NUREG-0894

Draft Environmental Statement

related to the construction of
Skagit/Hanford Nuclear Project,
Units 1 and 2

Docket Nos. STN 50-522 and STN 50-523

Puget Sound Power & Light Company
Pacific Power and Light Company
The Washington Water Power Company
Portland General Electric Company

U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Washington State
Energy Facility Site Evaluation Council
Olympia, WA 28504

Cooperating Agencies:

U.S. Department of Interior
Bureau of Reclamation
Boise, ID 83724

U.S. Department of Energy

- Richland Operations Office
  Richland, WA 99352
- Bonneville Power Administration
  Portland, OR 97208

NOTICE

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   Washington, DC 20555
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Documents available from the National Technical Information Service include NUREG series reports and technical reports prepared by other federal agencies and reports prepared by the Atomic Energy Commission, forerunner agency to the Nuclear Regulatory Commission.

Documents available from public and special technical libraries include all open literature items, such as books, journal and periodical articles, and transactions. *Federal Register* notices, federal and state legislation, and congressional reports can usually be obtained from these libraries.

Documents such as theses, dissertations, foreign reports and translations, and non-NRC conference proceedings are available for purchase from the organization sponsoring the publication cited.

Single copies of NRC draft reports are available free upon written request to the Division of Technical Information and Document Control, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

Copies of industry codes and standards used in a substantive manner in the NRC regulatory process are maintained at the NRC Library, 7920 Norfolk Avenue, Bethesda, Maryland, and are available there for reference use by the public. Codes and standards are usually copyrighted and may be purchased from the originating organization or, if they are American National Standards, from the American National Standards Institute, 1430 Broadway, New York, NY 10018.

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Manuscript Completed: April 1982
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SUMMARY AND CONCLUSIONS

This Environmental Impact Statement (EIS) was prepared by the U.S. Nuclear Regulatory Commission, Office of Nuclear Reactor Regulation, jointly with the Washington State Energy Facility Site Evaluation Council. The U.S. Department of Energy, Bonneville Power Administration, and the U.S. Bureau of Reclamation were cooperating agencies.

1. This action is administrative.

2. The proposed action is the issuance of construction permits to the Puget Sound Power and Light Company, Pacific Power and Light Company, The Washington Water Power Company, and Portland General Electric Company for the construction of the Skagit/Hanford Nuclear Project, Units 1 and 2, Docket Nos. STN 50-522 and STN 50-523.

   The Skagit/Hanford Nuclear Project (S/HNP), located on the U.S. Department of Energy Hanford Reservation in Benton County, Washington, will employ two boiling-water nuclear reactors, each with a maximum expected thermal power level of 3800 MWt and the net electrical capacity of 1275 MWe.

   The exhaust steam from the turbine generators will be cooled by a condenser, and the waste heat will be dissipated to the atmosphere by round mechanical-draft cooling towers. The cooling water will be drawn from the Columbia River, and the cooling tower blowdown will be returned back to the river where it will be discharged through a diffuser.

3. Summary of environmental impact and adverse effects:

- Approximately 258 hectares (640 acres) of the Hanford Reservation sagebrush/cheatgrass community will be diverted to industrial use for the duration of the S/HNP life (Appendix I).

- Increases in erosion and sediment transport due to construction activities would temporarily degrade the local receiving water quality.

- Alteration of drainage, percolation, and runoff patterns would result from project construction.

- 1.58 to 2.12 cubic meters per second (56 to 75 cubic feet per second) of water would be taken from the Columbia River at river mile 361.5 and would not be returned to the river.

- High volumes of commuter traffic on the site access road, Route 240, Bypass Highway, and other facilities would cause increased noise and air pollution of the types commonly associated with traffic movement.

- The construction of the site commuter access road, the widening of Route 240, and intersection improvements would commit construction materials and other resources that would not be retrievable after completion of project construction.

- Inadvertent loss of, or damage to, undiscovered cultural resources would be a possible unavoidable impact concomitant with any construction project.

- There would be a slight increase in the potential for fog and surface icing off site.

- There would be slight noise impacts at existing and planned residences along Route 240 west of the Bypass Highway, due to construction traffic.

- Construction workers at the site would be exposed to noise levels in a range that could cause some hearing loss.

- No significant environmental impacts are anticipated from normal operational releases of radioactive materials (see Section 4.2.12.3). The risk associated with accidental radiation exposure is very low (see Section 4.2.12.4).

4. Principal alternatives considered:

   a. Alternative energy sources
   b. Alternative energy systems
   c. Alternative sites
   d. Alternative plant and transmission systems

5. This Environmental Statement was made available to the public, to the Environmental Protection Agency, and to other specified agencies in April 1982.

6. On the basis of the analysis and evaluation set forth in this Statement, and after weighing the environmental, economic, technical, and other benefits of S/HNP, Unit 1 and 2, against environmental and other costs and considering available alternatives, the NRC staff concludes that the action called for under the National Environmental Policy Act of 1969 (NEPA) and 10 CFR 51 is the issuance of construction permits for the facility, subject to the following conditions for the protection of the environment:

   a. The applicant shall take the necessary mitigating actions, including adherence to his commitments summarized in Section 4.2.16.1, and additional staff requirements summarized in Section 4.2.16.2 of this Environmental Statement, during construction of the station and associated transmission lines to avoid unnecessary adverse environmental impacts from construction activities.

   b. The applicant shall establish a control program which shall include written procedures and instructions to control all construction activities as prescribed herein and shall provide for periodic management audits to determine the adequacy of implementation of environmental conditions. The applicant shall maintain sufficient records to furnish evidence of compliance with all the environmental conditions herein.

c. Before engaging in a construction activity not evaluated by the Commission, the applicant will prepare and record an environmental evaluation of such activity. When the evaluation indicates that such activity may result in a significant adverse environmental impact that was not evaluated, or that is significantly greater than that evaluated in this Environmental Impact Statement, the applicant shall provide a written evaluation of such activities and obtain prior approval from the Director of the Office of Nuclear Reactor Regulation and EFSEC for the activities.

d. If unexpected harmful effects or evidence of serious environmental damage are detected during facility construction, the applicant shall provide to the staff and EFSEC an acceptable analysis of the problem and a plan of action to eliminate or significantly reduce the harmful effects or damage.

e. In addition to the monitoring procedures described in the Environmental Report, with amendments, the staff recommendations included in Section 5.7 of this document shall be followed.

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FOREWORD

This environmental statement was prepared jointly by the Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, in accordance with the Commission's regulation 10 CFR 51, which implements the requirements of the National Environmental Policy Act of 1969 (NEPA) and the Washington State Energy Facility Site Evaluation Council (EFSEC). This joint environmental statement is prepared in accordance with an agreement (pursuant to a Memorandum of Understanding dated September 6, 1978, between the NRC and Washington State) dated July 31, 1981, between the Nuclear Regulatory Commission and the Washington State Energy Facility Site Evaluation Council that provides for one environmental statement that fully addresses both the State and Federal environmental assessment requirements. For the purposes of this EIS, NRC retained the administrative lead.

The NEPA states, among other things, that 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:

- Fulfill the responsibilities of each generation as trustee of the environment for succeeding generations.
- Ensure for all Americans safe, healthful, productive and aesthetically and culturally pleasing surroundings.
- Attain the widest range of benefical uses of the environment without degradation, risk to health or safety, or other undesirable and unintended consequences.
- Preserve important historic, cultural, and natural aspects of our national heritage, and maintain, wherever possible, an environment that supports diversity and variety of individual choice.
- Achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities.
- Enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Further, with respect to major Federal actions significantly affecting the quality of the human environment, Section 102(2)(C) of the NEPA calls for preparation of a detailed statement 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 that would be involved in the proposed action should it be implemented.

An environmental report accompanies each application for a construction permit or a full-power operating license for a nuclear power generating station. A public announcement of the availability of the report is made. Any comments on the report by interested persons are considered by the staff. In conducting the required NEPA review, the staff meets with the applicant to discuss items of information in the environmental report, to seek new information from the applicant that might be needed for an adequate assessement, and generally to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff seeks information from other sources that will assist in the evaluation, and visits and inspects the project site and surrounding vicinity. Members of the staff may meet with State and local officials who are charged with protecting State and local interests. On the basis of all the foregoing and other such activities or inquiries as are deemed useful and appropriate, the staff makes an independent assessment of the considerations specified in Section 102(2)(C) of the NEPA and in 10 CFR 51.

This evaluation leads to the publication of a Draft Environmental Statement, prepared by the Office of Nuclear Reactor Regulation, which is then circulated to Federal, State, and local governmental agencies for comment. A summary notice is published in the Federal Register of the availability of the applicant's environmental report and the Draft Statement. Comments should be addressed to the Director, Division of Site Safety and Environmental Analysis, at the address shown below.

After receipt and consideration of comments on the Draft Statement, the staff prepares a Final Environmental Statement, which includes: a discussion of concerns raised by the comments; a benefit-cost analysis, which considers the environmental costs of the plant and the alternatives available for reducing or avoiding them, and balances the adverse effects against the environmental, economic, technical, and other benefits of the plant; and a conclusion as to whether the action called for, with respect to environmental issues, is the issuance of the proposed permit, with appropriate conditioning to protect environmental values, or its denial. The Final Environmental Statement and the Safety Evaluation Report prepared by the staff are submitted to the Atomic Safety and Licensing Board at a public hearing for its consideration in reaching a decision on the application.

Single copies of this Statement may be obtained by writing the:

Director, Division of Licensing
Office of Nuclear Reactor Regulation
U.S. Nuclear Regulatory Commission
Washington, DC 20555

The State of Washington statute under which EFSEC is organized and operates requires that all evidence, including comments of the EIS received at a public hearing, be considered before EFSEC draws conclusions and makes a recommendation to the Governor as to the approval or rejection of an application for certification. For the purposes of this EIS, all references within this document to staff conclusions, judgments and recommendations represent positions of NRC staff only.

Washington State statute WAC 463-42-335 requires that geology and seismicity be addressed and discussed in the review of the Application for Site Certification. To satisfy that the requirement, Section 4.2.7 was prepared and included in this EIS. The discussion and findings contained in that section represent only the result of the EFSEC review. NRC considers geology and seismicity of the site in its review of safety considerations of the site attributes, which is conducted pursuant to the requirements of the Atomic Energy Act of 1954. The results of that review are reported by the NRC staff in the Safety Evaluation Report that, along with this EIS, will be submitted for the consideration by the Atomic Safety and Licensing Board.

Mr. Jan A. Norris is the NRC Environmental Project Manager for this project and represents NRC on the joint NRC/EFSEC Management Committee. Should there be questions regarding the content of this statement, he may be contacted at the above address or at (301) 492-4908. Mr. William L. Fitch represents EFSEC on the Management Committee. Mr. Fitch may be contacted at (206) 459-6490 or at the following address:

Washington Energy Facility Site Evaluation Council
4224 6th Avenue, S.E.
Building #1, PY-11
Olympia, Washington 98504

1. INTRODUCTION

1.1 THE PROPOSED PROJECT

Pursuant to the Atomic Energy Act of 1954, as amended, and the Commission's regulations in Title 10, Code of Federal Regulations, an application was filed by the Puget Sound Power and Light Company, Pacific Power and Light Company, The Washington Water Power Company, and Portland General Electric Company (collectively referred to in this EIS as the applicant) for construction permits for two boiling-water nuclear reactors designated as the Skagit/Hanford Nuclear Project (S/HNP), Units 1 and 2 (Docket Nos. STN 50-522 and STN 50-523). Each unit is designed for a rated core power of 3,800 megawatts thermal (MWt), with a net electrical output of approximately 1,275 megawatts electrical (MWe). Dissipation of waste heat will be accomplished by circular mechanical-draft cooling towers, three per reactor unit. The Columbia River will be the sole source of cooling water. The proposed facilities are to be located on a site to be purchased from the U.S. Department of Energy Hanford Reservation in Benton County, Washington.

Title 10 Code of Federal Regulations, Part 51 (10 CFR 51) requires that the Director of the Office of Nuclear Reactor Regulation, or his designee, analyze the applicant's Application for Site Certification/Environmental Report (ASC/ER) and prepare a detailed statement of environmental considerations. It is within this framework that this Environmental Statement related to the construction of the Skagit/Hanford Nuclear Project has been prepared by the Office of the Nuclear Reactor Regulation (staff) of the U.S. Nuclear Regulatory Commission.

On July 31, 1981 (pursuant to a Memorandum of Understanding dated September 6, 1978, between the NRC and Washington State), NRC and Washington State Energy Facility Site Evaluation Council (EFSEC) entered into an agreement to jointly issue one environmental statement that fully addresses both the State and Federal environmental assessment requirements. To that aim, the NRC staff and EFSEC divided the responsibilities for preparation of this EIS approximately along the following lines: (1) EFSEC generally took the lead in preparing sections dealing with need for the facility, alternative energy sources and systems, aquatic ecology, water and air quality, and socioeconomics; (2) NRC staff, in addition to retaining the administrative lead for the production and publication of the document, took the lead in preparing sections relating to alternative sites, terrestrial ecology, and all sections dealing with radiological impacts and assessments.

Major documents used in the preparation of this statement were the applicant's Preliminary Safety Analysis Report (PSAR),* and the Application for Site Certification/Environmental Report (ASC/ER)** and supplements thereto, issued for S/HNP. Independent calculations and sources of information were also used by the staff and serve as a basis for the assessment of environmental impact. Additional information was gained from visits by the staff to the S/HNP site, to alternative sites, and to surrounding areas during 1982.

As a part of its safety evaluation leading to the issuance of construction permits and operating licenses, the Commission makes a detailed evaluation of the applicant's plans and proposed facilities for mimimizing and controlling the release of radioactive materials under both normal conditions and potential accident conditions, including the effects of natural phenomena on the facility. Inasmuch as these aspects are considered fully in other documents, only the salient features that bear directly on the anticipated environmental effects are considered in this Environmental Impact Statement.

Copies of this Environmental Impact Statement and the applicant's ASC/ER and PSAR are available for public inspection at the Commission's Public Document Room, 1717 H Street, NW, Washington, DC; the Richland Public Library, Swift and Northgate Streets, Richland, WA 99352; and the EFSEC offices at 4224 6th Avenue, SE, Building #1, PY-11, Olympia, WA 98504.

1.2 STATUS OF REVIEWS, PERMITS, AND LICENSES

To construct the S/HNP and certain related facilities, the applicant is required to apply for and receive certain permits, licenses, and other authorizations from a number of Federal, State, and local agencies. These permits and licenses are listed in Table 12-1 of the ASC/ER. Reviews for such permits are also noted in Table 12-1 of the ASC/ER. Copies of appropriate permits secured to date are included in Appendix G of this EIS.

The applicant will be required to meet all Federal, State, and local water quality and effluent discharge limits as specified in the operating permits.

1.3 DOCUMENTATION

This draft EIS includes appendices that contain information pertinent to the findings of this report. They are as follows:

Appendix A -- reserved for comments to the draft EIS

*"Puget Sound Power and Light Company, Skagit/Hanford Nuclear Project, Units 1 and 2, Preliminary Safety Analysis Report," with amendments, Docket Nos. STN 50-522 and STN 50-523, December 1981, hereinafter referred to as the S/HNP PSAR.

**"Puget Sound Power and Light Company, Skagit/Hanford Nuclear Project, Units 1 and 2, Application for Site Certification/Environmental Report," with amendments, Docket Nos. 50-522 and STN 50-523, December 1981, hereinafter referred to as the S/HNP ASC/ER, 1981.

Appendix B -- NEPA Population-Dose Assessment

Appendix C -- Impacts of the Uranium Fuel Cycle

Appendix D -- Examples of Site-Specific Dose Assessment Calculations

Appendix E -- Rebaselining of the RSS Results for Boiling-Water Reactors

Appendix F -- Consequence Modeling Considerations

Appendix G -- Permits

Appendix H -- Proposed Rule on Alternative Sites

Appendix I -- Environmental Analysis of the Conditional Land Sale and Easement Contract with Puget Sound Power and Light Company, prepared by U. S. Department of Energy

Appendix J -- Environmental Analysis Report of Skagit/Hanford Nuclear Project Transmission Integration, prepared by Bonneville Power Administration

Appendix K -- Floristic List of Plant Taxa Found Within the Sagebrush-Bitter-brush/Cheatgrass Community of the Hanford Reservation

Appendix L -- Waterford, Fish-Eating Species, and Raptors That Occur on the Hanford Reservation

Appendix M -- Mammals That Occur on the Hanford Reservation

Appendix N -- Description of Soil Types Within the Site and Associated Areas With Cross-References to Other Classification Schemes

2. THE NEED FOR THE PROJECT

This chapter describes the planning process through which the applicant concluded that the power generated by the Skagit/Hanford Nuclear Project (S/HNP) was needed to meet the future electrical demand for its service area and the Pacific Northwest Region as a whole. It discusses the future power needs of the applicant and the region by presenting the Northwest Regional Forecast (PNUCC, 1981), other load forecasts and several new forecasts that are presently in draft form (March, 1982). Factors affecting future load forecasts are discussed to reflect the changing climate of electrical power demand in the Pacific Northwest region.

2.1 APPLICANT'S NEED AND SERVICE AREAS

The proposed S/HNP consists of two nuclear-powered electrical generating units, each with a net electrical output of 1,275 megawatts electric (MWe) (S/HNP ASC/ER, 1981). The purpose of the project as presently scheduled is to provide the applicant, and possibly other participating utilities in the Pacific Northwest Region, the increased electrical power required to meet their anticipated loads during the 1990s and beyond.

The project would be operated by the PSP&L and owned jointly by PSP&L and three other investor-owned utilities, Portland General Electric Company (PGE), Pacific Power and Light Company (PP&L) and The Washington Water Power Company (TWWPCo). The ownership shares in the project would be as follows: PSP&L-40 percent, PGE-30 percent, PP&L-20 percent, and TWWPCo-10 percent.

