform an inventory of shellfish stocks and recreational use of tidelands.

PROJECTS 1980-2000

Municipal and Industrial Water Supply

43.* Self-supplied industry surface water development.

44.* Water system expansion—Renton, Kent and Auburn.

45. Construction of additional storage in Cedar River watershed and install third pipeline—Seattle.

46. Increase storage capacity of North Fork Snoqualmie River project and install transmission lines—Seattle.

Irrigation

47.* Installation of individual farm irrigation pumping and sprinkler system (private)—Green River.

Water Quality Control

48.* Expansion of waste treatment and interception facilities for municipalities, industry and recreation development.

Navigation

49. Small boat harbor development—Well's Point—Edmonds.

50. Small boat harbor development—Golden Gardens—North.

51. Small boat harbor development—Fort Lawton—North.

52. Small boat harbor development—Fort Lawton—South.

53. Small boat harbor development—Elliott Bay—Magnolia Bluff.

Flood Control

54. Construction of levees and improvement of channel from R.M. 4.5- to R.M. 17.5—Cedar River.

Watershed Management

55. Small watershed multiple-purpose project—Lake Washington.

56. Small watershed multiple-purpose project—Sammamish River.

57. Small watershed multiple-purpose project-Cedar River.

58. Small watershed multiple-purpose project—Upper Green River.

Recreation

59. Development of four recreation sites along saltwater shoreline.

60. Development of one recreation site.

61. Development of two recreation sites.

62. Development of four recreation sites.

63. Development of one recreation site along Lake Union or Lake Washington Ship Canal.

64. Development of one recreation site along Sammamish River.

65. Development of two recreation sites along shoreline of Lake Washington.

66. Development of four recreation sites along Cedar River from mouth to Landsburg Dam.

67. Development of five recreation sites along Green River from mouth to city of Tacoma water supply diversion dam.

Fish and Wildlife

68.* Improve 51 miles of habitat on 22 streams.

69. Clear and improve two miles of channel, Burns and Crisp Creeks.

70.* Clear six miles of channel on three streams.

71.* Construct one mile of spawning channel.

PROGRAMS 1980-2000

Water Quality Control

l. Continue water quality surveillance programs.

Flood Control

m. Continue flood plain management programs.

Watershed Management

n. Continue technical assistance and management for State and Federal lands.

o. Continue technical assistance for on-farm and other practices.

Fish and Wildlife

p. Continue fish and wildlife programs.

PROJECTS 2000-2020

Municipal and Industrial Water Supply

72.* Self-supplied industry surface water development.

*Project not shown on Figure 6

TABLE 13. Future projects and programs, Cedar-Green Basins (Cont'd)

73. Water system expansion—Renton, Kent and Auburn.
74. Development of North Fork Skykomish River for water supply—Seattle.

Irrigation

75.* Installation of individual farm irrigation pumping and sprinkler system (private)—Green River.

Water Quality

76.* Expansion of waste treatment and interception facilities for municipalities, industry and recreation development.

Watershed Management

77. Small watershed multiple-purpose project—West Slope Seattle.
78. Small watershed multiple-purpose project—Lakota—Des Moines.

Recreation

79. Development of two recreation sites along salt water shoreline.
80. Development of one recreation site in this vicinity.
81. Development of two recreation sites in this vicinity.
82. Development of three recreation sites in this vicinity.
83. Development of five recreation sites along Cedar River from mouth to Landsburg Dam.
84. Development of five recreation sites along Green River from mouth to city of Tacoma water supply diversion dam.

Fish and Wildlife

85.* Construct 4 hatcheries or the equivalent.
86.* Develop 35 acres of rearing facilities.
87.* Develop one mile of spawning channel.
88.* Other projects for fish and wildlife.

PROGRAMS 2000-2020

Water Quality Control

q. Continue water quality surveillance programs.

Flood Control

r. Continue flood plain management programs.

Watershed Management

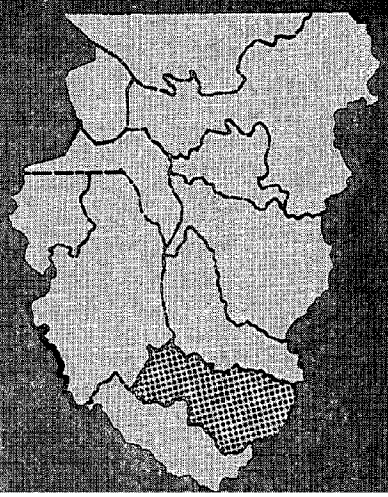
s. Continue technical assistance and management for State and Federal lands.
t. Continue technical assistance for on-farm and other practices.

Fish and Wildlife

u. Continuation of fish and wildlife programs.

*Project not shown on Figure 6

Puyallup Basin



COUNTIES AFFECTED:

Pierce

King

PUYALLUP BASIN

SUMMARY OF PLAN

Early Action 1970-1980

During this period municipal and industrial water supply needs of the city of Tacoma would be satisfied by utilizing storage provided by the Howard A. Hanson project on the Green River. Tacoma would also utilize ground water sources to meet peak demands and during periods when turbidity makes the Green River water unuseable. Ground water resources would continue to supply the preponderance of small and rural communities and industry.

About 2,500 acres of cropland would be placed under irrigation with water supplied by individual farmers from both surface and ground sources.

Compliance with State water quality standards would be obtained through installation of adequate collection and treatment facilities. Industrial plants would provide adequate treatment prior to discharge and would install outfalls and diffusers to achieve maximum dilution and dispersion into Puget Sound. A water quality surveillance program would be expanded in order to provide an adequate monitoring system with sampling stations on marine and fresh water. A comprehensive sewerage plan would be developed for the Basin.

Navigation needs would be met through deepening of Hylebos, Blair (Port Industrial) and Sitcum waterways to accommodate bulk cargo vessels and freighters. Lands found to be suitable for terminal or water transport-oriented industrial development would be retained for this purpose to insure future availability. Wet moorage would be provided for pleasure boaters through the construction of two small boat harbors with 1,550 moorage slips.

Power needs for the Basin would be satisfied by the Northwest Regional system. Future development for the satisfaction of Area power needs is discussed under Power in the Area portion of this Report.

During this period the community of Orting would be protected by a levee. Flood plain management would provide an effective means of reducing future flood damages through land use zoning of lands in the flood plain consistent with the levels of flood protection. Floodproofing and warning systems also would be implemented. These measures would contribute significantly to the reduction of future flood damages.

Five small watershed multiple-purpose projects are planned for implementation during this period to achieve floodwater damage reduction, protection and rehabilitation, and water management. These are located in the following areas: Algona-Pacific, Clear Creek, Hylebos Creek, Wapato Creek, and Clover Creek. The structural measures in these projects consist of stabilized channels and outlet control structures. Important complements to the watershed structural projects are the programs of technical assistance and improved management with installation of land treatment and water management measures.

Campgrounds, picnic areas, beaches, and boat launching ramps would be developed on existing public lands together with the acquisition of additional land and water areas to satisfy recreational needs. Additional land and water areas would be acquired along the Puget Sound shoreline to provide needed marine parks. About 60 recreation sites are planned for expansion or development before 1980.

Land acquisition including access and fish and wildlife enhancement projects would be undertaken to increase the opportunities for this form of outdoor recreation. Additional fish hatcheries would be constructed for both resident and migratory fish together with rearing ponds, spawning channels and fish passage facilities at Electron Dam. Cross-sectional stream surveys would be undertaken during this period in order to determine the minimum and optimum streamflows required for fish production.

Long-Range, 1980-2020

Expansion of the existing water supply systems and development of new sources would take place commensurate with population and industrial growth to satisfy projected needs of municipalities, small and rural communities and industry.

An additional 7,500 acres of land would be placed under irrigation during this period with water supplied from surface and ground water by individual users.

Existing treatment and collection facilities would be expanded commensurate with the growth in population and industrial development to insure that the State water quality standards are continually

complied with. The water quality surveillance program would be maintained.

Further terminal and water transport-oriented industrial development is envisioned during this period as facilities would be required to meet the navigation needs of the Basins. Hylebos and the Port Industrial waterway would be deepened to accommodate increased vessel drafts. The last site in the Basin suitable for a small boat harbor would be developed by the year 2000.

Power development may include pumped-storage at a number of the potential sites within the Basin. Oil or gas-fueled steam electric plants also may be located during this period to meet short-time peaking requirements. Development of nuclear electric generating plants may occur but definite scheduling of facilities and exact siting have not been completed and would be dependent upon future studies that considered shoreline characteristics nearness to major load centers and impacts on the environment.

During this period a storage project on the upper Puyallup River in connection with the levee at Orting, would provide 100-year protection in the flood plain from the dam site down to Sumner. A levee near South Prairie Creek would provide protection to agricultural lands near the community of South Prairie Creek. Flood plain management would be continued with zoning being required to guide future development and prevent unwarranted development in the flood plain.

Other watershed management needs in the Basin would be satisfied by the progressive development of four small watershed projects for floodwater damage prevention, rehabilitation and protection, and water management to make areas of the flood plains suitable for more efficient agricultural use. Upgrading of existing facilities and more intensive application of recurring and non-recurring land treatment practices would be required throughout the Basin. On-going watershed management programs which provide some degree of technical assistance and financial participation would be continued.

Additional development of campgrounds, picnic areas, and other recreation facilities would be undertaken after 1980 at about 90 sites throughout the Basin, on public lands as well as on private lands, with both public and private sectors participating in the providing of recreational facilities. Studies would be made of the Carbon, White and Puyallup rivers for possible inclusion of portions within a State recreation river system.

Additional fish and wildlife opportunities would be provided through anadromous and resident fish enhancement measures. A fish passage improvement is planned on Chambers Creek during the long-range period as well as additional spawning habitat development and construction of salmon hatcheries.

Table 14 summarizes the Puyallup Basin elements of the Comprehensive Plan, showing the benefits and costs for the early action portion of the Plan, and provides a summary of investment costs by water resource functions for the entire 50-year period ending in 2020. The early action portion of the Plan includes programs amounting to $138,860,000 and projects costing $127,100,000 for a total investment of $265,960,000 Program and project investment costs for the 1980-2000 period amount to $287,243,000 and for the 2000-2020 2020 period, $383,545,000; for a total 50-year investment of $936,748,000.

TABLE 14. Comprehensive Plan, Puyallup Basin

Feature	Item	1970-1980 Investment[1] Costs ($1000)	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs	Monitoring, Evaluation and							
Water Quality Control	Control Programs	2,600	--	--	--	4,200	5,100	11,900
Flood Control	Flood Plain Management	185	--	--	--	100	100	385
Watershed Management	Programs	135,672	--	--	--	94,[illegible]	138,264	368,059
Fish & Wildlife	Programs	403	--	--	--	630	630	7,663
Total Programs		$138,860				$ 99,053	$144,094	$382,007
Nonstorage Projects								
M&I Water Supply	Ground Water Use	13,154	1,239	1,239[5]	0	7,584	7,400	28,138
	Surface Water Use	28,909[4]	2,818	2,818[5]	0	28,932	52,207	110,048
Irrigation Water Supply	Ground Water Use	136	17	17[5]	0	231	109	476
	Surface Water Use	204	26	26[5]	0	449	231	884
Water Quality Control	Sewerage Treatment and Collection Facilities	34,000	1,964	1,964[5]	0	51,200	79,600	164,800
Navigation	Channels	5,430	318	389	71	4,488	0	9,918
	Small Boat Harbors[3]	(3,120)[3]	(200)[3]	(290)[3]	(90)[3]	(5,492)[3]	0	(8,612)[3]
Power[2]								
Flood Control	Channels and Levees	1,600	86	103	17	1,000[5]	0	2,600
Watershed Management	Flood Water Damage Reduction Rehabilitation and Protection, and Water Management	4,972	271	382	111	4,167	0	9,139
Recreation	Land Acquisition, Access and Recreation Facilities	35,389	2,339	3,255	916	55,600	88,040	179,029
Fish & Wildlife	Land Acquisition, Access and Enhancement Facilities	3,306	366	849	483	8,039	11,864	23,209
Total Nonstorage		$127,100	$ 9,444	$11,042	$1,598	$161,090	$239,451	$528,241
Storage Projects								
	Puyallup (Puyallup River)							
Flood Control		0	0	0	0	26,500	0	26,500
	Total Storage	$ 0	$ 0	$ 0	$ 0	$ 26,500	$ 0	$ 26,500
Total Program and Projects		$265,960	$16,567	$24,695	$8,128	$287,243	$383,545	$936,748

[1] Includes cumulative annual program costs for the period for management features and capital costs for nonstorage and storage projects.

[2] Power facilities not included in Basin plan.

[3] General Navigation facilities cost and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

[4] Includes costs for modifying Howard A. Hanson project.

[5] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT

The projects and programs are summarized in Table 15 by time periods. The project numbers identify features on Figure 7.

TABLE 15. Future projects and programs, Puyallup Basin

PROJECTS PRIOR TO 1980

Municipal and Industrial Water Supply

1. Expansion of Green River supply and transmission system—Tacoma.
2. Expansion of water supply systems—Puyallup, Buckley, Fort Lewis, Orting and other communities.
3.* Increase capacity of self-supplied industrial water systems.

Irrigation

4.* Installation of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

5.* Installation of sewerage systems with secondary treatment and disinfection—Orting, Wilkeson, Bonney Lake, Algona, Pacific and Carbonado.
6. Installation of secondary treatment and disinfection—Buckley, Sumner and Puyallup.
7. Installation of secondary treatment, disinfection, adequate outfall and collection facilities—Tacoma.
8. Installation of adequate treatment and adequate outfall—Industry.
9. Secondary treatment, disinfection and adequate outfall—Fort Lewis.

Navigation

10. Deepen Hylebos, Blair (Port Industrial) and Sitcum Waterways.
11. Small boat harbor development—Hylebos Waterway.
12. Small boat harbor development—Titlow-Day Island.

Flood Control

13. Construction of levee at Orting.

Watershed Management

14. Small watershed multiple-purpose project—Algona Pacific.
15. Small watershed multiple-purpose project—Clear Creek.
16. Small watershed multiple-purpose project—Hylebos Creek.
17. Small watershed multiple-purpose project—Wapato Creek.
18. Small watershed multiple-purpose project—Clover Creek.

Recreation

19. Development of six recreation sites along saltwater shoreline.
20. Development of four recreation sites.
21. Development of one recreation site.
22. Development of five recreation sites.
23. Development of three recreation sites along Puyallup River.
24. Development of four recreation sites.
25. Development of three recreation sites.
26. Development of five recreation sites along White River.
27. Development of one recreation site.
28. Development of 30 recreation sites on National Park and Forest lands.

Fish and Wildlife

29.* Acquisition and development of public access to eight lakes.
30. Expansion of Puyallup River trout hatchery.
31. Construction of steelhead rearing facilities.
32. Fish passage improvements at Electron Dam and Powerhouse.
33.* Construction of trout hatchery.
34.* Development and acquisition of 40 miles of streambank access.
35.* Acquisition and development of access to five saltwater areas.
36.* Channel and lake clearance.
37.* Acquisition and development of 600 acres of upland bird habitat and hunting area.
38. Expansion of pheasant game farm.
39. Fish passage improvements at White River diversion dam and increased salmon production on White River through artificial propagation facilities.

*Projects not shown on Figure 7

TABLE 15. Future projects and programs, Puyallup Basin (Cont'd)

PROGRAMS PRIOR TO 1980

Water Quality Control

a. Establish and operate water quality surveillance stations at key salt and fresh water locations and prepare comprehensive sewerage plan for the Basin.

Flood Control

b. Establish and administer county-wide flood plain zoning measures under flood plain management program.

Watershed Management

c. Provide technical assistance and management for State and Federal lands.
d. Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

e. Develop lake and stream fertilization techniques.
f. Make wildlife population analysis and timberland management practices studies, develop habitat improvement techniques and an education program on proper game hunting concepts, and begin a program with land owners for game habitat retention and hunter access.
g. Conduct cross-sectional stream surveys to determine minimum and optimum streamflows for fish.
h. Locate, survey, and mark boundaries of all State-owned second class tidelands in the Basin. Take steps to reserve all such lands for public use except as required for specific circumstances.
i. Perform an inventory of shellfish stocks and recreational use of tidelands.

PROJECTS 1980-2000

Municipal and Industrial Water Supply

40.* Expansion of existing water supply systems.

Irrigation

41.* Installation of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

42.* Expansion of waste treatment and interception facilities for municipalities, industry and recreation development.

Navigation

43. Deepen Hylebos and Blair (Port Industrial) Waterways seaward of 11th Street Bridge.
44. Small boat harbor development—Dumas Bay.

Flood Control

45. Construction of levee at South Prairie.
67. Puyallup River storage.

Watershed Management

46. Small watershed multiple-purpose project—White River.
47. Small watershed multiple-purpose project—Carbon River.
48. Small watershed multiple-purpose project—Puyallup River.
49. Small watershed multiple-purpose project—South Prairie Creek.

Recreation

50. Development of three recreation sites along saltwater shoreline.
51. Development of four recreation sites.
52. Development of three recreation sites.
53. Development of six recreation sites along the White River.
54. Development of one recreation site.
55. Development of three recreation sites.
56. Development of one recreation site.
57. Development of three recreation sites along Puyallup River.
58. Development of one recreation site in this vicinity.
59. Development of 20 recreation sites on National Forest and Park lands.

Fish and Wildlife

60. Improvement of salmon passage at Chambers Creek.
61. Clear channel, Greenwater River.
62.* Improvement of salmon habitat on eight streams.
63.* Construction of a salmon hatchery.
64.* Construction of 1 mile of salmon spawning channel.
65.* Game fish and wildlife improvements.
66.* Lake and channel clearance and habitat improvement on national forest lands.

PROGRAMS 1980-2000

Water Quality Control

j. Continue water quality surveillance program.

Flood Control

k. Continue flood plain management program.

Watershed Management

l. Provide technical assistance for onfarm and other private practices.
m. Provide technical assistance and management for State and Federal lands.

*Projects not shown on Figure 7

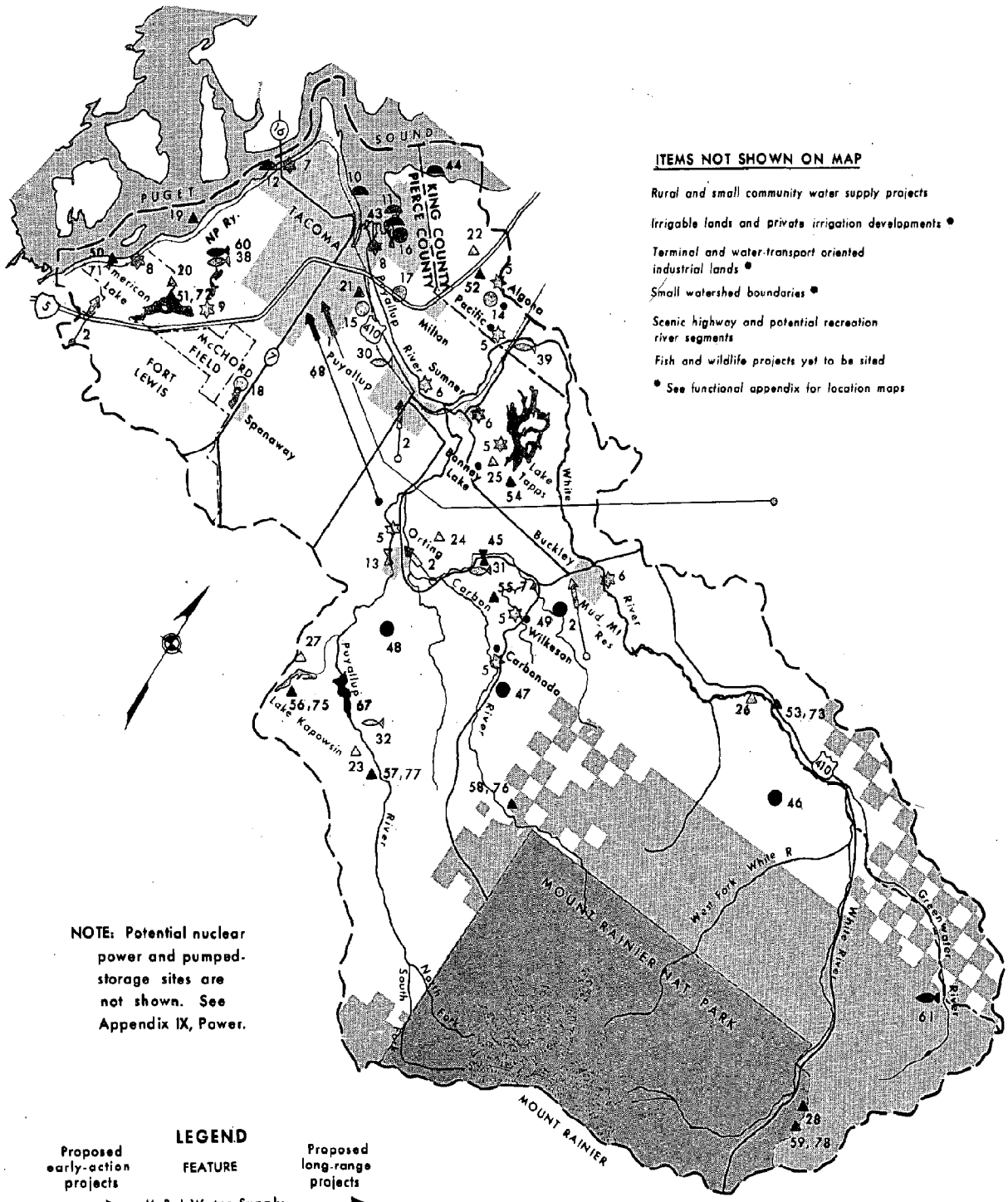


FIGURE 7. Comprehensive Plan Elements

TABLE 15. Future projects and programs, Puyallup Basin (Cont'd)

Fish and Wildlife

n. Continue fish and wildlife programs.

PROJECTS 2000-2020

Municipal and Industrial Water Supply

68. Develop Puyallup River supply for Tacoma.
69.* Expand existing water supply systems.

Irrigation

70.* Installation of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

70a.* Expand waste treatment and interception facilities for municipalities, industry and recreation development.

Recreation

71. Develop one recreation site along the saltwater shoreline.
72. Develop two recreation sites.
73. Develop eight recreation sites along White River.
74. Develop four recreation sites.
75. Develop one recreation site.
76. Develop one recreation site.
77. Develop four recreation sites along Puyallup River.
78. Develop 25 recreation sites on National Forest and Park lands.

Fish and Wildlife

79.* Construction of four salmon hatcheries.
80. Development of 16 acres of salmon rearing facilities.
81.* Development of 1 mile of salmon spawning channel.
82.* Game fish and wildlife improvements.
83.* Channel and lake clearance on National Forest lands.

PROGRAMS 2000-2020

Water Quality Control

o. Continue water quality surveillance program.

Flood Control

p. Continue flood plain management program.

Watershed Management

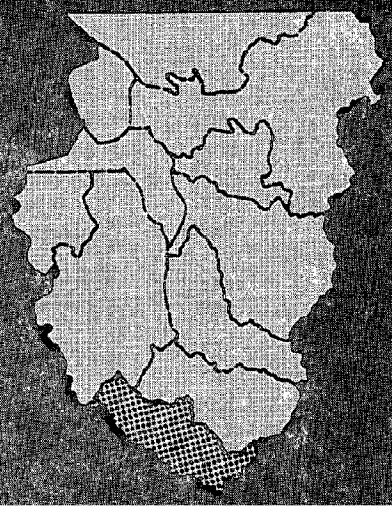
q. Provide technical assistance for onfarm and other private practices.
r. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

s. Continue fish and wildlife programs.

*Projects not shown on Figure 7

Nisqually-Deschutes Basins



COUNTIES AFFECTED:

Pierce

Lewis

Thurston

NISQUALLY–DESCHUTES BASINS

SUMMARY OF PLAN

In developing the plan for the Nisqually-Deschutes Basins, conflicting uses for the Nisqually Delta arose which could not be readily resolved without further detailed study. Development of the Nisqually Delta as a port facility and water-oriented industrial location could conflict with the present and projected use of this resource as a natural biotic, recreational, and wildlife area. Since this is an area of high priority for both uses, alternative plans for use of the Nisqually Delta are presented.

Alternative A is a plan for a projected recreational-wildlife biotic research use of the delta. Alternative B provides for the utilization of a portion of the delta for a navigation port and related industrial development.

ALTERNATIVE A

Early Action, 1970-1980

The present municipal and industrial water supply needs for the greater Olympia area can be met from ground water. The present sources of supply are considered adequate, and enlargement of existing supply systems would meet the projected needs. Detailed studies should be undertaken during this time period to determine the capability of the local ground water supply.

The water supply system for the Olympia area and the small rural community water systems should be enlarged to provide the peak flow and fire protection delivery capability outlined in the State's water supply system standards.

Irrigation water supplies, including about 2,200 acres of new lands projected to be irrigated by 1980, can be met from both surface and ground water sources. In the Deschutes Basin, the irrigable lands are in an area with an excellent ground water resource and these lands can be expected to be irrigated from this source through private farm development. In the Nisqually River Basin, the irrigation water supply would be obtained from both surface and ground water sources. Irrigation systems would be constructed by the individual farmer.

To comply with Washington State water quality standards, waste treatment and sewer outfall facilities would be installed by the various industries for treating industrial wastes prior to discharge into the offshore waters.

Water treatment needs can be met with the construction of secondary waste facilities with adequate sanitary sewers at Paradise, Longmire, Olympia, and Lacey. Water quality surveillance stations would be established at three new locations in the Basins to regularly measure the water characteristics. A comprehensive water pollution control and abatement plan would be developed for the basins.

The Nisqually and Deschutes Rivers flow for the greater part of their length through a natural sanctuary where outdoor recreation and forestry are primary uses. Hence, wasteloading is expected to be light and minimum flows for other purposes such as fish would be sufficient to maintain a desirable water quality. A continuing program of expanding waste treatment and sanitary sewers in all municipalities and small community systems would be necessary to keep pace with an expanding population. A study would be made of the Nisqually River for possible inclusion of portions within State recreation river system.

To meet the rapidly increasing demand of boating enthusiasts, a small boat harbor with 230 wet moorages would be built. An additional 420 wet moorages would be provided by the private sector prior to 1980. Approximately half of these moorages could be built in the Olympia Harbor area.

To meet the navigational shipping needs, the terminal facilities at the Port of Olympia would have to be expanded to its maximum physical boundaries. Dredging the shipping channel to a depth of 40 feet would be necessary to handle the increasing deep draft of the modern fleets.

Flood plain regulations would be established to reduce existing and future flood damages on both the Nisqually and Deschutes River flood plains. One-hundred year flood protection would be provided for the 8,000-acre Nisqually flood plain below Alder Dam with the assignment of 55,000 acre-feet of storage in Alder Reservoir for flood control regulation.

Other water resource needs would be met by the progressive development and implementation of watershed management programs; particularly agri-

cultural and urban water management and forest management measures.

The recreational plan includes land and facility developments interspersed throughout the Basins and along the shoreline of Puget Sound. With no additional upstream storage or similar upstream structural development, the Nisqually River, Mashel River, and tributary streams would be preserved in their present natural environment for use by future generations.

A minimum streamflow of 150 cfs for fish could be maintained in the 13-mile reach of the Nisqually River downstream from the Centralia City Power diversion canal and upstream from the powerhouse through agreement with the city of Tacoma and the city of Centralia. Streamflow records indicate that only a few times during the summer months has a flow this low occurred. The agreement would provide that this flow is maintained in the river. The streamflows for fish would be attained in the remaining Nisqually River due to the normal operation of Alder and LaGrande power facilities. Over 90 percent of the natural streamflow of the Deschutes River would be available for fish use. Other early action enhancement features for fish include spawning and rearing ponds and channels, an additional hatchery, stream channel clearance projects, acquisition and development of access to 7 lakes, and obtaining 50 miles of streambank greenbelt on the major river systems to insure public access to fishing areas.

The Nisqually Delta would be retained as a natural estuarine area. Public access would be provided to the delta, and facilities developed to permit recreational use, wildfowl hunting, and biotic research. The Department of Game has presently acquired 627 acres for development of the area into such a multiple-purpose plan. Its on-going program includes the acquisition of 3,000 acres in the delta. The delta is being studied for inclusion into the Nation's system of natural estuarine areas.

Long-Range, 1980-2020

During this period, the municipal and domestic water supply systems would need to be enlarged and expanded to keep pace with the population expansion. Should it be found from the quantitative ground water studies to be conducted during the early action period that ground waters are not available in sufficient quantities to satisfy projected needs, utilization of surface waters of the Deschutes River and/or the Nisqually River could satisfy the additional municipal and industrial requirements. Upstream storage would be necessary for the development of the Deschutes River as a municipal and industrial source.

A continuing planning and implementation program expansion of waste treatment and sanitary sewer facilities commensurate with a water quality surveillance program would be necessary to meet and maintain Washington State water quality standards.

Irrigation expansion would continue with an additional 13,00 acres of new lands projected to be irrigated. These lands are expected to be in scattered parcels throughout the Basins. The irrigation water supplies are expected to be obtained primarily from ground water. Irrigation development would be by private investment.