The applicant's assessment of need is based on (1) an analysis of power demand for their service areas and the Pacific Northwest region; (2) the adequacy of existing and planned power generating resources; and (3) an evaluation of the factors affecting the demand for power in the future. The forecasts and assumptions included in the 1981 Pacific Northwest Utility Coordinating Council (PNUCC) were used by the applicant in the need forecast.

Applicant's Service Areas

Figure 2.1 shows the service areas of the applicant in Washington and Oregon (Regional Siting Program, Nuclear Power Plant Siting Program, 1990 Unit, 1981). PSP&L serves nearly 1.3 million people within a 11,700-square-kilometer (4,500-square-mile) service area that includes several counties bordering Puget Sound in Western Washington and Kittitas County in Central Washington.

PGE, which is located in the heart of Oregon's population center, provides service to 54 incorporated cities, of which Portland is the largest, and to approximately 40 percent of Oregon State's population in a 8,710,000-square-kilometer (3,350-square-mile) service area.

PP&L serves approximately 650,000 electrical customers in more than 240 communities in Oregon, Washington, northern California, Idaho, western Montana, and Wyoming.

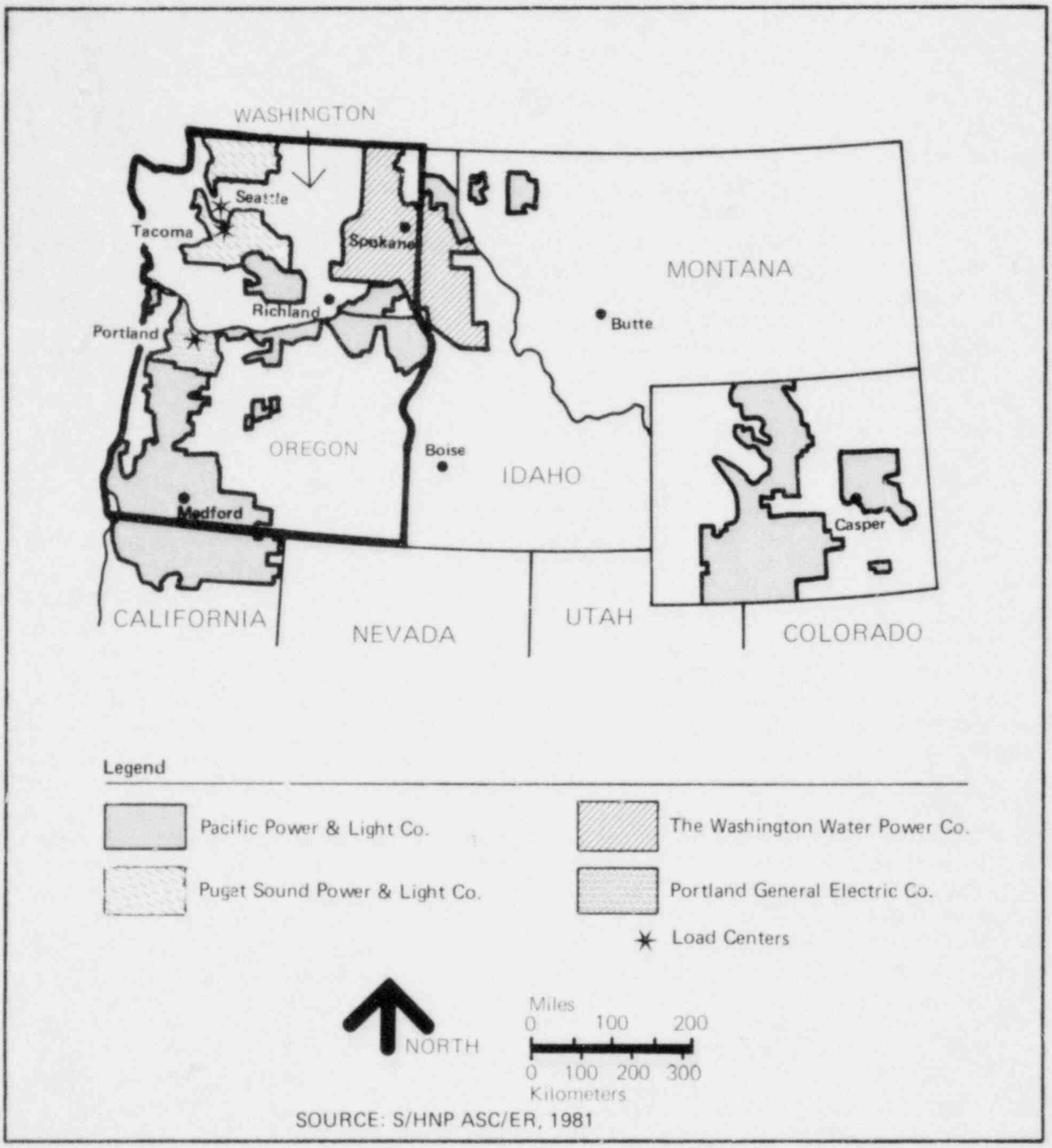

Figure 2.1 Service areas of participating utilities. Region of interest is in Washington and Oregon.

TWWPCo has a service area of approximately 67,600 square kilometers (26,000 square miles) and supplies electric service to more than 220,000 customers in 93 communities in eastern Washington and northern Idaho (S/HNP ASC/ER, 1981), of which Spokane is the largest.

During 1980, average annual kilowatt hours (kWh) consumed by PSP&L's residential customers was 15,489 kWh (nearly twice the national average) at a cost of 2.4 cents per kWh (approximately 1/2 the national average for investor owned utilities). Residential sales accounted for 55.4 percent of total sales during 1980, with commercial sales accounting for 25.0 percent and the remainder attributable to industrial and other sales (S/HNP ASC/ER, 1981). The high proportion of residential use and high rate of residential consumption can be attributed to the high proportion of electrically heated homes in PSP&L's service area.

Table 2.1 presents the current and 20-year projection of future resources of the four participating utilities for the years 1981-82 through 1998-99 (S/HNP ASC/ER, 1981). The participants currently obtain power from their own hydroelectric, combustion turbine, coal-fired and nuclear thermal generating facilities. The only presently operating nuclear plant in the region is the Trojan facility in Oregon. In addition, electrical generating capacity is obtained through contractual hydroelectric agreements with the mid-Columbia Public Utilities District and the Bonneville Power Administration (BPA). Additional coal-fired resources are obtained from Colstrip Units Nos. 1 and 2, which are sponsored by the Montana Power Company (PNUCC, 1981).

Future resources sponsored by the participants scheduled to come on-line beginning in 1983-84 include: a 63.0-percent share (648 MWe) in Montana Power Company's Colstrip Units 3 and 4 (likely to be delayed into the late 1980s); a 62.5-percent share (940 MWe) of TWWPCo's Creston Units 1, 2, 3, and 4 (likely to be delayed at least one year); a 30-percent share (253 MWe) of the WPPSS Satsop Nuclear Unit No. 3; and an 80-percent share (189 MWe) of Wyodak Unit No. 2 sponsored by PP&L in Wyoming (S/HNP ASC/ER, 1981).

The participants were also scheduled to receive a 10-percent share (93 MWe) of WPPSS' Satsop Unit No. 5; however, this project has been terminated and cannot be considered as a likely future resource. The S/HNP Units 1 and 2 are also considered as future resources and are included in Table 2.1.

Applicant's Service Area Power Needs

The average annual percent change in the power loads of the individual participants and their total load growth for the 1965-66 to 1980-81 period is presented in Table 2.2. During that period, the PSP&L average energy load increased approximately 178.0 percent or at an annual compound rate of 6.6 percent. PP&L's average load increased 108.0 percent at a compound annual rate of 4.6 percent. PGE's average loads increased 106.0 percent at a compound rate of 4.6 percent, and TWWPCo's average loads increased 98.0 percent at a compound annual rate of 4.2 percent. Combined, the participants' total average loads increased 120.0 percent at a compound annual rate of 5.0 percent. Short-term growth can be quite variable; for example, since 1979-80, combined load growth for the applicants has been less than 1.0 percent and actually declined between 1979-80 and 1980-81 (Table 2.2).

Table 2.1 Existing and planned resources for applicant (MWe)

Resources	1981-82		1982-83		1983-84		1984-85		1985-86		1986-87		1987-88		1988-89		1989-90	
	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak.	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.
System Hydro Electric	2652	1078	2652	1078	2652	1079	2648	1078	2648	1077	2652	1077	2652	1077	2653	1077	2652	1077
System Hydro Electric	3364	1630	3200	1605	3026	1530	2986	1508	2940	1482	2918	1464	2898	1457	2877	1440	2852	1432
Contracts In	-426	1062	4099	1163	3240	819	3122	783	3073	737	2795	658	2763	646	2727	574	2725	551
Contracts Out	1364	-307	-417	-223	-350	-202	-336	-195	-327	-191	-315	-184	-309	-180	-189	-144	-187	-133
Small Thermal	946	404	1387	423	1432	457	1450	476	1466	470	1506	495	1583	527	1628	554	1667	486
Centralia	756	660	946	660	946	660	946	660	946	660	946	660	946	660	946	660	946	660
Trojan	2362	529	756	529	756	529	756	529	756	529	756	529	756	529	756	529	756	529
Wyoming (Existing)	424	1618	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703
Boardman No. 1	165	314	424	318	424	318	424	318	424	318	424	318	424	318	424	318	424	318
Colstrip No. 1	165	124	165	124	165	124	165	124	165	124	165	124	165	124	165	124	165	124
Colstrip No. 2	0	124	165	124	165	124	165	124	165	124	165	124	165	124	165	124	165	124
Colstrip No. 3 (1/84; 63%)	0	0	0	0	441	132	441	294	441	324	441	324	441	324	441	324	441	324
Colstrip No. 4 (7/85; 63%)	0	0	0	0	0	0	0	0	440	264	440	324	440	324	440	324	440	324
Creston No. 1 (7/87; 62.5%)	0	0	0	0	0	0	0	0	0	0	0	0	313	188	313	234	313	235
Creston No. 2 (1/89; 62.5%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	312	94	312	210
Creston No. 3 (1/92; 62.5%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Creston No. 4 (7/93; 62.5%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
WNP No. 3 (12/86; 30%)	0	0	0	0	0	0	0	0	0	0	372	130	372	252	372	272	372	272
WNP No. 5 (12/88; 10%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	124	43	124	85
Wyodak No. 2 (12/85; 80%)	0	0	0	0	0	0	0	0	0	0	252	88	252	173	252	189	252	189
Skagit No. 1 (1/91; 100%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Skagit No. 2 (1/93; 100%)	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total Resources	15875	7236	15739	7504	15259	7273	15119	7402	15469	7621	15879	7834	16223	8246	16768	8439	16787	8510
Reserves	1383	0	-1387	0	-1408	0	-1417	0	-1479	0	-1589	0	-1633	0	-1698	0	-1709	0
Net Total Resources	14492	7236	14352	7504	13851	7273	13702	7402	13990	7621	14290	7834	14590	8246	15070	8439	15078	8510

Table 2.1 (continued)

Resources	1990-91		1991-92		1992-93		1993-94		1994-95		1995-96		1996-97		1997-98		1998-99	
	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.	Peak	Avg.
System Hydro Electric	2654	1077	2654	1077	2654	1077	2654	1077	2654	1077	2654	1077	2654	1077	2654	1077	2654	1077
System Hydro Electric	2841	1420	2839	1413	2825	1407	2819	1402	2814	1397	2755	1351	2749	1345	2744	1340	2739	1336
Contracts In	2760	554	1354	549	1283	542	1215	535	1140	529	1065	522	642	264	631	228	586	202
Contracts Out	-186	-129	-169	-129	-155	-125	-143	-122	-128	-120	-81	-99	-69	-99	-68	-94	-58	-88
Small Thermal	1724	426	1729	431	1796	467	1803	475	1829	490	1825	495	1830	470	1835	505	1840	510
Centralia	946	660	946	660	946	660	946	660	946	660	946	660	946	660	946	660	946	660
Trojan	756	529	756	529	756	529	756	529	756	529	756	529	756	529	756	529	756	529
Wyoming (Existing)	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703	2362	1703
Boardman No. 1	424	318	424	318	424	318	424	318	424	318	424	318	424	318	424	318	424	318
Colstrip No. 1	165	124	165	124	165	124	165	124	165	124	165	124	165	124	165	124	165	124
Colstrip No. 2	165	124	165	124	165	124	165	124	165	124	165	124	165	124	165	124	165	124
Colstrip No. 3 (1/84; 63%)	441	324	441	324	441	324	441	324	441	324	441	324	441	324	441	324	441	324
Colstrip No. 4 (7/85; 63%)	440	324	440	324	440	324	440	324	440	324	440	324	440	324	440	324	440	324
Creston No. 1 (7/87; 62.5%)	313	235	313	235	313	235	313	235	313	235	313	235	313	235	313	235	313	235
Creston No. 2 (1/89; 62.5%)	312	235	312	235	312	235	312	235	312	235	312	235	312	235	312	235	312	235
Creston No. 3 (1/92; 62.5%)	0	0	312	92	312	210	312	235	312	235	312	235	312	235	312	235	312	235
Creston No. 4 (7/93; 62.5%)	0	0	0	0	0	0	313	185	313	235	313	235	313	235	313	235	313	235
WNP No. 3 (12/86; 30%)	372	272	372	272	372	272	372	272	372	272	372	272	372	272	372	272	372	272
WNP No. 5 (12/88; 10%)	124	93	124	93	124	93	124	93	124	93	124	93	124	93	124	93	124	93
Wyodak No. 2 (12/85; 80%)	252	189	252	189	252	189	252	189	252	189	252	189	252	189	252	189	252	189
Skagit No. 1 (1/91; 100%)	1275	383	1275	852	1275	937	1275	937	1275	937	1275	937	1275	937	1275	937	1275	937
Skagit No. 2 (1/93; 100%)	0	0	0	0	1275	383	1275	852	1275	937	1275	937	1275	937	1275	937	1275	937
Total Resources	18140	8861	17057	9415	8337	10028	18595	10706	18547	10846	18465	10819	18053	10530	18043	10529	18008	10510
Reserves	-1906	0	-1911	0	-2125	0	-2165	0	-2174	0	-2180	0	-2184	0	-2193	0	-2200	0
Net Total Resources	16324	8861	15146	9415	16212	10028	16430	10706	16373	10846	16285	10819	15869	10530	15850	10529	15808	10510

Source: S/HNP ASC/ER, 1981.

Table 2.2 Historical average energy loads*

Year	Puget Sound Power & Light Average Load	Puget Sound Power & Light Percent Change From Previous Year	Portland General Electric Average Load	Portland General Electric Percent Change From Previous Year	Pacific Power & Light Average Load	Pacific Power & Light Percent Change From Previous Year	Washington Water & Power Average Load	Washington Water & Power Percent Change From Previous Year	Combined Average Load	Combined Percent Change From Previous Year
1965-66	593.2	7.6	766.6	6.8	1184	7.0	444.0	4.3	2987.8	6.9
1966-67	667.9	12.6	819.6	6.9	1243	5.0	463.9	4.5	3194.4	8.9
1967-68	746.0	11.7	886.7	8.2	1305	5.0	489.7	5.6	3427.4	7.3
1968-69	856.2	14.8	1013.3	14.3	1397	7.0	528.1	7.8	3794.6	10.7
1969-70	897.6	4.8	1066.6	5.3	1459	4.4	542.2	2.7	3965.4	4.5
1970-71	982.3	9.4	1158.6	8.6	1552	6.4	573.8	5.8	4766.7	7.6
1971-72	1,050.1	6.9	1256.1	8.4	1670	7.6	606.3	5.7	4582.5	7.4
1972-73	1,132.1	7.8	1329.2	5.8	1800	7.8	628.4	3.6	4889.7	6.7
1973-74	1,157.2	2.2	1325.8	(0.3)	1828	1.6	638.8	1.7	4949.8	1.2
1974-75	1,210.1	4.6	1337.5	0.9	1886	3.2	677.2	6.0	5110.8	3.3
1975-76	1,307.5	8.0	1414.3	5.7	2033	7.8	723.6	6.9	5478.4	7.2
1976-77	1,345.4	2.9	1433.1	1.3	2142	5.4	748.5	3.4	5669.0	3.5
1977-78	1,435.8	6.7	1462.9	2.1	2228	4.0	759.5	1.5	5886.2	3.8
1978-79	1,625.1	13.2	1593.5	8.9	2362	6.0	865.5	14.0	6446.1	9.5
1979-80	1,659.0	2.1	1592.4	(0.1)	2416	2.3	846.1	(2.2)	6513.5	1.0
1980-81	1,646.5	(0.8)	1580.3	(0.8)	2431	0.6	852.8	0.8	6510.5	0.0
Compound Annual Change		6.6		4.6		4.6		4.2		5.0

* Not Temperature Adjusted

Sources: S/HNP ASC/ER, 1981.
Combined data prepared by URS Engineers.

Applicant's Service Area Power Forecast

The applicant's forecasts of power demand for the applicant's systems and the net total peak and average resources, from 1981-82 through 1998-99, are given in Table 2.3 with the applicant's projected loads and surpluses or deficits. The scheduled output of the two proposed S/HNP units is included in Table 2.3 as coming on line in January 1991 and 1993. This would occur if PSP&L received State and Federal permits and, according to the applicant, if the economic and regulatory climate was acceptable to begin construction in 1983.