Additional wet moorages would be provided with construction of small boat harbors at Budd Inlet, Nisqually Delta, and Henderson Inlet. With these developments, an additional 3,610 wet moorages would be provided by 2020. These facilities would include moorages to handle a deficit need in the Puyallup Basin.

The Hawks Prairie area would be developed as a water-oriented industrial area. Minimum port facilities would be developed adjacent to the industrial area and a minimum amount of waterfront land would be taken for the actual port development. The development plan to be provided for the area should become a component part of the navigation plan for Puget Sound. This plan should include a compilation of related industrial and recreational uses with minimum environmental quality impacts.

Flood control storage of 15,000 acre-feet would be provided by development of a dam and reservoir at the Shellrock Ridge site on the Deschutes River by year 2020. This would provide 100-year protection to the long, narrow 2,700-acre Deschutes River flood plain. The use of levees to provide protection in this narrow flood plain are not economical and would be undesirable from an aesthetic, fish, and recreational standpoint. The flood plain management program would be continued.

Prior to the year 2020, land treatment facilities and small watershed multiple-purpose projects would be provided at specified locations along the Deschutes and Nisqually Rivers, Henderson and Budd Inlets, and tributary streams to the Nisqually River. These projects would provide adequate water management, small watershed flood protection, and soil stabilization for approximately 636,000 acres. Watershed management programs which offer technical assist-

ance and financial participation in local land and water-related projects and programs would be continued.

An additional 5,793 acres of land with appropriate facilities would be acquired and developed for recreational use. The fish and wildlife plan emphasizes additional spawning and rearing areas, channel clearance, educational programs, and acquisition of key wildlife ecological and hunting areas. Table 16 shows all elements of Alternative A and the attendant costs. The output of the programs are complementary to the listed project facilities. The early action plan for Alternative A includes programs amounting to $41,269,000 and projects costing $35,820,000 for a total investment of $77,089,000. Program and project investment costs for the 1980-2000 period amount to $120,703,000 and for the 2000-2020 period $112,560,000 for a total 50-year investment of $310,352,000.

TABLE 16. Comprehensive Plan, Alternative A, Nisqually-Deschutes Basins

Feature	Item	1970-1980 Investment[1] Costs ($1000)	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control Programs	350				240	286	876
Flood Control	Flood Plain Management	82				114	114	310
Watershed Management	Programs	40,710				68,131	34,506	143,347
Fish & Wildlife	Programs	127				478	470	1,075
Total Programs		$41,269				$ 68,963	$ 35,376	$145,608
Nonstorage Projects								
M&I Water Supply	Ground Water Use	1,290	168	168[3]	0	435	1,167	2,892
	Surface Water Use	0	0	0	0	0	0	0
Irrigation	Ground Water Use	273	32	32[3]	0	545	850	1,668
	Surface Water Use	27	3	3[3]	0	135	230	392
Water Quality Control	Waste Treatment and Collection Facilities	5,375	289	289[3]	0	6,760	10,200	22,335
Navigation	Channel Improvements	1,853	92	138	46	3,713	0	5,566
	Small Boat Harbors	(459)[2]	(29)[2]	(43)[2]	(14)	(4,387)[2]	(2,435)[2]	(7,281)[2]
Flood Control	Levees	0	0	0	0	0	0	0
Watershed Management	Floodwater Damage Reduction Water Management, Protection and Rehabilitation	0	0	0	0	4,340	100	4,440
Recreation	Land Acquisition, Access and Facilities	21,951	1,697	2,590	893	30,200	53,700	105,851
Fish & Wildlife	Production Enhancement Facilities, Access and Acquisition	5,051	494	1,456	962	5,612	7,437	18,100
Total Nonstorage		$35,820	$2,775	$4,676	$1,901	$ 51,740	$ 73,684	$161,244
Storage Projects								
Flood Control	Alder Dam and Reservoir	0		39	39	0	0	0
	Shellrock Ridge Dam and Reservoir	0	0	0	0	0	3,500	3,500
Fish and Wildlife	Alder Dam and Reservoir	0	0	43	43	0	0	0
Total Storage		$ 0	$ 0	$ 82	$ 82	$ 0	$ 3,500	$ 3,500
Total Programs and Projects		$77,089	$2,775	$4,758	$1,983	$120,703	$112,560	$310,352

[1] Includes cumulative annual program costs for the period for management features and capital costs for nonstorage and storage projects.

[2] General navigation facilities costs and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

[3] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT
ALTERNATIVES A AND B

The projects and programs of the Comprehensive Plan for the Nisqually-Deschutes Basins are summarized in Table 17 by time periods. The project numbers identify features on Figure 8, and are the same for both Alternatives A and B unless otherwise noted.

TABLE 17. Future projects and programs, Nisqually-Deschutes Basins

PROJECTS PRIOR TO 1980

Municipal and Industrial Water Supply

1. Increase delivery capability of McCallister Springs to 21 mgd capacity.
2. Increase delivery capability of water supply system for Tumwater.
3. Increase delivery capability of water supply system for Lacey.
4.* Increase delivery capability of water supply systems of the small and rural communities.

Irrigation

5.* Installation of individual farm irrigation pumping and sprinkler systems (private) to irrigate 2,700 acres.

Water Quality Control

6. Install secondary treatment facilities at Paradise and Longmire.
7. Provide facilities for adequate treatment of wastes, disinfection and an adequate outfall—Olympia.
8. Provide sewering in Lacey and interception to Olympia treatment plant.
9.* Improvement of waste collection facilities for recreation developments including small boat harbors.

Navigation

10. Deepen West Waterway to 40 feet in Budd Inlet.
11. Development of a small boat harbor—Olympia.

Flood Control

12. Obtain flood control storage in Alder Lake.

Recreation

13. Development of two urban recreation sites north of Olympia.
14. Development of three urban recreation sites near Tumwater.
15. Development of four recreation sites near Long Lake.
16. Development of two recreation sites in Offutt Lake.
17. Development of two recreation sites along Deschutes River between Lake Lawrence and Capitol Lake.
18. Develop a recreation site near Flander Lake.
19. Develop two recreation sites near Lake Lawrence.
20. Develop six salt water shoreline recreation sites between Nisqually Delta and Eld Inlet.
21. Develop two recreation sites near Harts Lake.
22. Develop two recreation sites near Tanawax Lake.
23. Develop one recreation site near Eatonville.
24. Develop three recreation sites near Alder Lake.
25. Develop one recreation site between Alder Lake and Rainier National Park.
26. Develop one recreation site near Mineral Lake.
27. Develop 15 recreation sites in the Snoqualmie National Forest and Rainier National Park.
28. Develop three recreation sites on Nisqually River between Alder Dam and Puget Sound.

Fish and Wildlife

29. Acquire public fishing access on Roy (Muck), Upper Twin, Lower Twin, Bald Hills, Southwick, Hewitt, and Elbow Lakes.
30.* Construct a stream fish hatchery.
31.* Develop steelhead and cutthroat rearing ponds.
32. Acquire and develop saltwater access—Nisqually Flats (Alternative A only).
33. Acquire and develop saltwater access—Henderson Inlet.
34. Acquire and develop 50 miles of streambank access.
35. Acquire and develop the 3,000-acre Nisqually Delta for a natural recreation, waterfowl and biotic research area (Alternative A only).

PROGRAMS PRIOR TO 1980

Water Quality Control

a. Establish and operate water quality surveillance stations at key salt and fresh water locations. Complete and implement a comprehensive sewerage drainage basin program to provide waste treatment and collection facilities necessary to accommodate expanding population and industrial development.

Flood Control

b. Establish and administer county-wide flood plain zoning measures under flood plain management program.

*Projects not shown on Figure 8

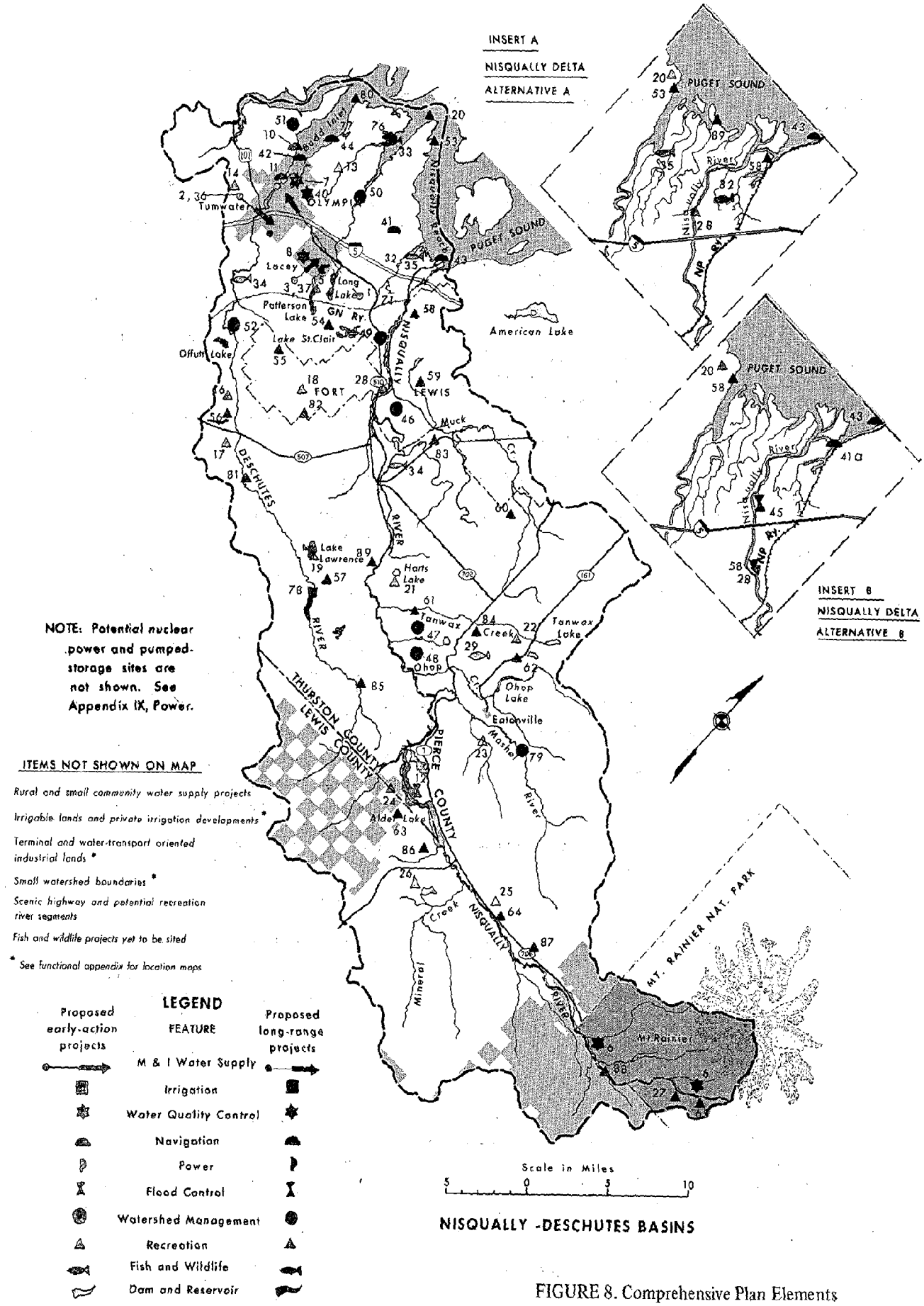


FIGURE 8. Comprehensive Plan Elements

TABLE 17. Future projects and programs, Nisqually-Deschutes Basins (Cont'd)

Watershed Management

c. Provide technical assistance and management for State and Federal lands.

d. Provide technical assistance for on-farm and other private practices. Establish zoning requirements to guide the build-up of intensive land use, changing land use and combinations of land and water use.

Fish and Wildlife

e. Conduct stream cross-section measurements.

f. Develop fish toxicants and lake fertilization techniques.

g. Develop fish management for large reservoirs.

h. Develop fish disease control program for lakes.

i. Develop local coop program for habitat development and access.

j. Develop public educational program for utilization of resources.

k. Conduct program studies to determine specific forest-wildlife management.

l. Develop eductional program to stress value of spiny-ray fish.

m. Perform an inventory of shellfish stocks and potential recreational use by tidelands.

PROJECTS 1980-2000

Municipal and Industrial Water Supply

36. Enlarge the water supply systems at Tumwater.
37. Enlarge the water supply systems at Lacey.
38. Enlarge the small and rural community systems.

Irrigation

39.* Installation of individual farm irrigation systems for irrigating 5,000 acres of new lands.

Water Quality Control

40. Enlarge and expand waste treatment, sewer facilities and adequate outfall at Olympia, Lacey and Tumwater.

Navigation

41. Acquisition of 3,000 acres for water-oriented industrial development on Hawks Prairie.

41a. Acquisition and development of port facility at Nisqually Delta (Alternative B only).

42. Deepen East Waterway and West Waterway in Olympia Harbor to 46 feet.
43. Small boat harbor development—Nisqually Delta.
44. Small boat harbor development—Budd Inlet.

Flood Control

45. Construct levees in Nisqually Delta (Alternative B only).

Watershed Management

46. Small watershed multiple-purpose project—Muck Creek.
47. Small watershed multiple-purpose project—Horn-Tanawax Creek.
48. Small watershed multiple-purpose project—Ohop Creek.
49. Small watershed multiple-purpose project—Nisqually River.
50. Small watershed multiple-purpose project—Henderson Inlet.
51. Small watershed multiple-purpose project—West Budd Inlet.
52. Small watershed multiple-purpose project—Deschutes River.

Recreation

53. Develop seven recreational sites along salt water shoreline.
54. Develop two recreational sites near Lake St. Clair.
55. Develop one recreational site East Olympia.
56. Develop three recreational sites along Deschutes River below Lake Lawrence.
57. Develop two recreational sites near Lake Lawrence.
58. Develop four recreational sites along Nisqually River between Alder Dam and Nisqually Delta.
59. Develop one recreational site near Nisqually Lake.
60. Develop one recreational site near headwaters of Muck Creek.
61. Develop two recreational sites near Seven Lake.
62. Develop two recreational sites near Tanawax Lake.
63. Develop two recreational sites at Alder Lake.
64. Develop two recreational sites upstream of Alder Lake.
65. Develop 20 recreational sites in the National Forest and Mt. Rainier National Park.

Fish and Wildlife

66.* Construct fish passage on five streams, 60 stream miles.
67.* Improve habitat on 16 streams, 38 stream miles.
68.* Clear channels on 10 streams, 54 stream miles.
69.* Construct 10 acres of rearing ponds and 1 mile of spawning channel.
70.* Construct salmon hatchery and other fish and wildlife facilities.

PROGRAMS 1980-2000

Water Quality Control

n. Continue water quality surveillance program and the periodic revision and implementation of the comprehensive sewage drainage basin plans.

*Projects not shown on Figure 8

TABLE 17. Future projects and programs, Nisqually-Deschutes Basins (Cont'd)

Flood Control

o. Continue flood plain management program.

Watershed Management

p. Provide technical assistance for on-farm and other private practices.
q. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

r. Complete stream cross-section measurements.
s. Continue fish and wildlife programs.

PROJECTS 2000-2020

Municipal and Industrial Water Supply

71. Enlarge McCallister Springs to its ultimate capability.
72.* Increase delivery capability of supply systems at Lacey and Tumwater.
73.* Increase delivery capability of small rural and community systems.

Irrigation

74.* Install the individual farm irrigation facilities for irrigating 8,000 acres of new lands.

Water Quality Control

75.* Construct the municipal, industrial and recreation waste treatment facilities as contained in the plan.

Navigation

76. Construct a small boat harbor—Henderson Inlet.
77. Enlarge small boat harbor at Budd Inlet.

Flood Control

78. Construct Shellrock Ridge Dam and reservoir on Deschutes River.

Watershed Management

79. Small watershed multiple-purpose project—Mashel River.

Recreation

80. Develop two recreation sites along salt water shoreline.
81. Develop two recreation sites along Deschutes River between Lake Lawrence and Capitol Lake.
82. Develop one recreation site near East Olympia.
83. Develop three recreation sites along Muck Creek.
84. Develop one recreation site along Tanawax Creek.
85. Develop one recreation site near Clear Lake.
86. Develop two recreation sites at Alder Lake.
87. Develop three recreation sites upstream from Alder Lake.
88. Develop 30 recreation sites in National Forest and Rainier National Park.
89. Develop five recreation sites along Nisqually River between Alder Dam and Nisqually Delta.

Fish and Wildlife

90.* Construct two salmon hatcheries.
91.* Develop 45 acres of salmon rearing facilities.
92.* Develop 1 mile of spawning channel.
93.* Additional game fish facilities—facilities unknown.
94.* Additional wildlife facilities—facilities unknown.

PROGRAMS 2000-2020

Water Quality Control

t. Continue water quality surveillance program and review of the comprehensive sewage drainage basin plan.

Flood Control

u. Continue flood plain management program.

Watershed Management

v. Provide technical assistance for on-farm and other private practices.
w. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

x. Continuation of fish and wildlife programs including shellfish enhancement.

*Projects not shown on Figure 8

SUMMARY OF PLAN

ALTERNATIVE B

Alternative B is the same as Alternative A except for the projected use of the Nisqually Delta. Alternative A projects development of the area for recreational and fish and wildlife uses. Alternative B discusses the development of a portion of the delta for a navigation port with corresponding terminal and water-oriented industrial land facilities. Based on current and projected trends of land use by the Navigation Appendix, the port facility would be needed after 1980.

Long Range 1980-2020—The projected port development covers approximately 1,300 acres and would be located on Pierce County side of the Nisqually River.

The port, terminal and industrial facilities would be constructed by 1985 when projected navigation related land use of the Puyallup River delta would equal available land at that location.

A deep draft terminal would be provided through dredging of a waterway east and separate from the main river channel. The terminal would accommodate 12 berths 1,000 feet long at depths from 55 to 85 feet. The interior waterway channel extending from deep water to 3,000 feet inland would be approximately 800 feet wide and 55 feet deep with the outer berths able to serve super-bulk cargo vessels of 71 foot draft.

A unit-train loop would connect with the main lines of the Northern Pacific and Union Pacific Railroads and encircle the bulk and general cargo terminal areas. Although projections of future commerce in terms of specific commodities have not been made beyond 1980, expectations are that bulk cargo including coal, metal ores and some general cargo would be handled at the Nisqually Delta facility. Water transport-oriented industrial use would primarily occur at the Hawks Prairie and Olympia Harbor sites.

The east bank of the Nisqually River would be stabilized through a distance of 16,000 feet, to preserve water quality by isolating the terminal area from the river. The west side of the river would remain in an undisturbed natural state which can be developed for other uses such as recreation, hunting and waterfowl resting area.

Partial development of the 1,300 acres could begin prior to 1980 as significant lead time is ordinarily required to prepare sites for terminal and industrial use where extensive dredging is required as in the case of Nisqually Delta.

The port development would require flood protection in excess of the 100-year flood. Flood control storage in Alder Reservoir, as discussed in Alternative A, would provide the 100-year protection and levees and channelization in the delta would provide protection in excess of 100 years.

The fish and wildlife and recreation features would remain the same as Alternative A except for that portion relating to the Nisqually Delta.

There would be some reduction of projected recreation visitation but this has yet to be evaluated.

Table 17 shows all elements of Alternative B and Table 18 the attendant costs. The output of the programs are complementary to the listed project facilities.

SEQUENCE OF DEVELOPMENT ALTERNATIVE B

The schedule of development of the projects and programs would be the same as Alternative A with the exception of navigation, flood control and fish and wildlife. These additions and deletions to Alternative A are shown in the inset on Figure and discussed as follows.

1970-1980

Fish and Wildlife

Delete the acquisition and development of the Nisqually Delta for fish and wildlife purposes.

1980-2000

Navigation

Acquisition and development of the port facility at the Nisqually Delta.

Flood Control

Construct flood control levees, straighten and deepen channels in the Nisqually Delta.

2000-2020

None

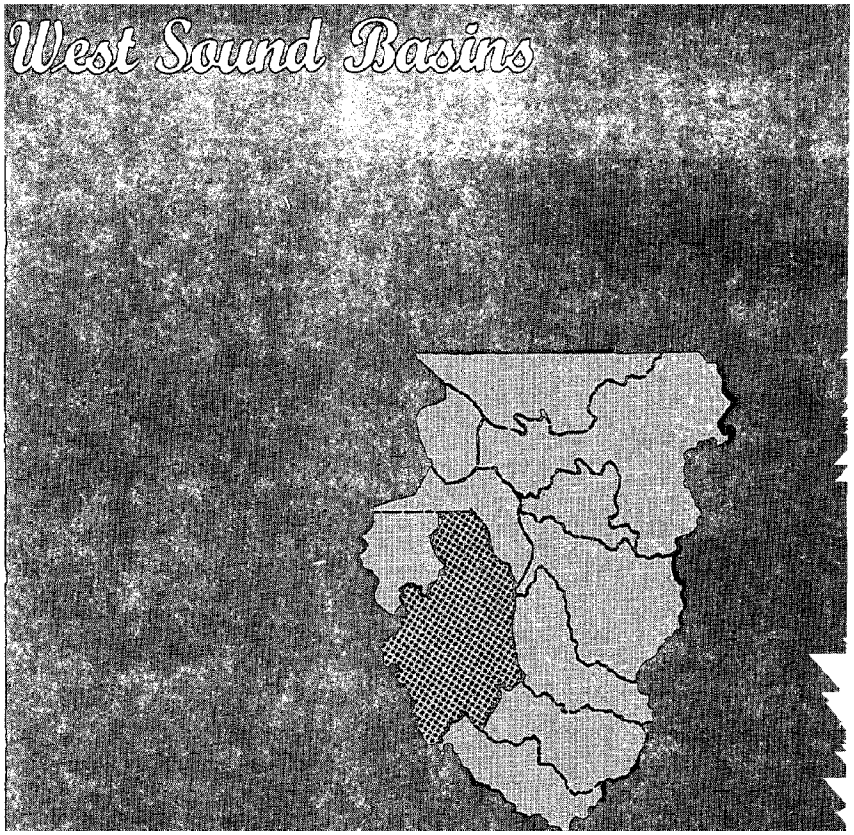
TABLE 18. Comprehensive Plan, Alternative B, Nisqually-Deschutes Basins

Feature	Item	1970-1980 Investment[1] Costs ($1000)	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control Programs	350				240	286	876
Flood Control	Flood Plain Management	82				114	114	310
Watershed Management	Programs	40,710				68,131	34,506	143,347
Fish & Wildlife	Programs	127				478	470	1,075
Total Programs		$41,269				$ 68,963	$ 35,376	$145,608
Nonstorage Projects								
M&I Water Supply	Ground Water Use	1,290	168	168[3]	0	435	1,167	2,892
	Surface Water Use	0	0	0	0	0	0	0
Irrigation	Ground Water Use	273	32	32[3]	0	545	850	1,668
	Surface Water Use	27	3	3[3]	0	135	230	392
Water Quality Control	Waste Treatment and *Collection Facilities*	5,375	289	289[3]	0	6,760	10,200	22,335
Navigation	Channel Improvements	1,853	92	138	46	6,113	0	7,966
	Small Boat Harbors[1]	(459)[2]	(29)[2]	(43)[2]	(14)[2]	(4,387)[2]	(2,435)[2]	(7,281)[2]
Flood Control	Levees	0	0	0	0	3,000	0	3,000
Watershed Management	Floodwater Damage Reduction, Water Management, Protection and Rehabilitation	0	0	0	0	4,340	100	4,440
Recreation	Land Acquisition, Access and Facilities	21,951	1,697	2,590	893	30,200	53,700	105,851
Fish & Wildlife	Production Enhancement Facilities, Access and Acquisition	2,551	347	1,313	966	5,612	7,437	15,600
Total Nonstorage		$33,320	$2,628	$4,533	$1,905	$ 57,140	$ 73,684	$164,144
Storage Projects								
Flood Control	Alder Dam and Reservoir	0	--	39	39	0	0	0
	Shellrock Ridge Dam and Reservoir	0	0	0	0	0	3,500	3,500
Fish & Wildlife	Alder Dam and Reservoir	0	0	43	43	0	0	0
Total Storage		$ 0	$ 0	$ 82	$ 82	$ 0	$ 3,500	$ 3,500
Total Programs and Projects		$74,589	$2,628	$4,615	$1,987	$126,103	$112,560	$313,252

[1] Includes cumulative annual program costs for the period for management features and capital costs for nonstorage and storage projects.

[2] General navigation facilities cost and benefits for public small boat harbors only. Total costs and benefits included with Recreation.

[3] Average annual benefits assumed equal to average annual costs.



COUNTIES AFFECTED:

Clallam

Jefferson

King

Kitsap

Mason

Pierce

Thurston

WEST SOUND BASINS

SUMMARY OF PLAN

Early Action, 1970-1980

During this period, municipal and industrial water supply needs of Bremerton and Port Townsend would be satisfied through further utilization of surface water sources. Shelton, Port Orchard, Poulsbo, and other rural communities would utilize ground water sources. Self-supplied industrial water would come from both surface and ground water sources.

About 400 acres of cropland would be placed under irrigation, with water supplied by individual farmers from both surface and ground sources. This increase would make a total of 1,600 acres of land in crop production.

Compliance with Washington State water quality standards would be obtained through installation of adequate collection and treatment facilities by a number of communities and cities in the Basins. Pulp mills would remove settleable solids from mill effluents prior to discharge and would install adequate outfalls and diffusers to achieve maximum dilution and dispersion into marine waters. A water quality surveillance program would be expanded in order to provide an adequate monitoring system with sampling stations on marine and fresh water. A comprehensive sewerage plan would be developed for the Basins.

Navigation needs of the Basins consist of meeting the needs of pleasure boat harbors. Six small boat harbors with over 4,300 wet moorages would be provided for pleasure boaters.

Power needs for the Basins would be satisfied by the Northwest Regional sys tem which is discussed under Power in the Area portion of this Report.

A levee project on the Dosewallips River to protect Dosewallips State Park is planned for early action. Flood plain management would provide an effective means of reducing future flood damages through land use zoning of lands in the flood plain, consistent with the levels of protection provided. Floodproofing and warning systems also would be implemented. These measures could contribute significantly to the reduction of future flood damages in the various drainages.

Two small watershed multiple-purpose projects are planned for implementation during this period to achieve floodwater damage reduction, rehabilitation and protection of watershed lands and water management. One project is located in the Goldsborough Creek drainage and the other on Chimacum Creek. These projects consist of stabilized channels and outlet control structures. Important complements to the watershed management projects are the programs of technical assistance and management and land treatment and drainage.

Campgrounds, picnic areas, beaches, and boat launching ramps would be developed on existing public lands, together with the acquisition of additional land and water areas to satisfy recreational needs. Additional land and water areas would be acquired along the Puget Sound shoreline to provide badly needed marine parks. Approximately 100 recreation sites are planned for expansion or development prior to 1980.

Land acquisition, including access and fish and widlife enhancement projects, would be undertaken to increase the opportunities for this form of outdoor recreation. Additional fish hatcheries would be constructed for both resident and migratory fish together with rearing ponds, spawning channels and fish passage improvements. Cross-sectional stream surveys would be undertaken during this period in order to determine the minimum and optimum streamflows required for fish production. Subsequent to these cross-sectional surveys further studies of new projects may be required, as well as reconsideration of the operation of existing projects.

Long Range, 1980-2020

A storage project is proposed on the Duckabush River to supply anticipated regional municipal and industrial water needs of the Kitsap Peninsula. Distribution would be accomplished using the existing Bremerton system. Other water users within the Basins would continue to develop both ground and surface sources.

An additional 1,000 acres of land would be placed under irrigation during this period with water supplied from ground and surface sources by individuals.

Treatment and collection facilities would be expanded commensurate with the growth in population and industrial development to insure that the State water quality standards are continually met.

The water quality monitoring, evaluation, and control program would be maintained.

Navigation development would be limited to satisfying the needs of pleasure boaters. Wet moorages would be provided at 17 small boat harbor projects, with over 21,000 wet moorages between 1980 and 2020.

Power development would probably include pumped-storage at a number of the potential sites within the Basin. Oil or gas-fueled steam electric plants may also be located during this period to meet short-time peaking requirements. Development of nuclear electric generating plants may occur but specific sites have not been determined and would be dependent upon future studies that considered shoreline characteristics nearness to major load centers and impacts on the environment.

Flood control structures envisioned during this period consist of a levee on the Skokomish River to provide protection to agricultural lands and one on the Big Quilcene River to provide protection to the community of Quilcene. Flood plain management would be continued with zoning by the counties to guide future development and prevent unwarranted development in the flood plain.

Further programs and projects would be undertaken to satisfy watershed management needs. These would include 19 multiple-purpose projects and a significant program of technical assistance, land treatment, and water management.

Additional development of campgrounds, picnic areas, and other recreation facilities would be undertaken after 1980 at over 170 sites throughout the Basins, on public lands as well as on private lands, with both public and private sectors participating in the providing of recreation facilities. Portions of the Skokomish River and its North and South Forks may be included in a State system of scenic and recreational rivers for retention in a free-flowing state for public use. Also, the Hamma Hamma, Duckabush, Dosewallips, and Big Quilcene Rivers could be included in the system.

Additional fishing opportunities would be provided through anadromous and resident fish resource enhancement measures. A number of fish passage improvements are planned during the long-range period, as well as additional spawning habitat development. Wildlife conservation and enhancement programs begun prior to 1980 would be continued.