As the data indicate, power deficits during the critical water year* begin to occur in 1983-84 and increase steadily throughout the forecast period. Deficits range from 349 MWe of average energy in 1983-84 to a peak deficit of 1,615 MWe in 1998-99, with an average annual deficit of 563 MWe. After 1983-84, average power deficits are predicted to peak in 1986-87; decline slightly in 1987-90 as Creston Unit No. 1 comes on line; increase again to a peak deficit in 1989-90; change to a surplus in 1993-94 as all of the Creston, WPPSS and Skagit/Hanford units come on line; then, deficits begin to increase again in 1994-95. With the absence of WPPSS Satsop Unit No. 5, these deficits would increase by 43 MWe in 1988-89, 85 MWe in 1989-90, and 93 MWe thereafter (S/HNP ASC/ER, 1981). For the preceding analysis, average energy figures were used; however, Table 2.3 also shows peak loads and resources for the applicant. In terms of peak loads, the forecasts indicate deficits beginning in 1984-85 and continuing throughout the forecast period.

The 1981 forecasts of peak and average loads also include reserve requirements. Reserve requirements are the electrical power necessary to offset uncertainty in load forecasting due to events such as forced outages, unanticipated load growth and project construction delays. Reserves include rights to interrupt power and standby operation of resources, e.g., contracts outside the region.

The reserve margin criterion for the Pacific Northwest Region is set forth in Section 8(b) of the Pacific Northwest Coordination Agreement as follows:

> The Coordinated System shall maintain reserve capacity at a level sufficient to protect against loss of load to the extent that the probability of load loss in a Contract Year shall be no greater than the equivalent of one day in twenty years. The determination of such probability shall be based upon characteristics of Peak Load variability and generating equipment Forced Outage rates.

For the applicant (except PP&L), reserves equaled 5.0 percent of their small thermal, combustion turbine, and hydroelectric capacity and 15 percent of their large thermal capacity. For PP&L, which is a predominantly thermal

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*The multi-month period during the 40 years of record during which the hydroelectric system would have generated a smaller amount of energy than during any other period and assuming reservoirs are full initially, operate to a prescribed pattern of monthly output and end empty. The water year 1936-37 represents the most severe streamflow condition with reservoirs full at the beginning of drawdown (PNUCC, 1981).

Table 2.3 Applicant load and resource projection (MWe)

Year	Type	Estimated System Loads	Total Resources	Reserves	Net Total Resources	Surplus or Deficiencies
1981-82	Pk.	12618	15875	1838	14492	1874
	Avg.	7047	7236	0	7236	189
1982-83	Pk.	13141	15739	-1387	14352	1211
	Avg.	7335	7504	0	7504	169
1983-84	Pk.	13656	15259	-1408	13851	195
	Avg.	7622	7273	0	7273	-349
1984-85	Pk.	14211	15119	-1417	13702	-509
	Avg.	7922	7402	0	7402	-520
1985-86	Pk.	14797	15469	-1479	13990	-807
	Avg.	8240	7621	0	7621	-619
1986-87	Pk.	15309	15879	-1589	14290	-1019
	Avg.	8537	7834	0	7834	-703
1987-88	Pk.	15812	16223	-1633	14590	-1222
	Avg.	8811	8246	0	8246	-565
1988-89	Pk.	16371	16768	-1698	15070	-1301
	Avg.	9913	8439	0	8439	-674
1989-90	Pk.	16947	16787	-1709	15078	-1869
	Avg.	9425	8510	0	8510	-915
1990-91	Pk.	17487	18140	-1906	16324	-1253
	Avg.	9733	8861	0	8861	-872
1991-92	Pk.	18001	17057	-1911	15146	-2855
	Avg.	10021	9415	0	9415	-606
1992-93	Pk.	18483	18337	-2125	16212	-2271
	Avg.	10291	10028	0	10028	-263
1993-94	Pk.	18972	18595	-2165	16430	-2542
	Avg.	10560	10706	0	10706	146
1994-95	Pk.	19509	18547	-2174	16373	-3136
	Avg.	10855	10846	0	10846	-9
1995-96	Pk.	20068	18465	-2180	16285	-3783
	Avg.	11162	10819	0	10819	-343
1996-97	Pk.	20646	18053	-2184	15869	-4777
	Avg.	11479	10530	0	10530	-949
1997-98	Pk.	21225	18043	-2193	15850	-5375
	Avg.	11802	10529	0	10529	-1273
1998-99	Pk.	21792	18008	-2200	15808	-5984
	Avg.	12125	10510	0	10510	-1615

Source: S/HNP ASC/ER, 1981

system, reserves are calculated at 6-1/3 percent of PP&L's small thermal, combustion turbines, and hydroelectric capacity, and 19 percent of its large thermal capacity. Table 2.3 gives the reserves projected in 1981 for its four companies through 1998-99. Tables 2.4 and 2.5 give the regional reserve margins. Planned regional energy reserves are equal to one-half years' projected load growth for utility type loads.

Based on these forecasts of power loads that were developed by the four participants for the 1981 forecast, a need exists for the S/HNP units. Factors affecting the actual consumptions of power are summarized in Table 2.6. One such factor, conservation, has become increasingly important as a load growth leveling factor. Increasing power costs and a slow economy are also slowing load growth.

Each of the participating utilities conducts numerous conservation programs such as home energy checks, low-interest insulation and weatherization loans, and hot water heater wrap programs. The impact of conservation on load forecasts will be discussed in detail in the following sections.

2.2 REGIONAL NEED FOR POWER

The forecast most widely used by utilities in the Pacific Northwest region has been the PNUCC West Group forecast. Until recently, this was accepted by BPA and regional utilities as the official regional forecast. BPA no longer adopts it as their basis for forecasting. The PNUCC West Group forecast was a summation of electric load estimates provided by each of the utilities operating in the West Group area (Figure 2.2). It included BPA's load estimates for their district loads.

At the time PSP&L prepared their Application for Site Certification (late 1981), the 1981 PNUCC forecasts had changed from the West Group area to the Northwest Regional Area in order to reflect the provisions of the Northwest Regional Power Act (PNUCC, 1981). In addition, the following major events had also occurred, which significantly altered load forecasting in the region.

(1) BPA began to prepare their own forecast.
(2) Conservation became a major factor in the forecast.

For these reasons, this EIS also presents the latest load forecast information for the entire Northwest Region.

Regional Forecast

In June 1981, the PNUCC published the 1981-1992 Northwest Regional Forecast, which included the region defined in the Regional Power Act (Figure 2.2). This represents approximately 10 percent more load than the previous West Group area. The forecast is issued annually in the spring. The next forecast is scheduled to be issued in April 1982. The following summarizes the 1981 PNUCC Northwest Regional Forecast.

Summaries of the projected regional January peak capability and the regional year energy capability from the PNUCC forecast are presented in Tables 2.4 and 2.5. Hydroelectric generation provides the greatest energy capability for the

Table 2.4 Summary of regional peak resources-January peak capability (MWe)

Resource	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Hydroelectric	31,590	31,820	31,799	31,887	32,156	32,167	32,313	32,310	32,343	32,266	32,323
Existing											
Coal	2,807	2,807	2,807	2,807	2,807	2,807	2,807	2,807	2,807	2,807	2,807
Nuclear	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080	1,080
Combustion turbine	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104	1,104
Cogeneration	44	44	44	44	44	44	44	44	44	44	44
Miscellaneous	123	123	123	123	123	123	123	123	123	123	123
Planned											
Coal											
Valmy 1	121	121	121	121	121	121	121	121	121	121	121
Colstrip 3	---	---	456	456	456	456	456	456	456	456	456
Valmy 2	---	---	---	121	121	121	121	121	121	121	121
Colstrip 4	---	---	---	---	456	456	456	456	456	456	456
Creston 1	---	---	---	---	---	---	500	500	500	500	500
Creston 2	---	---	---	---	---	---	---	500	500	500	500
Creston 2	---	---	---	---	---	---	---	---	---	---	500
Nuclear											
WNP 2	---	---	---	1,100	1,100	1,100	1,100	1,100	1,100	1,100	1,100
WNP 1	---	---	---	---	---	1,250	1,250	1,250	1,250	1,250	1,250
WNP 3	---	---	---	---	---	1,240	1,240	1,240	1,240	1,240	1,240
WNP 4	---	---	---	---	---	---	1,250	1,250	1,250	1,250	1,250
WNP 5	---	---	---	---	---	---	1,240	1,240	1,240	1,240	1,240
Skagit 1*	---	---	---	---	---	---	---	---	---	1,288	1,288
Combustion turbine	178	178	178	178	178	178	178	178	178	178	178
Renewable	---	---	42	42	42	42	42	42	42	42	42
Total resources	37,047	37,277	37,754	39,063	39,788	42,289	45,425	45,922	45,955	47,166	47,723
Exports	(1,972)	(1,986)	(1,799)	(1,809)	(1,819)	(2,252)	(521)	(388)	(400)	(406)	(416)
Imports	2,800	2,767	2,703	2,594	2,513	2,708	2,650	2,592	2,527	2,379	2,217
Incremental losses	(57)	(57)	(50)	(50)	(50)	(26)	(1)	---	---	---	---
Hydroelectric realization adjustment	(4,047)	(4,068)	(4,066)	(4,065)	(2,528)	(2,520)	(2,520)	(2,519)	(2,522)	(2,513)	(2,520)
Reserve requirement	(3,529)	(3,994)	(4,478)	(4,987)	(5,507)	(6,029)	(6,579)	(7,169)	(7,791)	(8,031)	(8,259)
Net peak resources	30,242	29,939	30,064	30,746	32,397	35,170	38,454	38,438	37,769	38,595	38,745

* These resources are now 1275 MWe.
NOTE: Numbers in parentheses indicate deficits.

Table 2.5 Summary of energy resources contract year energy capabilities (average MWe)

Resource	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Hydroelectric	12,685	12,691	12,680	12,726	12,772	12,802	12,849	12,835	12,837	12,830	12,827
Existing											
Coal	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989	1,989
Nuclear	1,280	1,208	765	765	765	765	765	765	765	765	765
Combustion Turbine	354	354	354	344	344	344	344	344	171	171	171
Cogeneration	31	31	31	31	31	31	31	31	31	31	31
Miscellaneous	5	5	5	5	5	5	5	5	5	5	5
Planned											
Coal											
Valmy 1	71	95	95	95	95	95	95	95	95	95	95
Colstrip 3	---	---	137	308	342	342	342	342	342	342	342
Valmy 2	---	---	71	95	95	95	95	95	95	95	95
Colstrip 4	---	---	---	---	283	342	342	342	342	342	342
Creston 1	---	---	---	---	---	---	300	375	375	375	375
Creston 2	---	---	---	---	---	---	---	150	338	375	375
Creston 2	---	---	---	---	---	---	---	---	---	---	150
Nuclear											
WNP 2	---	---	275	729	825	825	825	825	825	825	825
WNP 1	---	---	---	---	62	766	938	938	938	938	938
WNP 3	---	---	---	---	---	434	852	930	930	930	930
WNP 4	---	---	---	---	---	62	766	938	938	938*	938
WNP 5	---	---	---	---	---	---	434	852	930	930	930
Skagit 1	---	---	---	---	---	---	---	---	---	386	869+
Combustion turbine	4	4	4	4	4	4	4	4	4	4	4
Renewable	3	3	27	35	35	35	35	35	35	35	35
Total resources	16,422	16,452	16,433	17,126	17,637	18,936	21,011	21,890	21,985	22,401	23,031
Exports	(661)	(450)	(316)	(321)	(325)	(330)	(334)	(306)	(302)	(298)	(303)
Imports	2,208	2,314	2,230	2,177	2,130	2,029	1,850	1,761	1,713	1,662	1,621
Incremental losses	(11)	(2)	---	---	---	---	---	---	---	---	---
Thermal realization adjustment	---	---	29	(12)	(102)	(27))	(253)	(585)	(393)	(304)	(333)
Estimated hydroelectric maintenance	(101)	(100)	(96)	(104)	(106)	(100)	(96)	(98)	(100)	(96)	(96)
Reserve requirement	(346)	(336)	(300)	(297)	(289)	(295)	(305)	(313)	(312)	(316)	(322)
Net energy resources	17,511	17,878	17,980	18,569	18,945	20,213	21,873	22,349	22,591	23,049	23,598

* Revised to 382 Mwe
\+ Revised to 860 MWe
NOTE: Numbers in parentheses indicate deficits

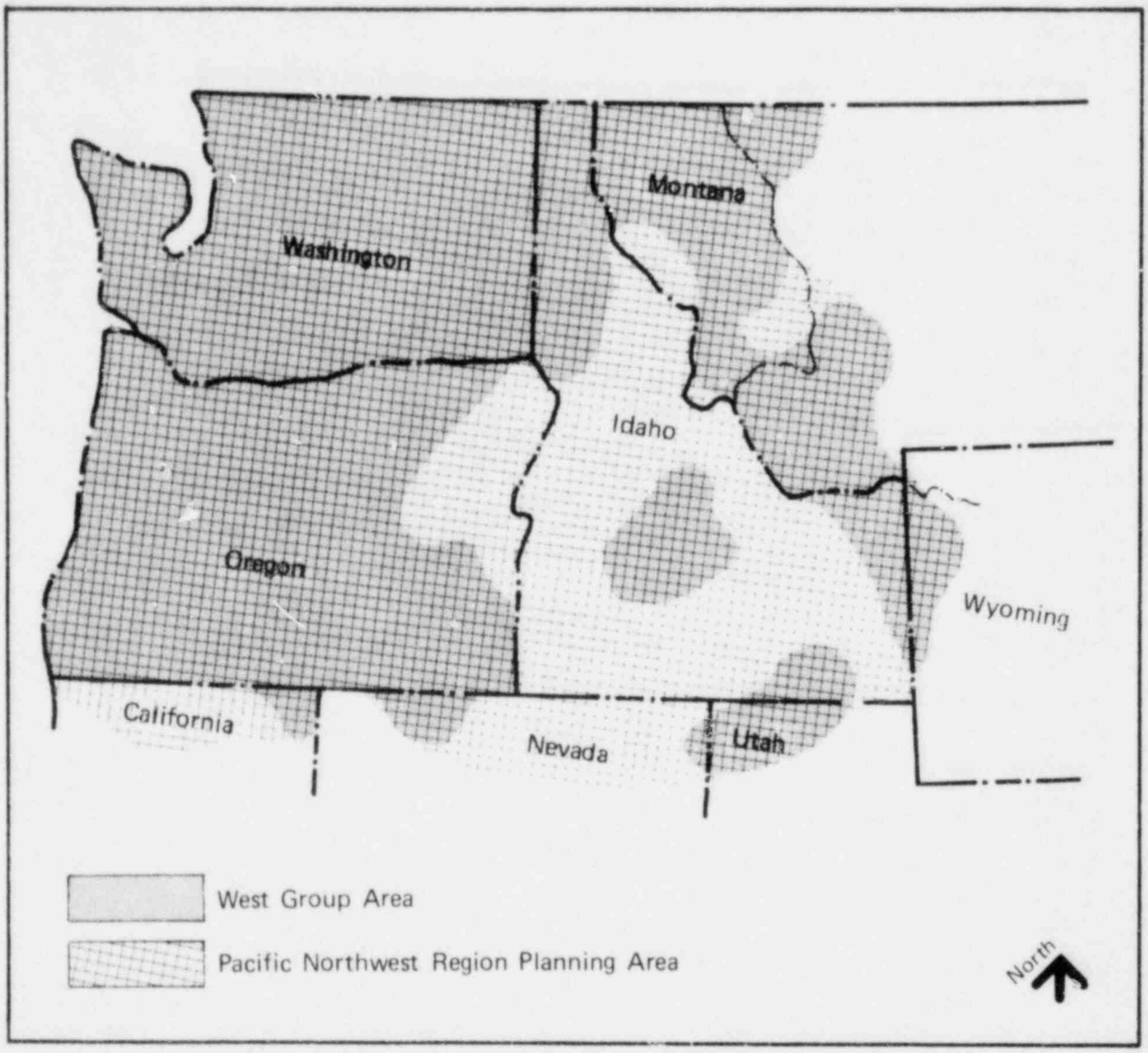
Table 2.6 Summary of factors affecting growth of demand in the applicant's service area and region

Actual deficits would be less due to	- loads increase at less than the forecasted rate due to conservation, slow economic growth or erroneous forecast assumptions
	- increased purchases from other areas
	- stream flows greater than the minimum necessary for hydroelectric
	- thermal generation outages less than forecast
Actual deficits would be greater due to:	- new thermal plants (including nuclear) are cancelled or delayed beyond probable energy dates
	- loads increase at greater than the forecast rate
	- greater thermal generation outage rates

Source: U.S. Department of Interior, Bureau of Reclamation, and Washington State EFSEC, 1981.

region. Other categories include coal fuel, nuclear fuel, combustion turbines, cogeneration, renewable resources, and miscellaneous resources. Not all of the existing cogeneration capacity is presently utilized. The amount of cogeneration resources is likely to increase in future years. Tables 2.4 and 2.5 also give planned energy generating projects, their capacities, and their operational dates. Various other adjustments to the regional energy capability are shown. Thus, regional net peak resource capability in 1990-1991 is expected to be 38,595 MWe. Net energy capability is anticipated to be 23,049 MWe.

Table 2.7 compares the deficits anticipated for the region by operation year through 1992 for peak capability and average year capability. Peak total load (41,399 MWe) in 1990-1991 (Table 2.7) relative to peak capacity of net resources



Source: U.S. Department of Interior, Bureau of Reclamation, and Washington State EFSEC, 1981.

Figure 2.2 Pacific Northwest Region planning area

Table 2.7 Loads and resources Northwest regional area

Description	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
COMPARISON LOAD AND RESOURCE											
January Peak - MWe											
Load											
1. Total	30,432	31,723	33,049	34,363	35,554	36,621	37,736	38,952	40,194	41,399	42,542
2. Firm	29,408	30,721	31,988	33,245	34,418	35,462	36,543	37,733	38,955	40,154	41,293
3. Net Resources[1]	30,242	29,939	30,064	30,746	32,397	35,170	38,454	38,438	37,769	38,595	38,745
Surplus (Deficit)											
4. Total	(190)	(1,784)	(2,985)	(3,617)	(3,157)	(1,451)	718	(514)	(2,425)	(2,804)	(3,797)
5. Firm	834	(782)	(1,924)	(2,499)	(2,021)	(292)	1,906	705	(1,186)	(1,559)	(2,548)
Energy - Average MWe											
Load											
6. Total	18,898	19,651	20,485	21,319	21,952	22,543	23,152	23,812	24,478	25,131	25,775
7. Firm	17,841	18,603	19,385	20,151	20,765	21,332	21,913	22,540	23,187	23,834	24,474
8. Net Resources[1]	17,511	17,878	17,980	18,569	18,945	20,213	21,873	22,349	22,591	23,049	23,598
Surplus (Deficit)											
9. Total	(1,387)	(1,773)	(2,505)	(2,750)	(3,007)	(2,330)	(1,279)	(1,463)	(1,887)	(2,082)	(2,177)
10. Firm	(330)	(725)	(1,405)	(1,582)	(1,820)	(1,119)	(40)	(191)	(596)	(785)	(876)
INTERRUPTIBLE LOAD											
11. January Peak - MWe	1,024	1,002	1,061	1,118	1,136	1,159	1,188	1,219	1,239	1,245	1,249
12. Energy - Average MWe	1,057	1,048	1,100	1,168	1,187	1,211	1,239	1,272	1,291	1,297	1,301
RESERVE CONTINGENCIES[2]											
13. January Peak - MWe	---	---	---	---	---	---	---	---	---	---	---
14. Energy - Average MWe	356	374	374	374	374	374	374	374	547	547	547

Table 2.7 (continued)

Description	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
PROSPECTIVE RESOURCES											
15. January Peak - MWe	---	---	18	351	673	792	1,094	1,100	1,226	2,096	2,184
16. Energy - Average MWe	---	1	14	67	94	142	153	166	264	354	359
PROBABILITY THAT RESOURCES WILL BE INSUFFICIENT TO MEET:[3]											
Total energy load in at least one 4-month period of											
17. Year Shown %	34	43	42	47	49	49	35	35	51	52	50
18. Years 1981-82 Thru Year Shown %	34	57	71	82	89	93	95	96	98	99	99
Firm energy load in at least one 4-month period of											
17. Year Shown %	11	19	23	28	27	25	12	12	24	25	26
18. Years 1981-82 Thru Year Shown %	11	16	39	53	63	70	73	76	81	85	88

[1]Resources include hydroelectric, small fossil-fueled plants, cogeneration, renewables, Hanford NPR through June 1983, Centralia, Trojan, Colstrip 1 and 2 (50%), 3 and 4 (65.1%), Jim Bridger (partial), WNP 1, 2, 3, 4, 5, Boardman, Skagit 1, and net contractual imports/exports with utilities outside the area. Hanford is not included as a peak resource. Estimated amounts for scheduled maintenance (energy only) and for hydroelectric realization adjustment (peak only) have been deducted. All existing thermal units and future thermal units under 500 megawatts (peak and energy) are included in amounts as submitted by respective project owners. The energy availability of all future thermal units, 500 megawatts or larger, has been included as 60% of the first full year and 75% thereafter, and modified by a thermal realization adjustment. Both peak and energy resources have been reduced by reserve requirements.

[2]The energy megawatts tabulated in line 14 reflect the amounts of energy available from existing fossil and combustion turbine installations, which may be considered available as reserve energy resources. These are predominantly petroleum-fueled plants utilizing high cost fuels of questionable availability. The amounts are in addition to those included as firm energy resources in line 8.

[3]Based on same data as used in comparison of energy loads and resources, except that there is no consideration of energy reserve requirements or realization adjustment. Study initialized on the basis of full reservoirs on July 31, 1981.

(38,595 MWe) indicates a total deficit of 2,804 MWe in peak capability. Removal of interruptible loads would drop the deficit to 1559 MWe. In terms of average energy demand in 1990 (25,131 average MWe), the deficit expected is 2,082 average MWe. If interruptible loads were removed, the deficit would be 785 average MWe.

Although interruptible loads are included in the PNUCC Northwest Regional Forecast as total load requirements, often a portion or all of the interruptible load could be used as a resource to offset firm load requirements because interruptible users often have contingency contracts to meet their power needs during power shortages.

As given in Table 2.7 (see line 17), PNUCC predicted approximately a 50-percent chance of a power shortage in most years of the 1980s and, between 1981 and 1991-92, a 99-percent chance of at least one 4-month period of insufficient resources to meet firm load. These predictions assumed the S/HNP and WNP-4 and -5 units would be built on schedule. With the termination of WNP-4 and -5, other factors being equal, power deficits would be expected to increase.

Notwithstanding the significant deficits shown, there are many resources (prospective resources) that could possibly come on line during the decade that are not far enough along in planning to be included in the forecast. These resources, their potential operation date, and size are listed in Table 2.8.

As development of these resources progresses, they would be transferred from the prospective resource category to the planned resource category. At that time, they can be included in the overall load resource forecast. The resources would contribute various amounts to the peak and average energy resources. One major factor that will affect these forecasts is the Northwest Regional Power Act. Because of its importance to the region energy situation, it is summarized here.

Pacific Northwest Electric Power Planning and Conservation Act of 1980

The regional nature of the power supply in the Pacific Northwest has been further reinforced by the signing into law of the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (Northwest Regional Power Act) on December 5, 1980. Under this law, the Administrator of the Bonneville Power Administration (BPA) may purchase electrical power resources that are consistent with a regional plan adopted by a council of representatives of the states of Montana, Idaho, Washington, and Oregon. Before such purchases can be made, however, it must be shown that, after notice to the public and a public hearing, power from the proposed project is needed after first giving consideration to energy savings through conservation, energy available from renewable resources, and energy produced from waste heat or high fuel efficiency processes.

It should be noted that the conditions of the Act apply to energy projects in which the sponsor has applied to BPA to guarantee funding for the project. Neither the applicant nor other potential participants in the S/HNP have applied to BPA for funding guarantees relative to the proposed CGS. As a result, these considerations of the Regional Power Act do not apparently apply

Table 2.8 Schedule of prospective resources January 1981 through June 1992

Plant	Assumed Operation Date	Capability (MWe)
Hydroelectric		
Dry Falls	June 1983	17.0
O'Sullivan Dam	June 1983	4.5
Sullivan Creek	January 1984	18.0
Summer Falls	June 1984	74.0
Bonneville (Fishway Units)	July 1984	11.0
Wanapum (Units 11-14)	December 1984	322.0
Priest Rapids (Units 11-14)	August 1985	322.0
Cougar (Unit 3)	June 1986	35.0
Strube Lake	June 1986	4.5
Wynoochee	July 1986	12.0
Dworshak (Unit 4)	April 1987	220.0
The Dalles (Fishway Unit)	July 1987	4.0
Blue River	July 1987	10.0
Kootenai River Project	September 1987	180.0
Fall Creek	July 1988	6.0
Dorena	July 1988	4.0
McNary (Second Powerhouse)	May 1990	746.0
Libby Reregulator	November 1991	90.0
Coal		
Unit 1 (Idaho Power)	June 1989	250.0
Unit 2 (Idaho Power)	June 1990	250.0

Source: PNUCC, 1981

to this project as yet. Many uncertainties, however, do concern the effect of the Act on the regional planning process. The major provisions of the act are included from a summary prepared by BPA:

"A Regional Planning Council is formed with representation from each of the states. The Council will draw up a plan for meeting the electrical needs of the region, taking into account the social and economic effects of alternative courses of action. The plan must give highest priority to cost-effective conservation, treating it as a resource preferable to all other means of responding to demand for electricity. Renewable sources of energy must be given next highest priority in the regions's power planning, to the extent that they are cost-effective, ranking ahead of conventional thermal generating resources. Among thermal options, fuel-efficient methods of producing energy must be given priority.

"Bonneville Power Administration becomes responsible for meeting the loads of customers and managing the regional electrical system to achieve the purposes of the Act relating to fish, system efficiency and experimental projects. BPA must give priority to cost-effective conservation and renewable resources in meeting the region's needs. BPA may also purchase the generating capabilities of new thermal projects, but only after determination that they are required in addition to all cost-effective conservation and renewables that can be achieved or developed in time. Such projects must also be found reliable and compatible with the regional electric system. BPA will spread the benefits and the costs of resources among all of its customers through its rates.

"The supply preference and resulting price advantages to co-ops and publicly owned utilities by Federal law are protected and enhanced. BPA is given the responsibility of meeting the full future requirements of preference customers -- something BPA was not previously authorized to do.

"The residential and farm customers of investor-owned utilities receive rate relief. The utilities sell to Bonneville, at the average cost of their power, an amount of electric energy equal to their residential and farm loads. Bonneville sells to them, in return, enough energy at BPA standard rates to cover these residential and farm loads. The rate advantages cannot enhance company profits, but must be passed on directly to the customers.

"Direct service industries receive new 20-year contracts for power from BPA, but at a higher price than they are paying under existing contracts. They will, in effect, pay the cost of rate relief to the residential and farm customers of investor-owned utilities during the first four years, and a substantial portion, thereafter, which they agreed to do in exchange for assurances of long-term supplies.

"BPA sells electricity at a rate that reflects the melded cost of Federal hydropower and more expensive thermal resources, conservation and renewable sources of energy. The Act contains incentives as well as to encourage conservation and renewables. BPA may credit utilities for their individual actions to implement conservation and renewables.

"The Regional Council establishes a program to protect and enhance the fisheries resources of the Columbia River and to mitigate damage already done to anadromous fish. Funding for the program is to come from BPA rate revenue.

"All planning for electric resources and fish protection must involve the public. State and local control of land use and water rights is protected under the Act and the decision to allow construction of new resources is left with utilities and State siting authorities.

"The new Regional Council must provide a method for balancing environmental protection and the energy needs of the region. For each few energy resource, the provisions of the National Environmental Policy Act must be complied with."

Other Need Determinations

The National Resources Defense Council (NRDC) submitted an alternative scenario (NRDC, 1980) of Northwest energy consumption to BPA. This scenario is not a forecast; it is a series of possibilities relating to energy conservation, and generation that may happen or could happen in the Northwest. The NRDC states that, if their conservation measures were implemented, the region would have an energy surplus through 1995. BPA has found serious fault with the methodology used in the scenario, and, primarily because of this, places little faith in the numerical results. BPA did state, however, that the bulk of the conservation measures advocated in the scenario appear to be cost-effective, although they had reservations about the feasibility and potential success of the implementation of the measures. The BPA has since developed its own scenario. The study, prepared by BPA Division of Conservation (BPA, April 1981) assesses the theoretical potential for conservation and renewable resource use in the West Group area to the year 2000. It was prepared without consideration for the Regional Power Act. BPA found that by 1990, based on the 1980 PNUCC forecast, approximately 1,500 MWe could be saved on its own authority, and that the region, with codes and regulations, could save 3,404 MWe. This savings assumes that social and institutional constraints would change. Ignoring all constraints, the "technically feasible" (although unrealistic, according to BPA) savings is nearly 6,000 MWe.

The PNUCC also prepared a conservation study that was released in July 1981. Findings of the study (PNUCC, 1981) suggest that additional programmatic savings may be developed over and above the conservation levels assumed in the PNUCC forecast. The estimates are that 1,394 MWe of additional savings may be developed by 1990. The additional savings are primarily a result of financial incentives to be offered under the Regional Power Act.

In January 1982, a study sponsored by the Washington State Legislature and prepared by the Washington Energy Research Center (WERC) of the University of Washington and Washington State University (1982) was released in draft form. It forecasts a most likely regional load growth of 1.5 percent annually between 1980 and 2000. This rate of load growth is substantially lower than the 3.2 percent annual growth forecast included in the 1981 PNUCC Regional Forecast. A major factor in this lower forecast was the demand-dampening effect of increases in retail electric rates (Washington Energy Research Center, 1982). The study also assumed moderate levels of conservation and renewable resource development. Comments to and revisions of this report before its final publication date may revise this estimate. If, however, the forecast rate of growth were revised to 2.0 percent instead of 3.2 percent, savings in peak firm load would exceed 5,000 MWe; savings in firm energy would exceed 2,500 MWe.

Currently, BPA is developing its own forecast of regional power needs, with publication anticipated during April 1982. According to BPA, the forecast will include a rate of average load growth between 1.5 and 2.0 percent annually. The resource section of this forecast is not complete. Such a rate of growth would confirm the region's trend toward lower load growth. A simple discussion of the potential effects of 2.0 percent load growth is included here and in Chapter 3, "Alternatives to the Project."

Under the Northwest Regional Power Act, the Regional Council representing Washington, Oregon, Idaho, and Montana will develop and adopt a Regional Electrical Power and Conservation Plan. This Plan will include a 20-year forecast that, in cooperation with BPA, must analyze which resources BPA should acquire to meet forecasted loads. Under present scheduling the Plan would not be complete when S/HNP is licensed, although preliminary drafts may be available. The forecast in this plan could be significantly different from existing forecasts because it would be the first that would be able to include all of the provisions of the Act, including energy priorities and fish flows.

The fisheries enhancement portion of the Regional Power Act represents a major provision of the act that could substantially impact both existing power resource levels and forecasted load deficits (surpluses). Although details of the program have not yet been developed, estimated losses of existing hydroelectric power resources resulting from fisheries enhancement have ranged from 800 MWe to 3,000 MWe. Such losses would significantly alter future load forecasts.

An additional factor that could significantly alter existing load forecasts is the irrigation requirements in the Columbia Basin area. These water requirements, which are not included in the latest PNUCC forecast, result from agreement by the Bureau of Reclamation to provide water for irrigation. Estimates of hydroelectric power resources foregone for irrigation have ranged from 500 to 1,000 MWe and higher.

In summary, the 1981 PNUCC forecast appears to indicate a need for the S/HNP. However, future energy activities in the regional area, could have a significant effect on that need.

2.3 STAFF ASSESSMENT OF NEED

It is beyond the scope of this EIS to develop an independent load forecast for the Pacific Northwest Region. Rather, official forecasts and alternative scenarios available at the time of EIS publication were reviewed and have been discussed. This is a particularly difficult time to quantify the regional power needs of the Pacific Northwest. Nuclear power plants have been terminated, spiraling power costs are affecting consumption, the Regional Forecast is 1 year old and is no longer used by BPA as a basis for forecasting, and the Northwest Regional Council is 1 year from producing their own plan and forecast. A forecast prepared by the Washington legislature (Washington Energy Research Center, 1982), which predicts drastic reduction in power consumption, is still in draft form. Recognizing that the loads and resources in the 1981 PNUCC Regional Forecast will change significantly over the next few months and certainly over the next year, the status of need is summarized.

The 1981 Northwest Regional Forecast indicates a deficit in total energy (average MWe) in 1991-92 of 2,177 MWe. This deficit would occur if it were assumed that the S/HNP project were built and delivering 869 average MWe (aMWe) and that WNP-4 and -5 were delivering a total of 1,868 aMWe. If load growth, as projected in the forecast, remained the same (3.2 percent), the regional deficit without the S/HNP would total 4,914 MWe, (total) and 3,613 MWe (firm) in 1991-92 now that WNP-4 and -5 have been terminated.

If the total average regional load growth from 1981-82 to 1991-92 changed to 2 percent (as a hypothetical example), and if WNP-4 and -5 were not built and other factors remained the same, the total aMWe load deficit would be reduced from 2,177 MWe to approximately 1,300 MWe. Firm load deficits would change from a deficit of 876 MWe to nearly zero.

A similar situation may exist for the applicant. In 1991-92, these companies forecast a deficit of average electric energy of 606 MWe during critical water conditions. Again, this deficit assumed that WNP-5 and S/HNP were built. Respectively, they are assumed to contribute 93 and 852 MWe to the four companies' planned resources. Without WNP-5, this same level of forecasted load growth would result in a 1991-92 deficit of 699 MWe.

During this 10-year forecast period, the four companies project a somewhat higher growth rate in electrical load (3.6 percent) than the region as a whole (3.2 percent). Again, this figure was prepared for inclusion in the 1982 Northwest Regional Forecast and is subject to the same potential for revision when this year's edition is released. If the companies' forecasts were to experience the same percentage level of reduction as the example shown above (3.2 to 2 percent), their load growth over this 10-year period might reduce from 3.6 percent to 2.25 percent. The impact of this on their projected 1991-92 deficit would be to change it to a surplus of 612 MWe. Elimination of the anticipated contribution of WNP-5 would decrease this critical water year surplus to 519 MWe. This contribution from S/HNP 1 in this year is projected at 852 average MWe. Thus, without the scheduled completion of S/HNP 1, the companies would still forecast a deficit in a critical water period (333 average MWe) at this lower hypothetical growth rate. The deficit is one-half that currently projected. This simplified analysis indicates the degree to which a lowered expectation of electric load growth alone might affect the need for the S/HNP as presently scheduled.

Moreover, the extent to which the fisheries enhancement portion of the Northwest Regional Power Act will affect future resource estimates is also uncertain, with estimates of hydroelectric power loss due to fisheries enhancement ranging from 800 MWe to 3,000 MWe. These new forecasts, as the 1981 PNUCC forecast on which the need for the S/HNP is based, are still only disciplined estimates of future events. Their results are sensitive to many assumptions which may or may not turn out to be accurate. This level of uncertainty also affects the assessment of need for the project.

Should the project not be completed on schedule and load growth increase faster than projected, the region may face potential deficits of electricity. On the other hand, if the plant is brought on line after a period of slower growth, its capacity might represent a surplus. Analysis of the costs and benefits of such "underbuilt/overbuilt" outcomes can place some perspective on the importance of load forecasting.

Responses to an underbuilt situation could include:

(1) Curtailment of Interruptible Power--In the past, regional variations in hydroelectric availability have been managed through curtailment of BPA's direct service customers. Use of this practice imposes costs on the curtailed industries. The companies proposing the S/HNP do not have sufficient interruptible service to successfully employ this strategy themselves.