Table 19 summarizes the West Sound Basins' elements of the Comprehensive Plan, showing the benefits and costs for the early action portion of the Plan, and provides a summary of investment costs by water resource features for the entire 50-year period ending in 2020. The early action portion of the Plan includes programs amounting to $98,744,000 and projects costing $88,995,000, for a total investment of $187,739,000. Program and project investment costs for the 1980-2000 period amount to $271,206,000 and for the 2000-2020 period, $314,250,000, for a total 50-year investment of $773,195,000.

TABLE 19. Comprehensive Plan, West Sound Basins

Feature	Item	1970-1980 Investment[1] Costs ($1000)	1970-1980 Average Annual Costs ($1000)	1970-1980 Average Annual Benefits Gross ($1000)	1970-1980 Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control Programs	750	--	--	--	360	480	1,590
Flood Control	Flood Plain Management	125	--	--	--	100	100	325
Watershed Management	Programs	97,404	--	--	--	121,702	120,616	339,722
Fish & Wildlife	Programs	465	--	--	--	800	800	2,065
Total Management		$ 98,744				$122,962	$121,996	$343,702
Nonstorage Projects								
M&I Water Supply	Surface Water	5,850	688	688[4]	--	4,420	2,210	12,480
	Ground Water	2,470	279	279[4]	--	1,770	3,150	7,390
Irrigation	Private Development	50	7	7[4]	--	70	70	190
Water Quality Control	Collection and Treatment	10,900	676	676[4]	--	25,300	37,300	73,500
Navigation	Small Boat Harbors	(8,685)[2]	(556)[2]	(806)[2]	(250)[2]	(17,539)[2]	(26,659)[2]	(52,883)[2]
Power[3]								
Flood Control	Levees	150	11	12	1	1,140	0	1,290
Watershed Management	Floodwater Damage Reduction, Rehabilitation and Protection, and Water Management	1,079	59	150	91	8,055	970	10,104
Recreation	Land Acquisition, Access and Recreation Facilities	62,212	5,405	6,000	595	82,100	133,700	278,012
Fish & Wildlife	Land Acquisition, Access and Enhancement Facilities	6,284	583	1,571	988	13,389	14,854	34,527
Total Nonstorage		$ 88,995	$7,708	$9,383	$1,675	$136,244	$192,254	$417,493
Storage Projects								
	Dam and Reservoir, Duckabush River							
M&I Water Supply		--	--	--	--	12,000	--	12,000
Total Storage		--	--	--	--	$ 12,000	--	$ 12,000
Total Programs and Projects		$187,739	$7,787	$9,283	$1,675	$271,206	$314,250	$773,195

[1] Includes cumulative annual program costs for the period for management measures and capital costs for nonstorage and storage features.

[2] General Navigation facilities costs and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

[3] Power facilities were not included in basins plan.

[4] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT

The projects and programs are summarized in Table 20 by time periods. The project numbers identify features on Figure 9.

TABLE 20. Future projects and programs, West Sound Basins

PROJECTS PRIOR TO 1980

Municipal and Industrial Water Supply

1. Expansion and updating of existing sources and systems to supply Shelton, Bremerton, Port Orchard, Gig Harbor and Port Townsend.
2. Development of contiguous ground water systems to supply Bainbridge Island and the northern Kitsap Peninsula.

Irrigation

3.* Construction of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

4. Construction of treatment and outfall facilities at Port Townsend, Fort Warden and industrial water at Port Townsend.
5. Interception to Bremerton of industrial shipboard wastes from naval shipyard.
6. Modification of log storage practices in Shelton Harbor.
7.* Systematic waste collection, treatment and discharge for newly developed areas including small boat harbors.

Navigation

8. Small boat harbor development—Port Discovery.
9. Small boat harbor development—Sequim Bay.
10. Small boat harbor development—Sinclair Inlet.
11. Small boat harbor development—Mats Mats Bay.
12. Small boat harbor development—Brownsville.
13. Small boat harbor development—Dyes Inlet.

Flood Control

14. Construct levee on the right bank of the Dosewallips River.

Watershed Management

15. Small watershed multiple-purpose project—Chimacum Creek.
16. Small watershed multiple-purpose project—Goldsborough Creek.

Recreation

17. Enlargement or new development of two recreation sites.
18. Enlargement or new development of one recreation site.
19. Enlargement or new development of six recreation sites.
20. Enlargement or new development of three recreation sites.
21. Enlargement or new development of two recreation sites.
22. Enlargement or new development of one recreation site.
23. Enlargement or new development of 15 recreation sites in Olympic National Forest and Park.

Fish and Wildlife

24. Construction of fish passage facilities over barriers on the Hamma Hamma River and Kennedy Creek.
25. Enlarge Bay Lake.
26.* Construct new Hood Canal salmon hatchery.
27.* Construct new trout hatcheries.
28. Enlarge George Adams salmon hatchery.
29. Enlarge Hood Canal salmon hatchery.
30.* Increase capacity of game farm by 5,000 pheasants.
31.* Develop steelhead and searun cutthroat rearing ponds.
32.* Clear stream channel and lakes.
33.* Improve big game habitat.
34.* Acquire and deyelop access to 13 lakes.
35.* Acquire and develop 10 saltwater access areas.
36.* Acquire and develop 100 miles of streambank access.
37.* Acquire and develop estuarine waterfowl and fur animal environment—1,400 acres.
38.* Acquire and develop upland game habitat.
39.* Acquire and develop elk habitat.

PROGRAMS PRIOR TO 1980

Water Quality Control

a. Establish and maintain water quality surveillance stations and prepare comprehensive sewerage plan for Basins.

*Projects not shown on Figure 9

TABLE 20. Future projects and programs, West Sound Basins (Cont'd)

Flood Control

b. Establish and maintain flood plain zoning on the Skokomish, Hamma Hamma, Duckabush, Dosewallips, Big Quilcene and Little Quilcene Rivers.

Watershed Management

c. Provide technical assistance and management for State and Federal lands.
d. Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

e. Conduct cross-sectional measurements to determine minimum streamflows to maintain existing levels of fish production.
f. Locate, survey and mark boundaries of all State-owned second class tidelands. Take steps to reserve all such lands for public use except as required by specific circumstances.
g. Develop lake and stream fertilization techniques.
h. Develop new fish toxicants.
i. Develop a cooperative program with land owners to maintain wildlife habitat and allow hunter access.
j. Develop an educational program to stress habitat utilization and retention for the wildlife resource.
k. Develop compatible forest-wildlife management practices and conduct wildlife population analyses.

PROJECTS 1980-2000

Municipal and Industrial Water Supply

40. Construct facilities to develop a regional water system for the Bremerton area in the Duckabush River.
41.* Expansion of existing water supply systems at Shelton, Port Orchard, Gig Harbor, Port Townsend, Bainbridge Island, Vashon Island, Pouslbo and rural system and self-supplied industrial.

Irrigation

42.* Construction of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

43.* Expansion of existing waste treatment facilities.
44.* Construction of new waste collection and treatment facilities to accommodate newly locating developments.
45.* Provide for collection and treatment of pleasure boating related wastes.

Navigation

46. Small boat harbor development–Port Townsend.
47. Small boat harbor development–Oak Bay.
48. Small boat harbor development–Hoodsport.
49. Small boat harbor development–Manchester.
50. Small boat harbor development–Bainbridge Island–Murden Cove.
51. Small boat harbor development–Bainbridge Island–Lynwood Center.
52. Small boat harbor development–Hood Canal–Coon Bay.
53. Small boat harbor development–Hood Canal–Duckabush.
54. Small boat harbor development–Hood Canal–Union.

Flood Control

55. Construct 6,000-foot levee, right bank, Big Quilcene River.
56. Construct levee on Skokomish River.

Watershed Management

57. Small watershed multiple-purpose project–Skookum Creek.
58. Small watershed multiple-purpose project–Northwest Shelton.
59. Small watershed multiple-purpose project–South Fork Skokomish.
60. Small watershed multiple-purpose project–North Hood Canal.
61. Small watershed multiple-purpose project–Carr Inlet.
62. Small watershed multiple-purpose project–Vashon Island.
63. Small watershed multiple-purpose project–West Kitsap area.
64. Small watershed multiple-purpose project–East Kitsap area.
65. Small watershed multiple-purpose project–Quilcene.
66. Small watershed multiple-purpose project–East Jefferson.
67. Small watershed multiple-purpose project–Sequim Bay.
68. Small watershed multiple-purpose project–Johnson Creek.

Recreation

69. Enlargement or development of two recreation sites.
70. Enlargement or development of four recreation sites–Discovery Bay.
71. Enlargement or development of one recreation site–Indian Island.
72. Enlargement or development of four recreation sites.
73. Enlargement or development of 13 recreation sites–Hood Canal.

*Projects not shown on Figure 9

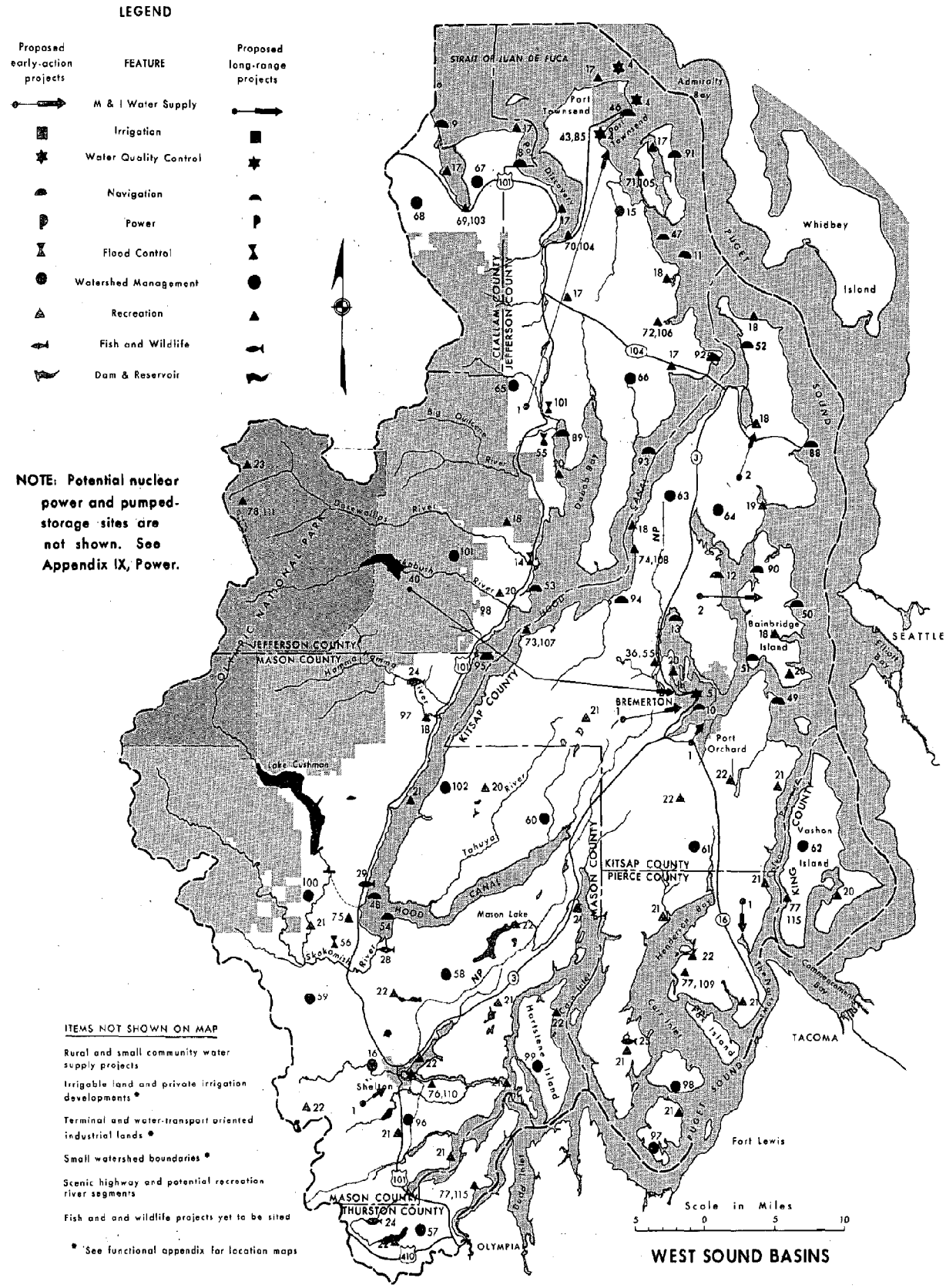


FIGURE 9. Comprehensive Plan Elements

TABLE 20. Future projects and programs, West Sound Basins (Cont'd)

74. Enlargement or development of 23 recreation sites—Kitsap Peninsula.
75. Enlargement or development of four recreation sites.
76. Enlargement or development of two recreation sites.
77. Enlargement or development of 18 recreation sites—Southern Puget Sound.
78. Enlargement or development of 15 recreation sites—Olympic National Forest and Park.

Fish and Wildlife

79.* Conduct habitat improvement on 19 streams for 31 miles.
80.* Provide channel clearance on eight streams for 14 miles.
81.* Improve fish passage on six streams for 52 miles.
82.* Construct four hatcheries, 40 acres of rearing ponds and 3 miles of spawning channel.

PROGRAMS 1980-2000

Water Quality Control

l. Continue monitoring, evaluation and control programs.

Flood Control

m. Continue flood plain zoning program.

Watershed Management

n. Provide technical assistance and management for State and Federal lands.
o. Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

p. Continue management and educational programs initiated in the early action period.

PROJECTS 2000-2020

Municipal and Industrial Water Supply

83.* Expansion of systems to meet demands.

Irrigation

84.* Construction of individual farm irrigation pumping and sprinkler systems (private).

Water Quality Control

85.* Expansion of existing waste collection and treatment facilities.
86.* Construction of new waste collection and treatment facilities to accommodate newly locating and expanding development.
87.* Provide for collection and treatment of pleasure boating related wastes.

Navigation

88. Small boat harbor development—Kingston.
89. Small boat harbor development—Quilcene Bay—East Side.
90. Small boat harbor development—Bainbridge Island—Fletcher Bay.
91. Small boat harbor development—Marrowstone Island—East Side.
92. Small boat harbor development—Hood Canal—Bywater Bay.
93. Small boat harbor development—Hood Canal—Thorndyke Bay.
94. Small boat harbor development—Hood Canal—Warrenville.
95. Small boat harbor development—Hood Canal—Anderson Cove.

Watershed Management

96. Small watershed multiple-purpose project—Isabella.
97. Small watershed multiple-purpose project—Anderson Island.
98. Small watershed multiple-purpose project—McNeil Island.
99. Small watershed multiple-purpose project—Hartstene Island.
100. Small watershed multiple-purpose project—North Fork Skokomish.
101. Small watershed multiple-purpose project—Dosewallips-Duckabush.
102. Small watershed multiple-purpose project—East Hood Canal.

Recreation

103. Enlargement or development of one recreation site.
104. Enlargement or development of five recreation sites—Discovery Bay.
105. Enlargement or development of one recreation site—Indian Island.
106. Enlargement or development of four recreation sites—Port Ludlow.
107. Enlargement or development of 15 recreation sites—Hood Canal.

*Projects not shown on Figure 9

TABLE 20. Future projects and programs, West Sound Basins (Cont'd)

108. Enlargement or development of 11 recreation sites—Kitsap Peninsula.
109. Enlargement or development of four recreation sites—Southern Puget Sound.
110. Enlargement or development of two recreation sites.
111. Enlargement or development of 20 recreation sites—Olympic National Forest and Park.

Fish and Wildlife

112.* Construct five hatchery equivalent stations.
113.* Develop 150 acres of rearing facilities.
114.* Develop 1 mile of spawning channel.

PROGRAMS 2000-2020

Water Quality Control

q. Continue monitoring, evaluation and control programs.

Flood Control

r. Continue flood plain zoning.

Watershed Management

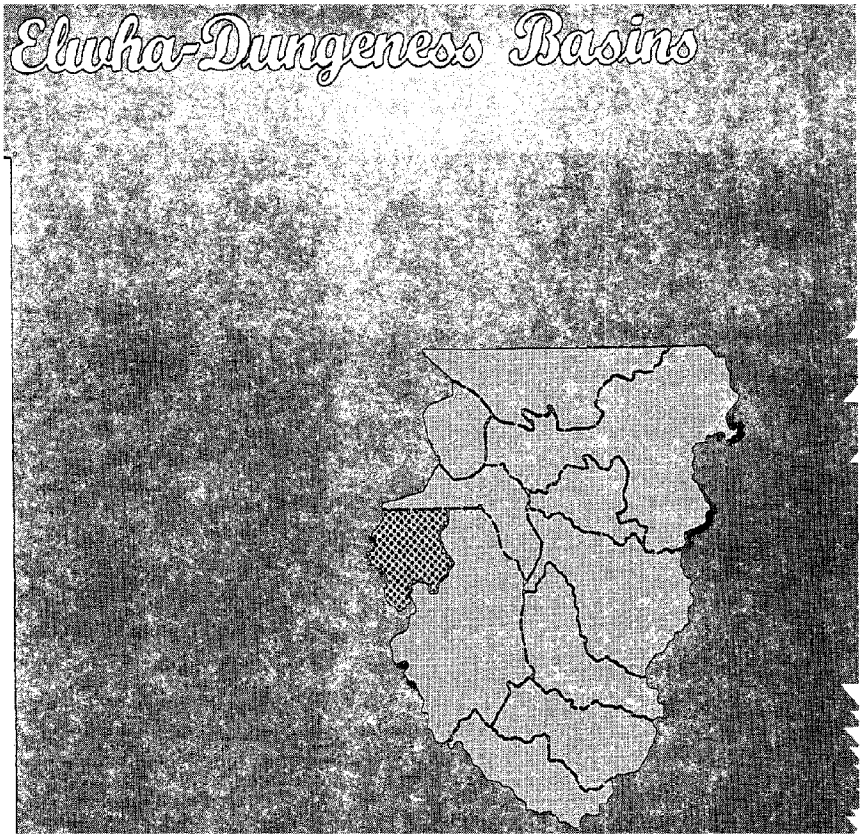
s. Provide technical assistance and management for State and Federal lands.
t. Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

u. Continue management and educational programs initiated in the early action period.

*Projects not shown on Figure 9

Elwha-Dungeness Basins



COUNTIES AFFECTED:

Jefferson

Clallam

ELWHA–DUNGENESS BASINS

SUMMARY OF PLAN

Early Action 1970-1980

The sources of water supply for the Elwha River Basin are adequate through year 1980. To meet the projected increase of production at the Port Angeles pulp mills prior to 1980, the self-supplied industrial water diversion and conveyance facilities from the Elwha River will require enlarging.

To circumvent the spring turbidity problem on Morse Creek, Port Angeles is expected to provide a Ranney Well near the Elwha River to an approximate capacity of 5 mgd prior to 1980. The Ranney Well water supply would supplement the Morse Creek supplies.

The city of Port Angeles must enlarge their system delivery capability to meet the peak day demands and fire control needs. The system delivery capability is projected to be 14.7 mgd by year 1980.

The water supply system for Sequim and the small rural community water systems should be enlarged to provide the peak flow and fire protection delivery capability outlined in the State's water supply system standards.

The projected water supply and streamflow needs in the Dungeness River Basin can be met by modernizing or updating the existing irrigation system. The updated irrigation system would consist of a closed pipe conveyance and distribution system capable of supplying water by gravity at sprinkler pressure to an irrigable area of 22,000 acres. This includes 6,100 acres of lands which are not now irrigated.

Streamflow in the Dungeness River would be increased during the critical summer months. Under present day diversions, this would leave in the river an additional 31,000 acre-feet during the summer months over that which presently exists. This volume is nearly equal to the entire present combined mean monthly flow of August, September, and October. The additional streamflow would provide an adequate transportation flow for fish along the entire reach of the river and increase the rearing potential for both resident and anadromous fish.

With the irrigation system in pipe, certain sections of the present open irrigation ditches could be utilized for additional spawning and rearing area for anadromous fish. A steelhead rearing pond would be part of the early action program. Ten miles of streambank access and 250 acres of waterfowl habitat would be acquired to enhance angler and hunter success. Cooperative landowner-hunter programs would be developed to insure access to prime hunting grounds.

To comply with Washington State water quality standards, waste treatment and sewer outfall facilities would be installed by the various industries for treating industrial wastes prior to discharge into the off-shore waters. Water quality surveillance is an essential element of the water quality program. Stations should be maintained at Ediz Hook, Pilot Station, the pulp mills outfalls, the ferry dock, Morse Creek and Dungeness Spit to regularly measure the water quality characteristics. The Elwha and Dungeness Rivers flow for the greater part of their length through a natural sanctuary, Olympic National Park, where outdoor recreation is the primary use. Hence, wasteloading would be light and minimum flows for other purposes such as fish will be sufficient to maintain a desirable water quality. A continuing program of expanding waste treatment and sanitary sewers in all municipalities and small community systems would be necessary to keep pace with an expanding population.

To meet the rapidly increasing demand of boating enthusiasts and satisfy part of the existing unmet needs, 710 wet moorages would be provided at new boat harbors located near the Elwha and Dungeness Rivers. To meet the projected commercial navigation needs, a continuing program of land acquisition and facility development would be necessary by the Port of Port Angeles.

Flood plain regulations would be established to reduce existing and potential flood damages and permit optimum agricultural use of the 750-acre Elwha River flood plain and the 2,900-acre Dungeness River flood plain. Levees would be provided as they are needed and are economically justified.

Other water resource needs would be met by the progressive development and implementation of watershed management programs; particularly agricultural and urban water management, with agricultural and forest rehabilitation and protection measures. No specific projects are planned for the early action time period.

The plan for recreation would provide for land and facility developments interspersed throughout the Basin and along the shoreline bordering the Strait of Juan de Fuca. The base of Dungeness Spit would be obtained for limited recreational use commensurate with the spit's present use as a natural wildlife refuge.

Fish passage facilities would be constructed at Elwha Dam which would permit the introduction of various salmon species to the hitherto inaccessible area of the Elwha River upstream from Elwha and Glines Canyon Dams. Both the upstream and downstream migrants would be transported around Elwha Dam and Lake Aldwell.

Other early action measures which would be undertaken to increase production of fish and wildlife, would be to provide a spawning channel, develop a fish hatchery capable of being expanded, rehabilitate and fertilize Lake Sutherland, acquire 25 miles of streambank access along the Elwha and independent drainages to insure public access to these areas, develop 250 acres of waterfowl habitat and implement programs to stress value of the fish and wildlife resources. Cross-sectional stream surveys would be undertaken during this period in order to determine the minimum and optimum streamflows required for fish production. Subsequently further studies of new projects may be required, as well as the reconsideration of the operation of existing projects.

Long-Range 1980-2020

Additional water supplies for industry and streamflow for fish in the Elwha River would be obtained by modifying the use of the 30,000 acre-foot Lake Aldwell formed by Elwha Dam. Outlet works would be placed in the left abutment with adequate capacity to meet the projected downstream fish flows and industrial water demands. The full water requirements can be met most of the time under the proposed operation, but not fully during the critical period of record (1935-1946). Even with reduced fish flows, the total projected water requirements cannot be met with upstream storage 100 percent of the time.

The 1,600 cfs outlet facilities would permit the present 3,000 acre-foot active pool to be increased to 29,500 acre-feet. The modified operation would alter the existing average summer recreation pool by less than 20 acres. It is not expected to change the projected recreation or angler-day use of the reservoir.

The present electric power generation facilities in Elwha Dam would be retained. A maximum annual power benefit foregone of $130,000 would be attributed to the project if the power facilities were totally removed.

The municipal water diversion facilities on Morse Creek would be enlarged to the ultimate capacity of 14 mgd. The conveyance facilities from the diversion to Port Angeles would be enlarged to meet peak requirements necessary.

During this period the municipal and domestic water supply systems should be expanded to keep pace with the population growth. The Dungeness River water supplies are adequate to meet Sequim's year 2020 needs.

A continuing program of expanding existing and constructing new municipal and industrial waste treatment and sanitary sewer facilities commensurate with a water quality surveillance program would be necessary to meet and maintain Washington State water quality standards.

Prior to year 2000, an additional 350 wet moorages would be provided at the small boat harbor near the Elwha River, 150 wet moorages at the existing small boat harbor in Port Angeles and an additional 1,000 salt water wet moorages at a new small boat harbor located near the mouth of the Dungeness River.

A continuing program of land acquisition for water oriented industry and terminal facility development would be necessary by the Port of Port Angeles. During the period 1980-2020, 1,170 acres of additional land would be needed to meet the projected commercial navigation business volume.

A flood plain management program would be continued. Twenty-five year flood protection would be provided to 2,200 acres of the 2,900-acre flood plain after year 2000 with the construction of levees along the lower 8 miles of the Dungeness River.

A 7,000-foot levee along the right bank of the Elwha River would provide 25-year protection to 750-acre flood plain. Incidental flood protection in excess of the 25-year flood would be obtained with the modified operation of Lake Aldwell reservoir.

Prior to year 2000 small watershed projects would be provided near Port Angeles, along the Dungeness River, McDonald, Morse and Siebert Creeks. Upgrading of existing facilities and more intensive application of recurring and nonrecurring land treatment practices would be required throughout the Basins. Watershed management programs which offer technical assistance and financial partici-

pation in local land and water related projects and programs would be continued. After year 2000 small watershed protection projects would be provided along Ennis Creek and the Lower Elwha River.

An additional 1,280 acres of land with appropriate facilities would be acquired and developed for recreational use. The upper reaches of the Elwha, Dungeness, and Grey Wolf Rivers, and the Tyler Peak scenic area would be retained in their natural state.

Additional fish and wildlife objectives would be satisfied with salmon and steelhead rearing impoundments, stream channel clearance, channel cross-section improvements, fish passage over natural barriers, and improvement of waterfowl habitat.

Table 21 summarizes the elements of the Comprehensive Plan for the Elwha-Dungeness Basins, showing the benefits and costs for the early action program (projects and programs required by 1980), and provides a summary of investment costs by water resource functions for the entire 50-year period ending in 2020. The early action plan includes programs amounting to $18,409,000 and projects costing $41,447,000 for a total investment of $59,856,000. Program and project investment costs for the 1980-2000 period amount to $58,572,000 and for the 2000-2020 period $72,273,000 for a total 50-year investment of $190,701,000.

TABLE 21. Comprehensive Plan, Elwha-Dungeness Basins

Feature	Item	1970-1980 Investment[1] Costs ($1000)	Average Annual Costs ($1000)	Average Annual Benefits Gross ($1000)	Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality Control	Monitoring, Evaluation and Control Programs	350				440	520	1,310
Flood Control	Flood Plain Management	31				20	20	71
Watershed Management	Programs	17,852				23,229	24,437	65,517
Fish & Wildlife	Programs	176				309	300	785
Total Programs		$18,409				$23,998	$25,277	$ 67,684
Nonstorage Projects								
M&I Water Supply	Ground Water Use	24	6	6[4]	0	18	18	60
	Surface Water Use	1,440	1,673	1,673[4]	0	2,660	830	4,930
Irrigation	Surface Water Use	15,380	897	1,467[4]	570	0	0	15,380
Water Quality Control	Waste Treatment and Collection Facilities	13,595	713	713[4]	0	9,760	21,300	44,655
Navigation	Small Boat Harbors	(1,434)[3]	(92)[3]	(133)[3]	(41)[3]	(1,613)[3]	(1,411)[3]	(4,458)[3]
Power[2]								
Flood Control	Levees	0	0	0	0	0	2,750	2,750
Watershed Management	Floodwater Damage Reduction, Protection and Rehabilitation, and Water Management	0	0	0	0	2,962	300	3,262
Recreation	Land Acquisition, Access and Facilities	8,259	698	1,125	427	12,700	19,800	40,759
Fish & Wildlife	Production Enhancement Facilities, Access and Acquisition	2,749	282	1,758	1,476	3,474	1,998	8,221
Total Nonstorage		$41,447	$4,269	$6,742	$2,473	$31,574	$46,996	$120,017
Storage Projects								
	Elwha Dam and Reservoir							
Industrial Water Supply		0	0	0	0	1,500	0	1,500
Fish & Wildlife		0	0	0	0	1,500	0	1,500
Total Storage		$ 0	$ 0	$ 0	$ 0	$ 3,000	$ 0	$ 3,000
Total Programs and Projects		$59,856	$4,269	$6,742	$2,473	$58,572	$72,273	$190,701

[1] Includes cumulative annual program costs for the period for management features and capital costs for nonstorage and storage projects.

[2] Power facilities not included in basin plan.

[3] General Navigation facilities cost and benefits for public small boat harbors only. Total pleasure boat facilities costs and benefits included with Recreation.

[4] Average annual benefits assumed equal to average annual costs.

SEQUENCE OF DEVELOPMENT

The projects and programs are summarized in Table 22 by time periods. The project numbers identify features on Figure 10.

TABLE 22. Future projects and programs, Elwha-Dungeness Basins

PROJECTS PRIOR TO 1980

Municipal and Industrial Water Supply

1. Construct Ranney well and conveyance system to Port Angeles.
2. Enlarge the industrial water supply diversion facilities and transmission pipeline and tunnel from Elwha River to Port Angeles.
3. Enlarge the transmission system for Sequim.
4.* Expand the small and rural community municipal water supply and transmission systems.