(2) Power Purchase from Outside the Region--This response assumes that both power and intertie capacity will be available when needed. The costs of such purchases can also be substantially above regional generation costs.

(3) Power Replacement Through Short-Term Construction of Gas and Oil-Fired Combustion Turbines--Use of these units not only results in extremely high power costs, but also represents very inefficient use of these fossil fuels.

(4) Systematic Load Reduction Through Customer Conservation or Fuel-Switching--Voluntary or pricing incentive programs to persuade customers to reduce their electrical use will also impose added costs on either the customers or utilities involved. Such programs may be difficult to manage if large load reductions are sought.

(5) Implementation of State Electrical Curtailment Programs--All the northwest states have developed emergency electric energy curtailment programs. These programs impose use restrictions on electricity in an effort to secure mandatory load reductions with a minimum of social and economic reduction. They have never been tested in a large deficit situation.

(6) Curtailment of Regional Economic Activity--Lack of adequate electricity could result in serious disruption of the regional economy with consequent costs.

An overbuilt situation would require different responses including:

(1) Export of Surplus Power Out of Region--Again, this solution assumes that markets will be available when needed to absorb the surplus power. Further adequate intertie capacity must be found to move the power to the markets. The price available may also be less than generation costs.

(2) Plant Curtailment With Loss of Revenue--Whether the new unit or some other older plant is shutdown, revenue loss be incurred as fixed costs on the new plant continue to be paid. These costs represent much of the generating costs of a nuclear unit.

The variation in water availability for hydroelectric generation from year to year can act to move the region from a position of deficit to surplus in consecutive years. Table 2.7 shows that the deficit levels forecast in the 1981 PNUCC Forecast produce an annual chance of firm energy curtailment of between 12 percent and 28 percent. Thus, one might experience a deficit/underbuilt situation one year in four or five. Consequently, the costs of deficit in those years should properly be compared with the costs of surplus/overbuilt in the remaining water years.

A potential benefit of project completion, which produces a surplus generating capacity situation, would be the ability to shut down older plants burning oil or natural gas. In the Northwest, few such units exist and the proposed projects would far exceed their current capacity and use. Benefits of such fuel substitution would only occur through power export to California or the Southwest and displacement of oil- and gas-fired generation there. Such substitution also assumes that the delivered cost of surplus Northwest generation would be less than the replaced fossil generation.

Summary

Staff analysis concludes that on the basis of the published 1981 forecasts by the four companies and the 1981 PNUCC Regional Forecast, the S/HNP will be needed to alleviate electricity deficits in critical water years. However, the conclusion must be qualified by the evidence noted that the future forecasts may predict much lower load growth rates with a consequent delay in the time the project capability would be needed.

Project completion ahead of need or failure to meet needs will both impose costs on the region. The magnitude of these costs will depend on many factors. Quantification of these costs is not possible with the information availabe to date and will depend heavily on the actual hydroelectric resource condition existing at the time.

Project completion in advance of regional need will allow substitution of oil or natural gas only if markets and transmission capability exists for California and Southwestern areas.

2.4 CONCLUSION

In the foregoing analysis, the staff has attempted to recognize and assess the uncertainties that are inherent in the question of whether S/HNP is needed in the timeframe proposed. The staff has reviewed all relevant currently published forecasts of regional demand and resources. Because of the level of uncertainty inherent in these forecasts, the staff has attempted to analyze and assess the potential costs and benefits of completing this project ahead of, or behind schedule of, its actual need to meet regional demand. Based on its analysis of the published 1981 forecasts of the four applicants and the 1981 PNUCC Northwest Regional Forecast, the staff concludes that S/HNP will be needed by its projected completion dates to alleviate electricity deficits as projected under the critical water assumption. These forecasts do not appear to be seriously defective in their assumptions and, therefore, the staff concludes that they are reasonable based on current knowledge and data. Future forecasts will, of course, provide more current information and may alter the staff's conclusion of when S/HNP will be needed. However, given the legal responsibility imposed on all public utilities to provide adequate and reliable service--and the severe consequences that may be imposed on the public based a failure to discharge that responsibility--the uncertainties of prediction must be weighed in favor of concluding that there is a demonstrated need for the facilities.

3. ALTERNATIVES TO THE PROJECT

3.1 ALTERNATIVE ENERGY SOURCES AND SYSTEMS

3.1.1 Alternatives Not Requiring New Generating Capacity

3.1.1.1 No-Action Alternative

The no-action alternative is taken here to mean that factors such as denial of the necessary Federal and State permits, financing, or some other factor unrelated to need for power could result in a decision by the applicant not to proceed with the construction and operation of the proposed S/HNP units even if the project were needed. Environmental impacts of the no-action alternative are compared with those of other alternatives in this section. The no-action alternative would result in the S/HNP not being built and no other alternative would be built or implemented to take its place. This would mean that the electrical capacities to be provided by the project would not become available.

The most significant regional effect of no action would be the power resource loss to various utilities. Assuming that a need for the facility exists, some utilities, during a critical low water year, would possibly be forced to implement some power-reduction measures through State curtailment plans. Others may attempt to purchase power elsewhere or begin to plan their own generating facilities. Costs for an identical plant built later could be higher due to inflation.

If the S/HNP were not built and the PNUCC Regional Forecast proved correct, local economies could suffer due to lack of power for industrial and commercial use by the late 1980s. By 1991-92, absence of S/HNP would increase the average total energy deficit by 860 MWe from 2,177 MWe to 3,037 MWe. Firm load deficit would increase from 876 MWe to 1,736 MWe. These effects may be revised considerably by the 1982 PNUCC forecast.

Environmental impacts predicted from the project would not occur on the Hanford Reservation if the project were not built. If other generating sources were built in the future, some of these impacts (air, groundwater, socioeconomics) could eventually occur in other areas.

The applicant has purchased components for the project with a value of approximately $300 million. If the project were not built, PSP&L would be faced with owning surplus nuclear equipment. Presently, there appears to be no demand for nuclear components. Potential losses resulting from such conditions may be transferred by PSP&L directly or indirectly to their stockholders or ratepayers.

3.1.2 Alternatives Requiring New Generating Capacity

3.1.2.1 Delay

Project delay based on the 1981 PNUCC forecast may increase costs and could result in power shortages until this or other power resources could be made available. Delay would also increase the probability of energy shortage or curtailment in 1991-92. It would probably result in a widespread and active search for new power development possibilities in the Northwest. Conservation may temporarily ameliorate shortages. If delayed, the project may increase in costs, which ultimately would be borne by regional and participant ratepayers. If delay resulted in a need for more purchases of power, additional financial burden would be placed on the region.

Delay could also provide sufficient time for alternative energy and conservation options to be developed, thereby possibly reducing the need for the project. For example, a delay might provide enough time to determine the availability and potential for acquisition of WNP-4 and -5.

3.1.2.2 Acquisition of WPPSS Nuclear Project Numbers 4 and 5

The applicant's position with regard to possible acquisition of WNP-4 and -5 was contained in the response to NRC inquiry and stated:

> "Whether the acquisition of WNP-4 and/or WNP-5 is feasible and would be preferable to completion of Skagit/Hanford 1 and/or 2 is a complex question that cannot be answered at this time. For example, we do not know whether either of the WPPSS units will be offered to us or on what terms: price, date of turnover, guarantee of clear title, protection against claims, warranties as to quality and licensability of work performed and equipment on hand and on order, quantities and price of uranium, nuclear fuel and fuel services included, payment schedule, and financing. We do not know whether the WPPSS state and federal licenses for the units can and would be transferred to us and whether these transfers would involve any licensing risks or cause delays in resuming construction. We do not know whether the Regional Power Council will find that the WPPSS units will be needed on-line consistent with their scheduled completion dates. We do not know how feasible it would be for us to own and operate one unit of a twin unit project, sharing the common facilities with the Supply System. Until these and the other questions involved are answered, it will not be possible to make reliable economic comparisons between the various alternatives, such as the comparative cost of power over the anticipated operating lives of the respective units, or the comparative cost to the ratepayers of the region of the various alternatives. Puget Power is willing to explore these questions in cooperation with other parties. It seems only realistic, however, to suggest that developing reliable answers may be a rather time consuming process. It should also be noted that the key answers are dependent upon parties and events beyond the control of Puget Power. Pending the emergence of reliable answers, we intend to continue on schedule with our efforts to license the Skagit/ Hanford units."

One factor that the applicant has not mentioned in this response is disposition of part or all of the $300 million worth of components purchased for the original Skagit project.

A delay in the construction schedule of the S/HNP would allow the applicant time to examine many of the issues mentioned above. The staff agrees that acquisition of WNP-4 appears to be an uncertain prospect and, for that reason, does not consider this a viable alternative at this time.

3.1.2.3 Curtailment

The Washington State Energy Office has prepared an Electrical Contingency Plan (1980) to provide options for dealing with electrical shortages. It contains curtailment guidelines for the four-state region (Oregon, Idaho, Washington, and Montana) in six stages. Each stage is triggered by a level of energy supply. The first stage is a "Watch"--an alert that a shortage is forthcoming. The last three stages include various levels of mandatory curtailment, including, in Stage III, mandatory shutdown of large users of electrical energy.

The probability of curtailment, which could result from the no-action alternative, is similar to the probability of total energy load insufficiencies shown in the loads and resources table (see Table 2.7, Section 2.2).

3.1.2.4 Conservation

Conservation is an important factor included in forecasts issued by Bonneville Power Administration (BPA) and local utilities, including the applicant. The extent to which additional conservation might be implemented in the future is of concern, and could affect the size, timing, or possibly the need for the proposed project. This section discusses conservation as an alternative to the S/HNP.

The Bonneville Power Administration has stated that sufficient conservation actions in the Pacific Northwest would reduce demand for additional peak generators (BPA, 1980). The staff believes that this statement would also apply to baseload facilities, because peak loads determine the actual facilities requirements and are a more critical factor in determining needed generative facilities. Whether such actions would be sufficient (i.e., equivalent to 2,600 MWe) to provide a viable alternative to the S/HNP will remain unanswered because of uncertainties regarding the success of the various conservation measures.

Among the numerous advantages of conservation, cost is probably at the top of the list (BPA, 1980). Conservation is generally less costly than new power plants and generally requires a shorter lead time (BPA, 1980). Because of the recent increases in power costs due to rising fuel costs and purchases of power outside of the region, industry and the public have become active in conservation. Cogeneration is under way in the pulp and paper industry and energy-efficient equipment is being installed by the aluminum industry. Some public and private utilities now have weatherization programs that include no-interest or low-interest loans and conservation pilot programs. BPA can also finance some conservation investments.

Passage of the Regional Power Act places a new emphasis on conservation and requires BPA to give it priority while acquiring new resources. Conservation itself is now treated and defined as a resource under the Regional Power Act through billing credits, surcharges, and a 10-percent cost-effectiveness advantage for conservation compared to energy generation.

The West Group Forecast and Northwest Regional Forecast (PNUCC, 1981) presented in Chapter 2 contains estimates of energy savings through conservation as forecast by individual utilities. The Econometric Forecast technique used to confirm these forecasts uses factors such as appliance use, insulation variables, electricity prices, and solar applications to generate predictions of reduction in energy sales due to price changes (implicit conservation) and changes in appliance efficiencies, housing insulation standards, and solar applications (explicit conservation). The PNUCC has estimated that 1,350 average MWe of potential programmatic conservation are included in the PNUCC forecast for 1990 and an additional 1,000 average MWe are not yet included. The Bonneville Power Administration (BPA, April 1981) concluded that, based on the 1980 forecast, the BPA could implement programs that could save an additional 1,535 average MWe by 1990 (300 MWe is being implemented) and that, if regional regulations and codes were passed, a "potentially" achievable level of 3,170 average MWe could be saved.

Other conservation studies have been done or are under way. A study by the National Resources Defense Council (NRDC, 1980) suggested that no additional power plants would be required in the region through 1995. It was a scenario rather than a forecast of optimum conservation potential and suggested a savings of more than 10,000 MWe. BPA criticized the assumptions and methods of this study, although BPA stated that the methods suggested appeared to be cost effective and technically feasible. In April 1981, BPA suggested a maximum "technically feasible" level of more than 9,000 MWe by 2000 (ignoring all constraints).

3.1.2.5 Purchased Power

For purchased power to be a reasonable alternative to the proposed project, long-term commitments of substantial amounts of energy would be required from production facilities outside the region. The applicant has stated that other utilities would be unable to make long-term commitments for firm power. Some short-term commitments could be obtained; however, the risks over the longer term are not acceptable to the applicant.

The Western System Coordinating Council (WSCC), Summary Estimated Loads and Resources, 1981, suggests that deficits within in the Northwest Power Pool can be reduced with agreements between WSCC members but no agreements have been signed. Only during median hydroelectric conditions would surplus energy be available. During critical water years, no excess power would be available from the Northwest Pool. Several proposals have been made to develop more intertie capacity between the Northwest and Southwest. If these transmission lines were built, they would double existing intertie capacity (Washington Energy Research Center, 1982). If built, seasonal exchanges could be made with Southwest utilities. This is not a viable alternative for baseload capacity at this time because the lines have not been proposed yet but there is some potential for future resource acquisition.

3.1.2.6 Cogeneration

Cogeneration refers to the use of an energy source to yield both electric and thermal (heat) energy. The main advantage of using cogeneration systems is the significant increase in efficiency of fuel consumption. Fuel efficiency may increase from 25 to 30 percent for a thermal power plant to 70 to 80 percent for a cogeneration facility. The result is a net savings of fuel and associated costs.

The present Northwest Regional Forecast shows only 44 MWe of cogeneration available from 1981 through 1992. In contrast, 1,430 MWe of existing and unutilized capacity has been listed as available in the region (Rockwell Corporation, 1979). This resource, if developed, could have a significant impact on the regional deficit.

A reduced level of load growth, such as that presently being experienced in the Northwest, may reduce the rate of utilization of cogeneration opportunities. Such opportunities are mostly industrial. A slow economy reduces industrial output that reduces energy consumption, which in turn reduces cogeneration potential. The forest products industry presents a good example of such causal events.

Certain environmental advantages of cogeneration and steam turbine application may occur. Higher thermal efficiencies of cogeneration facilities can reduce fuel consumption relative to thermal facilities only and reduce air emissions. Cogenerating facilities also tend to be smaller resulting in increased dispersal of environmental impacts compared to large centralized generating stations.

3.1.2.7 Coal

By the time the plant is operating (1990s), U.S. production of coal is predicted to exceed 1 billion tons per year. The use of coal has been increasing annually. Present recoverable resources total more than 400 billion tons (S/HNP ASC/ER, 1981).

One large mine-mouth coal-fired plant presently exists at Centralia in Western Washington. It is sponsored by the utilities who are sponsoring the S/HNP. PSP&L is presently sponsoring up to 500 MWe of a coal-fired plant currently planned for construction in the early to mid-1980s near Creston, Washington.

PSP&L states that Canadian coal is not considered available because of lack of an assured supply for 35 years. They also state that, other than eastern Montana, western coal reserves are not of suitable quality or quantity and are not economically feasible to mine. The sponsors of the Creston project, however, of which PSP&L is a 25-percent participant, are still examining Canadian and Wyoming coals.

Overall typical operational environmental impacts from a typical coal plant resulting from air emission and ash disposal are more detrimental than from a nuclear plant. Costs, when considered over the life of the plant, are greater for coal because of the transportation costs of fuel (S/HNP ASC/ER, 1981).

3.1.2.8 Geothermal

In the region as a whole, opportunities for proven geothermal applications are uncertain and do not presently provide feasible alternatives to the S/HNP (Table 3.1).

In a recent study (BPA, 1981) 66 MWe of geothermal resources were identified that could be developed by 1990. A total of 163 MWe could be developed by 2000.

Table 3.1 Geothermal resources displacement of electric energy, residential section, West Group area

Area	1985	1990	1995	2000
Washington	34	229	455	719
Oregon	104	214	358	532
Idaho	18	38	63	103
Western Montana	3	11	25	37
Northern California	4	7	14	18
Northern Nevada	3	9	14	19
Total	166	508	929	1428

A U.S. Geological Survey study (1978) listed a total of 2,059 MWe in electrical energy available in Oregon and Washington from hydrothermal converter systems in excess of 150°C. No assessment is made, however, as to the feasibility and plans for development of the resources.

To date, there are no proven resources in Oregon or Washington that are planned to produce electrical power in the near future. The staff concludes that it is unrealistic to defer needed electricity generating capacity expansion in the expectation of geothermal development. Although it is possible that some geothermal production may occur over the next 10 years, there is no indication that geothermal energy would be considered a viable alternative to the project.

3.1.2.9 Oil and Natural Gas

The use of oil and natural gas to generate new baseload electrical energy is prohibited by the Fuel Use Act.

3.1.2.10 Solar

Solar energy appears to show promise as a significant energy source for the near future. Present technical feasibility, however, is not sufficiently developed for solar power to serve as an alternative to a large base-load plant.

Passive solar systems that take advantage of solar energy through design and construction of new structures will also supplement as an energy source, although they are generally more cost-effective in the Southwest and other sunny areas. Their development is based on an individual application and cannot be considered as an alternative to the S/HNP.

3.1.2.11 Hydroelectric

The applicant has stated that they currently utilize their own hydroelectric resources to the maximum extent possible and that planned additional resources are in the forecast.

On a regional basis, the potential for hydroelectric power development is different. Permit status is still highly speculative and may not relate to the actual number of megawatts of power that may eventually be available. For example, some of these permits include rivers that may be classified under Wild and Scenic River status; water rights may not be available for others; severe local concerns may prevent construction of others. For example, Copper Creek Dam was set aside by the Seattle City Council in 1981, which reduces the potential hydroelectric output by 120 MWe.

Preliminary results of the National Hydroelectric Study (U.S. Army Corps of Engineers, 1979) indicates that existing small hydroelectric projects could expand to add 310 MWe of average energy to the region's resource base and the development of 195 undeveloped sites could theoretically add 1,800 MWe average energy. The economic and environmental feasibility of these developments has not been determined.

The Bureau of Reclamation, however, identified "economically viable" sites totaling 60 MWe that could be built with no significant environmental or social impacts.

The PNUCC recognizes the potential for hydroelectric development and lists 20 planned resources from 1981 through 1988 with a combined nameplate rating of approximately 2,000 MWe. These are considered in the load forecast. An additional 18 prospective (less certain) projects total approximately 2,100 MWe. Each would be included in future forecasts.

Hydroelectric power as an alternative to the S/HNP is further constrained by the fact that most low-head systems currently under consideration are intended to provide peaking energy and cannot ensure a reliable baseload. The proposed S/HNP, however, is a baseload plant that would provide continued firm power. Therefore, the 2,100 MWe of hydroelectric power that could possibly be added to the regional resource would primarily provide peaking power, not baseload, and could not be considered as an alternative.

3.1.2.12 Wind

The use of wind power to provide large-scale energy production is presently an experimental technology. Smaller scale applications may be feasible in some areas and may provide some presently undetermined portion of the region's energy needs. Oregon State University has postulated a 3,000 MWe capacity for the region; however, BPA feels that 60 MWe may be a more reasonable value. According to the ASC/ER, the applicant is presently assessing wind energy potential and believes a development program could begin in the mid-1990s, although electrical output is uncertain. Because of its technological status and intermittent nature, wind is not considered to be a technologically feasible alternative to the proposed S/HNP.

3.1.2.13 Combined Renewable Resources and Cogeneration

Although the preceding resources taken individually above cannot serve as an alternative to the S/HNP, the possibility remains that, when combined, the potential might be different. As stated earlier, however, this report does not present an independent demand forecast analysis. The only combined analysis incorporating all of these resources is the PNUCC regional area forecast. This forecast reflects the potential effects of combined renewable resources and cogeneration. It is feasible that a reduced load growth rate, increased cogeneration, low-head hydroelectric, and power exchanges could justify a delay for the S/HNP.

3.1.3 <u>Staff Assessment of Alternative Energy Sources and Systems</u>

Puget Sound Power and Light Company has stated that they are committed at this time to seek necessary permits for this project. They are not committed to begin construction immediately upon receipt of those permits. Rather, they will decide to construct once the economic and regulatory climate appears conducive to the construction of a nuclear power plant.

This approach opens the possibility to consider alternative energy sources that may not have been available had the applicant committed to begin construction in 1983. Thus, it may make some alternatives (e.g., conservation, cogeneration) more viable.

This approach also pushes the on-line date of the plant toward the end of the 10-year forecast, and potentially beyond. Assuming no construction delay, the staff agrees, based on the 1981 PNUCC forecast, that the no-action and delay alternatives could result in power shortages in a critical low water year. Obvious new conservation potential (1,000 MWe) has been more than offset by the apparent termination of WNP-4 and -5 (1,868 MWe). A load growth rate of 2 percent or less per year, however, appears to reduce the need for the project as presently scheduled.

Coal appears to be more costly over the life of the plant and presents much greater environmental impact; the acquisition of WNP-4 and -5 does not appear viable at this time. Other measures by themselves or together are not under the control of the applicant and cannot be relied on to provide the needed baseload power. The staff concludes that no alternative energy sources or systems provide a viable alternative to the project as currently scheduled.

3.2 ALTERNATIVE SITES

The staff's consideration of alternative sites and the reviews of the applicant's site selection efforts began with the review of the initial application for the Skagit project filed with NRC in September 1974. Since then, a number of additional siting efforts by the applicant and reviews by the staff took place that represent a very large body of information relating to siting resources available for location of the Skagit plant (Regional Siting Program, June 1980; Bechtel Corporation, 1970; Bechtel Corporation, 1966; NRC, Testimony of Leech et al., 1979; NRC, Testimony of Jacobsen, 1975; NUREG-75/025). The results of these separate efforts performed within the last 12 years, done by different teams, using a variety of methodologies and screening criteria, were reviewed by the staff once more. A large part of the information was updated and supplemented by the applicant and the staff to satisfy the needs of the current review. This evaluation of the composite siting efforts to date by the applicant builds on, augments, and summarizes previous staff evaluations of alternative sites.

On April 9, 1980, the Nuclear Regulatory Commission published in the Federal Register, pages 24168-24178, a proposed revision to 10 CFR 51, Licensing and Regulatory Policy and Proceedings for Environmental Protection; Alternative Site Reviews (see Appendix H). In its review of alternative sites, the staff used the proposed rule on alternative sites as guidance.

Purpose and Scope of Review

The purpose of this review is to determine whether an applicant's proposed site for nuclear power plant construction and generation represents a reasonable choice from a group of alternative sites that were selected using a process sensitive to environmental concerns. The scope of the review includes analyses directed at making the following determinations:

(1) Whether the reconnaissance level information submitted by the applicant is sufficient to support the analyses necessary to reach reasoned conclusions;

(2) Whether the region of interest (ROI) considered was of sufficient size to reflect reasonably available environmental diversity of water bodies and associated physiographic units;

(3) Whether the candidate sites are the best that could reasonably be found based on an analysis of the merits of the candidate sites measured against a set of environmental criteria; and

(4) Whether one or more alternative sites is obviously superior to the applicant's proposed site based on a sequential two-part analytical test. The first part of the test determines whether any of the alternative sites is environmentally preferable to the proposed site using a set of environmental threshold criteria. The second part overlays consideration of project economics, technology, and institutional factors to determine whether, if such an environmentally preferred site exists, such a site is, in fact, an obviously superior site.

Puget Sound Power and Light Site-Selection Process

Siting Objectives

The overall objective of PSP&L's site-selection efforts was to identify sites that would be suitable for the construction and operation of several nuclear power generating facilities. This necessitates that suitable sites meet specific project requirements and the appropriate Federal and State regulations concerning plant construction and operation so that plant licensing could proceed without delays.

Siting Process

In support of the consideration of alternative sites, the applicant submitted results of the site selection process used by PSP&L, including cumulative results of several major siting studies (Bechtel, 1966; Bechtel, 1970; Regional Siting Program, 1980); the information generated for the Final Environmental Statement for the Skagit Nuclear Power Project, and the licensing proceedings conducted by the Atomic Safety and Licensing Board (ASLB). The efforts used systematic review and screening processes to arrive at a large number of sites that complied with Federal, State, and local regulations. These regulations and the specific project requirements formed the basis for criteria that were applied to geographic areas in several stages and in various combinations to delineate a final slate of candidate sites (S/HNP/ER Amendment 3, 1981; Regional Siting Program, 1980).

Specific project requirements used as criteria included project dates, number of units, plant size, cooling system options, reviews of previously identified and existing sites, and transmission systems. Federal guidelines used to design siting methodology and screening criteria included NRC Regulatory Guide 4.7, Revision 1; Regulatory Guide 4.2, Revision 2; and the Environmental Standard Review Plan, Section 9.2. State regulations bearing on the siting process included the State of Washington Energy Facility Site Evaluation Council's (EFSEC) Rules Relating to Siting Energy Facilities and the State of Oregon Energy Facility Siting Council's (EFSC) Rules Relating to Siting Energy Facilities (Regional Siting Program, 1980).

Region of Interest

The final region of interest (ROI) used by PSP&L and delineated by the Regional Siting Program (RSP) Site Selection Study included the states of Washington and Oregon and is shown in Figure 3.1 (Regional Siting Program, 1980). The ROI changed in size several times throughout the entire site-selection process (NRC, Testimony of Leech et al., 1979). The ROI delineated in the studies was significantly smaller than the ROI established by the RSP. The initial ROI included only PSP&L's service area. In 1970, the ROI was expanded to include the area generally bounded by the Canadian border, the Pacific Ocean, and the Cowlitz River but also including the Hanford Reservation in south-central Washington. Finally, the Regional Siting Program expanded the ROI to include all of Washington and Oregon (NRC, Testimony of Leech et al., 1979).

Candidate Sites

Table 3.2 presents the final slate of candidate sites identified by the composite site selection process and submitted in PSP&L Amendment 3 to the Skagit/Hanford Nuclear Project Environmental Report (S/HNP ASC/ER, 1981). The Skagit, Cherry Point, Goshen, and Hanford sites were identified in siting studies conducted by PSP&L and Bechtel in 1966, 1970, and 1972 (NRC, Testimony of Leech et al., 1979). Ryderwood was identified in 1973 after a geological reconnaissance was made of the Cowlitz River area by Bechtel (Bechtel, 1973). The Hanford sites were again identified as candidate sites by NRC staff testimony before the ASLB in 1979 (NRC, Testimony of Leech et al., 1979). The Pebble Springs South, Eltopia, and Centerville sites were identified as candidate sites by the Regional Siting Program (Regional Siting Program, 1980).

Site Description

Figure 3.2 shows the location of the relevant candidate sites identified in Amendment 3. In the following narratives, each site is briefly described. Further information on each of the sites is provided in this review.

Skagit--The Skagit site is located near Minkler Lake in the Skagit County approximately 11.2 km (7 mi) from Sedro Wooley, Washington. The area is currently used as pastureland and for tree farms. Water would be obtained from the Skagit River (Puget Sound Power and Light Company, 1974).

Goshen--Located approximately 11.2 km (7 mi) north-northeast of Bellingham in Whatcom County, the site is currently half forested with the remainder used for agricultural purposes, predominantly grazing. Water would be obtained from the Nooksack River (Puget Sound Power and Light Company, 1974).

Ryderwood--Located near the southern boundary of Lewis County in Western Washington approximately 16.0 km (10 mi) northwest of Castle Rock and 6.4 km (4 mi) west of Vader, the Ryderwood site is located in an area called Couger Flat. Land uses include tree farms, grazing land, and commercial timber forests. Water would be obtained from the Cowlitz River (Puget Sound Power and Light Company, 1974).

Cherry Point--This site is located approximately 20.2 km (12 mi) west-northwest of Bellingham, Washington, in Whatcom County on the shoreline of the Strait of Georgia in Puget Sound. Currently, the site is partially forested with the

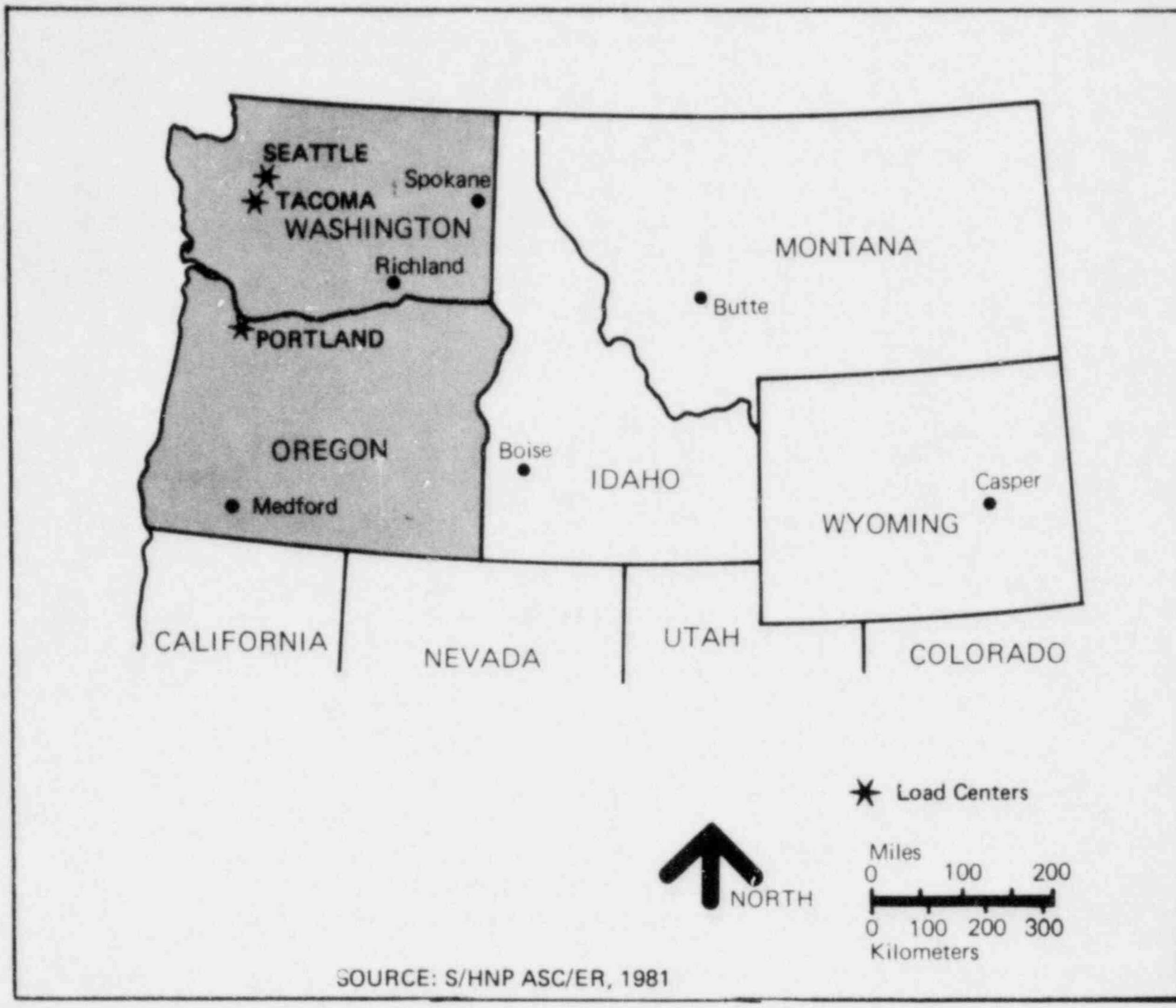


Figure 3.1 The region of interest

Table 3.2 Candidate sites

Sites	Location	Source of Cooling Water
Skagit	Skagit County, WA	Skagit County
Goshen	Whatcom County, WA	Nooksack River
Cherry Point	Whatcom County, WA	Puget Sound (Marine)
Ryderwood	Lewis County, WA	Cowlitz River
Hanford 22-1	Benton County, WA	Upper Columbia River
Hanford 22-2	Benton County, WA	Upper Columbia River
Hanford 23	Franklin County, WA	Upper Columbia River
Eltopia	Franklin County, WA	Upper Columbia River
Pebble Springs South	Gilliam County, OR	Middle Columbia River
Centerville	Klickitat County, WA	Middle Columbia River
Proposed S/HNP	Benton County, WA	Upper Columbia River

Sources: S/HNP ASC/ER, 1981; Regional Siting Program, 1980.

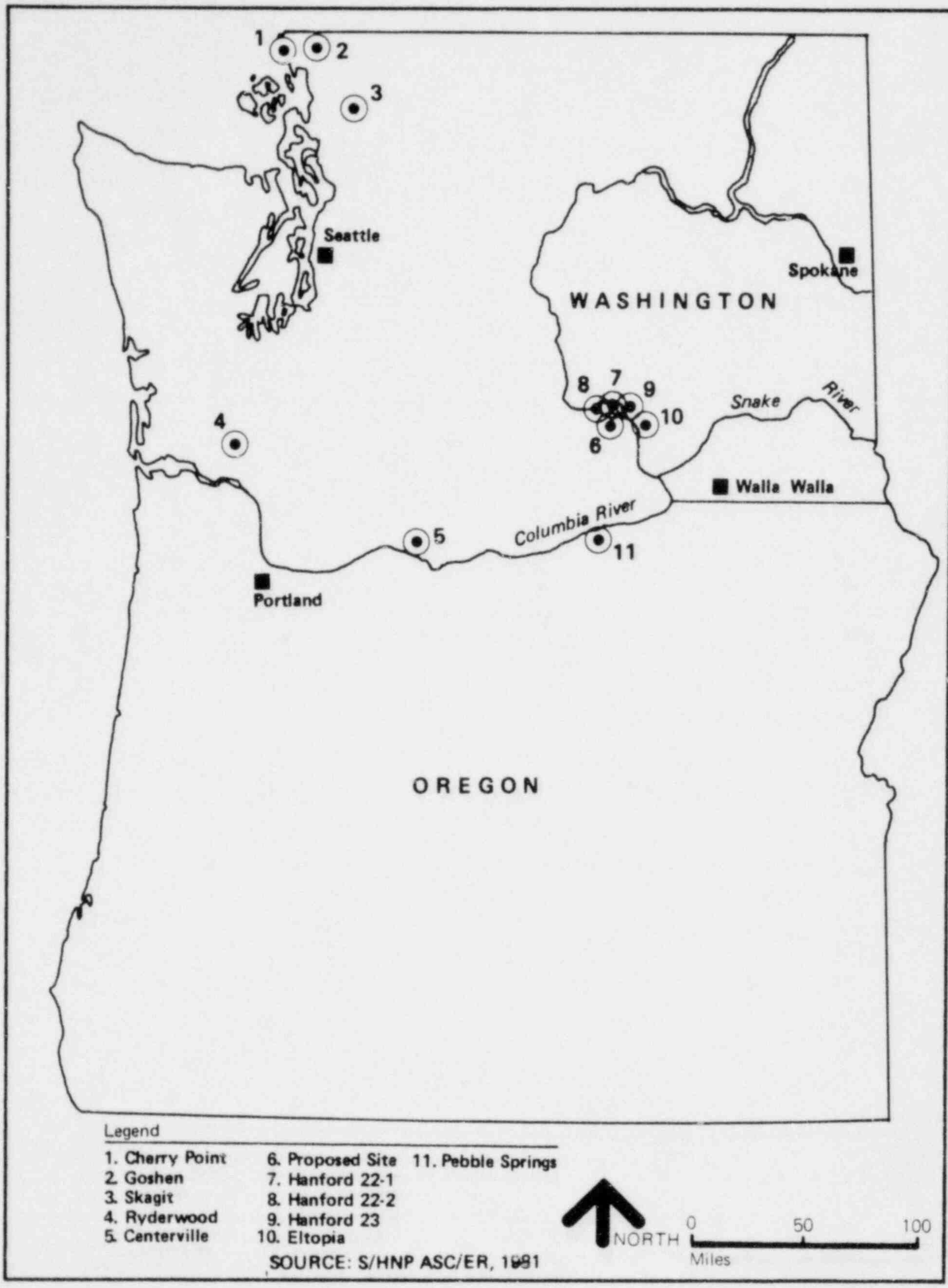


Figure 3.2 Final candidate sites

remainder used for agriculture. The site is adjacent to an oil refinery and is zoned industrial. Water would be obtained from Puget Sound for a once-through cooling system (NRC, Testimony of Jacobsen, 1975; NUREG-75/025).