Irrigation

5. Construct new irrigation diversion, pipeline conveyance and lateral distribution system for 22,000 acres on Dungeness River plain.
6.* Install the individual farm irrigation systems required to irrigate 6,100 acres of new lands on Dungeness River plain.

Water Quality Control

7. Install in-plant waste treatment facilities at the specified industries in Port Angeles and Port Angeles Harbor.
8. Construct waste treatment facilities and sanitary sewers at Sequim, Sequim Bay, Port Angeles, and small municipalities.
9. Improvement of waste collection facilities for recreation developments including small boat harbors.

Navigation

10. Acquire additional waterfront land around Port Angeles for water related navigational development.
11. Construction of a small boat harbor development at Elwha River and Dungeness River.

Recreation

12. Development of three recreation sites below Elwha Dam on Elwha River.
13. Development of two recreation sites between Lake Sutherland and Lake Aldwell.
14. Develop two urban recreation areas along waterfront near Port Angeles.
15. Develop two salt water beach recreation areas between Port Angeles and McDonald Creek.
16. Develop recreational area at Dungeness Spit.
17. Development of one recreation site on Morse Creek and one on Siebert Creek.
18. Development of two recreation sites along Dungeness River below Sequim.
19. Development of one recreation site along Dungeness River above Canyon Creek.

Fish and Wildlife

20. Fish passage facilities around Elwha and Glines Canyon Dams.
21.* Development of a kokanee spawning channel and steelhead rearing pond.
22. Rehabilitation of Lake Sutherland.
23.* Construction of an expandable fish hatchery.
24.* Acquisition of 5 miles of streambank access along Elwha River, 10 miles along Dungeness River, and 20 miles along independent drainages below Olympic National Park boundary.
25. Update present irrigation system for low flow augmentation Dungeness River.
26. Rehabilitate 15 miles of irrigation ditches for supplemental salmon spawning and rearing area.
27.* Acquire and develop 250 acres of waterfowl and fur animal habitat for hunting and other nature associated recreation.

PROGRAMS PRIOR TO 1980

Water Quality Control

a. Establish and operate water quality surveillance stations at key salt and fresh water locations and implementation of a comprehensive sewerage Basin plan.

Flood Control

b. Establish and administer county-wide flood plain zoning measures under flood plain management program.

Watershed Management

c. Provide technical assistance and management for State and Federal lands.
d. Provide technical assistance for on-farm and other private practices.

*Projects not shown on Figure 10

TABLE 22. Future projects and programs, Elwha-Dungeness Basins (Cont'd)

Fish and Wildlife

e. Develop lake fertilization techniques.
f. Make wildlife population analysis and timberland management practices studies, develop habitat improvement techniques and an education program on proper game hunting concepts, and begin a program with land owners for game habitat retention and hunter access.
g. Develop fish disease controls and new toxicants.
h. Conduct cross-sectional stream surveys to determine minimum and optimum streamflows for fish.
i. Locate, survey, and mark boundaries of all State-owned second class tidelands in the Basins. Take steps to reserve all such lands for public use except as required for specific circumstances.
j. Perform an inventory of shellfish stocks and recreational use of tidelands.
k. Fertilization of Lake Sutherland.

PROJECTS 1980-2000

Municipal and Industrial Water Supply

28. Enlarge the municipal water supply storage and transmission facilities from Morse Creek.
29. Enlarge the industrial water supply transmission system from Elwha River to Port Angeles.
30. Construct outlet works in Elwha Dam.
31.* Increase capacity and enlarge the small and rural community systems.

Water Quality Control

32. Install additional in-plant industrial waste treatment facilities at Port Angeles.
33.* Expansion of waste treatment and sanitary sewer facilities for municipalities and recreation developments.

Navigation

34. Expand Port Angeles small boat harbor.
35. Expand Elwha River—East small boat harbor.
36. Construct a new small boat harbor—Jamestown.
37. Development of additional water transport-oriented lands in Port Angeles.

Watershed Management

38. Small watershed multiple-purpose project—Morse Creek.
39. Small watershed multiple-purpose project—Port Angeles.
40. Small watershed multiple-purpose project—Dungeness River.
41. Small watershed multiple-purpose project—McDonald Creek.
42. Small watershed multiple-purpose project—Siebert Creek.

Recreation

43. Development of two recreation sites near Lake Aldwell.
44. Development of a salt water recreation site west of Port Angeles.
45. Development of two additional urban recreation sites near Port Angeles.
46. Development of recreational site on Morse Creek.
47. Development of two recreation sites between Siebert and Morse Creeks.
48. Development of recreation site in McDonald Creek drainage.
49. Development of two recreation sites in Lower Dungeness River.

Fish and Wildlife

50. Improve stream and streambed cross-sections, six streams—18 miles.
51. Channel clearance, Dungeness River—8 miles.
52. Fish passage over major barriers on Dungeness River—6 miles.
53. Construct 10 acres of salmon rearing ponds.
54. Construct a new salmon hatchery.

PROGRAMS 1980-2000

Water Quality Control

l. Continue water quality surveillance program.

Flood Control

m. Continue flood plain management program.

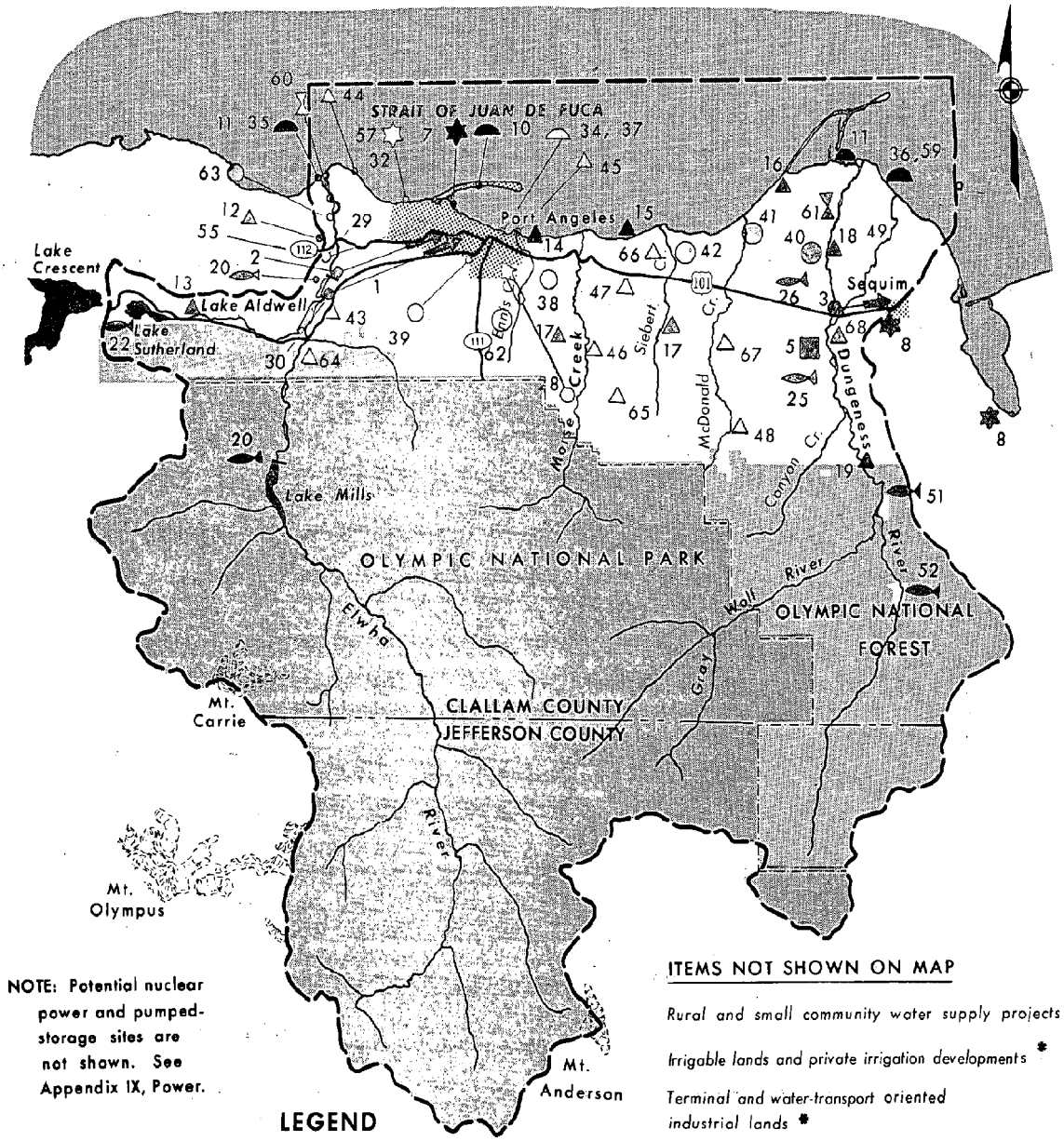
Watershed Management

n. Provide technical assistance for on-farm and other private practices.
o. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

p. Continue fish and wildlife programs.

*Projects not shown on Figure 10



NOTE: Potential nuclear power and pumped-storage sites are not shown. See Appendix IX, Power.

LEGEND

Proposed early-action projects	FEATURE	Proposed long-range projects
	M & I Water Supply	
	Irrigation	
	Water Quality Control	
	Navigation	
	Power	
	Flood Control	
	Watershed Management	
	Recreation	
	Fish and Wildlife	
	Dam and Reservoir	

ITEMS NOT SHOWN ON MAP

Rural and small community water supply projects

Irrigable lands and private irrigation developments *

Terminal and water-transport oriented industrial lands *

Small watershed boundaries *

Scenic highway and potential recreation river segments

Fish and wildlife projects yet to be sited

* *See functional appendix for location maps*

Scale in Miles

5 0 5 10

ELWHA-DUNGENESS BASINS

FIGURE 10. Comprehensive Plan Elements

TABLE 22. Future projects and programs, Elwha-Dungeness Basins (Cont'd)

PROJECTS 2000-2020

Municipal and Industrial Water Supply

55. Enlarge the industrial diversion and transmission facilities from Elwha River to Port Angeles.
56.* Increase capacity of transmission and storage facilities at Port Angeles, Sequim and the small rural and community systems.

Water Quality Control

57. Install additional in-plant industrial waste treatment facilities at industries located in Port Angeles.
58.* Expansion of waste treatment and sanitary sewer facilities for municipalities and recreation developments.

Navigation

59. Enlarge small boat harbor—Jamestown.

Flood Control

60. Construct 1.5 miles of levee along right bank Elwha River.
61. Construct 8.0 miles of set back levees along left bank Dungeness River.

Watershed Management

62. Small watershed multiple-purpose project—Ennis Creek.
63. Small watershed multiple-purpose project—Elwha River.

Recreation

64. Development of one recreation site—Elwha River.
65. Development of one recreation site—Morse Creek Watershed.
66. Development of two recreation sites—Siebert Creek Watershed.
67. Development of one recreation site—McDonald Creek.
68. Development of one recreation site—Dungeness River near Sequim.

Fish and Wildlife

69.* Develop 30 acres of salmon rearing facilities.
70.* Obtain land acquisition including habitat areas.

PROGRAMS 2000-2020

Water Quality Control

q. Continue water quality surveillance program.

Flood Control

r. Continue flood plain management program.

Watershed Management

s. Provide technical assistance for on-farm and other private practices.
t. Provide technical assistance and management for State and Federal lands.

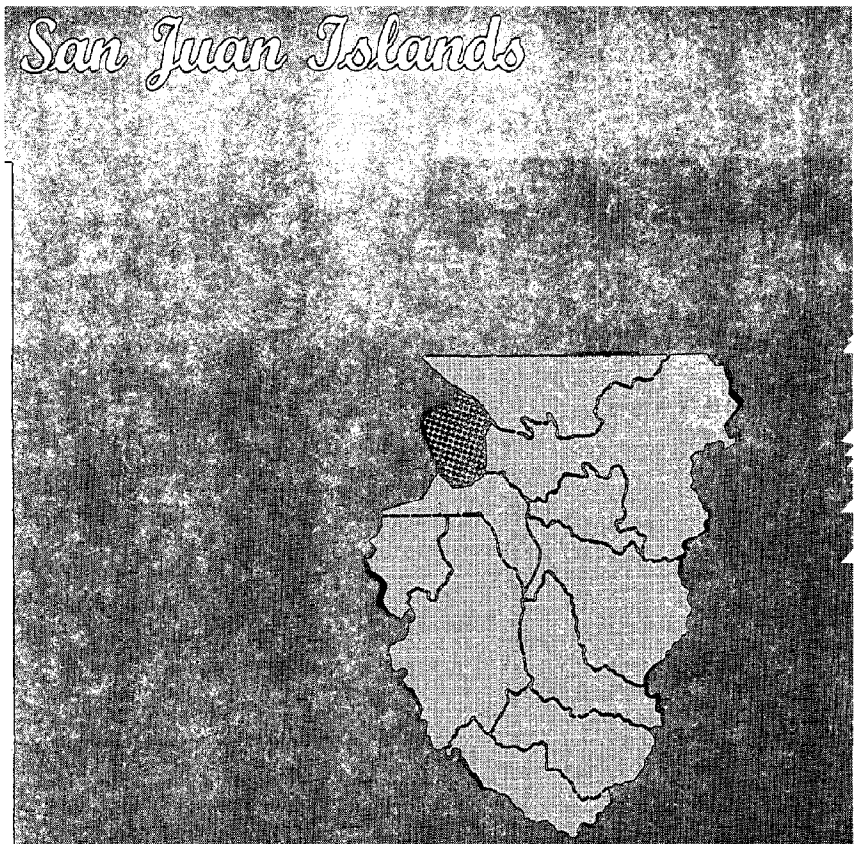
Fish and Wildlife

u. Continue fish and wildlife programs.

*Projects not shown on Figure 10

COUNTY AFFECTED:

San Juan



SAN JUAN ISLANDS

SUMMARY OF PLAN

Early Action, 1970-1980

The early action program emphasizes expansion and analysis of present surface and ground-water supplies and facilities, additional waste treatment and sewers, acquisition of land and construction of recreational facilities, new boat harbors and moorages, and obtaining access to areas for fishing and hunting uses.

Present water supplies are adequate to to 1980, although some systems would require new distribution facilities such as meters and larger pipelines.

To comply with the Washington State water quality standards, the city of Friday Harbor would require primary treatment facilities, disinfection facilities and adequate marine discharge throughout the Islands to intercept septic tank effluent and prevent beach and marine-water contamination. Water quality management, planning and surveillance are essential elements of the water quality program. Stations should be established at Lawrence Point, Waldron Island, and Friday Harbor for water quality surveillance.

There would be four new small boat harbors established throughout the Islands prior to 1980 providing about 1,464 wet moorages. Twelve harbors with 6,300 wet moorages would be constructed between 1980 and 2020.

The recreation plan proposes facilities on 400 acres of lands by 1980. Nearly a third of the early investment would be for purchasing land, principally salt water beach areas and beach access. A coordinated development plan would be established between Federal and state and local governmental bodies to acquire land and develop facilities in an orderly arrangement. The plan should include underwater and shoreland recreation areas, park and recreation areas, aquacultural sites.

Early action objectives involving fish and widlife would require acquisition of additional land at numerous locations throughout the Islands for public access. These lands would be in addition to those needed for outdoor recreation. A controlled rearing impoundment would be developed for salmon production at False Bay in addition to development of a fresh water lake for trout fishing. Fish programs to enhance shellfish production and development of marine water rearing areas are proposed. Wildlife development would include acquisition of additional lands for waterfowl and upland game habitat.

Nuclear power generation was investigated for the Islands. The possibilities of a nuclear power site being located on any of the Islands are indefinite since they are located away from the present and projected main load centers; however, there are many factors to be considered in a site selection which have not been evaluated to date. Therefore, the actual site selection for nuclear power generation has not been included as a part of this plan.

New installations for watershed management, upgrading of existing facilities, and more intense application of recurring and non-recurring land treatment practices, are required. These measures are part of the watershed management program to meet needs for floodwater and sediment damage reduction, water management, and watershed rehabilitation and protection. The cost of this work causes a continuing requirement of public and private funds to protect and develop water and related land resources in the Islands. Watershed management programs that offer technical assistance and financial participation in local land and water related projects and programs would be continued.

Long-Range 1980-2020

To meet future water supply needs for the islands of Orcas, Shaw, San Juan and Lopez, water would be obtained from Mountain Lake on Orcas Island. The western arm of Orcas Island would receive its water from this diversion. However, the community in and around the East Sound area would continue to obtain its water supply from present sources. Water for the other islands would be conveyed by an inter-island pipeline to distribution centers at specified locations throughout the Islands. Individual municipal distribution systems would connect to the pipeline or the distribution centers. The distribution system costs are not included in the plan.

A continuing program of expanding existing and constructing new municipal and industrial waste treatment and sanitary sewer facilities commensurate with a water quality surveillance program would be necessary to meet and maintain Washington State water quality standards.

By the year 2020, an additional twelve harbors with 6,300 wet moorages would be constructed.

Three small water shed projects for floodwater damage reduction, rehabilitation and protection, and water management, should be provided in these Islands prior to 2020. Upgrading of existing facilities and more intensive application of recurring and non-recurring land treatment practices would also be required. Ongoing watershed management programs which provide some degree of technical assistance and financial participation would be continued.

An additional 2,310 acres of land with appropriate facilities would be acquired and developed for recreational use.

To meet the continuing needs for fish and wildlife would require acquisition of additional and at numerous locations throughout the Islands for public access. These lands would be in addition to those needed for outdoor recreation. Controlled rearing impoundments would be developed for salmon production in addition to development of fresh water lakes for trout fishing. Fish programs to enhance shellfish production and develop marine-water rearing areas and wildlife programs to acquire additional lands for waterfowl and upland game habitat are a part of the plan.

Table 23 summarizes the San Juan Islands in elements of the Comprehensive Plan, showing the benefits and costs for the early action portion of the Plan, and provides a summary of investment costs by water resource functions for the entire 50-year period ending in 2020. The early action portion of the Plan includes programs amounting to $12,252,000 and projects costing $18,303,000 for a total investment of $30,555,000. Program and project investment costs for the 1980-2000 period amount to $46,833,000 and for the 2000-2020 period, $46,396,000; for a total 50-year investment of $123,784,000.

TABLE 23. Comprehensive Plan, San Juan Islands

Feature	Items	1970-1980 Investment[1] Cost ($1000)	Average Annual Costs ($1000)	Average Annual Benefits Gross ($1000)	Average Annual Benefits Net ($1000)	1980-2000 Investment Costs ($1000)	2000-2020 Investment Costs ($1000)	1970-2020 Investment Costs ($1000)
Management Programs								
Water Quality	Monitoring, Evaluation & Control Programs	340	-	-	-	160	200	700
Watershed Management	Programs	11,897	-	-	-	13,989	13,720	39,606
Fish & Wildlife	Programs	15	-	-	-	0	0	15
Total Programs		$12,252	-	-	-	$14,149	$13,920	$40,321
Non-Storage Projects								
M&I Water Supply	Ground Water Use	670	21	21[2]	0	--	--	670
	Surface Water Use	--	--	--	--	10,200	--	10,200
Water Quality Control	Waste Treatment & Collection Facilities	1,824	44	44[2]	0	2,968	3,600	8,392
Navigation	Small Boat Harbors	(2,951)	(189)	(274)	(85)	(3,625)	(6,100)	(12,676)
Power[3]								
Watershed Management	Floodwater Damage Reduction, Protection and Rehabilitation, and Water Management	0	0	0	0	2,736	0	2,736
Recreation	Land Acquisition, access and facilities	15,224	1,112	2,700	1,588	16,200	28,200	59,624
Fish & Wildlife	Production Enhancement Facilities, access, & Acquisition	585	47	103	56	580	676	1,841
Total Non-Storage		$18,303	$1,224	$2,868	$1,644	$32,684	$32,476	$ 83,463
Total Programs and Projects		$30,555	$1,224	$2,997	$1,769	$46,833	$46,396	$123,784

[1] Includes cumulative annual program costs for the period for management features and capital costs for projects.

[2] Average annual benefits assumed equal to average annual costs.

[3] Power facilities not included in Island plan.

SEQUENCE OF DEVELOPMENT

The projects and programs of the Comprehensive Plan are summarized in Table 24 by period. The project numbers identify features on Figure 11.

TABLE 24. Future projects and programs, San Juan Islands

PROJECTS PRIOR TO 1980

Municipal and Industrial Water Supply

1.* Update present municipal and industrial water storage and distribution system for San Juan and Orcas Islands.

Water Quality Control

2. Construct waste treatment and sewerage facilities at Friday Harbor and Camp Orkila.

Navigation

3. Construct small boat harbor at Friday Harbor, San Juan Island.
4. Construct small boat harbor at East Sound, Orcas Island.
5. Construct small boat harbor at Armitage Island.
6. Construct small boat harbor at Mackaye Harbor, Lopez Island.

Recreation

7. Acquire and/or develop one recreation site, San Juan Island.
8. Acquire and/or develop two recreation sites, San Juan Island.
9. Acquire and/or develop three recreation sites, San Juan Island.
10. Acquire and/or develop one recreation site, Lopez Island.
11. Acquire and/or develop three recreation sites, Lopez Island.
12. Acquire and/or develop one recreation site, Decatur Island.
13. Acquire and/or develop one recreation site, Blakely Island.
14. Acquire and/or develop two recreation sites, Shaw Island.
15. Acquire and/or develop one recreation site, Orcas Island.
16. Acquire and/or develop two recreation sites, Orcas Island.
17. Acquire and/or develop one recreation site, Clark Island.
18. Acquire and/or develop one recreation site, Platos Island.
19. Acquire and/or develop one recreation site, Waldron Island.
20. Acquire and/or develop one recreation site, Stuart Island.

Fish and Wildlife

21.* Develop three estuarine rearing ponds.
22.* Develop fresh water lake for trout fishing.
23. Acquisition and development of six salt water access areas.
24.* Acquisition for wildlife habitat improvement and hunting access.
25. Acquisition and development of salt water access for waterfowl hunting and observation.

PROGRAMS PRIOR TO 1980

Water Quality Control

a. Establish and operate water quality surveillance stations at key salt and fresh water locations.

Recreation

b. Provide for the effective recreation use and public access to State-owned tidelands.

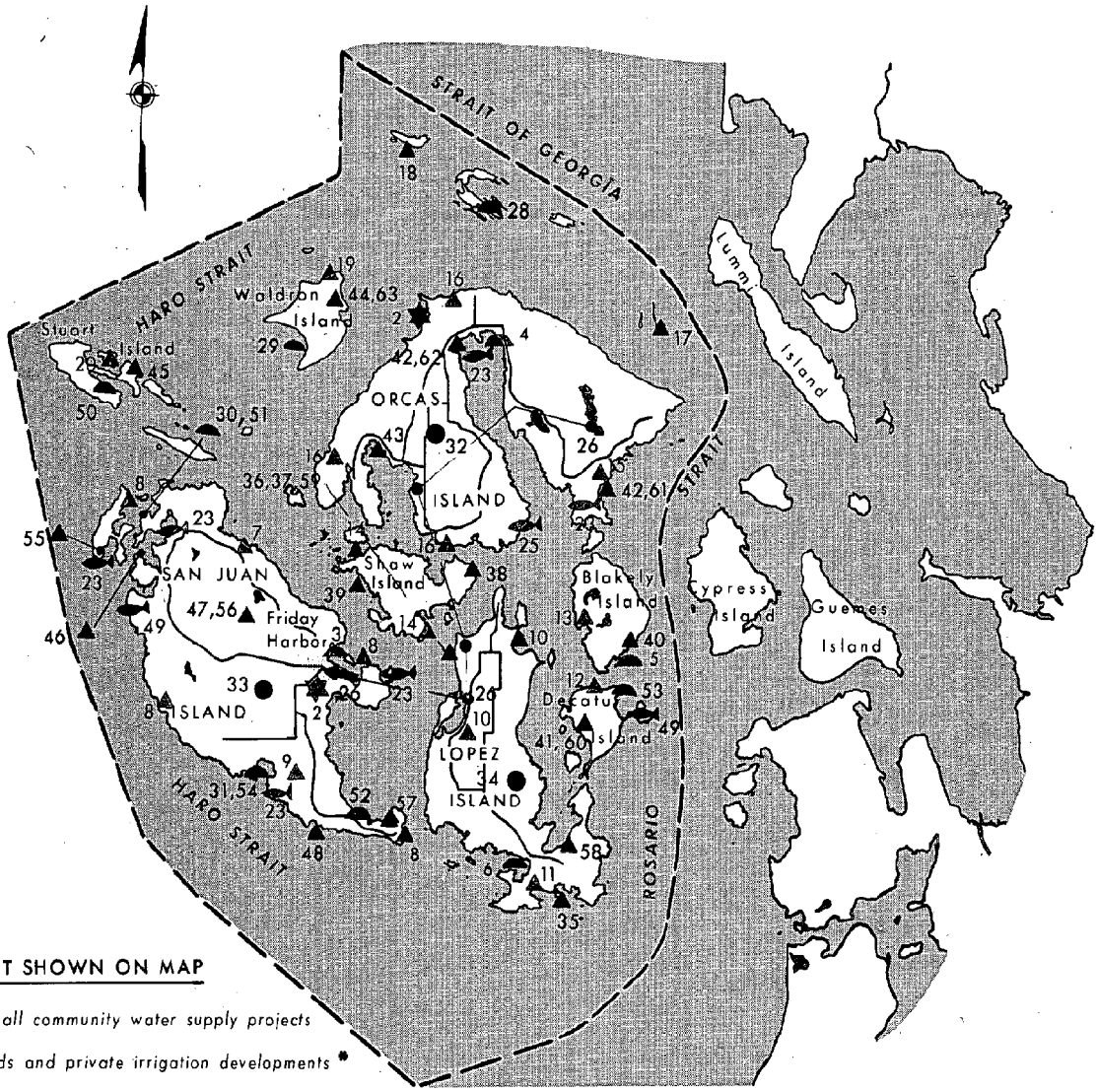
Watershed Management

c. Provide technical assistance and management for State and Federal lands.
d. Provide technical assistance for on-farm and other private practices.

Fish and Wildlife

e. Develop lake fertilization techniques.
f. Make wildlife population analysis and timberland management practices studies, develop habitat improvement techniques and an education program on proper game hunting concepts, and begin a program with landowners for game habitat retention and hunter access.
g. Develop fish disease controls and new toxicants.
h. Conduct cross-sectional stream surveys to determine minimum and optimum streamflows for fish.
i. Locate, survey, and mark boundaries of all State-owned second class tidelands in the Islands. Take steps to reserve all such lands for public use except as required for specific circumstances.
j. Perform an inventory of shellfish stocks and recreational use of tidelands.

*Projects not shown on Figure 11



ITEMS NOT SHOWN ON MAP

Rural and small community water supply projects

Irrigable lands and private irrigation developments *

Terminal and water-transport oriented industrial lands *

Small watershed boundaries *

Scenic highway and potential recreation river segments

Fish and wildlife projects yet to be sited

* *See functional appendix for location maps*

NOTE: Potential nuclear power and pumped-storage sites are not shown. See Appendix IX, Power.

LEGEND

Proposed early-action projects	FEATURE	Proposed long-range projects
	M & I Water Supply	
	Irrigation	
	Water Quality Control	
	Navigation	
	Power	
	Flood Control	
	Watershed Management	
	Recreation	
	Fish and Wildlife	
	Dam & Reservoir	

Scale in Miles

5 0 5 10

SAN JUAN ISLANDS

FIGURE 11. Comprehensive Plan Elements

TABLE 24. Future projects and programs, San Juan Islands (Cont'd)

PROJECTS 1980-2000

Municipal and Industrial Water Supply

26. Construct municipal and industrial water supply pipeline and storage areas from Mountain Lake on Orcas Island to West Sound of that island and to the other islands of Shaw, Lopez and San Juan.

Water Quality Control

27. Continue construction of waste treatment and sewerage facilities.

Navigation

28. Develop new small boat harbor at Fossil Bay, Sucia Island.
29. Develop new small boat harbor at Cowlitz Bay, Waldron Island.
30. Develop new small boat harbor at Roche Harbor, San Juan Island.
31. Develop new small boat harbor at False Bay, San Juan Island.

Watershed Management

32. Provide small watershed multiple-purpose project for Orcas-Waldron Islands.
33. Provide small watershed multiple-purpose project for San Juan Island.
34. Provide small watershed multiple-purpose project for Lopez-Blakely-Decatur Islands.

Recreation

35. Acquire and/or develop three recreation sites, Lopez Island.
36. Acquire and/or develop one recreation site, Lopez Island.
37. Acquire and/or develop two recreation sites, Lopez Island.
38. Acquire and/or develop two recreation sites, Shaw Island.
39. Acquire and/or develop one recreation site, Shaw Island.
40. Acquire and/or develop one recreation site, Blakely Island.
41. Acquire and/or develop one recreation site, Decatur Island.
42. Acquire and/or develop two recreation sites, Orcas Island.
43. Acquire and/or develop one recreation site, Orcas Island.
44. Acquire and/or develop one recreation site, Waldron Island.
45. Acquire and/or develop one recreation site, Stuart Island.
46. Acquire and/or develop two recreation sites, San Juan Island.
47. Acquire and/or develop one recreation site, San Juan Island.
48. Acquire and/or develop three recreation sites, San Juan Island.

Fish and Wildlife

49. Develop and construct an additional 20 acres of rearing impoundments for salmon.

PROGRAMS 1980-2000

Water Quality Control

k. Continue water quality surveillance program.

Watershed Management

l. Provide technical assistance for on-farm and other private practices.
m. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

n. Continue fish and wildlife programs.

PROJECTS 2000-2020

Navigation

50. Construct small boat harbor at Reid Harbor, Stuart Island.
51. Construct small boat harbor at Nelson Bay, Henry Island.
52. Construct small boat harbor at Griffin Bay, San Juan Island.
53. Construct small boat harbor at Fauntleroy Point, Decatur Island.
54. Construct small boat harbor at False Bay—Stage II, San Juan Island.

Recreation

55. Acquire and/or develop three recreation sites on Henry Island.
56. Acquire and/or develop one recreation site near Sportsman Lake, San Juan Island.

TABLE 24. Future projects and programs, San Juan Islands (Cont'd)

57. Acquire and/or develop two recreation sites near Low Point, San Juan Island.
58. Acquire and/or develop three recreation sites near Mud Bay, Lopez Island.
59. Acquire and/or develop one recreation site near Flat Point, Lopez Island.
60. Acquire and/or develop one recreation site on Decatur Island.
61. Acquire and/or develop one recreation site near Doebay, Orcas Island.
62. Acquire and/or develop one recreation site near Dolphin, Orcas Island.
63. Acquire and/or develop one recreation site on Waldron Island.

Fish and Wildlife

64.* Provide additional fish and wildlife facilities including access and habitat areas.

PROGRAMS 2000-2020

Water Quality Control

o. Continue water quality surveillance program.

Watershed Management

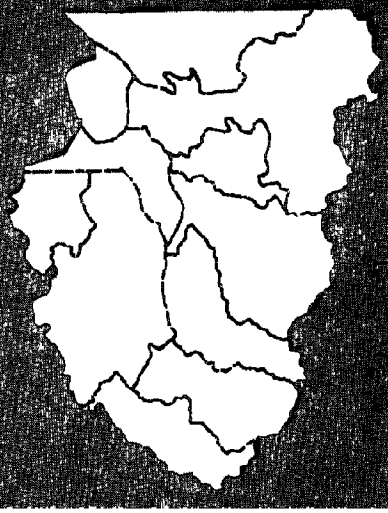
p. Provide technical assistance for on-farm and other private practices.
q. Provide technical assistance and management for State and Federal lands.

Fish and Wildlife

r. Continuation of fish and wildlife programs including shellfish enhancement.

*Projects not shown on Figure 11

Exhibit B
Economic Projections



GENERAL

Exhibit D, Appendix IV, Economic Environment, projects economic activity in terms of output, value added (gross regional product), employment and population from a 1963 base to 1980, 2000 and 2020, the major forecast effort aimed at the year 1980 with a projection method involving input-output analysis. This relatively new technique in regional analysis not only examined the present, but provided a tool for viewing the future. The 2000 and 2020 projections utilized different forecasting methods.

The 1963 analysis of the Puget Sound Economic Area was highly dependent upon the recently completed interindustry study of the State of Washington. For that year, a 54-sector purchase and sales flow model of the State's economy was developed by a group of researchers from the University of Washington. Both the final product and many of the unpublished working papers were made available for generating the model for the Puget Sound Economic Area.

Each and every industry in the Area was aggregated into 56 sectors—from agriculture through manufacturers, services and the like—tables were developed showing sales output to: (1) every other industry in the Area; (2) local consumers, local investors and local governments; and (3) sales to the Federal Government, other areas of the United States and to world markets. The sales to other industries in the Area represented purchases by these industries. These relationships indicated the influence of output changes in one industry on its suppliers and, in turn, on their suppliers.

Changes and demands of local consumers, investors and government by and large depend upon changes in their incomes. As the model showed the total effects of changes in output in any one industry on the various parts of the local economy, the estimation and demand arising outside the local economy (e.g., exports by local producers) allowed the determination of local economic development.

In the projection process, account was taken of: changes in technology, expected local production of goods now imported into the Area; productivity increase; labor force participation rates; the changing pattern of consumer behavior as per capita incomes increase; and the emergence of new industries. Further care was taken not to protect output greater than available supply conditions warrant, such as in forest products.

COMPREHENSIVE PLAN IMPACTS FROM OBERS PROJECTIONS

The economic projections made for the Puget Sound and Adjacent Waters Comprehensive Study (PS&AW) provided the basis for estimating future water and related land resource needs and development of the Comprehensive Plan. Alternative projections have been made for the Area by the Regional Economics Division, Office of Business Economics, and the Economic Research Service (OBE-ERS). The latter projections are contained in a report entitled, "Preliminary Report on Economic Projections for Selected Geographic Areas, 1929 to 2020, Volume I," published by the United States Water Resources Council, Washington, D.C., March 1968 and were prepared for use in the Columbia-North Pacific Region Comprehensive Framework Study as well as other similar regional "Type 1" studies. These projections are compared in Tables B-1 and B-2.

TABLE B-1. Total employment—Puget Sound Economic Area (comparison of OBERS and PS&AW projections) 1980-2000-2020

Year	OBERS	PS&AW	Difference PS&AW Over OBERS Number	Percent
1980	978,681	973,100	-5,581	-0.6
2000	1,338,231	1,535,400	197,169	15
2020	1,773,299	2,434,400	661,101	37

TABLE B-2. Population—Puget Sound Economic Area (comparison of OBERS and PS&AW projections) 1980-2000-2020

Year	OBERS	PS&AW	Difference PS&AW Over OBERS Number	Percent of OBERS	Percent of PS&AW
1980	2,449,700	2,726,900	277,200	11	10
2000	3,345,300	4,300,500	955,200	29	22
2020	4,448,100	6,809,400	2,361,300	53	35

The above Tables B-1 and B-2 show that the projections are fairly similar for the period up to 1980. However, as they extend forward in time to the year 2000 and 2020 the PS&AW projection increases at a faster rate. By 2020 the PS&AW projection indicates 37 percent more employment and 53 percent more population. The difference can be attributable to the difference in assumptions, methodology, and judgment that were utilized in the projection process. These projections and a comparison of assumptions and methodology used in their derivation are discussed in Appendix IV, Economic Environment.

The Comprehensive Plan was reexamined on the basis of OBERS projections to determine its sensitivity in terms of time scale and investment impacts. This comparison is discussed by each major plan feature.

MUNICIPAL AND INDUSTRIAL (M&I) WATER SUPPLY

Forecasts of future M&I use were based upon population and value-added projections. M&I use is projected to increase approximately 133 percent between 1980 and 2020 as compared to a 150 percent increase in population (PS&AW) over this same period. Assuming a direct correlation with population the following forecasts of M&I needs would result from employing OBERS population projections:

Projected Water Use – Puget Sound Area (MGD)

Year	OBERS	PS&AW
1980	1,150	1,278
2000	1,578	2,023
2020	2,053	3,159

The effects on the long-range portion of the Comprehensive Plan would be to shift some M&I projects scheduled for construction before the year 2000 to after that year. As shown in the tabulation above the 2020 M&I use under OBERS is slightly less than the 2000 M&I use under PS&AW. Consequently, projects planned for construction between 2000 and 2020 would not be included in the Comprehensive Plan. Accordingly the overall M&I investment costs could be reduced by about $190,000,000.

IRRIGATION

Irrigation projections were based upon estimated needs for food and fiber, location and extent of potentially irrigable lands, urban encroachment, historical trends, and the availability of adequate water supplies. These factors limit the acreage which could economically be irrigated.

Population projections, only in their relationship to land use encroachment, were a consideration in the irrigation projections. As less urban land would be required under OBERS projections, the amount of irrigated land could be somewhat greater than presently projected. However, the incremental difference would be minimal since the principal potential irrigated areas near urban centers would have been taken out of production by 1980 under either base study. Consequently, the forecasts developed in the PS&AW Study are considered to be reflective of the needs as would be contained if the OBERS projections were employed.

WATER QUALITY CONTROL

Projections of municipal and industrial wastes were based upon population and value-added, with the assumptions made that additional pulp production required for paper and allied products would be of the Kraft process. Raw wastes from the paper and allied products industry account for about 90 percent of the total current wasteload in the Puget Sound Area. Total raw (before treatment) wastes are projected to increase approximately 53 percent between 1980 and 2020 as compared to a 150 percent increase in population. Projected unit wasteloads of the Kraft process pulp production are assumed to decrease from 30 lbs. BOD/ton in 1980 to 20 lbs. BOD/ton by 2020. Assuming the 1980 level of wasteloading would be the same under the OBERS projections and allowing for 11,000,000 PE wasteload from continuation of existing sulfate process pulp and paper plants and a direct correlation with population on the balance of the wasteloads generated in the Area the following wasteloads are forecast on the basis of OBERS projections:

Projected Municipal and Industrial
Wasteloads – Puget Sound Area
(Population Equivalents)

Year	OBERS	PS&AW
1980	18,524,000	18,524,000
2000	20,561,000	23,587,000
2020	22,193,000	28,943,000

The effects on the long-range portion of the Comprehensive Plan would be to shift expenditures of some funds required for treatment and collection facilities from the 1980-2000 period to the 2000-2020 period. As shown in the tabulation above, the 2020 wasteloads under OBERS are slightly less than the 2000 wasteloads under PS&AW. Consequently, Water Quality Control investments could be reduced by approximately $508,000,000 the amount scheduled for 2000-2020. The impact translates into the 1980-2000 investment being spread over 1980-2020.

NAVIGATION

Future waterborne commerce tonnages for the Puget Sound Area were projected by employing a linear regression model based on correlations between commerce and gross national product. The gross national product projections for 1980, 2000 and 2020 used in the PS&AW Economic Study were employed in the regression model to develop estimates of future levels of waterborne commerce in the Area. A comparison of the GNP projections used in the PS&AW Study, converted to 1958 dollars, with those used in the OBERS studies, indicates that the OBERS projections are about 5 percent higher in 1980 than the PS&AW projections, with the difference diminishing to approximately half of 1 percent for the year 2020. As a result of the small difference in GNP projections, the projections of waterborne commerce under the OBERS criteria would be expected to be essentially the same as that developed in the PS&AW Study.

The requirements for deep and shallow draft navigation channels and land area for terminal and water transport-oriented industries were based on national trends in vessels and trends in land use. The Navigation Study assumed that a representative cross-section of the world's fleet would be sailing into the Puget Sound waters over the 50-year study period. Consequently, the schedule of harbors and channel projects and associated costs contained in the Comprehensive Plan, would not be affected by the OBERS projections.

Small boat harbor needs as developed from the Navigation Study were related to projections of wet moorages. The wet moorage needs were projected from a 1966 base derived from a questionnaire survey of Puget Sound pleasure boaters. The PS&AW population growth rates, with the addition of a 1 percent allowance for accelerated interest in pleasure boating and other factors, were used to arrive at the pleasure boat ownership growth rate. This in turn was assumed to equal the wet moorage needs growth rate. Tabulated below is a comparison of wet moorage needs as derived under the PS&AW Study with that derived from the OBERS population projections:

Projected Wet Moorage Needs
Puget Sound Area
(Wet Moorages)

Year	OBERS	PS&AW
1980	42,200	43,800
2000	70,000	70,900
2020	113,400	143,400

An examination of the above wet moorage needs indicates the relatively minor reduction in the projected wet moorage needs for the Puget Sound Area of about 11 percent for the year 2000 and of about 20 percent for the year 2020. The effects on the long-range portion of the Comprehensive Plan would tend to be minimal. The wet moorage needs for the populous Cedar-Green and Puyallup Basins were not satisfied by the Comprehensive Plan with a residual need of about 17,000 wet moorages projected by 2020. Consequently, little or no impact on small boat harbors contained in the Comprehensive Plan would be expected from use of the OBERS projections.

POWER

Electric power requirements in the long-range period were forecast on the basis of Pacific Northwest regional power study growth rates as forecast by the Pacific Northwest Utilities Conference Committee. Consequently, the population projections for the Area do not enter directly into the development of the future power requirements in the long-range period for the Puget Sound Area. The electric power requirements are projected to increase approximately 728 percent between 1980 and 2020 as compared to the 150 percent increase in population. The projected electric power requirements of the Area under the OBERS criteria would be the same as that developed in the PS&AW Study.

Satisfaction of future Puget Sound Area power requirements is dependent upon additional importation of power from outside the Area as well as power production that can be generated within the Area. Consequently, there would be no impact on power development as scheduled in the Comprehensive Plan from employment of the OBERS projections in any case.

FLOOD CONTROL

Future flood damages projected for the 1980 development level were derived from a 1966 base and employment of annual growth rates from various economic parameters. The growth rates of the four components of future annual damages, agriculture, building and equipment, transportation facilities, and other were correlated with population, value-added for select industries, and trends in agricultural production. The long-range levels of flood damage projected for 2000 and 2020 are primarily based on extension of trends developed in projecting the 1980 level of flood damages with allowances made for urban encroachment on agricultural lands. Future flood damages are projected to increase approximately 227 percent between 1980 and 2020.

As a number of factors were considered in projecting the future flood damages, a comparison of damages under the OBERS criteria can only be considered approximate. However, the forecasts shown below, which are derived by reducing the PS&AW projected flood damage levels for 2000 and 2020 by the percent differences in population projection, are considered to be reasonable estimates of the future levels of flood damages that would result from using OBERS projections.

Projected Average Annual
Flood Damages
Puget Sound Area ($1,000)

Year	OBERS	PS&AW
1980	10,560	10,560
2000	14,320	18,360
2020	22,451	34,530

Employment of the OBERS projections would have limited effects on flood control features of the Comprehensive Plan. Most flood control projects contained in the Plan are scheduled for construction prior to the year 2000. A reduction in the average annual benefits of the early action projects could occur as the incremental benefits derived from property and land value growth would be less under the OBERS projections. However, the benefit reductions would probably be relatively minor.

WATERSHED MANAGEMENT

The future needs for watershed management were related to the PS&AW population projections. The needs for food and fiber were based on national projections. Therefore, employment of the OBERS projections would not have affected acreage requirements for food and fiber.

Using the OBERS population projection for 2020 would result in a reduction of urban water management improvement needs from 1,040,300 acres to 773,000 acres as shown in the tabulation below:

Projected Urban Water Management
Puget Sound Area
(Acres)

Year	OBERS	PS&AW
1980	711,700	731,400
2000	719,500	799,500
2020	773,000	1,040,300

The reduction of 267,000 acres of land requiring urban water management improvement by 2020 would not affect cropland reduction projections but rather that acreage of forest now projected to be lost to urban development would be reduced. The cost of urban water management under the OBERS projection would be approximately $26 million less for 1980, $108 million less for 2000, and $361 million less for 2020 than shown for the Comprehensive Plan

RECREATION

Future recreation demand was forecast from a 1960 base. An estimate was made of the population seeking outdoor recreation opportunities in the Puget Sound Area. The 1969 participating population was projected to grow at the rate developed from PS&AW population projections for 1980, 2000 and 2020. Future recreation demand is projected to increase approximately 257 percent between 1980 and 2020 as compared with 150 percent increase in population. The difference in percent increase is a result of projected increases in participation rates in the various outdoor recreation activities. Since future recreation demand is directly correlated with population, the impact from OBERS projections on recreation demand can be easily demonstrated, as shown below:

Projected Recreation Demand
Puget Sound Area
(1000 Recreation Days)

Year	OBERS	PS&AW
1980	45,500	50,100
2000	75,200	96,400
2020	116,200	178,700

As shown in the tabulation above, the recreation demand as projected under OBERS would have a 22 and 35 percent reduction over the demand forecast in the PS&AW Study for the years 2000 and 2020, respectively. Although the investment costs for the various time periods would not be reduced exactly by the same percentage difference in population projection, this approximation will suffice for purposes of comparison. Accordingly, the Comprehensive Plan costs for campgrounds, picnic areas, beach, swimming pools and boating facility developments would be reduced by about $101,000,000 and $267,000,000 for the 1980-2000 and 2000-2020 periods, respectively.

FISH AND WILDLIFE

Future demands for fish and wildlife (user -days) were projected on the basis of population

FISH AND WILDLIFE

Future demands for fish and wildlife (user-days) were projected on the basis of population forecasts. The fish and wildlife demands were projected in three categories: hunting, sport fishing,

and commercial fishing. The hunting demand is projected to increase approximately 100 percent between 1980 and 2020, the sport fishing demand 260 percent, and the commercial fishing demand 79 percent. As these projections for sport hunting and fishing were directly correlated with population forecasts for the Puget Sound Area a fairly accurate measure is possible of future fish and wildlife demands under OBERS, as shown below:

Projected Sport Hnting
Puget Sound Area
(1000 User-Days)

Year	OBERS	PS&AW
1980	1,471	1,635
2000	2,068	2,651
2020	2,126	3,271

Projected Sport Fishing
Puget Sound Area
(1000 User-Days)

Year	OBERS	PS&AW
1980	8,540	9,489
2000	11,891	15,245
2020	15,955	24,546

Projected Commercial Fishing
Puget Sound Area
(1000 lbs.)

Year	OBERS	PS&AW
1980	47,308	52,565
2000	56,299	72,178
2020	61,085	93,977

Projected fish and wildlife demands as shown above would be reduced under the OBERS projections 22 and 35 percent over those shown for PS&AW for the years 2000 and 2020, respectively. As shown in the tabulation above the 2020 fish and wildlife activity under OBERS is nearly the same as the 2000 activity under PS&AW. Consequently, fish and wildlife investments could be reduced by approximately $123,000,000, the amount scheduled for 2000-2020. The impact translates into the 1980-2000 investment being spread over 1980-2020.

SUMMARY

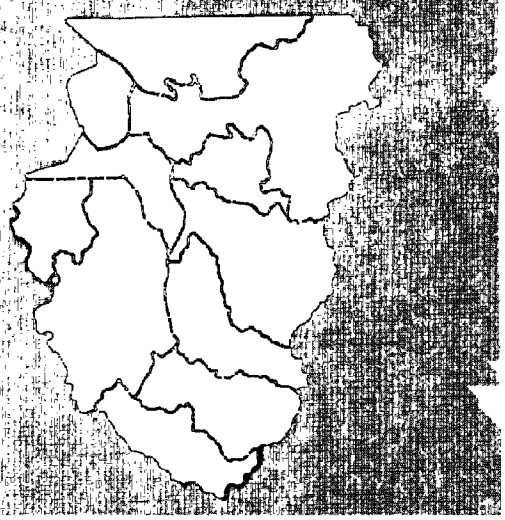
The methodology employed in making the OBERS projections is a function of what happens in the Nation with a disaggregation of national totals into over 200 subregions; whereas the PS&AW Study concentrated on only one region. The PS&AW Study with an intense investigation of the Area has the capability of taking more economic growth factors into consideration. The role of different statistical methods and the substantial judgments employed in each of the two separate economic studies both contributed to the divergent projections. Consequently, the periodic and systematic updating of the Comprehensive Plan should consider the economic growth that has occurred in the interim period. The next review study would have the benefit of data developed from the 1970 census and therefore, a more accurate indication of the true direction of the local economy would be available for use in updating studies.

The overall impact of OBERS economic projections on the Comprehensive Plan would be primarily on those functions where future needs were closely related to population growth. These were municipal and industrial water supply, water quality control, watershed management, recreation, and fish and wildlife. The approximate reduction in investment costs over the 50-year study period would be about $1,684,000,000 with most of this reduction occurring in the 2000-2020 period.

Exhibit C

County Workshops

(Public Review of Preliminary Findings of Puget Sound Study)



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COUNTY WORKSHOPS

INTRODUCTION

The preliminary findings of the Puget Sound Study were announced by publication of Information Bulletin No. 3 early in 1970 (see Appendix I, Digest of Public Hearings, Volume II). These bulletins were widely distributed and became the basis for public testimony at Puget Sound Task Force hearings during May and June of 1970. Testimony presented during these hearings demonstrated the need for greater public involvement and review of the Task Force Report and Appendices. Accordingly, a series of workshops was proposed for each of the counties of the study area. A representative of the State Department of Ecology and the Formulation Team of the Puget Sound Study was named as Workshop Coordinator. After county officials set the first meeting date, the Coordinator opened the workshop series in each of the twelve Puget Sound counties; provided assistance to the workshop groups and attended 33 of the 50 of the workshop meetings.

The broad purpose of the workshops was to provide for grassroots review and comment on the preliminary findings of the Puget Sound Study. Specific objectives were to explain the origin, purpose, and procedure of the study; to obtain comments on desired and necessary local and regional projects and programs; to identify any regional and local needs which might have been overlooked and to encourage discussions and communications about the study. The workshop program was equally intended to provide a basis for county and municipal positions on the study findings and to give guidance to future resource planning in the Puget Sound Area. The intent was that workshop participants represent a broad cross-section of interests in the area, and attendance lists signed at each meeting were used to evaluate the actual broadness of representation.

Information Bulletin 4 (see Appendix I, Digest of Public Hearings, Volume III) describing the workshop program was published and widely distributed as a way of encouraging and initiating the public review.

Near the end of the workshop series the Task Force published Information Bulletin 5 (see Appendix I, Digest of Public Hearings, Volume III) to summarize workshop activity and state the most frequently raised workshop comments and issues.

A summary of workshop activity is shown as follows:

PUGET SOUND STUDY WORKSHOPS
*(Does not include committee meetings)

COUNTY	FIRST WORKSHOP DATE	FIRST WORKSHOP ATTENDANCE	TOTAL WORKSHOPS
Jefferson (Port Townsend)	Nov. 9	40	4
Mason (Shelton)	Nov. 30	25	3
Kitsap (Port Orchard)	Dec. 3	33	5
King (Seattle)	Dec. 17	50	6
San Juan (Friday Harbor)	Dec. 19	23	3
Skagit (Mount Vernon)	Dec. 21	40	1
Clallam (Port Angeles)	Jan. 19	21	4
Whatcom (Bellingham)	Jan. 10	108	9
Thurston (Olympia)	Jan. 22	30	5
Island (Coupeville)	Jan. 26	22	3
Snohomish (Everett)	Feb. 2	50	3
Pierce (Tacoma)	Feb. 3	20	4

*Committees were formed in some counties to provide for additional review and discussion. The number of these meetings was not recorded.

Before the workshops began in each county, the program was submitted for public announcement in daily and weekly newspapers and in some cases over local radio stations.

At the first meeting in each county the group of workshop participants was encouraged to establish its own organization and use a 60-day review and discussion period. The period of time ultimately used was often in excess of 60 days.

The Workshop Coordinator distributed Task Force publications, including copies of the Summary Report Draft and two sets of published appendices in each county, and advised participants of the location and further availability of reports. The Coordinator reviewed the workshop concept and purpose, suggested a general review procedure and reports to read, and arranged for presentation by Task Force technical advisors at the request of workshop participants.

Time and locations of the first meetings were set by county officials. Subsequent meeting dates and times were selected by the participants. The group also decided whether or not to use committees to accomplish the review. Individuals chose the reports that they would review.

Near the conclusion of the workshops a summary of the principal questions and issues raised at the workshops was made and the Puget Sound Task Force prepared responses (see page C-17) for those questions and issues. Many of the responses resulted in changes and additions in the Summary Report. Supplemental issues raised by the workshops and the Task Force responses are also included in this Exhibit (see page C-25).

Summaries of the workshops and workshop comments are presented in the following section for each of the counties of the Puget Sound and Adjacent Waters study area. The comments include points that were stated in written comments received as the end-product of the workshops. In most cases the points of interest or concern were expressed by only a few participants while other points were of interest to a larger number of people. Whether expressed by many or relatively few, the ideas are included here to make them known to the local, State and Federal agencies responsible for water resource management in the Puget Sound area. Comments received from workshops are contained in an unpublished appendix. The unpublished appendix is available for inspection from the Washington State Department of Ecology, P.O. Box 829, Abbott Rathael Hall, St. Martin's College, Olympia, Washington 98504. Summaries for those counties and cities that submitted them are contained in Appendix I, Digest of Public Hearings, Volume III.

A brief evaluation by the Puget Sound Workshop Coordinator (see page C-28) together with guidelines (see page C-29) for future public participation in water and related land resource studies are contained in the latter portion of this section. The guidelines were prepared as suggestions by a consultant to one of the Federal agencies who attended some 30 of the workshop sessions as an observer.

COUNTY WORKSHOP SUMMARIES

County	*Page*
Jefferson	C-6
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Skagit	C-10
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Whatcom	C-11
Thurston	C-12
Island	C-13
Snohomish	C-13
Pierce	C-14

JEFFERSON COUNTY

Jefferson County citizens were the first to begin the workshop program using a three and one-half month workshop review series for the Puget Sound and Adjacent Waters Study. The first of the series of four meetings began on the afternoon of November 9, 1970, and continued with evening meetings on December 8, 1970, and February 4, 1971 and an afternoon session on February 22, 1971. All meetings were held in the Commissioners' Chambers in Port Townsend.

The total attendance at the first meeting was approximately 40 people. Over the course of four workshop meetings, the total number of participants gradually diminished so that the final meeting of February 22, had a total attendance of eleven.

In addition to those who attended as individual citizens there was also representation from the local Grange, fire districts, educational institutions, booster club, garden club, environmental organizations, Soil and Water Conservation District, community club, pulp and paper industry, power company, Chamber of Commerce and various agencies of municipal, county, State and Federal government.

The meetings were coordinated by a member of the Board of County Commissioners who served as chairman pro tem of each of the four meetings of the workshop.

Most participants used the brochures and maps of Information Bulletin No. 3 for their review.

Workshop comments expressed concern about limited water circulation in Kilisut Harbor. A problem resulting from removal of a bridge and replacement by a causeway between Indian and Marrowstone Islands. Two limited-capacity culverts in the causeway were felt to be limiting tidal circulation and resulting in lower water quality in the vicinity of Kilisut Harbor and Oak Bay. Increased waste discharges from pleasure boating and industrial and residential development as well as silt deposition from land will aggravate the problem and prevent the proper and protective utilization of the full potential of the Harbor.

Interest was also shown in the workshops for water quality and the need for additional water supplies in unincorporated areas of the county. The possibility of acquiring water rights on the Dosewallips and Duckabush Rivers was discussed as was the status of water rights on the Big Quilcene River and the critically low flow in the river during the summer. Some expressed concern, ... "that the Public Utility District is not moving fast enough with regard to the development of additional water supplies."

There is a need to define the source, quality and quantity of ground water in Chimacum Valley and elsewhere in Jefferson County. Concern was also shown over the drainage problem in Chimacum Valley.

More study of water supply for the community of Quilcene was stated as needed and concern was shown over the new rule in the Olympic National Park that excludes horses on all trails that require staying in the park overnight.

The following information was provided for consideration in updating the Task Force Report:

> Crown Zellerbach Company is now providing treatment of all liquid waste emptying into Port Townsend Bay.
>
> The Port Commission has developed and improved a small boat harbor at Quilcene.
>
> The Army Corps of Engineers has dredged a channel into Mats Mats Bay, and the Port Commission has installed moorage facilities.

Workshop comments of a more general nature involved questions on how the Puget Sound Study would be used and who composed the Puget Sound Task Force. Recommendations for future actions stated the need to resolve conflicts between resource uses; for more local planning that would include increased public participation; to seek money to implement locally acceptable projects; to keep the Puget Sound report up-to-date and plan for and determine methods to finance facilities for part-time (seasonal) peak populations.

MASON COUNTY

The two-month workshop series in Mason County included three workshops with a total attendance of 25 at the first meeting. This attendance generally prevailed throughout the series. The meetings were held in the County Courthouse in Shelton during the afternoon hours of November 30, 1970, January 6, and January 27, 1971.

Participants included members of the local Grange, Chamber of Commerce, improvement and civic clubs, fire districts, sportsmen's groups, private

industry, interested citizens, and representatives of local, State and Federal government.

The review program was coordinated by the Director of the Mason Regional Planning Council. Review committees were organized on the basis of one committee for each appendix.

Among the needs noted during the workshops were that consideration should be given to fees and funding directly from users and from those who benefit directly from facilities. The need was stated for more efficient use and re-use of water resources, especially municipal supplies. The need to plan early for locally acceptable levels of population and economic growth, and the need to obtain land use rights to assure use for later development or preservation were also mentioned. The need to initiate effective flood plain management at an early date was emphasized. Also noted was the need to determine future power requirements and plan early for siting of power facilities. Programs and firm target dates are needed that will lead to the control of wastes from pleasure craft, marinas and related facilities. Expansion of public involvement and education programs were supported for water and land resource planning and development. Greater depth in studying problems in Mason County is also needed.

Concern was expressed over the effects of a possible cross-Sound bridge near the year 1980, and the adequacy of ground water and surface water supplies to meet future irrigation requirements. Financial assistance is needed locally to plan for and develop facilities that would serve a large seasonal (summer) population.

Information on soils was considered to be very useful and was recommended for separate printing and distribution.

It was suggested that recommendations that applied to the Navigation report and Pleasure Boating Study be sent to the U.S. Coast Guard, State Legislature and the Shelton-Mason County Journal.

KITSAP COUNTY

The series of five Kitsap County workshops continued through three and a half months with an afternoon meeting being held on December 3, and evening meetings on December 17, 1970, and January 21, February 25, and March 18, 1971.