Hanford 22-1--This site is located in Benton County, Washington, within the Hanford Reservation of the U.S. Department of Energy approximately 24 km (15 mi) north of Richland. The area has been dedicated for use for nuclear-related activities with only a small portion being intensively used at present. Water would be obtained from the Columbia River (Regional Siting Program, 1980).

Hanford 22-2--Located approximately 40 km (25 mi) northwest of Richland in Benton County, Washington, this site is also located on the Hanford Reservation. Current land use and water sources are the same as the Hanford 22-1 site (Regional Siting Program, 1980).

Hanford 23--This site is located in Franklin County on the Hanford Reservations east of the Columbia River approximately 32 km (20 mi) north of Richland. The site is presently in an area leased by the Washington State Department Game as a wildlife recreation area with archery and shotgun hunting permitted. Irrigated agricultural uses are located immediately east of the site. Water would be obtained from the Columbia River (Regional Siting Program, 1980).

Eltopia--Located in Franklin County, Washington, approximately 20.8 km (13 mi) north of Pasco, the site is currently used for irrigated agriculture. Water would be obtained from the Columbia River (Regional Siting Program, 1980).

Pebble Springs South--This site is located in Gilliam County, Oregon, approximately 6.4 km (4 mi) southeast of Arlington. The site is used for seasonal grazing. Areas immediately north of the site have been proposed by Portland General Electric for Pebble Springs Nuclear Units 1 and 2 and contain a substation and a meteorological tower. Water would be obtained from the Columbia River Regional (Regional Siting Program, 1980).

Centerville--Located approximately 11.2 km (7 mi) south of Goldendale, Washington, in Klickitat County, the site is presently used for dryland and irrigated farming. Water would be obtained from the Columbia River (Regional Siting Program, 1980).

Proposed Skagit/Hanford Site--This site is located in Benton County, Washington, within the Hanford Reservation of the U.S. Department of Energy approximately 20.8 km (13 mi) north of Richland and 4 km (2.5 mi) southwest of the Hanford 22-1 site. The area has been dedicated for nuclear-related activities with only a small portion being intensively used at present. Water would be obtained from the Columbia River (S/HNP ASC/ER, 1981).

3.2.1 Staff Analysis of Applicant's Site-Selection Process

3.2.1.1 Adequacy of Reconnaissance Level Information

The only area of information that lacked sufficient research/investigation was groundwater hydrology. Groundwater was not investigated as a potential source of cooling water in any of the siting studies (Bechtel, 1966; Bechtel, 1970; Regional Siting Program, 1980). Groundwater was not investigated by the applicant as a source of cooling water for several reasons. First, groundwater and wastewater is customarily considered in areas with critical water shortages. Other reasons include competition with agricultural uses of groundwater, overdraft and salinity problems, and uncertainties regarding adequate supplies to last for the duration of the project's life.

In general, the information supplied by the applicant, augmented by information generated by the staff, was sufficient to conduct analyses and make reasoned conclusions.

3.2.1.2 Region of Interest

Size

The region of interest (ROI) selected for examination by PSP&L included the states of Washington and Oregon and is shown in Figure 3.3. As stated previously, the ROI changed in size several times throughout the evolutionary site-selection process. The current ROI was delineated by the Site Selection Study conducted by the Regional Siting Program (Regional Siting Program, 1980).

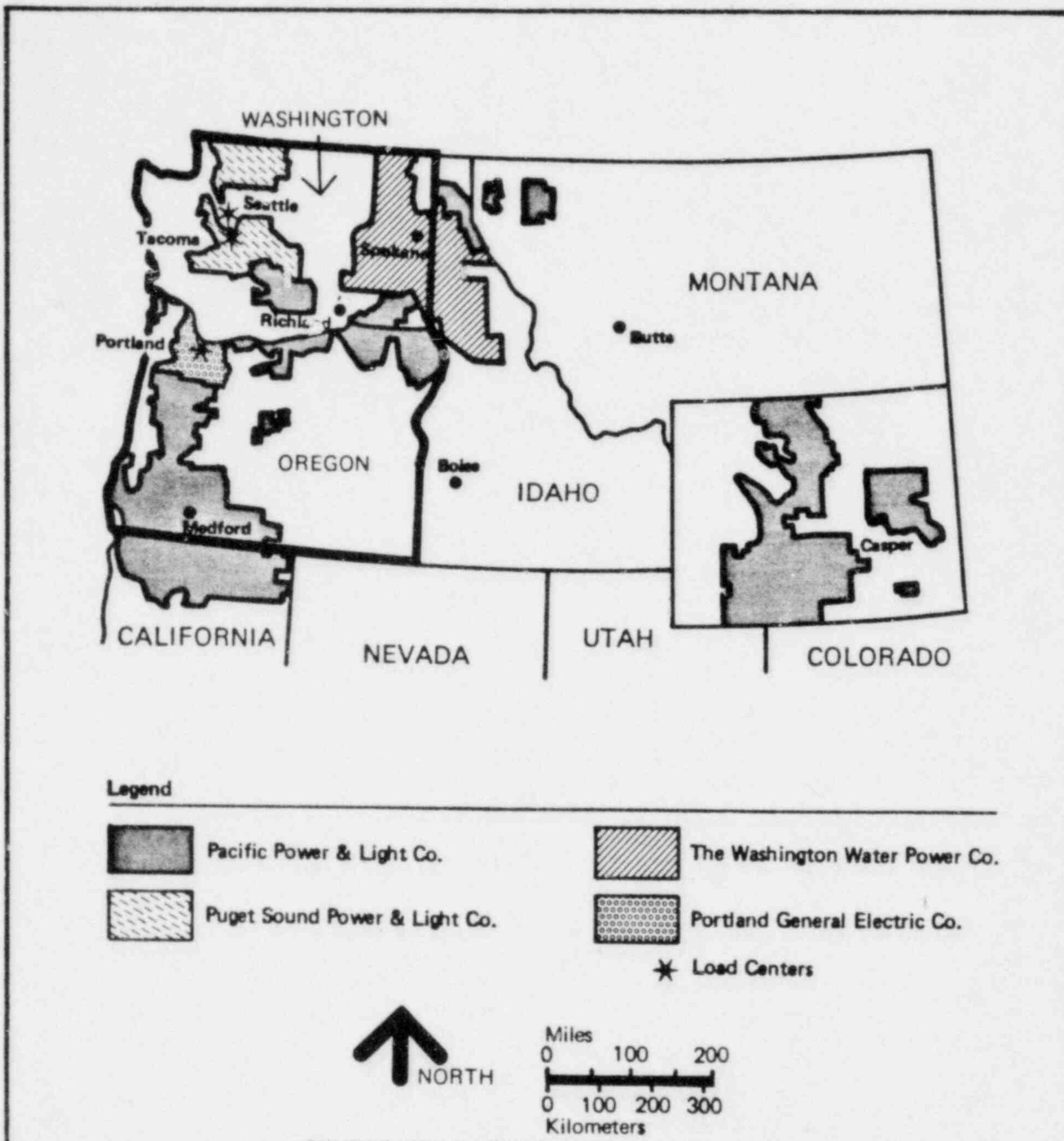
Guidance regarding the adequacy of the size of the ROI states that the initial geographic area for the ROI can be either in the state in which the proposed site is located or the service area of the applicant. The actual ROI then must be greater than the initial geographic area if environmental diversity would likely be substantially increased without incurring exhorbitant costs (see Section V within Appendix A of the proposed rule, which is included in Appendix H of this EIS).

Size and Location Compared to Applicant's Service Areas

Figure 3.4 shows the ROI in relation to the participating utilities' service areas. The ROI includes all of the participating utilities service areas, except those portions of Pacific Power and Light Company's service area located in northern California, Idaho, Montana, and Wyoming service areas, and The Washington Water and Power Company's Idaho service areas. The ROI also encompassed areas not served by the participating utilities. These areas include: most of central and southeastern Oregon, the northwest coast of Oregon, the Olympic Peninsula and west coast areas of Washington, and an area including much of central and southern Washington.

Environmental Characteristics

The ROI includes many areas exhibiting widely diverse types of water resources and physiographic characteristics. Climate, hydrology, geology, topography, vegetation, and soils combine to form 15 different physiographic provinces within Oregon and Washington (Franklin and Dyrness, 1973). Figure 3.4 shows these physiographic provinces and the location of the alternative sites characterized by gently undulating to moderately hilly topography. Water resources in the ROI are numerous and abundant. They vary from the Pacific Ocean and Puget Sound (an inland ocean inlet that runs parallel to Washington's Pacific Coast in northwest Washington) to major rivers, alpine lakes, and large lakes and reservoirs formed by the region's many hydroelectric dams.



SOURCE: S/HNP ASC/ER, 1981

Figure 3.3 Service areas of participating utilities. Region of interest is in Washington and Oregon

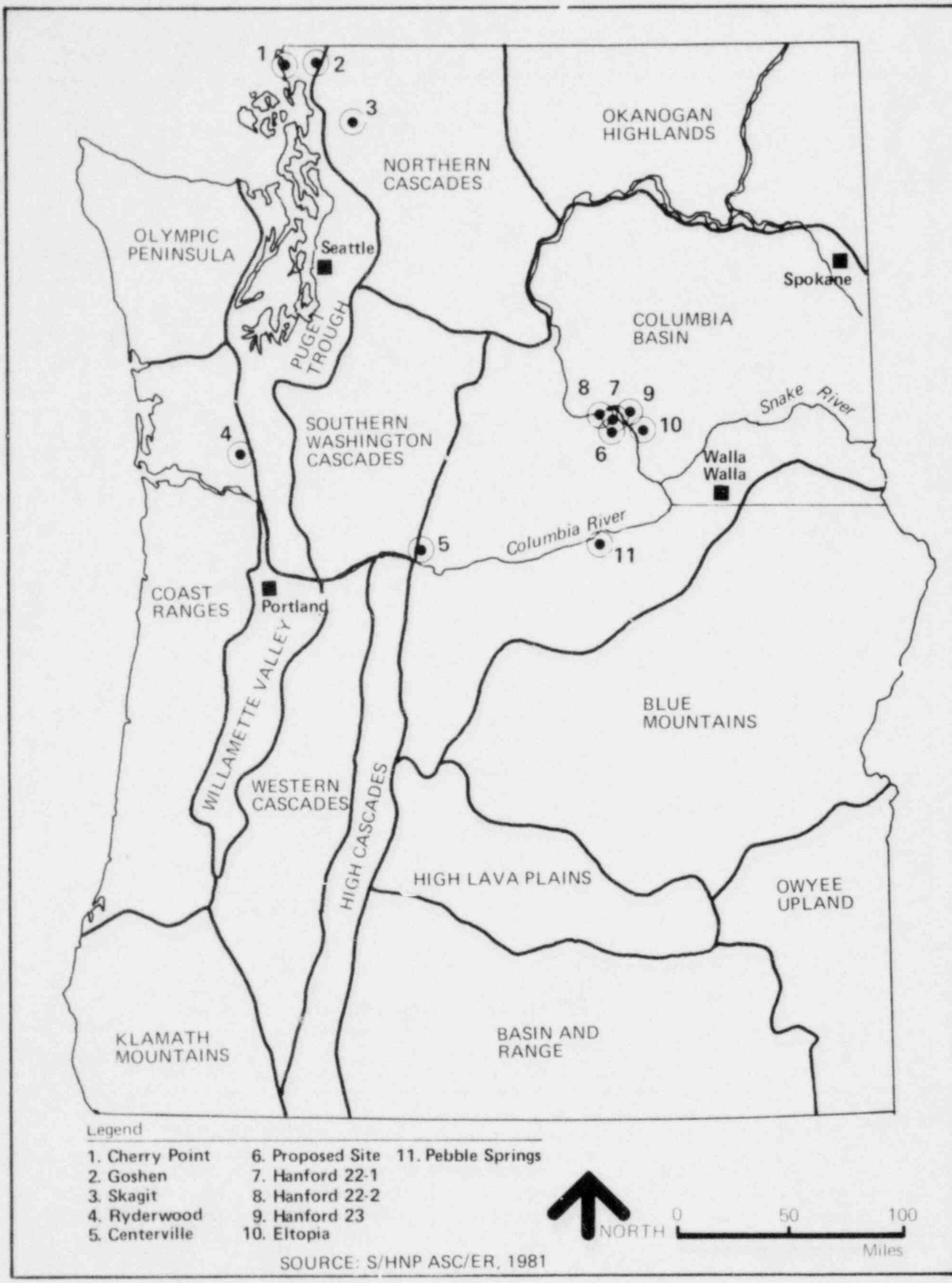


Figure 3.4 Final candidate sites with physiographic unit boundaries

The general physiographic character of these provinces ranges from the high mountains of the Cascade and Olympic Ranges, and the flat river valleys of the Willamette and Puget Trough areas, to the arid desert areas of southeastern Oregon. The largest physiographic provinces, the Columbia Basin, is an area characterized by gently undulating to moderately hilly topography. High volcanic peaks occur in the Southern and High Cascades provinces, while deep river canyons occur along the upper Columbia River in central Washington and along the Snake River which forms the northeastern boundary of Oregon.

The staff believes that, although the applicant's service area extends beyond the boundaries of the States of Washington and Oregon and include small parts of Idaho, Montana, Wyoming, and California, the environmental diversity of water resources and associated physiographic units is well represented within the proposed ROI. All major types of water bodies, such as upper and lower reaches of large rivers, small rivers, lakes, bays, and oceans, are included in the ROI. The staff further believes that expanding the ROI beyond the boundaries of Washington and Oregon would not substantially increase the available environmental diversity of resources and that it would not yield significant additional new alternatives for limiting of environmental impacts. Consequently, the staff believes that the ROI as submitted by PSP&L is of sufficient size and does need not to be enlarged.

Institutional Constraints on Siting

The primary institutional constraint on the PSP&L's siting options is the State of Oregon's Initiative No. 7, which was passed by a vote of the people in November 1980 (Oregon Revised Statutes 469.595). This initiative stated that a nuclear power plant could not be licensed in the State without a vote of the people and that a nuclear plant could not be constructed until a Federal nuclear waste depository was licensed and operating.

3.2.1.3 Selection of Candidate Sites

Guidance from the proposed rule on alternative sites (see Appendix H of this EIS for proposed Appendix A, Section VI to 10 CFR 51) provides two ways of demonstrating that the sites qualify to be in the final slate of alternative sites used in the subsequent site-specific comparison, and thus be among the best that could reasonably be found. They must be either (1) identified through the use of site-selection methodology that includes an environmentally sensitive site screening process, which, in addition, meets seven process-oriented criteria (Appendix A, Section VI.3); or (2) meet eight environmental threshold criteria (Appendix A, Section VI.2.b), in which case there shall be no further review of the site-selection process.

In addition, candidate sites found in the final slate should include (1) at least four sites to provide reasonable representation of the diversity of land and water resources within the ROI; (2) one or more of these sites associated with each type of water source and physiographic unit reasonably available within the ROI; and (3) one alternative site with the same water source as the proposed site.

The candidate sites proposed by the applicant were selected through the use of several siting studies over the span of several years, using diverse staffs, methodologies, and screening criteria. Because of this lack of uniformity in approaches to the siting process and associated difficulties in evaluating of such efforts, the staff chose the review option that focuses on the environmental characteristics of the candidate sites and evaluates them for conformity with the following environmental threshold criteria listed in Section VI.2.6 of the proposed rule given in Appendix A (see Appendix H):

(1) Consumptive use of water would not cause significant adverse effects on other water users.

(2) There would not likely be any further endangerment of plant or animal species listed by Federal or State agencies as threatened or endangered.

(3) There would not likely be any significant impacts to spawning grounds or nursery areas of significance in the maintenance of populations of important aquatic species.

(4) Discharges of effluents into waterways would likely be in accordance with State or Federal regulations and would not likely adversely affect efforts of State or Federal agencies to implement water quality objectives.

(5) There would be no preemption or likely adverse impacts on land uses specially designated for environmental or recreational purposes such as parks, wildlife preserves, State and national forests, wilderness areas, flood plains, wild and scenic rivers, or areas listed in the National Register of Historic Places.

(6) There would not likely be any significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.

(7) The population density, including weighted transient population, projected at the time of initial operation of a nuclear power plant, would not exceed 500 persons per square mile averaged over any radial distance out to 30 miles from the site, and the projected population density over the lifetime of the nuclear power plant would not exceed 1,000 persons per square mile.

(8) The site is not located in an area where additional safety considerations or environmental considerations for one site compared with other reasonable sites within the region of interest would result in the reasonable likelihood of having to expend substantial additional sums to make the project licensable from the safety standpoint or to mitigate unduly adverse environmental impacts.

In the following analysis, the staff determines whether the slate of candidate sites meets the previously stated criteria.

Diverse Water and Land Resource Review

Water resources considered for use among the candidate sites included Puget Sound (marine water) for one site and rivers for the remaining sites. Although water sources, such as reservoirs, lakes, cooling ponds, and bodies of saltwater were eliminated in the Regional Siting Program (Regional Siting Program, 1980) after initial consideration due to uncertainties concerning possible delays in licensing (water quality regulations restricting thermal discharges), such sources were not eliminated from consideration in the earlier siting studies (Bechtel, 1970).