Total attendance at the first meeting was about 33. The last meeting was attended by about 10 people.

In addition to interested citizens, workshop attendants represented the League of Women Voters, Soil and Water Conservation District, environmental groups, Labor Council, garden clubs, Jaycees, engineers' societies, community organizations, and various agencies of local, State and Federal government. The meetings which were held in the County Courthouse in Port Orchard, were coordinated locally by the Kitsap County Planning Director.

Review comments and concerns that originated in committees were later brought to the full workshop meetings. In the full meetings the following resolutions and recommendations were made:

"We recommend the Puget Sound and Adjacent Waters Task Force members, as well as those officials in a position to implement the study and plan, do so in light of the following resolutions and recommendations:

"That the Puget Sound and Adjacent Waters Task Force update their plans as data is provided by the Puget Sound Governmental Conference research team efforts in this area.

"That we not export water from the twelve (12) county area due to its possible limited nature.

"That Appendix VI, Municipal-Industrial Water Supply, indicates that through the year 2020, Municipal-Industrial Water Supply will be mainly from ground water. Consideration must be given to measure withdrawal rates and monitoring for salt water intrusion to protect this resource from depletion and/or pollution.

"Study results indicate that economic activities associated with agriculture, forestry, recreation, fisheries, and mining will expand to meet the need of a growing population. Another county function, that of a suburban community for the Central Economic Division of Puget Sound, will expand especially with the construction of a bridge over Puget Sound by 1990. It is recommended that the water related subjects in this study be coordinated with the report, 'Overall Economic Development Plan for Kitsap County, Washington.'

"That the Kitsap County Workshop of the Puget Sound and Adjacent Waters Task Force reflects the increasing concern of the people of the entire Puget Sound area, that all possible measures be taken to develop the tremendous potential of the Puget Sound fisheries and marine 'farming' into a new asset to the economy of the area. Therefore, be it resolved, that no new or expansion of existing oil handling ports or facilities be permitted which would ne-

cessitate increased tanker traffic in the confined waters of greater Puget Sound and the San Juan Archipelago; and that drilling for oil in the sea floor of the inland waters of Washington State be prohibited by law; and that tankers and barges over 20,000 dwt carrying petroleum cargo be prohibited by law from entering Admiralty Inlet into inner Puget Sound, and from entering the San Juan Archipelago; and that studies be initiated to establish procedures and controls for all petroleum tankers and barges over 5,000 dwt and other vessels carrying large quantities of petroleum and hazardous pesticides and poisonous chemical products which transit the confined waters of greater Puget Sound and the San Juan Archipelago; and that scientific studies be initiated immediately by competent chemists and marine biologists to establish baseline levels of toxic hydrocarbon content in edible shellfish at selected locations throughout greater Puget Sound.

"That there be a reestablishment and enforcement of the Rivers and Harbors Act, especially Sec. 13, wherein it requires removal of construction rendered objectionable by age and state of repair prior to transfer of ownership."

Discussions during meetings also pointed out the need for marinas as well as pleasure boats to be equipped with proper waste collection and handling facilities. Early development of these facilities for boats should be accompanied at the same time by development of receiving facilities at marinas.

More general comments were that implementation of the recommendations of the Puget Sound Study should be considered from the standpoint of increased economic activity and employment as well as environmental protection. Likewise, possible different rates of growth should be considered for the area. Planning by various levels of government should include the public with the purpose of education as well as information-gathering. It was emphasized that local interests need financial aid to implement projects and programs. Study data and local goals should be included in keeping the report current. Secondary and tertiary sewage treatment should always be considered.

The hope was expressed that the workshop group could continue as at least the start of a county advisory committee.

KING COUNTY

The workshop program in King County extended over a period of two and one-half months and included six evening workshops with an attendance of 50 at the first meeting held on December 17, 1970. An estimated 30 persons attended the final meeting.

In addition to interested citizens, workshop attendants represented the State Legislature, Washington Environmental Council, King County Environmental Development Commission, Puget Sound Coalition, Environmental Works, Sierra Club, League of Women Voters, University of Washington, West Seattle Community Club, American Institute of Architects, Exploring Division of Boy Scouts of America, the Steelhead Trout Club and various agencies of local, State and Federal government.

The review program was led by three graduate engineering students from the Water and Air Resources Division, Department of Civil Engineering, and the University of Washington. The King County Planning Department provided major assistance to the workshops. Workshop participants chose to perform the review through committees, each of which usually reviewed only one of the technical appendices.

Review comments indicated that the report should include more information on, and incorporation of, local policy for growth and resource management. Great reliance should not be placed upon the aerospace industry in the future economy of the Puget Sound area. Dispersion of population and economic activity would provide a more stable foundation for the future. A recently updated version of the Washington State input-output table should be used in fugure projections.

Earlier inclusion of the public in basin planning assumptions should be sought. More systematic procedures are needed for public participation, as well as to help keep account of current political pressures and the interests of urban areas. Assumptions regarding population/land use densities, including the possibility of a cross-Sound bridge, should reflect current preferences and local policy.

Detailed comments on water supply usually involved suggestions for reevaluating projections, per capita water use and the using of current information. More attention to expansion of distribution works for water supplies was recommended. It was felt that the city of Seattle has adequate water in King County for a supply that would last well into the future.

Ferry systems were suggested as possible waterborne mass transit alternatives to highway corridors in and around Puget Sound.

Sewage discharge regulations must be established to handle shipboard wastes that will result from increased pleasure craft activities.

The goals of planning for future power facilities in the study were thought to have been met. It was suggested that thermal power plants in the Puget Sound Basin are vital to the economic welfare of the area.

Areas of historic and natural significance were emphasized. Concern was shown regarding a continuous 16 mile waterfront boulevard from North Fort Lawton to South Lincoln Park.

The need for a continued fresh water supply to Green Lake for water quality purposes was emphasized.

Interrelationships and competition between stream fish populations and power generating operations were subjects of concern and were emphasized in comments on the Fish and Wildlife report. Concern was shown over the opening, except possibly in the distant future, of watersheds now closed to the public. Complete and inclusive cost and benefit analysis should be a major consideration in any decision to open municipal watersheds.

Future projections of water pollution problems and resulting needs for treatment should include constant reevaluation of other factors that involve economic growth, and growth rates and location of population. Costs for waste collection, treatment and outfall facilities may be too low and could require Federal funding assistance.

Consideration of intangible benefits was emphasized for the Plan Formulation appendix. The changing attitudes of the public were cited in suggestions to continually keep the report up-to-date. The many faceted planning objectives of Senate Document 97 were thought by some to be oriented toward economic productivity and were laudable from that viewpoint, although stronger emphasis on an environmentally-oriented objective was recommended.

Concern was expressed over possible port accommodation of oil tankers. A solution to concerns over potential oil spills could involve the prohibition of all oil tanker movement in Puget Sound.

Ecological impacts of power and flood control facilities should be thoroughly identified as should similar aspects of any alteration of natural streamflows.

Reasonably detailed presentation of alternative choices, as in the Nisqually Delta, was supported as a particularly proper attitude and procedure in planning.

Comments noted some question as to whether resource-use priorities should be maintained for fish or public water supply particularly in the Cedar River system. Future use of ground water shown in the report was thought by some to be excessively high in the Cedar-Green Basins. Studies of ground water quality and quantity were thought to be needed.

Comments favored consolidation of water systems. Greater coordination among port districts and expansion of existing ports rather than development of new port facilities were recommended.

The dam on the Middle Fork of the Snoqualmie River was usually supported by many residents of that valley but opposed by many others who questioned the ability of zoning ordinances to maintain open space in the downstream area.

SAN JUAN COUNTY

The series of San Juan County Workshops continued through two and one-half months with 3 Saturday morning meetings being held on December 19, 1970, and January 30 and February 27, 1971.

Total attendance at the first meeting was 23. The last meeting was attended by 12 people. The meetings were held in the County Courthouse in Friday Harbor.

In addition to interested citizens, workshop attendants included representatives of various citizen committees, as well as representatives from county, municipal, state and federal government.

The workshops were coordinated by The Chairman of the County Planning Commission. Review comments stated a need to seek a reasoned balance between population, resource use and environmental quality. The availability of water will become the limiting resource of the area. A recommendation was made for obtaining additional hydraulic data for the islands including precipitation, climate, ground water and water quality, as expressed in Appendix III.

Comments were made on the need for water storage facilities and for early public acquisition of potential storage and use of 35,000 acres on a basis of 18" to 28" of precipitation. It was noted that costs of storing available waters are too expensive to allow for irrigation use. Requests were made for special studies of the economics of tourism and to consider

the effective use of available water and to provide a basis for optimum development. The present scarcity of planning information for the islands was commented upon as well as the fact that the population of the county is already at the 1985 estimate and may reach the 2020 projection by 1980. This would mean that the 1980-2020 population projections will require review and updating.

Agricultural production was stated as declining due to sub-division, residential development and increasing taxation. The forest industry also is declining but some land purchasers are retaining forest stands for aesthetic purposes.

Comments were made on the selection of alternate sites for boat moorages and the use of floats at ends of roads and streets was suggested as an alternate to boat moorages. Increased citizen participation is needed for the final selection of locations for small boat moorage and marinas. Comments were made on the need for strict environmental control criteria for radioactive emissions, thermal pollution, disposal of radio-active wastes and accidents involving nuclear reactors. Some stated that residents of San Juan Island do not want any reactors in the county, although a minority report favored a small nuclear plant which would include desalinization works.

Seasonal visitors create severe sanitation problems at 11 or more parks and recreation acres. Early action is urgently needed for facilities to prevent and control sanitation problems related to the seasonal influx. It was recommended that an upper limit be established to modify peaks of recreational use so that the islands will not be over run. It was noted that additional parks would place additional burdens on the tax base, which was already a problem.

Some favored the management of the inter-tidal areas' water quality, including additional monitoring to protect areas of scientific value, and as a means to insure more fish for food and sports fishing. Also favored were more fish and wildlife. Programs proposed for the San Juans were noted as primarily for the benefit of non-residents and therefore government support (or user fees) were considered necessary for implementation.

SKAGIT COUNTY

The public review program in Skagit County included one evening workshop on December 21, 1970 with 40 in attendance. The review program was basically completed by a single county committee.

In addition to interested citizens, workshop attendants included representatives from environmental groups, civic organizations, business, Northwest Nuclear and various agencies of municipal, county, state and federal government. The workshop report indicated committee membership of nine with only 4 being non-agency persons. One federal employee committee member subsequently indicated it was not his desire nor that of his agency to take a position as might be implied by the prepared comments of the committee.

The Citizen Review Program was coordinated by a representative of the Board of County Commissioners and the County Planning Director.

Review comments and suggested changes in population trends, after the time table for completion, can change the priority of projects. The study should eventually determine ultimate levels of population that consider a balance of economics, ecology and taxation. Elements of the plan should be activated dependent upon detailed studies and consent and payment by the user. The study was stated to show large benefits for recreation and fisheries which are generally intangible to the general population. Projects and programs should be in compliance with state or federal ecological criteria. Plan B was preferred locally for the Skagit (Scenic and Wild Rivers). The concept of flood plain management rather than structural control of floods was also given as a preference.

There was not agreement with irrigation development trends which have been presented. Commencement of a storm and sanitary waste separation program was recommended at an early date. Also recommended was regionalization of waste treatment at Mt. Vernon-Burlington-Sedro Woolley sewer systems and correction of the pulp mill waste treatment program at Anacortes.

Channel improvement to accommodate super tankers in Fidalgo and Padilla Bays was not desired. Funding was recommended to repair the existing Skagit River Levee and channel where necessary and opposition was shown to the Avon By-Pass. Placement of the Nookachamp Levee near Clear Lake was supported to reduce costs and protect a majority of the local population. Adverse comments were given on the Skagit and Samish Basin Dams; however, the combining of land drainage and storm water separation programs was favored. Channelization of the Samish River was opposed but stabilization of land use, concentration of industry in select locations and periodic review of economic projections were sup-

ported. The report notes that development trends and industrial plans point to concentration in the southwest Padilla Bay–March Point areas of the Skagit-Samish Basin.

Small craft navigation needs and corrections which should be made during detailed planning were suggested. The potential for major port development was acknowledged and an alternate use of the March Point-South Padilla Bay area for a general cargo and dry bulk major port was proposed if high volume petroleum shipping does not materialize.

Coordination of project choices and programs within the basin and with exterior basins was recommended as was scheduling and programming of research related to nuclear power and associated environmental impacts.

A county office commented adversely on the workshops and indicated that the primary concern of citizens appeared to be for additional information. The work and planning coordination shown by the Task Force was commended.

CLALLAM COUNTY

The workshop series in Clallam County lasted about one and one-half months and included four workshops with a total attendance of 20 at the first meeting. Meetings were held in the Clallam County Courthouse in Port Angeles on the evenings of January 19, February 1 and 8, and March 8, 1971. Participants included representatives of the League of Women Voters, private industry, Soil and Water Conservation District, the Grange, local, state and federal agencies and interested citizens. The meetings were coordinated by a member of the Board of County Commissioners.

Comments by reviewers in the Clallam County workshops were that refinements and corrections of data including proposed locations of small boat moorages are needed. Further consideration of geological and tidal conditions was recommended in siting of small boat harbors. Reference was made to changing land values and increasing property tax rates which tend to accelerate the trends of changing land use. Irrigated agricultural lands are being rapidly displaced by residential use. Reference was made to preferred areas for residential development in terms of both economic efficiency and minimum ecological impact. A recently completed soil survey offers additional information on soils in the National Forest land of the Dungeness Basin. Careful attention to unstable soils was emphasized for any planning and siting of new developments. Potential ecological problems could result from land development and/or logging on the local soil formations that are highly susceptible to erosion. Loss of game habitat to other land uses will result in decreased hunting opportunities, particularly with the probable loss of the most choice local sites. Accelerated acquisition of additional waterfowl habitat is needed while this land is still available at reasonable prices. There is a need to preserve the existing native trout in Lake Sutherland while eliminating the present undesirable scrap fish population. This would require development of a new specific scrap fish poison. The growth predicted for the food processing industry through the year 2000 was thought to be too high. The installation of irrigation pipeline was stated to be dependent upon consolidation of existing irrigation districts and companies. It was recommended that the plan include a reference to consolidation.

WHATCOM COUNTY

The series of nine Whatcom County Workshops continued through a period of nearly two months with meetings being held in January, February and March, 1971. Total attendance of the initial meeting was 108.

In addition to interested citizens workshop attendants included representatives of granges, drainage districts, the university, municipal, county, state and federal government.

The meetings were coordinated locally by a representative of county government. Workshop participants chose to perform their review by means of committees that usually reviewed one or two of the technical appendices that pertained to their preferred subjects.

Review comments stated that additional detail may be desirable especially during detailed planning. Recognition is needed that counties have the tools to control flood plain damages to a great degree by zoning, sub-division and building code ordinances. Workable land and water use policies must strike a balance between economic use and provision of a wholesome environment and more recreation. The study should be considered as a valuable compilation of data which is not ready for implementation but which can become the basis for a good resource plan.

Local individuals or an independent non-agency group with broad representation from each basin were recommended as those who could produce an

ecologically sound river basin plan. Some felt that the public may be unwilling to pay for elements or projects of the plan.

It was recommended that local people should be continuously involved in planning decisions affecting the quality of the environment. Planning should be in keeping with a desired population level. Concern was expressed that the reports are printed and cannot be changed. The compatability of flood control and recreation was questioned. Use of an unbiased team of ecologists was suggested for review of specific projects. A periodic study review of 3 years, intensive review prior to implementation of projects and more local input during the intensive review were recommended.

Added ground water inventories were felt to be needed and greater consideration of air pollution influences on water quality were proposed. Additional weather stations and stream flow gages were thought to be needed. The study was cited as a valuable source of resource information to assist in follow-up studies.

THURSTON COUNTY

The series of five Thurston County workshops continued through a period of two months with meetings being held on the afternoon of January 22 and the evenings of January 27, February 10 and March 3 and 31, 1971. Attendance at the initial meeting was 30. The final meeting was attended by 12 persons.

In addition to interested citizens, workshop participants included representatives of a county advisory committee, the League of Women Voters, environmental groups, colleges, local press and various agencies of municipal, county, state and federal government.

The meetings were coordinated by the Thurston Regional Planning Council. Workshop participants chose to perform the review through organization of committees that usually reviewed only one or two of the technical appendices that pertained to preferred subjects.

Review comments stated that the study is considered to be a detailed examination and investigation which requires the review of additional alternates, increased citizen involvement and additional planning detail. There is a need for periodic updating of information including population and economic trends and water supply needs, especially as these may affect evaluation of future funding requests. Updating is especially significant in terms of new technical studies and reports. The value of the study in the quantification and cataloging of basic research information must be maintained by keeping current the information that has been collected.

The study should examine a number of the issues and needs on a continuing basis or as part of detailed analyses. A number of these issues must be evaluated in a comprehensive and rational manner from an unbiased and uncommitted point of view, which includes provision for local technical and citizen review.

It was thought that in order to be successful, comprehensive planning support must be engineered from the local citizenry. It was emphasized that the series of findings and plan formulation are a beginning point and not an end. The goals and objectives of the region and the local area must be woven into the fabric of the planning process.

The study should include reference to the 1970 interim Legislative Study performed by Drs. Alcorn and Ray.

A suggestion was made for a new alternate to include total preservation along the entire Nisqually Delta. Additional detailed studies were suggested to solve anticipated needs and problems. Local water quality problems and conflicts were felt certain to increase.

Numerous questions were raised concerning elements of development and preservation of the Nisqually Delta including elements of Plan A and B, both of which were felt to require additional detailed analysis. Additional work was also thought to be required in the Plan Formulation Appendix to make it comprehensible.

Diminishing population growth and zero growth were suggested as alternates in comprehensive planning. Analysis of current growth trends was emphasized as only one element in economic projections. Establishment of regional goals for population growth were recommended and the use of ceilings on power production was suggested as a way of achieving the population goal.

The study was felt to catalogue the resources of the region and present a look at the future under existing trends. The added work of completing the plan by presenting other alternates should be done without delay.

Expansion and more efficient use of existing navigation facilities were suggested. Preference was

stated for development of light industry and exclusion of oil storage facilities in the Deschutes and Nisqually Basins.

Comments were made on the need for sanitation facilities at marinas and at State Parks financed by user charges. Public beaches and State Parks were recommended in Thurston County. Summertime boat moorage facilities, licenses and pleasure boat sanitation regulations were felt to be needed. Tax relief for operators and builders of marinas was suggested.

Support was shown for the Recreation Plan under Plan A in the Plan Formulation Appendix, public acquisition of key sites, orderly and planned development, additional public access to water areas, special fishing and recreation for the very young, aged and handicapped, bicycling and hiking paths and public transportation to key recreational facilities.

It was noted that the study may cause city and county government to continually update both short term and long range planning. Additional water quality monitoring was desired in reference to selected use areas, in both fresh and marine waters. Treatment of surface water runoff from built-up areas was also desired.

Maximum controls on tankerships carrying bulk liquids was suggested as was further use of pipelines rather than tanker penetration of Puget Sound. Consideration of Alaskan Oil Impact on Puget Sound was recommended and should include both transportation and refineries. Attention was noted regarding the increasing occurrences of accidental spills and the need for a management plan for the total marine area of Puget Sound was emphasized.

Use of waste-water for irrigation was suggested as an alternate to additional waste treatment. Additional marine hydrology and climatology studies were felt necessary. An additional marine park at the head of Budd Inlet as a joint port, city and county, state and federal project was recommended.

ISLAND COUNTY

The series of three Island County Workshops continued during a period of approximately one and one-half months with evening meetings being held on January 26, February 23, and March 9, 1971. Attendance at the initial meeting was 22 persons. The final meeting was attended by about 10 persons. All sessions were held in the County Courthouse in Coupeville.

In addition to interested citizens, workshop participants included representatives of environmental groups, park and water districts, natural and historical societies, school districts, civic clubs and various agencies of municipal, county, state and federal government. The meetings were coordinated by the Office of County Engineer.

Review comments included detailed suggestions and corrections concerning transportation, power, recreation and population projections. An eventual need for state and federal construction money assistance was noted. Some workshop participants favored the current county water and sewer plan and took a very strong position that present well water systems are low in quality and are not a reliable source of potable water. Workshop suggestions concurred with the need for small boat moorages on Whidbey and Camano Islands and for development of desired land recreational sites including provision for horse, bicycle and pedestrian trails. Increased public access was supported for several beach areas and preservation of areas that are felt locally to be unique was suggested.

Concern was shown over the basis of proving a surface water claim and the difficulty of establishing an Island County surface water right to mainland water.

SNOHOMISH COUNTY

The series of 3 Snohomish County Workshops continued through 2 months with an afternoon meeting being held on February 2 and evening meetings on March 19 and April 5, 1971. Total attendance at the first meeting was 50. The last meeting was attended by about 30 persons. Meetings were held in the auditorium of the Public Utility District Building.

In addition to interested citizens the workshop participants included representatives of granges, drainage districts, Indian Tribes, labor council, private industry, League of Women Voters, environmental groups, Snohomish County Economic Development Council and municipal, county, state and federal government. The meetings were conducted by a representative of the County Engineer.

Comments from most of the members of one Committee favored the construction of the Middle Fork Dam on the Snoqualmie River and second stage construction of Culmback Dam on the Sultan River for flood control purposes.

Irrigation requirements were thought to be easily met without affecting other uses and without public funding. Intensive watershed management was

considered necessary to obtain the maximum benefit from flood control measures. Continued cost sharing between private land owners and governmental agencies was also felt necessary. More detailed studies on set-back levees at French Creek and Marshland Drainage Districts were suggested in addition to early action on Channel Enlargement of the Snohomish River and sloughs in the Delta area.

Concurrence was given to watershed management proposed for Patterson Creek. Watershed management action was supported for Trail Slough, Ebey Slough and Allen Creek along with consolidation of diking and flood control districts. Action programs which consider sequence of development and financing within existing fiscal policy and criteria were felt necessary.

Comments were made that the study is not a comprehensive plan that includes economic efficiency, flexibility, environmental quality and usability.

Comments were given regarding the dynamics of county development and the use of the comprehensive plan as a flexible, long range advisory instrument that expresses goals and objectives for the areas of growth and development. Some thought the study should be referred to as a generalized Preliminary Water and Related Land Resource Study with documentation of local and regional goals, policies and related factors suggested.

A need was expressed for a procedure to resolve tensions between local, regional and state planning and the manner to which the study is to be utilized on those respective levels. A multi-level of government and citizens was suggested for involvement in plan formulation with continuous input from these levels. A need to have legislative actions updated and provide for rapid adoption to legislative change was expressed.

Some suggested that population projections for regions and counties be expressed as ranges which are changeable and related to optimum or ultimate development, as expressed in policies and goals. Early updating to reflect trends and developments was recommended.

Comments were made regarding impacts of changing local goals on single purpose plans. The importance of land use zoning and land use interrelationships was stressed as was the need for policies on future development of mineral deposits.

A need was expressed for detailed analysis of the Everett water supply problem in terms of supply, peak demands, alternate sources, proposed low flow requirements, watershed management and ownership.

Some felt that a policy and procedure should be established for consolidation of small watersheds and that pricing policy should be considered as a way of reducing water demands. Support of recommendations was shown for a super-agency at the regional or state level to coordinate future port development.

Some questioned whether or not state and regional goals and policy for industrial growth justify the increasing power-use projections. A need was expressed for additional information on land impacts and alternate sources of power to meet the high demands forecasted. Single purpose appendices such as flood control should discuss the significance of proposals in terms of limits and/or encouragement to the use and development of flood plains. It was suggested that increased emphasis should be placed on flood plain management as an alternate for flood control. It was further suggested that watershed management and flood control be combined since these activities are complementary.

PIERCE COUNTY

A series of 4 workshops began on February 3 and continued for almost two months with meetings on February 16, March 4 and March 25, 1971. A total attendance of 20 at the first meeting diminished to about 7 at the final session. All meetings were held in the evening in the County Commissioners' Chambers, County-City Building in Tacoma.

Various people that attended meetings represented themselves, several levels of government, Tacoma Community College, local Granges, League of Women Voters of Tacoma-Pierce County, Sierra Club, Conservation Northwest, Tahoma Audubon Society, Nisqually Parkway Association, Puyallup Valley Chamber of Commerce, Pierce County Sportsmen's Council and private consultants.

A representative of the Pierce County Commissioners arranged for the meeting place. However, meetings were conducted by the Puget Sound Study Workshop Coordinator. Representatives of the League of Women Voters helped gain publicity for the workshops.

Comments referred to the need for continued emphasis on water quality improvement and municipal waste treatment. The Green River/City of Tacoma watershed should be kept closed to maintain water purity without full treatment until such time as the need for added recreational area is fully demonstrated. Recreation sites should be designed for more

seclusion of picnic and camping areas to enhance the aesthetic value of the sites.

Opposition was shown to ever-increasing intensive use of flood plains. The Nisqually Delta, which is attractive to many for various types and degrees of use and preservation, should be analyzed from a standpoint that would examine all uses. Any moratorium on future actions in the Delta should be binding on all concerned. Further development of the lower Puyallup River Delta was suggested as a possible alternative for development of the Nisqually. More intensive use of existing port and industrial facilities was also recommended as an alternative to Nisqually development with new technology and research cited as possible ways to accomplish this intensification. Almost compulsory guidance was recommended to insure that only water-requiring development, if acceptable, be allowed to be located on shorelines. Even very modest multiple use of the Nisqually Delta was cautioned since the unique biotic aspects of the area are extremely sensitive to all degrees of environmental change.

It was suggested that wherever possible, parks be planned along the Puyallup River from the mouth to Puyallup and Sumner. It was noted that sport fishing in the Puyallup Basin should be reestablished to levels of several years ago. Lands recommended for eventual industrial use were felt to be out of proportion to the minimal lands recommended for open space and recreational use.

Broader comments stated a need to plan for various economic and population levels. Subsidy was suggested for consideration when planning or developing facilities that benefit those beyond the immediate users. Intangible values, though difficult to define and use, should be a consideration in planning. New techniques for handling intangibles should be an objective in the refinement of other planning methods. Environmental effects should always be thoroughly examined and discussed in depth.

Interest rates, prevailing policies and other factors that are basic to planning should be reevaluated as the much needed and strongly recommended updating of the report is done. In future planning, and as the report is kept up to date, citizen participation should be included at the beginning and developed throughout the process for education of citizens as well as gathering of public policy.

PUGET SOUND AND ADJACENT WATERS COMPREHENSIVE WATER AND RELATED LAND RESOURCES STUDY

ISSUES

RAISED DURING PUBLIC REVIEW

OF STUDY FINDINGS

*Note: Issues and Task Force responses on the following pages have been typed and composed verbatim as distributed at the Final Public Hearings except that references to Summary Report draft have been changed to Summary Report as published.

AND

RESPONSES

BY

PUGET SOUND TASK FORCE

PACIFIC NORTHWEST RIVER BASINS COMMISSION

DISTRIBUTED AT

FINAL PUBLIC HEARINGS

21, 22 APRIL 1971

Fifty workshops were held from November 1970 through early April 1971 in the twelve counties involved in the Puget Sound Study. The workshops were held because of desires for more thorough review expressed by citizens at hearings last May and June in Mount Vernon, Everett, and Olympia. Citizens, groups, and agencies were invited to participate. Copies of the Summary Report draft and appendices were furnished to counties and cities. Members and staff of the Puget Sound Task Force made themselves available to answer questions.

A broad cross-section of more than 500 persons took part, representing farm groups, chambers of commerce, garden clubs, improvement clubs, power companies and PUD's, labor unions, forest products and other industries, conservation and environmental organizations; students; federal, state, county, city and district agencies; citizen groups, and just plain citizens.

The issues most frequently raised at the workshops are summarized in the following pages. Many of these were listed in Bulletin 5, distributed before the hearings. However, some issues have been added as a result of workshop comments received after Bulletin 5 was published. Following each issue is a response from the Task Force.

The Task Force will consider all comments from the public, including those made at all public hearings and workshops, in completing its report. Any additional comments must be received by May 7.

Comments made subsequent to the hearings should be sent to:

Alfred T. Neale, Chairman
Puget Sound Task Force
Washington State Department of Ecology
Post Office Box 829
Olympia, Washington 98504

Note:

*References to Summary Report revised from draft to Summary Report as published, in order to facilitate review.

1. Who is the **Puget Sound Task Force?** (Why are most members from federal agencies? Who chose them?)

Response: Task Force membership is made up of one representative of each of the following:

State of Washington
Department of Army
Department of Labor
Department of Health, Education and Welfare
Department of Transportation
Department of Agriculture
Department of Commerce
Department of the Interior
Department of Housing and Urban Development
Federal Power Commission

The makeup of the Task Force parallels membership on the Columbia Basin Interagency Committee and its successor the Pacific Northwest River Basins Commission. Because each state has only one member in the parent organization and the Puget Sound Study was entirely within one state, only one member was appointed from that level of government. That member, however, who is Chairman of the Task Force, is the focal point for representation of all state and local governmental entities. Representatives were chosen by the respective agencies.

2. Everyone wondered **how the Task Force report would be used.** (Is it a guide, a blueprint, or just another set of books to gather dust on a shelf? When something is to be done under the report, who does it, how does it get done, and who pays for it? Will local views be considered?)

Response: The Task Force report provides short and long term guidance for detailed water related planning and program administration by federal, state and local governments and by private individuals and corporations.

Updating will occur periodically, as well as detailed planning (see page 7-3, Summary Report).

Any programs and projects described in the report that are carried out will be initiated and paid for according to established procedures. Detailed studies leading to action can be started in many different ways; by requests of citizens to local, state or federal government, by requests of local officials to the Legislature or Congress, or by independent private action. The public will play a continuing but more decisive role in future planning by furnishing local views throughout the implementation process (see pages 6-3 and 7-3, Summary Report).

3. Future studies should be based on **several different growth rates of population and economic development.** (Some of the economic projections were felt to be unrealistically large. Many persons felt that policy decisions should be made to decrease or limit growth, and that conscious efforts could and should be made to do so. There was great concern that growth could cause a dramatic change in the character of the area. Various methods of limiting population could be considered.)

Response: The economic projections used in the Puget Sound Study were based upon what was expected to occur in the future in employment, population, and economic activity. The needs for water and related land resources were estimated and a Comprehensive Plan to meet the needs was developed. Policy decisions about limiting or encouraging growth cannot be made by the Puget Sound Task Force. However, whatever level of growth occurs, the governmental agencies with water resource responsibilities, intend to meet the needs in an environmentally acceptable manner. The value of the Puget Sound Study lies in demonstrating the effects on water and related land resources if growth occurs as forecasted. The Task Force will recommend re-examination of economic projections with local governments and lay citizens participating.

4. In cases of conflicts among resource uses, **the conflicts should be clearly set forth** and planners should suggest ways for resolving them. (Perhaps the method used–making independent single-purpose studies and then trying to resolve conflicts–is not the best possible. Just what is the status of all the appendices? Will the person interested in power? for example? or watershed management, bother to pick up the Plan Formulation or Summary Report, or just look at the volume with the title he is interested in? The result would just be more piecemeal resource planning).

Response: One of the primary purposes of comprehensive planning is to identify conflicts and then resolve these conflicts considering total resources and alternative solutions. The Task Force believes that public involvement is necessary to resolve conflicts. (In two areas, Skagit River and the Nisqually Delta, the Task Force did not resolve the conflicts but did recommend means for their resolution.) (The procedures used are described in Appendix XV, Plan Formulation, pages 10-17, and 10-60, Plan A and B.)

The Task Force has pointed out that the single-purpose technical appendices were just that, technical resource documents. They are working documents only. The Summary Report presents the final position of the Task Force and reflects the programs and projects recommended by the various technical committees unless modified in Appendix XV, Plan Formulation, or the Summary Report itself.

5. The general land-use planning done in the study should be followed by **more detailed studies** to guide economic growth toward publicly accepted goals. (Were urban interests in land use adequately reflected? Some of the areas frequently discussed in relation to future land-use decisions were:

Nisqually Delta–Port or wildlife? Can they be combined? How can a moratorium on decisions be enforced?

Skagit Valley–Necessity for more flood control?

Snohomish-Snoqualmie Valley–Dams? Development? Agriculture? Recreation?

San Juan Islands–Real estate? Developments? Water and sewer problems?)

Response: The general land-use planning undertaken in the study demonstrates various land use patterns under four assumptions of population density (see Part 6, Appendix V, Water-Related Land Resources). The Task Force recognizes the need for further detailed land use studies including future management of Puget Sound estuaries (see page 1-8, Summary Report) and recommends state guidelines be established to resolve land-use conflicts. The Summary Report will be revised to recommend that land use goals be determined by methods that assure public participation. Under Washington State law cities and counties can control land use.

6. **Recommendations should be modified** where local conditions and public goals have changed by the time specific projects are begun. (Local population projections for the future have already been reached in some cases. This affects the timing of provisions for water supply and other projects. Decisions to build or not to build a cross-sound bridge and a bridge to the lower end of Whidbey Island have many effects which must be kept in mind.)

Response: Recommendations in the report are subject to complete reexamination to reflect local positions and goals at the time of detailed implementation studies (see page 6-3, Summary Report).

7. Effects of al projects and programs **on the natural environment** must be thoroughly considered. Hidden costs and benefits must be identified, along with ways of comparing natural and economic values.

Response: The Task Force recognizes the importance of preserving the natural environment and recommends a large number of streams, identified in the Summary Report draft, be studied for possible inclusion in a state system of recreational rivers, protection of significant archeological and historical sites and outstanding natural and underwater marine areas; maintaining riverflows for fish, recreation and aesthetics; and acquiring numerous beach and watershed areas for recreation. Some alternatives were dropped because of their bad effects on basin environments. In two major areas of use conflicts, Nisqually Delta, and Skagit River, alternative plans are presented. In other cases provisions for mitigation of possible adverse effects to the environment are included. Detailed studies of programs and projects will be done according to the National Environmental Policy Act of 1969 (see page 5-7, Summary Report and similar state legislation). All costs and benefits will be identified in these studies. The detailed studies may also alter the Comprehensive Plan.

8. Local areas will need **money** to implement their shares of projects and programs proposed in the report. (How will the money for local shares be obtained? In spite of the large amounts involved, estimates of cost for some projects seemed too low.)

Response: Financial help to local governments for implementing programs and projects will be obtained through existing federal and state authorities or through private financing. Additional details are contained in Appendix II, Political and Legislative Environment. Some funding must be obtained locally—by tax levees or bond sales. Costs shown in the report are approximate with detailed studies required to determine firm costs.

9. **User fees** should be considered in financing some projects and programs. (Admission fees or licenses for some activities may provide more and better facilities, as well as assuring careful use.)

Response: The Task Force agrees with the concept of user fees and this is discussed in Appendices VI and X, M&I Water Supply and Recreation. The exact mode of financing specific programs and projects will be determined in the more detailed future implementation studies.

10. The **report should be kept current**, with citizen and local government participation throughout future studies. (This should include corrections of numerical data, recent changes in the field, and incorporate new federal, state, and local policies for resource management. There must be ways to get and use continued public and local government involvement on policy questions as well as ideas about specific programs and projects. Why was there not more throughout the study?)

Response: The report is intended to be kept current with improved local government and citizen participation recommended in future studies (see Part 7, Appendix II, Political and Legislative Environment and page 6-3, Summary Report). The Task Force will include guidelines in the Summary Report for assuring future public involvement in follow-on planning or implementation.

The Task Force sought to obtain public involvement through the initial hearings conducted in 1964 and throughout the study by meeting with interested groups, county governments and regional planning organizations. However, as the May-June 1970 public hearings demonstrated, future public involvement will need to be improved. This is recognized in Appendix II, Political and Legislative Environment and the Summary Report. The final versions of the Summary Report will stress that in the detailed implementation studies the public be given an active role initially and throughout the studies.

11. **Benefit-cost analysis should** not be the only factor in deciding whether a project should be undertaken. Broader methods must be used in making these decisions. (There are a lot of pitfalls to reducing a day of fly fishing on a free-flowing, unpolluted stream to dollars.)

Response: We agree. Benefit-cost analysis was not the only basis of selecting elements of the Comprehensive Plan. Intangible benefits including the saving of human life, improvement of living conditions and the safeguarding of the natural environment were also considered as part of the Planning criteria (see page 1-14, Summary Report). Storage projects recommended in single-purpose planning were in

many basins excluded from the Comprehensive Plan in order to retain rivers in their free-flowing state (see Appendix XV, Plan Formulation). (Examples, North Fork Skykomish, North and South Forks Stillaguamish, Miller River).

12. Many **local problems** in estuaries, lakes, and streams were identified as needing immediate attention. (Problems included poor water circulation, lack of access to water, over-use and over-crowding of available areas and littering.)

Response: Help for local problems should be requested by local government or citizens. See Appendix II, Political and Legislative Environment for agencies and the kinds of help they can furnish.

13. **Flood plain management** should be considered for many streams in the area. (This would not only help hold down flood damages but would make more space available for recreation and greenbelts.)

Response: Flood plain management with local land use zoning, flood-proofing, early warning systems and flood insurance has been recommended for all of the major river basins. The use of flood plain management to reduce the growth in flood damages and facilitate the retention of open space was recognized by the Task Force (see Appendix VII, Flood Control, Appendix XV, Plan Formulation and page 4-23, Summary Report). The state, city and county governments already have authority to do flood plain management.

14. **Leaving an area undeveloped** should always be one of the choices considered. (The effect of not doing anything about a projected need should be compared with an estimate of how critical the need itself is.)

Response: Nondevelopment alternatives were considered throughout the planning process. (See page 1-11 Summary Report and Appendix XV, Plan Formulation). Retaining free-flowing rivers, zoning flood plains, and preserving unique and historical sites are some examples. The report will be revised to stress this alternative during detailed implementation studies.

15. **Wastes** from commercial vessels, ferries and pleasure craft and related shore facilities must be collected and properly treated. (Tax breaks or other inducements may encourage operators and builders of marinas to install sanitary, discharge and garbage facilities.)

Response: Sanitation requirements for pleasure boats and moorages are discussed in the Task Force report and appendices (see page 3-6 Summary Report, page 1-68, Appendix XIII, Water Quality Control and page 2-21, Appendix XV, Plan Formulation.) The need for proper waste collection from commercial vessels and pleasure craft will be further emphasized in the final version of the Summary Report.

16. The waters of Puget Sound should be studied and managed as **a single system.** (Major activities on one part of the Sound may have effects on distant parts of it. There is no consideration of Puget Sound as a transportation corridor for ferries which might be preferred to more highway corridors.)

Response: The navigation studies viewed the deep draft shipping potential of Puget Sound on a regional basis, with waterborne commerce projected for the entire area and then allocated to the various ports. The Summary Report will be revised to include a recommendation for a single planning entity for guiding future developments for waterborne commerce (see page 2-86, Appendix VIII, Navigation). In addition to the Navigation Committee other technical committees recognized the Sound as a single entity (see Appendix X, Recreation, Appendix XI, Fish and Wildlife, and Appendix II, Political and Legislative Environment). However, the Task Force agrees that further studies should place greater emphasis on Puget Sound as one eco-system and will include in the final version of the Summary Report a recommendation for conducting model studies of the Sound for use in forecasting effects of thermal plant cooling water discharges and municipal and industrial waste discharges. The report will be revised to include a recommendation of expanded ferry service as an alternative to cross-sound bridging of Puget Sound.

17. Stringent regulations must be imposed to avoid **oil spills** in Puget Sound. (The Alaska oil discoveries have dramatized the problem. The transport of other toxic substances must also be regulated. The importance of aquaculture and commercial and recreational fishing was emphasized).

Response: We agree. The importance of aquaculture and commercial and recreational fishing and boating in Puget Sound is discussed in the Task Force report and appendices. (See pages 3-20, 4-30 and 5-4, Summary Report; Ap-

pendix X, Recreation; page 7-3, Appendix II, Political and Legislative Environment and Appendix XI, Fish and Wildlife.) The concern over potential damage to these and other resources has prompted revision of the Summary Report to recommend concerted action by all responsible agencies to regulate vessel movements on Puget Sound and adjacent waters. This revision will include the recommendation that federal and state agencies and marine industry make joint studies leading to a navigation control system that will minimize the possibilities of collisions.

18. All levels of government should strive for **public participation** at the beginning and throughout all planning activities.

Response: We agree. She response to Issue 10.

19. Technological advances are needed to produce **more efficient small-scale units** for water supply and sanitation uses. (Outlying areas which are new or growing especially require such systems.)

Response: Those who need small-scale units should contact their county or city health departments or the State Departments of Ecology or Health and Social Services.

20. **Comprehensive planning, land use zoning, tax incentives, public purchase of development rights, and early acquisition of sites for preservation or development** should be considered as ways to deal with increasingly heavy demands on natural resources. (Many of these means could be used now at the local level).

Response: The Task Force report recommends early identification of sites for preservation or development in accordance with heavy demands on natural resources. Recommendations made in:

Appendix II, Political and Legislative Environment, Part 7

Appendix X, Recreation, pages 1-6 and 1-7

Appendix XI, Fish and Wildlife, pages 3-56, 3-78

will be included as part of the Summary Report by reference.

21. Communities with large summer (or winter) populations need methods to **finance** needed facilities for water supply and sanitation.

Response: The Task Force recognizes the need for more effective methods of financing both seasonal and long term facilities for water supply and sanitation. Specific discussions on financing are contained in:

Appendices II, Political and Legislative Environment, Part 7, page 7-3, *Administrative* and Financial Support.

Appendix VI, M&I Water Supply, pages 2-29, 2-30 and in each basin

Summary Report, Part 6.

Additional references will be included in the final version of the Summary Report.

22. Just what is meant by **watershed management**, and why are such large sums of money recommended for it in the report?

Response: Watershed management involves the activities of private developers, agriculture and forestry and federal, state and local government in construction of urban and suburban storm run-off systems, small dams and stock ponds, placement of riprap along stream banks, and land treatment and management for drainage and erosion control. Costs are large because most of the land in the Puget Sound area is affected. For specific references see:

Appendix V, Water-related Land Resources

Appendix XIV, Watershed Management

Appendix XV, Plan Formulation

Summary Report

23. **Irrigation** projections should be reconsidered for areas where farmland is being taken out of production because of encroaching residential or industrial use, or tax reassessment under threat of such use. (Farmers are in a state of uncertainty in such areas, and the need for irrigation water may decrease rather than increase. The effects of such losses of farmlands may be lessened by increased farming efficiency and by careful location of new and expanding developments to avoid use of the best farm land. Two new ideas, using cooling water from thermal power plants and irrigating forestlands, may also have an impact on future needs for irrigation water.)

Response: The projections for irrigation developments will be reviewed periodically. Present and future irrigation needs will be determined by the farmers involved. Possible use of thermal power plant cooling water for irrigation and the potential increase in forest production through irrigation will be examined during future detailed studies.

Specific references include:

Appendix VII, Irrigation, page 2-19

Appendix XV, Plan Plan Formulation, page 2-53

Summary Report, page 4-16

24. The effect of **tax policies** on land and resource-use policies should be carefully considered. Action should be taken to remedy pressures often caused by increased assessments to take land out of open space and recreation use. (It should be possible for land owners to agree to hold lands for later purchase by government. This is difficult under present law.)

Response: The Task Force will recommend in the final version of the Summary Report that federal, state and local governments reexamine current policies with regard to taxation to determine if desirable changes in resource use can be induced through modification in tax policy.

25. The large **projections of future power needs** should be re-examined. (Estimates of future demands for power and water should take into account the possibility of decreased as well as increased per capita use. A rationale to choose among different kinds of power generation must be developed, as well as better methods of choosing sites, especially for nuclear power plants. Advance purchasing of sites for future power plants should be considered. Citizens should be educated about muclear power.)

Response: The Task Force agrees. Projections of future power needs are based upon population and economic projections. If these projections should change when they are periodically re-examined, the projections of future power needs will also change.

A projection of decreased per capita use of electric power would require an increase in the projection of per capita use of other energy sources, such as natural gas, coal, oil, wood, paper, etc. for heating, cooking, clothes drying, etc. or a reduction in the standard of living.

There is a very definite rationale for choosing among different kinds of power generation based upon the most economic alternatives to hydroelectric generation. This rationale, termed "Value of Power" was developed by the Federal Power Commission and was endorsed and is followed by the private, public, and federal constructing agencies. (See Appendix IX, Power)

The Task Force endorses the formation of the Washington State Thermal Power Plant Site Evaluation Council. The Council is now examining sites when an interest is shown by a developing agency. Possibly in the future the council could evaluate and recommend advance purchase of sites which meet its criteria.

26. Among matters needing **early attention** are:

a. **Water supply and distribution problems.** (Some of the concerns expressed included maintaining the purity of municipal water by closed watersheds or by treatment, or by a combination of both; complete inventory of ground water supplies and appropriate conservation keeping them free of sewage or salt water pollution; what to do under the new water rights registration law, and the status of municipal water rights on various streams; skepticism about interbasin transfers; water tables and whether water supplies are being mined, and the need for recycling to help maintain water tables; the need for more efficient use of existing water resources as a first step in meeting future water requirements.)

Response: The Task Force discussed the problems of multiple-use of municipal watersheds and recommended additional studies be undertaken to determine the desirability and justification for opening these areas to recreational use (see page 4-29, Summary Report). A recommendation will be included in the final version of the Summary Report stressing the need for a complete regional inventory of ground water resources, and establishing a program to insure their conservation. Water rights are being reviewed under state law with all who desire a water right required to file with the Department of Ecology by 1974. More efficient use of existing water supplies will be reaffirmed in the final version of the Summary Report. For example, use of pipe instead of open ditches for irrigation; replacement of leaky water systems; and use of meters would allow a reduction in losses and wastage.

b. **Small boat harbors.** (Most agreed that more are needed, but there was dissatisfaction with some of the proposed locations.)

Response: Sites shown in the Task Force report for small boat harbors are listed as potential sites with detailed studies and public meetings required before final selection (See Appendix VIII, Navigation). Permits are also required from state and federal agencies before facilities can be constructed.

c. **Recreational access of various kinds.** (Some kinds of recreation seem to have been omitted, for example: clam digging, beachcombing and bird watching. Development of new or existing recreation areas must include planning for bicycle, horse and walking trails. What about the effect of existing or increased pollution on water-based recreation? Pollution can foreclose some recreation uses. The problem of flotsam and jetsam on Puget Sound is not dealt with.)

Response: Recreational planning undertaken by the Task Force incorporated the diverse forms of outdoor recreation activity. (See Appendix X, Recreation and Appendix XI, Fish and Wildlife). The final version of the Summary Report will be made more explicit in this regard.

Measures contained within the Comprehensive Plan are intended to eliminate or reduce the current level of water pollution. The problem of debris as related to pleasure boating was identified in Appendix VIII, Navigation. The Summary Report will recommend a study of debris prevention, control and removal.

d. Degree of **sewage treatment** required before dumping into Puget Sound or inland waters. (Many advocated secondary and tertiary treatment of wastes.)

Response: The Task Force report supports the Inter and Intra State Water Quality Standards (See page 4-18, Summary Report). Secondary and tertiary treatment may be necessary in some instances to meet these standards. Standards will be periodically reviewed and upgraded by the Environmental Protection Administration and the State of Washington Department of Ecology.

e. **Estuaries.** (Estuaries have special needs and values that should be considered separately.)

Response: The uniqueness and importance of Puget Sound estuaries are of concern to the Task Force and are discussed in Appendix X, Recreation, Appendix XI, Fish and Wildlife, Appendix XIII, Water Quality Control, Appendix XV, Plan Formulation, and the Summary Report where a separate section is provided on this subject discussing the need for a coordinated program of future use.

f. **Storm water.** (Should it be separated from other wastes? Treated with them? Diverted?)

Response: The Task Force supports separation of storm and sanitary sewers (see page 3-6, Summary Report). The final version of the Summary Report will recommend an investigation leading to a solution of pollution problems associated with storm runoff.

27. Do we really have**enough acres of land and gallons of water** to meet the projected needs. (Many uses–for example, waterfowl feeding and water-oriented industry–may be completely incompatible.)

Response: Enough land and water resources are available to meet the projected demands through the year 2020 for most uses if development follows the Comprehensive Plan. Finding this out was the purpose of the Task Force Study (See page 4-5, Summary Report).

SUPPLEMENT TO

ISSUES RAISED DURING PUBLIC

REVIEW OF STUDY FINDINGS

AND RESPONSES

Additional issues below were identified and raised in material received from various counties too late to be included in "Issues and Responses" distributed at the Final Public Hearings April 21 and 22, 1971. The Task Force response follows.

1. Some kinds of **experts** seem not to have been involved in the planning, for example, oceanographer, limnologist, planner-ecologist. Were there enough persons with an overall view, besides specialists or those with special interest?

Response: Through an interagency approach with multiple-discipline representation the Task Force sought to obtain an overall view.

2. Who decides how **Costs** are apportioned among various levels of government, and private users?

Response: Existing legislation establishes the basis for cost-sharing.

3. **Projections** are most appropriately made by regional agencies, since they can be more easily affected by regional policy, and can themselves in turn influence regional policy.

Response: The Task Force was the only regional body which had authority to make projections for the entire 12-county area.

4. **Computers** should be used to help keep the report current.

Response: Agree.

5. **Economic benefits** shown did not always reflect local judgment.

Response: Criteria on benefits used in the study were established by the National Water Resources Council. However, reference to "local judgement" took place throughout the study period when substantive liaison was established with local officials in the study area. This liaison took place before, during and after plan formulation.

6. **Solitude,** for example in a wilderness setting, is an absolute and its loss is also absolute. How can one arrive at its cost?

Response: No solution to this problem has yet been developed; nevertheless the Task Force sought to give intangibles thorough consideration during plan formulation.

7. The county workshops emphasized **local problems,** which was valuable, but sometimes the relationship to the whole region was obscured.

Response: This was perhaps a deficiency in the workshop effort. However, a goal of the effort was to relate local problems to the overall plan (see page 2 of Information Bulletin 4, Appendix I, Digest of Public Hearings, Volume III).

8. **Live-aboard vessels,** whose numbers are increasing, add to the problem of wastes from boats and ships.

Response: Agree, the Summary Report discusses this need on page 3-10.

9. Since **solid waste disposal** policies affect water quality and land use decisions, they should be discussed. Provision must be made for safe, adequate disposal of **dredging spoils** before any dredging projects are undertaken. **Air pollution** also affects water quality and should be taken into consideration.

Response: Agree, see Appendix VIII, Navigation for discussion of this problem.

10. Existing **ports** should be expanded, rather than allowing entirely new areas to be developed. Projections of future waterborne commerce seem too large. Revision would have a major effect on terminal land needs.

Response: Terminal land requirements make up a relatively small part of navigation-related lands (see Appendix VIII, Navigation, for basis of land needs determination). The Summary Report proposes control of port development through centralized planning (See Recommendation 13, page 7-3).

11. The increased **public participation** called for will cost money, for example to print more copies of materials. This money must be found.

Response: Agree; Task Force calls for Federal legislative action to allow Federal agencies to include the necessary funds for public participation in future planning budgets (see Summary Report, page 6-4).

12. How can **seasonal visitors**—both long-term, part-time residents and short-term tourists—be assessed their fair share of costs for water supply and sanitation facilities?

Response: By appropriate user fees and by taxes or charges on services and supplies directly related to vists by seasonal visitors.

13. Projections of vast increases in the **tourist industry** are unwelcome in some areas, especially where water supply and sewage facilities are already strained.

Response: If local governments in those areas desire to discourage the tourist industry, they can adopt this as their policy and use existing institutions and laws to implement that policy. For example they can deny tourist business as operating licenses; they can adopt land use restrictions and zoning, develop special laws that inhibit tourism; deny building permits; and build and operate their utility systems

with that thought in mind. The Task Force mission was not to discourage development but only to assure that what development does occur, occurs in accordance with guidelines that are likely to be environmentally acceptable.

14. **Tax incentives** (as for pollution abatement) should be used only with great care, and on a short-term basis.

Response: Agree.

15. An intermediate**unit of government**, like Metro in King County, is useful for basin-wide planning, able to deal with both local governments and State (and Federal) agencies.

Response: Agree.

16. Suggested techniques for slowing the rise in per capita **power consumption** should be discussed. The effect of possible future widespread use of electrical cars on power demand was not considered, nor were other future technical developments.

Response: Although no method for slowing the rise in power consumption was proposed, proper planning should assure equitable user charges, and will result in higher relative costs. This, in turn, will inhibit use. The use of electric cars and the energy requirements for pollution control, recycling of waste materials, rapid transit, or other future technical developments may well make the projected estimates of per capita consumption too low.

17. Potential **nuclear sites** should have been evaluated as to cost and environmental acceptability. Sources, transportation, and disposal of nuclear fuel should be taken into consideration.

Respose: Will be in future site studies.

18. More **weather and stream gaging stations** are needed for long-term water supply predictions and short-term flood warnings.

Response: This is recognized in the Summary Report (see pages viii and 2-12).

19. There should be more consideration of **fish other than salmon.**

Response: This is recognized in the Summary Report (see pages 2-12, 3-20 and 4-30).

20. The **basic goals** of the study which resulted in the selection or exclusion of alternatives in the plan are not revealed. The study should have considered changing public attitudes, and proposed alternate plans to accommodate changing situations. Decision-makers change, and their priorities change; the study must reflect these possibilities.

Response: Alternatives were presented and reasons for their rejection are given in Appendix XV, Plan Formulation (see "Basis of Planning" and "Alternative Elements" sections for each basin).

21. Future such plan teams should include **lay citizens.**

Response: Agree in principle but requirements for continuity (the individual make-up of citizen groups are constantly changing) may make it infeasible. However, all public participation in planning must be programmed as a continuing process and this includes public scrutiny of plan formulation.

22. There should be more suggestions for **new legislation** and changes in existing agencies and legislation, as well as recommendations for better enforcement or new means of enforcement of existing legislation.

Response: Suggestions have been made by the Task Force for legislative action at State and Federal levels (see Summary Report page 6-4).

23. There is no consideration of the relationship of **water pricing** and water use, and the practice of making small water users help subsidize facilities for larger water users.

Response: Although no method for slowing the rise in water consumption was proposed, proper planning would make certain that all costs identified with the water supply are included in the rate structure. This would include intangible costs and externalities as well as tangible costs. Progressive rate structures are being used in some countries to control use. Agree that small water districts should share in the cost savings resulting from regional water supply systems (see Appendix XV, Plan Formulation, Snohomish (pg 7-22) and Cedar-Green (pg 8-24) basins).

24. The relation between **upstream land development** and what happens downstream should be emphasized.

Response: See Appendix V, Water-Related Land Resources, and Appendix XIV, Watershed Management.

25. The **burden of recreational uses on the natural environment** is not enough recognized, for example fish wastes from hatcheries, oil and noise pollution from boats, erosion from trailbikes.

Response: Agree; this will have to be resolved by those actually administering the hatcheries, small boat traffic and trails.

26. **Flood control and watershed management** should be considered together rather than separately.

Response: Agree; the Task Force acted to assure that these few functions were coordinated in the comprehensive plan.

EVALUATION BY THE WORKSHOP COORDINATOR

During the workshop review, a problem frequently noted by participants was that of trying to judge a project solely on the basis of cost and benefit factors. This problem is exemplified in trying to evaluate the workshops by simply equating the time and effort expended against the workshop results. Much of the benefit that can be assigned to the workshops is, as yet, impossible to measure; not only because of the abstract nature of many of the recommendations but also because the ultimate use made of those recommendations can only be judged by observing the course of resource management from here on in the future.

An obvious major benefit was that 500-plus workshop participants were made aware of the findings of the first regional analysis of water resources in the Puget Sound area. The counterpart of this basic communication process was that the resource-managing agencies also learned from the experience. Hopefully, the result will be that both the public and government have a reinforced attitude to work toward the ideal of involving all those who are willing in guiding how the resources are managed.

A more specific benefit of the workshops was that participants were able to make their opinions known on the individual projects contained in the Puget Sound study. The opinions covered a broad front and comments ranged from major support for some projects to criticism that some projects were being resurrected in the report despite long-standing local opposition. Without any attempt to weigh the attitudes for and against a project, the benefit rests in the fact that those attitudes, as well as those projects, were brought to the surface for discussion and examination.

It should be noted that many of the workshop comments cited extremely detailed data corrections. These corrections will be useful in future work on the study to bring it up to date. Therefore, this detailed information, as well as all other comments, will be retained intact for the use of the organization that will perform the updating. (Comments received from workshops are contained in an unpublished appendix. The unpublished appendix is available for inspection from the Washington State Department of Ecology, P. O. Box 829, Abbott Rathael Hall, St. Martin's College, Olympia, Washington.)

Due to the desire by more and more people to have some understanding of, and influence on the future of natural resources, considerable thought has been given to methods of improving public participation. Suggested guidelines for public participation in future planning studies follow this section. However, there are basic points that should be noted here—not only to provide a better perspective of the comments, but also for the purpose of describing the various pitfalls and successes in order that anyone who attempts similar activities in the future can gain from the experiences of the Puget Sound study workshops.

The entire workshop program was designed to be conducted in a very informal and unstructured manner even though this approach was frequently challenged when meetings were held in the formal and imagination-stifling atmosphere of a courtroom. Furthermore, without firm guidance, the workshop discussions sometimes departed from the overall purpose of the meetings and resulted in debate between participants and local officials over narrow and often coveted subjects that did not relate directly to the findings of the Puget Sound study.

The undirected approach to the workshops, the difficulty in attracting participants who were willing to do in-depth studying, and the frequent tendency of participants to review only one, two or three favorite subjects, sometimes combined to result in comments that were inappropriate or out of context with the study. Some comments pertained to information contained elsewhere in the report while other comments noted information that had never been intended for inclusion in the study.

Most of the problems could be overcome by using a study coordinating staff rather than a single coordinator, a more ordered and nearly step-by-step review procedure and the most important requirement of all—early, and more detailed evaluation of the participants as to the purpose of their involvement and the consideration that would be made of their thoughts and ideas. It is also essential that this early education include the purpose and degree of detail that is intended in the final report on plans that they are helping to produce.

The workshop program waited almost inactively for nearly six months between the time of announcement and the actual beginning of meetings. The delay was the result of staff and financial deficiencies in local government, not a sufficiently long preparation time, unfamiliarity with the work-

shop concept, absence of local coordinators who could initiate the program and, in some cases, governmental apprehension toward the program.

Once started, the workshop discussions and the written comments frequently showed knowledgeable thinking but did not often result in concensus opinions although numerous issues were repeated in several counties. The major issues and the responses to those issues by the Puget Sound Task Force are contained elsewhere in this exhibit (See pages C-17 and C-25). In addition, other common interests can be identified by comparing the subjects that are noted in the preceding workshop summaries.

Nevertheless, although concensus within a single workshop group was not the usual occurrence, this fact should not be an unmanageable frustration to the resource planners but rather a guide to a more extensive program in the future.

In brief, the workshops were a positive step in public participation. The comments from the workshops, while not often showing unanimous attitudes, did reveal an encouraging degree of interest and awareness by participants. It is incumbent upon government to cultivate that awareness through improved methods of early public participation that must include a basic education on any planning program that is being started, broadening of frequently found "backyard" protectiveness, and finally governmental consideration and response to ideas expressed by participants.

Equally, it is incumbent upon the public when finding the opportunity to participate, to do so in the spirit of constructive and shared government. The extra effort and costs required of the public to actively work at participation can perhaps be eased in the future by increased budgets within government that are earmarked for that particular purpose. Until the time when that assistance is made available, the work done by the public must be expected to include the gritty duties as well as the glorious aspects that are imagined of planning.

The workshop program of the Puget Sound study achieved a degree of pioneering in public involvement but more importantly it acted as a new educational experience for both public and government with the resulting benefits for exceeding the costs.

SUGGESTED GUIDELINES

FOR

FUTURE PUBLIC

PARTICIPATION

The county workshops for the Puget Sound and Adjacent Waters Study provided valuable experience in planning for and dealing with public participation in water resources planning. The following suggestions are based primarily on this experience.

In the beginning.—Public participation should be part of the program, planned for and budgeted for from the beginning of the study. It must be a continuing activity and be understood to be a continuing activity. Those running the program must be committed to the idea and its value. The public will quickly detect if this is not the case. They must be convinced that what they say and do in the public participation process can make a difference in the final results; otherwise participation will be small. A continuing process will help accommodate changing ideas over time, and will help bring both the public and the planners along together.

How to start.—Responsibilities must be clear. The entity having primary responsibility for public involvement must be clearly designated. Followup, preparation and sending out of notices, contacting of the press, arranging for a meeting place, and taking care of other attendant matters should be done by this entity. At the first public meetings planners should discuss the scope and purposes of their study and lay out alternatives in broad outlines, with widespread publicity and appropriate written material available. After the planners and other professionals have heard from the public and governmental bodies with regard to desired goals, they can begin discussing different ways of reaching these goals. During subsequent meetings with the public alternatives should be discussed completely and gradually narrowed to several which merit detailed investigation. The whole planning process must display the alternatives clearly, so people understand the choices open to them.

Publicity.—Individual notices (specific and simply written) should be mailed to known interested people. They should be encouraged to invite their friends and associates. Everything should make the gatherings sound interesting and open to all. Those who are not really interested will drop out anyhow. The chairman or coordinator must have time and appropriate contacts to get publicity in local newspapers and on radio and TV. It may be appropriate to post notices in some areas. If there is a printed information bulletin, it should be clear, non-technical, and informative. There should be an effort to get publicity throughout the process. Controversy will help, and will help keep people coming.

Who should come.—All kinds of people should come, but many will not. Every effort must be made to assure the attendance of persons known to beinterested in water resources and public affairs, including, for example, those from farm groups, chambers of commerce, garden clubs, public utilities, labor unions, industries, conservation and environmental organizations, students, and governmental agencies. There should never be any question that some type of person would not be welcome. Public officials and civil servants should come, but should not overwhelm the group, either by their numbers or their expertise. People working on the study should come prepared to explain why they are doing what they are doing. Even if the best person to answer a specific question is not there, it reassures people to see that real live human beings are doing the study.

When and where.—Time and place should be convenient and suitable for the general public in the area. In most communities weekday evenings are best, but community custom may be different and should rule. The place should be centrally located in the geographical area, easy to find, and if possible, comfortable or at least not forbidding. It is ideal to be able to gather around a table, far from ideal to have to sit in a sloped amphitheater.

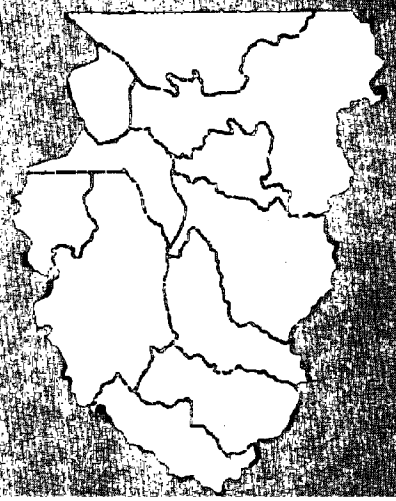
What to have at meetings.—Maps and displays may be helpful. There must be adequate materials available for those who want and need them. A digest of lengthy material is enough for most people. Those who are really prepared to work can be given the more complete material. The formal governmental review process should not be allowed to forestall

public scrutiny of plans in the making. There should be an attendance sheet at each meeting, which should ask for affiliations. The contribution of a public relations director for a local office of a national industry, and that of an officer of a group of 500 local citizens, may be evaluated somewhat differently as might that from one outspoken college student compared to a resident living in a problem area.

What to do at meetings.—Some sort of organization should be set up at the first meeting. One or more prospects for chairman can be lined up in advance, and if the group does not immediately organize itself, one of these people can volunteer. The job need not be difficult, and it helps assure continuity. Members of a volunteer group (like the League of Women Voters) could do this, if proper approaches are made to them in advance. Needed staff help, and money for postage and other expenses, should be furnished to any such volunteers. Meetings should be run informally, but moderated in a businesslike way, without technical jargon, intimidation, or defensiveness. Difficult participants can be tolerated for awhile and then turned off gently. Everyone's contribution should be welcomed, as long as he lets others have their say. Both spoken and written material may be presented.

How to followup.—It is a good idea to try to get people to write down what they think. It will be more organized if they have taken time to think it over and summarize it, and it is easier to deal with. It can be read back or distributed to the group for further comment (with the writer's permission). But, in addition, somebody should take full notes of all the meetings to capture their flavor and make sure that no useful information escapes. Planners should not be discouraged by lack of attendance, misunderstanding, and distrust. If people get feedback from the planners, and see that changes are made as a result of what they say, more trust and cooperation will develop for the future.

Exhibit D
Final Public Hearings



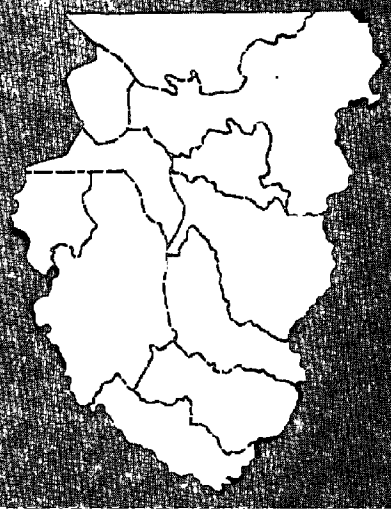
SUMMARY FINAL PUBLIC HEARINGS

Bremerton Hearing: Approximately 60 persons were in attendance with about 50 percent being from agencies that participated in the Puget Sound and Adjacent Waters Study. No prepared testimony was received, although several questions were asked by the audience with regard to the costs of measures proposed by the Task Force.

Seattle Hearing: Approximately 150 persons attended the hearing with about 30 of these being from agencies that participated in the Puget Sound Study. Twenty persons presented prepared testimony at the hearing and eight submitted written testimony subsequent to the hearing. The study was generally viewed as a good inventory of the Puget Sound area resources, useful to local resource planning authorities. However, provision for updating the study was strongly urged.

Some disagreement with current planning by the city of Seattle Water Department was noted. The study was criticized for not giving adequate recognition to Indian water rights. Concern was expressed over possible adverse environmental impacts that could result from small watershed projects. Some expressed the view that future planning should be toward desired goals of population and economic development rather than for trends. Retention of the Snoqualmie River valley from Fall City to Snohomish in a greenbelt was desired. The Middle Fork Snoqualmie Dam was recognized as having value in reducing flood hazards and thereby allowing an improvement in agricultural enterprise. A need was expressed for a factual ecological study. (See Appendix I, Digest of Public Hearings, Volume III, for presentation of verbatim testimonies).

Glossary



GLOSSARY

Acre-Foot (ac. ft.)—A unit commonly used for measuring the volume of water or sediment; equal to the quantity of water required to cover one acre to a depth of one foot and equal to 43,560 cubic feet or 325,851 gallons.

Alluvium—Soil material, such as sand, silt, or clay, that has been deposited by water.

Anadromous Fish—Species that are hatched in fresh water, mature in salt water, and return to fresh water to spawn.

Angler-day—A day or any part of a day spent fishing by an individual.

Aquifer—A rock formation, bed, or zone containing water that is available to wells. An aquifer ay be referred to as a water-bearing formation or water-bearing bed.

Arable Lands—Lands which are delineated by classification procedure as suitable for irrigation development.

Artesian Water—Ground water under sufficient pressure to rise above the level at which the water-bearing bed is reached in a well. The pressure in such an aquifer commonly is called artesian pressure, and the rock containing artesian water is an artesian aquifer.

Base Flow—See Base Runoff.

Base Runoff—Sustained or fair weather runoff. In most streams, base runoff is composed largely of ground water effluent. The term base flow is often used in the same sense as base runoff. However, the distinction is the same as that between streamflow and runoff. When the concept in the terms base flow and base runoff is that of the natural flow in a stream, base runoff is the logical term.

Basin—A geographic area drained by a single major stream. For the purposes of this study the Puget Sound and Adjacent Waters Area has been subdivided into the following nine basins and the Whidbey-Camano and San Juan Islands.

1. Nooksack-Sumas
2. Skagit-Samish
3. Stillaguamish
4. Snohomish
5. Cedar-Green
6. Puyallup
7. Nisqually-Deschutes
8. West Sound
9. Elwha-Dungeness

BOD (Biochemical Oxygen Demand)—The quantity of oxygen utilized in biochemical oxidation of organic matter in a specified time and at a specified temperature. It is determined entirely by the availability of the material as a biological food and by the amount of oxygen utilized by the micro-organisms during oxidation. Usually expressed in terms of BOD_5, it is the quantity of oxygen utilized in a five-day period at 20° C.

Bottom Land—Lowland formed by alluvial deposits along a river or stream.

Capacity Factor (Electric Power)—The ratio of the average load on the generating plant for the period of time considered to the capacity rating of the plant.

Capital Expenditures—Outlays for plant and equipment which are normally charged to fixed asset accounts.

cfs (Cubic Foot per Second)–A unit of discharge for measurement of flowing liquid equal to a flow of one cubic foot per second past a given section. Also called second-foot.

Channel Storage–The volume of water at a given time in the channel or over the flood plain of the streams in a drainage basin or river reach. Channel storage is sometimes significant during the progress of a flood event.

Chlorination–The application of chlorine to water, sewage, or industrial wastes generally for the purpose of disinfection, but frequently for accomplishing other biological or chemical results.

COD (Chemical Oxygen Demand)–The quantity of oxygen utilized in the chemical oxidation of organic matter. It is a measure of the amount of such matter present.

Coliform Bacteria–A species of genus escherichia bacteria, normal inhabitant of the intestine of man and all vertebrates.

Construction Cost–The total cost of construction, including real estate, engineering, design, administration and supervision.

Consumptive Use–The quantity of water discharged to the atmosphere or incorporated in the products in the process of vegetative growth, food processing, industrial processes, or other use. Hence, the amount of water no longer directly available.

Consumptive Use Irrigation–All withdrawals are considered to be consumptive unless the full amount of the withdrawal is returned to the source.

Demand (Fish and Wildlife)–The number of hunter-days, angler-days, non-hunting or fishing use, or commercial harvest that are expected at a given date.

Demand–A need or desire. (Differs from the usual economic definition of demand under which a need is not necessarily reflected in a demand.)

Depletion, Streamflow–The amount of water that flows into a valley, or onto a particular land area, minus the water that flows out of the valley or off from the particular land area.

Design Load–The maximum number of recreationists expected to use an area at any one time on an average weekend day during the peak month of annual visitation for which facilities and land or water would be provided.

Discharge–In its simplest concept, discharge means outflow; therefore, the use of this term is not restricted as to course or location and it can be used to describe the flow of water from a pipe or a drainage basin.

Discharge, Average–The arithmetic average of the annual discharges for all complete water years of record whether or not they are consecutive. The term "average" is generally reserved for average of record and "mean" is used for average of shorter periods; namely daily mean discharge.

Diversion–The taking of water from a stream or other body of water into a canal, pipe or other conduit.

DO (Dissolved Oxygen)–The oxygen dissolved in water or other liquid, usually expressed in milligrams per liter or percent of saturation.

Domestic Coastwise Receipts and Shipments–Domestic waterborne commerce receiving a carriage outside of the Puget Sound Area.

Domestic Internal Receipts and Shipments–Domestic waterborne commerce between ports or landings wherein the entire movement takes place within Puget Sound Area.

Drainage Area–The drainage area of a stream, measured in a horizontal plane, which is enclosed by a drainage divide.

Drainage Basin–A part of the surface of the earth that is occupied by a drainage system, which consists of a surface stream or a body of impounded surface water together with all tributary surface streams and bodies of impounded surface water.

Drainage Divide–The line of highest elevations which separates adjoining drainage basins.

Economic Base Study–A study which evaluates the economic structure of the region to provide economic projections necessary for the appraisal of future water resource needs.

Effective Precipitation–That part of the precipitation falling on a crop area that is effective in meeting the consumptive use requirements of the crop.

Effluent–Municipal or industrial waste water which is partially or completely treated or in its natural state, flowing from a process basin, or treatment plant.

Environment–The total of all external factors that affect an animal. Not to be confused with Habitat, which refers to the place where an animal is found.

Erosion, Bank–Destruction of land areas located adjacent to a stream from the erosive action of high stream discharges.

Escapement–Number of anadromous fish that return from the ocean to fresh-water streams and spawn.

Estuary–Semi-enclosed body of water which has a free connection with the open sea and within which ocean water is measurably diluted with fresh water derived from land drainage.

Eutrophication–The process of over-fertilization of a body of water by nutrients which produce more organic matter than the self-purification processes can overcome.

Exceedence Frequency–Percent of values that exceed a specified magnitude.

Farm Delivery Requirement–The amount of water in acre-feet per acre required to serve a cropped area from a canal or pipe turnout. It is the crop irrigation requirement plus farm waste and deep percolation.

Fingerling–Young fish which are self-subsistent, but not yet mature.

Firm Power–Power intended to have assured availability to the customer to meet all or any agreed upon portion of his load requirements.

Fish Farm–A controlled natural rearing impoundment or relatively small pond for fish.

Flood–Any relatively high streamflow or an overflow or inundation that comes from a river or other body of water and causes or threatens damage.

Flood Peak—The highest value of the stage or discharge attained by a flood; thus, peak stage or peak discharge. Flood crest has nearly the same meaning but, since it connotes the top of the flood wave, it is properly used only in referring to stage.

Flood Plain—A strip of relatively smooth land bordering a stream that has been or is subject to flooding. It is called a "living" flood plain if it is overflowed in times of high water, but a "fossil" flood plain if it is beyond the reach of the highest flood.

Flood, Probable Maximum—The largest flood for which there is any reasonable expectancy in the geographical region involved.

Flood Stage—The stage at which overflow of the natural banks of a stream begins to cause damage in the reach in which the stage is observed.

Flood, Standard Project—A hypothetical flood that might result from the most severe combination of meteorological and hydrological conditions that are reasonably characteristic of the geographical region involved. The SPF is an important consideration for design of flood control structures.

Floodway—The channel of a river or stream and those parts of the flood plains adjoining the channel which carry and discharge the floodwater or floodflow of any river or stream.

Food Fish—In Washington, those species of fish which may be harvested and sold as a commercial venture.

Foreign Imports and Exports—Waterborne commerce between the Puget Sound Area and foreign ports including the Canal Zone.

Freeboard—The vertical distance between a design maximum water level and the top of a structure. This space is utilized for safety.

Gaging Station—A particular site on a stream, canal, lake or reservoir where systematic observations of gage height or discharge are obtained.

Game Fish—In Washington, those designated species of fish which may be taken by sporting means only.

Gigawatt (gw)—One million kilowatts.

gpcd—Gallons per capita per day.

gpd—Gallons per day.

Ground Water—Water in the ground that is in the zone of saturation from which wells, springs and ground water runoff are supplied.

Habitat—Area which supplies food, water, shelter, and space necessary for a particular animal's existence.

Harbors of Refuge—A temporary haven for small craft in distress or seeking shelter from approaching storms; also a safe place of rest and replenishment for transient boats.

Hardness—A characteristic of water; chiefly due to the existence therein of the carbonates and sulfates and occasionally nitrates and chlorides of calcium, iron, and magnesium; which causes "curdling" of.

Hunter-day—A day or any part of a day spent hunting by an individual.

Hydrogen Ion Concentration (pH)—The weight of hydrogen ions in grams per liter of solution. Commonly expressed as the pH value that represents the logarithm of the reciprocal of the hydrogen ion concentration.

Hydrologic Cycle—A term denoting the circulation of water from the sea, through the atmosphere, to the land; and, thence, with many delays, back to the sea by overland and subterranean routes, and in part by way of the atmosphere without reaching the sea.

Industrial Water—The industrial category includes those major water-using industries whose size is related to a significantly larger population than that of the local area and whose water needs are normally supplied through a municipal distribution system. For the purposes of this analysis, these industries are the following:

Pulp and paper
Other major forest products
Food processing
Petroleum processing
Primary metals
Thermal and nuclear power

Infiltration—The flow of the fluid into a substance through pores or small openings. It connotes flow into a subs· in contradistinction to the word percolation, which connotes flow through a porous substance.

Interception (Hydrology)—The process of storing rain or snow on leaves and branches or other objects which eventually evaporates back to the air.

Intraport Receipts and Shipments—Which include waterborne commerce between the arms or channels of a port, as between the inner and outer harbor of the Port of Seattle, and local traffic movement of freight and passengers within the confines of a single arm or channel of a port.

Irrigated Land—Land receiving water by controlled artificial means for agricultural purposes from surface or subsurface sources.

Irrigation Conveyance Loss and Waste—The loss of water in transit from a reservoir, point of diversion, or ground water pump (if not on farm) to the point of use, whether in natural channels or in artificial ones, such as canals, ditches, and laterals.

Irrigation Depletion—The amount of diverted water consumptively used, beneficially and nonbeneficially, in serving a cropped area. It is the gross diversion minus return flow.

Irrigation Requirement, Crop—The amount of irrigation water in acre-feet per acre required by the crop; it is the difference between crop consumptive use requirement and effective precipitation.

JTU (Jackson Turbidity Units)—The JTU is a measurement of the turbidity, or lack of transparency, of water. It is measured by lighting a candle under a cylindrical transparent glass tube and then pouring a sample of water into the tube until an observer looking from the top of the tube cannot see the image of the candle flame. The number of JTU's varies inversely with the height of the sample (e.g., a sample which measures 2.3 cm has a turbidity of 1,000 JTU's whereas a sample measuring 72.9 cm has a turbidity of 25 JTU's).

Kilowatt (kw)—The electric unit of power which equals 1,000 watts or 1.341 horsepower.

Kilowatt-Hour (kwh)—The basic unit of electric energy. It equals one kilowatt of power applied for one hour.

Lagoon—A relatively shallow basin, built by excavation of the ground and diking, for the purpose of treating wastes by storage under conditions that favor natural biological treatment and accompanying bacterial reduction.

Land Use—Primary occupier of a tract of land grouped into classes with similar characteristics, i.e., cropland, rangeland, forest land, or other.

Load Factor—The ratio of the average load over a designated period to the peak-load occurring in that period.

Man-day—Synonymous with angler-day and/or hunter-day.

Major Replacement Costs—Costs of replacement of rehabilitation of major structural or equipment items within the project life.

Marina—A marine development having moorages. Other facilities may be available, including repair facilities, bait, tackle and general supply services. Restaurants and hotels or motels are often part of a modern marina complex.

Marine Fish—All fish species that spend their entire life in salt water. Includes bottom fish such as flounder and sole.

Megawatt (mw)—One thousand kilowatts.

Megawatt-Hour (mwh)—One thousand kilowatt-hours.

mgd—Millions of gallons per day.

mg/l—Milligrams per liter.

Moorage Facility—One or more piers, wharves, floats, or permanently anchored buoys to which boats can be secured and left in the water for storage purposes; or land or deck storage areas used with hoists or inclined railways.

MPN (Most Probable Number)—In the testing of bacterial density by the dilution method, that number of organisms per unit volume which, in accordance with statistical theory, would be more likely than any other possible number to yield the observed test result or which would yield the observed test result with the greatest frequency. Expressed as density of organisms per 100 ml.

Municipal Water—The municipal category includes not only urban domestic water use but also those other civic, commercial, and small industrial uses which are typically supplied through a municipal distribution system and the magnitude of which is related to local population.

Nonconsumptive—Nonconsumptive uses related to surface water only, are where no water is diverted from the confines of the surface water source area or channel, where the waters pass over, under, around or through an on-stream project, or when being diverted (effectively) at the upstream edge of a project and being returned (effectively) to the channel at the downstream edge of a project. It is considered nonconsumptive water use when water diverted from a surface water source is returned to the same source at any location upstream from the point of diversion. Transportation losses, evaporation, and seepage are not considered consumptive.

Nonstructural Measures—Measures for managing, utilizing, or controlling water and related lands without structural development to achieve the desired objective. Such measures include flood plain zoning, flood warning systems, legal restraints, and preservation, as well as the more common land management measures.

Operation and Maintenance Costs—Average annual costs of project operation and normal maintenance.

Opportunities—Potential developments or potential utilization capable of being realized.

Outdoor Recreation—Leisure time activities which utilize an outdoor setting.

Outdoor Recreation Activity—A specific leisure time action or pursuit in an outdoor environment.

Outdoor Recreation Area—A land and/or water area where outdoor recreation is recognized as the dominant or one of the major resource management purposes.

Outdoor Recreation Site—A tract of land developed for specific recreation activities.

Outdoor Recreation Unit—A facility or group of complementary facilities designated to accommodate a family or other small group.

Outfall—A sewer, drain, or conduit from which sewage, industrial wastes, or drainage is discharged.

Peak Load—The maximum load in a stated period of time. Usually it is the maximum integrated load over an interval of one hour which occurs during the year, month, week, or day. It is used interchangeably with peak demand.

pH—See Hydrogen Ion Concentration. The neutral value of pH is 7.0. Higher values indicate an alkaline solution and lower values indicate an acid solution.

Population Equivalent (PE)—The average daily amount of BOD_5 exerted by the organic waste from one person. A value of 0.17 pounds of BOD_5 is normally equated to one PE.

Potential Pleasure Boat Mooring Harbors—Harbors under this category are sites now developed for pleasure boat moorages or having physical characteristics suitable for this use.

Potential Terminal Facilities—Waterfront open space that is suitable for waterborne commerce terminals and generally includes water area out to the pier head line or about 40 feet depth below MLLW.

Potential Water Transport-Oriented Industries—Open space areas suitable for water transport-oriented industry including waterfront land not required for terminal facilities and inland to a maximum of about 5 miles from possible deep water transport terminal.

Potentially Irrigable Land—Land having soil, topography, drainage, and climatic conditions suitable for irrigation.

ppm—Parts per million.

Primary Waste Treatment—The removal of settleable, suspended, and floatable solids from waste water by the application of mechanical and/or gravitational forces. In primary treatment, unit processes such as sedimentation, flotation, screening, centrifugal action, vacuum filtration, dissolved air flotation, and others designed to remove settleable, suspended, and floating solids have been used. Generally, a reduction in dissolved or colloidal solids has been obtained in primary treatment, but this effect is incidental and not the planned purpose of primary treatment.

Public and Private Marine Facilities–Public facilities refer to marine facilities operated by public agencies such as State, counties, cities, and ports for use by the general public. Private facilities refer to marine facilities operated for profit by private ownership. They are available for general public use.

Puget Sound Area–The twelve counties in northwestern Washington bordering Puget Sound and Adjacent Waters. These consist of Whatcom, San Juan Island, Skagit, Snohomish, King, Pierce, Kitsap, Thurston, Mason, Jefferson, and Clallam Counties. Only Puget Sound and adjacent saltwaters were examined with reference to marine facilities and boating demand. Lake Washington was included as an extension of Puget Sound.

Range–Land area used by an animal. Most common reference is to the seasonal ranges (winter, summer, fall/spring) used by big game animals.

Recurrence Interval–The average number of years within which a given event will be equaled or exceeded.

Registered Boat–An undocumented craft propelled by an engine of more than 10 horsepower, used on navigable waters of the United States and registered by the United States Coast Guard, as requred by the Federal Boating Act of 1958.

Rehabilitation–Chemical treatment of a body of water to remove undesirable fish populations, followed by restocking with desired species. Term is also used to mean renovation of land.

Resident Fish–Species that spend their entire life cycle in a fresh-water environment.

Reservoir–A pond, lake or basin, either natural or artificial, for the storage, regulation, and control of water.

Return Flow (Irrigation)–Irrigation water applied to an area which is not consumed in evaporation or transpiration and returns to a surface stream or ground water aquifer.

River Reach–Any defined length of a river.

Runoff–That part of the precipitation that appears in surface streams. It is the same as streamflow unaffected by artificial diversions, storage or other works of man in or on the stream channels.

Runoff, Average Annual–Average of water year runoff in inches or acre-feet for the total period of record.

Salinity– The relative concentration of dissolved salts in seawater and is determined by various methods when compared to the international standard of Eau de Mer Normale. Usually expressed in parts per thousand=0/00.

Salmonid–Refers to cold-water fishes of the family salmonidae. Represented by the salmon, trout, whitefish, and chars (such as Dolly Varden and brook).

Scrap Fish–Pertains to marine species. Includes all mixed fish purchased for reduction or animal feed which dealers have not separated as to species. Mostly dogfish, hake, and tomcod.

Secondary Treatment–The removal of dissolved and colloidal materials that, in their natural state as found in waste water, are notamendable to separation through the application of primary treatment. Secondary treatment will generally reduce the BOD_5 of sewage by 85 percent.

Sediment–(1) Any material carried in suspension by water which will ultimately settle to the bottom after the water loses velocity. (2) Fine waterborne matter deposited or accumulated in beds.

Service Areas—An area described for planning purposes whose boundaries would include the future population or industrial activities which could logically and functionally obtain water supply and waste disposal services from a central or integrated system or where the problems are so interrelated that the planning should be done on an integrated basis.

Sludge—The accumulated settled solids deposited from sewage or industrial wastes, raw or treated.

Storage—Water naturally or artificially impounded in surface or underground reservoirs.

Storage Capacity, Active (Usable)—The volume normally available for release from a reservoir below the stage of the maximum controllable level (total capacity less inactive and dead capacity).

Storage Capacity, Dead—The volume of a reservoir below the sill or invert of the lowest outlet.

Storage Capacity, Exclusive Flood Control—The space in reservoirs reserved for the sole purpose of regulating flood inflows to abate flood damage.

Storage Capacity, Surcharge—The volume of water in a reservoir between the designed maximum water surface elevation and normal pool elevation for either a gated or ungated spillway.

Storage Capacity, Total—The total volume of a reservoir exclusive of surcharge.

Stream—A general term for a body of flowing water. In hydrology, the term is generally applied to the water flowing in a natural channel as distinct from a canal. More generally, as in the term stream gaging, it is applied to the water flowing in any channel, natural or artificial.

Streamflow—The discharge that occurs in a natural channel. Although the term discharge can be applied to the flow of a canal, the word streamflow uniquely describes the discharge in a surface stream.

SWL—An abbreviation for sulfite waste liquor, a by-product of sulfite-type pulp and paper mills.

Terminal Facilities—The area of piers, wharves, open and covered storage areas used for waterborne commercial cargo and passenger service together with mooring areas for such vessels.

Tertiary (Advanced) Treatment—Selective application of biological, physical, and chemical separation process to effect removal or organic and inorganic substances, primarily phosphorous and nitrogen, that resist conventional treatment practices.

User-days—Of general recreation, angling and/or hunting; expressed demand.

Water-Related Activities—Those activities that are water-based or enhanced by water.

Watershed—A term to signify drainage basin or catchment area.

Water Table—The upper surface of a zone of saturation. No water table exists where that surface is formed by an impermeable body.

Water Transport-Oriented Industries—Waterfront and other lands being used by industries that require or gain a significant advantage by nearness to water transport facilities. Industries of this type are:

Transportation Equipment Manufacture
Primary Metal Manufacture

Chemicals and Allied Products Manufacture
Petroleum Refining and Related Industries
Paper and Allied Products Manufacture
Wholesalers With Stocks, Distributors
Lumber and Wood Products Manufacture
Stone, Clay and Glass Products Manufacture
Warehousing and Storage

Water Yield–Runoff, including ground water outflow that appears in the stream, plus ground water outflow that leaves the basin underground. Water yield is the precipitation minus the evapo-transpiration.

Zero Damage Flow–The maximum flow a stream can carry without causing overbank flow and damages.

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