Among the candidate sites, six different sources of water are identified. Puget Sound would be used for the Cherry Point site. For the Skagit site, water would be obtained from the Skagit River. The Nooksack River would be used for the Goshen, and the Cowlitz River would be used for the Ryderwood site. Of the remaining sites, all would utilize water from the Columbia River. The Hanford and Eltopia sites would use the upper-Columbia, whereas the Pebble Springs South and Centerville sites would utilize the middle-Columbia.

The group of candidate sites also represents the wide range of land resources found in the ROI. The proposed Skagit/Hanford site, Hanford 22-1, 22-2, and 23 sites are located in an arid, semidesert area in south central Washington. Eltopia is located in a similar geographic area; however, the area is currently used for irrigated farming.

The area around the Centerville site is used for both dryland and irrigated farming. The Pebble Springs South site is in an area used for seasonal grazing, whereas the Ryderwood and Goshen sites are partially forested and used for grazing.

Cherry Point lies in a relatively flat coastal area immediately adjoining Puget Sound that is partially forested and used for agriculture. Land adjacent to the Cherry Point site also contains heavy industrial uses, including an oil refinery and an aluminum smelter. The Skagit site is located near Minkler Lake above the Skagit River Valley with uses ranging from farming and forestry to recreation and tourism.

Based on the preceding examination, seven of the eleven sites represent a reasonable diversity of land resources, whereas six of eleven sites represent a reasonable diversity of water resources.

Water Source and Physiographic Character of Site Alternatives Compared With ROI Water Sources and Physiographic Character

Based on an analysis of the water sources and physiographic characteristics of the ROI and candidate sites, the slate of candidate sites proposed by the applicant appears to reasonably represent the various types of water sources and physiographic units available in the ROI as discussed below.

Potential cooling water sources included lakes, reservoirs, rivers, streams, and bodies of saltwater. As previously noted (Diverse Water and Land Resource Review), lakes, reservoirs, and saltwater sources were eliminated from consideration in the RSP Siting Study but not in the earlier studies, because of the high) potential for licensing delays (Regional Siting Program, 1980; Bechtel, 1966; Bechtel, 1970). The final range of water resources, represented by the alternative sites, includes different reaches of the Columbia River, the Nooksack River, the Skagit River, the Cowlitz River, and Puget Sound. Other rivers in the region, such as the Snake River or the Pend Oreille River (both included for final consideration as cooling water sources in the Regional Siting Program), are adequately represented by the proposed rivers.

Within the ROI, approximately 15 physiographic regions exist. These regions represent a widely diverse and complex pattern of land forms, soils, vegetation, and climate. The group of candidate sites fall into four physiographic provinces: the Columbia Basin (Proposed Skagit/Hanford Site, Hanford 22-1, Hanford 22-2, Hanford 23, Eltopia, Pebble Springs South, and Centerville); the Coast Ranges (Ryderwood lies in this province but is close to the Puget Trough province); the Puget Trough (Cherry Point and Goshen); and the Northern Cascades (Skagit). Figure 3.5 shows the lands that were eliminated in relation to the physiographic provinces. To the extent that siting criteria (such as geologic and seismic conditions, transmission access, water sources, sensitive terrestrial and aquatic areas, dedicated lands, and population centers) limited the suitability of certain physiographic provinces, the slate of candidate sites appears to reasonably represent the types of physiography available in the ROI.

Sites Utilizing the Same Water Sources as the Proposed Site

The Hanford 22-1, Hanford 22-2, Hanford 23, and Eltopia alternative sites utilize the same water source as the proposed site. All four would obtain water from the upper stretches of the Columbia River.

Evaluation of the Slate of Candidate Sites Against the Environmental Threshold Criteria

Consumptive Use of Water

Only sites obtaining water from rivers having a 20-year, 30-day low flow in excess of 20 times the anticipated project water demand are the desired locations. The project's anticipated average consumptive demand is 1.59 m^3/s (56.2 cfs); therefore, the minimum river flow requirement would be 31.83 m^3/s (1,124 cfs). Were the guideline applied to the maximum anticipated demand, the minimum flow requirement would be 52.4 m^3/s (1,872 cfs). For the purpose of this analysis, average consumptive use was applied.

Based on these parameters, all candidate sites, except Goshen, meet the water consumption requirements. For the Goshen site, the 20-year, 30-day low flow is approximately 24.92 m^3/s (880 cfs) or approximately 78.0 percent of the required flow.

Threatened and Endangered Species

During winter, the bald eagle, which is listed as a threatened species by the U.S. Fish and Wildlife Service, is known to use areas along the Columbia River associated with the proposed S/HNP site; the Skagit site and Hanford sites 22-1, 22-2, 23; and the transmission intertie of the Eltopia site ((NUREG-75/025; Regional Siting Program, 1980). The longbilled curlew, known to nest 1.6 to 3.2 km (1 to 2 mi) from Hanford Site 22-1 and in the area around the Hanford sites, was discussed as a sensitive species (Regional Siting Program, 1980); however, it was not listed as sensitive by the Washington Department of Game as of 11-12-81 (Washington State, Department of Game, 1981). No known endangered or threatened terrestrial animals are associated with Pebble Springs South site or Centerville site (Regional Siting Program, 1980). The Ryderwood site area is known to contain two species listed as endangered, the Columbian white-tailed deer and the brown pelican (NUREG-75/025).

Figure 3.5 Dedicated lands and population centers in Washington and Oregon areas excluded by Oregon EFSC

Astragalus columbianus, a plant proposed for Federal listing as an endangered species and listed as endangered in Washington State (S/HNP ASC/ER, 1981), is found in the Hanford Reservation. Its distribution could include the proposed Hanford site and Hanford Sites 22-1, 22-2, and 23 (Regional Siting Program, 1980). Protected plants that may inhabit Pebble Springs South site include Cryptantha leucophaea, and Astragalus kentriophyta var. douglasii. The former is listed by the State as sensitive and the latter as possibly extirpated in Washington (Regional Siting Program, 1980; Washington State, Department of Game, 1981).. A. kentriophyte var. douglasii is also a candidate for Federal status (Washington State, Department of Game, 1981). Due to its proximity to the Columbia River Gorge, the Centerville site is within the range of several unspecified plant species included on proposed lists of threatened or endangered plants. In addition, the cooling water pipeline of this alternative traverses the area most likely to support rare plants (Regional Siting Program, 1980). No protected plants have been identified for the Eltopia site (Regional Siting Program, 1980).

Information reviewed for the Goshen and Cherry Point site alternatives did not indicate the presence of any threatened or endangered species (Bechtel, 1966; Bechtel, 1970; Puget Sound Power and Light Company, 1974; NRC, Testimony of Jacobsen, 1975; NUREG-75/025).

Except as noted above, no information concerning the effects of transmission lines, pipelines, and access roads on protected species has been encountered. The documents reviewed do not contain precise information concerning the type or extent of winter use that the four Hanford sites receive from the bald eagle, nor do they report quantitatively the distribution of Astragalus columbianus population on the Hanford Reservation and on the four Hanford sites (Regional Siting Program, 1980; S/HNP ASC/ER, 1981; NUREG-75/025).

Based on the information provided, threatened or endangered animal species are present in the vicinity of the Hanford, Eltopia, Skagit, and Ryderwood sites, and sensitive plant species could occur in the vicinity of the Pebble Springs South and Centerville sites.

Spawning and Nursey Areas of Aquatic Species

Since lakes, reservoirs (except some Columbia River reservoirs), and groundwater sources were screened out, major rivers (and certain Columbia River impoundments) remain on the list. The list of candidate sites involves water sources from a variety of large rivers known to contain a reasonably wide spectrum of aquatic biological resources, except that all rivers represented contain significant runs of anadromous fishes. Since "large river" (reservoir) sites on the Columbia River upstream of Grand Coulee Dam do not involve anadromous fish runs, and since these biological resources are significant, the reasonable diversity criterion, when applied only to freshwater biological resources, is not strictly met. Aside from biological diversity, the candidate site list represents diverse water sources.

The Skagit, Goshen, Ryderwood, and Cherry Point sites are located west of the Cascades. The Goshen site would use the Nooksack River as a water source, the Skagit site would use the Skagit River, the Ryderwood site would use the Cowlitz River, and the Cherry Point site would use Puget Sound. The bodies of water being considered for sources of cooling water for the Skagit, Goshen, and Ryderwood sites support different stocks of anadromous fishes (Puget Sound Power and Light Company, 1974; Puget Sound Task Force, 1970). Due to its unique intake and discharge structures, the staff believes that the Skagit site can meet the criterion. If a similar system were used for the Goshen and Ryderwood sites, the staff believes that these sites could also meet the criterion; however, the smaller river flows of the Nooksack and Cowlitz Rivers also increase the potential for adverse aquatic effects. The Cherry Point site is located on the Strait of Georgia in Puget Sound, an area known to contain abundant quantities of commercially and recreationally important aquatic species including many varieties of anadromous fishes, shellfish, and other important fish species. Because of this, the staff believes that the Cherry Point site could meet the criterion only if special care were taken in the design of the intake and discharge system.

The proposed S/HNP site and Hanford 22-1, 22-2, and 23, Eltopia, Pebble Springs South, and Centerville sites would all use the Columbia River for a water source. Information on these sites is contained in the RSP and in NRC testimony (Leech et al., July 1979). Although extensive species lists are not given in these documents, "important" organisms are identified and the Regional Siting Program asserts that intake and discharge structures could be located in areas where they would not influence spawning or nursery areas or migration routes of these species. These eastern sites therefore meet the criterion.

Water Quality

This criterion requires that the site must discharge its effluents into waterways in accordance with State and Federal regulations and not adversely affect efforts of State or Federal agencies to implement water quality objectives. To the extent that mitigation plans would have to be developed in order to meet water quality regulations, all of the candidate sites meet this criterion. The Skagit, Goshen, and Cherry Point sites have the most restrictive water quality classification (AA) of all the sites (Washington State, Department of Ecology, 1977). The remaining sites have equivalent classifications (A) (Washington State Department of Ecology, Dec. 1977).

Land Use

This criterion requires that the site cannot preempt or adversely impact lands specifically designated for environmental or recreational uses. Such uses include: parks, wildlife preserves, State and national forests, wilderness areas, flood plains, wild and scenic rivers, or areas listed in the National Register of Historic Places.

Only one of the candidate sites does not meet this criterion: Hanford 23. The Hanford 23 site is currently located on land leased by the Washington Department of Game as a wildlife recreation area (Regional Siting Program, 1980).

Terrestrial and Aquatic Ecosystems

The staff's review of the terrestrial resources associated with the candidate sites reveals no biotic communities unique to those resource areas. For this reason, the staff therefore believes that there will be no significant impact on terrestrial ecosystems as a result of locating a nuclear power plant at any of the candidate sites.

Puget Sound and the Nooksack, Skagit, and Cowlitz Rivers are known to contain various anadromous fish stocks. The unique intake and discharge structure designed for the Skagit site would minimize impacts to the aquatic ecology of the Skagit River (Puget Sound Power and Light Company, 1974). A similar system used at the Goshen and Ryderwood sites would also minimize ecological impacts at those sites. However, the lower stream flows at those sites also increases the potential of aquatic ecology effects. For the Cherry Point site, careful intake and discharge system design would have to be used to mitigate the potential of adverse aquatic ecology impacts to an area known for its commercially and recreationally important aquatic life. The staff believes that, if appropriate measures were used, these sites would meet the criterion.

The proposed Hanford Sites 22-1, 22-2, and 23 and Eltopia site are situated on the Hanford Reach of the Columbia River. This reach is unique in that it is the last free-flowing stretch of the Columbia River between tidewater and the Canadian border supporting the only significant mainstream populations of chinook salmon and steelhead trout. Nevertheless, the RSP asserts that intake and discharge structures could be placed so as not produce a significant effect on this ecosystem. The Pebble Springs and Centerville sites are on impounded reaches of the Columbia in areas that contain no unique ecosystems. In addition, it is stated in the Regional Siting Study that intake and discharge structures could be placed in such a way that surrounding ecosystems would not be significantly affected. All Columbia River sites, therefore, meet the criterion.

Population Density

The staff has examined and assessed the population densities in the vicinity of the proposed site as well as those in the vicinities of the proposed alternative sites. Table 3.3 gives the locations of the alternative sites used by the staff in assessing the population densities.

The population densities (including weighted transients) for the proposed site and for each of the alternative sites for various distances out to 48 km (30 mi) for the year 1990 (estimated year of plant startup) and for the 2030 (estimated end of plant life) are shown in Table 3.4. It can be seen from the table that neither the proposed site nor any of the alternative sites exceed 500 persons per square mile at the time of plant startup nor 1,000 persons per square mile at the end of the projected plant life. The staff concludes that all candidate sites meet this criterion.

Excessive Cost of Making the Site Licensable From the Standpoint of Safety

(1) Geology and Seismology--Using the information presently available to the NRC staff, three of the ten alternative sites appear preferable to the proposed Skagit/Hanford site with the remainder of the alternative sites appearing to be less preferable. The relative geologic and resulting seismologic ranking of one or more of the alternative sites in the Hanford Reservation area may change pending acceptable resolution of several geologic features currently being investigated by Puget Sound Power & Light Company and by the Washington Public Power Supply System. The

Table 3.3 Locations of proposed alternative sites

Name	Latitude	Longitude
Cherry Point	48° 52' 30"N	122° 45' 10"W
Skagit	48° 32' 10"N	122° 06' 58"W
Ryderwood	46° 23' 40"N	123° 01' 44"W
Goshen	48° 51' 53"N	122° 20' 48"W
Hanford 22-1	46° 33' 20"N	119° 22' 33"W
Hanford 22-2	46° 38' 36"N	119° 34' 05"W
Hanford 23	46° 36' 47"N	119° 21' 16"W
Eltopia 24a	46° 27' 11"N	119° 09' 46"W
Pebble Springs South	45° 40' 37"N	120° 08' 06"W
Centerville 49a	45° 43' 50"N	120° 52' 25"W

Table 3.4 Population densities (people/square mile)

Name	Year	Inhabitants in Radial Distances from Reactors			
		0-5 mi	0-10 mi	0-20 mi	0-30 mi
Cherry Point	1990	43	110	270	390
	2030	110	180	470	660
Skagit	1990	74	70	58	88
	2030	160	140	110	160
Ryderwood	1990	16	20	88	42
	2030	26	31	130	95
Goshen	1990	160	200	140	180
	2030	260	340	230	300
Hanford 22-1	1990	0	1	44	64
	2030	0	1	72	110
Hanford 22-2	1990	0	1	6	31
	2030	0	2	9	50
Hanford 23	1990	0	9	12	55
	2030	0	14	17	91
Eltopia	1990	33	14	130	66
	2030	55	20	210	110
Pebble Springs South	1990	4	2	2	3
	2030	4	2	2	4
Centerville 49a	1990	14	17	23	14
	2030	20	24	34	20
Skagit/Hanford	1990	0	2	59	77
	2030	0	3	82	98

three apparently preferable alternative sites are Eltopia, Pebble Springs South, and Centerville.

Based on present staff knowledge, none of the sites would result in the reasonable likelihood of having to expend substantial additional sums of money to make the project geologically licensable from the safety standpoint.

(2) Hydrology--The staff has reviewed the available information on the hydrologic impacts of the candidate sites. Although there are several sites that would have significantly higher pumping costs and one site may require special engineering provisions to compensate for flood effects, it is the staff's judgment that the cost of site-specific hydrologic considerations for either the proposed site or any of the alternative sites would result in expenditures of substantial additional sources to make it licensable from the aspects of hydrologic safety.

(3) Meteorology--The climate of Washington State is a function of location with respect to the north-south mountain ranges that are situated in the western third of the state. Four sites (Cherry Point, Goshen, Skagit, and Ryderwood) are located west of or in the mountain areas and generally experience large amounts of precipitation compared with the remaining eastern candidate sites that are in an area of low total annual precipitation. From a severe weather point of view, the four western sites are located in Tornado Region II (see Regulatory Guide 1.76) with a suggested design maximum wind velocity of 300 mph. The remaining sites are located in Tornado Region III with a suggested design maximum wind velocity of 240 mph. Because of the differences in design-basis tornado characteristics between Region II and Region III, structural designs for plants at western sites may be more costly than for plants at the other sites. The generally higher winds expected nearer the coast (i.e., Cherry Point, Goshen, Skagit, and possibly Ryderwood) will provide better transport and diffusion of gaseous effluents than that found in the eastern alternatives.

Past experience has shown that the differences of potential diffusion conditions between the best coastal diffusion sites and the relatively poorer inland sites result in very small increased incremental costs of radioactive waste systems and engineered safety features needed for the poorer sites versus the better sites. Sites in both locations, eastern and western, have been demonstrated to be licensable without expenditure of substantial additional sums to compensate for the meteorological characteristics of such sites.

(4) Industrial, Military, and Transportation Facilities--The staff has examined and assessed the proposed site and each of the alternative sites with regard to industrial, military, and transportation facilities for the likelihood of having to expend substantial additional sums of money to make the project licensable.

The proposed site and 8-km (5-mi) area surrounding the site are both totally contained within the U.S. Department of Energy (DOE) Hanford Reservation. There are no military bases, missile sites, manufacturing plants, chemical plants, chemical storage facilities, explosives storage facilities, or airports within the 8-km (5-mi) radius of the proposed site except for facilities operated for DOE. Structures that are currently within a 8-km (5-mi) radius of the proposed site include WNP-2 located 7.7 km (4.8 mi) east-southeast, the Wye Radioactive Waste Burial Ground located 7.4 km (4.6 mi) east-southeast, a central landfill located approximately 4.0 km (2.5 mi) north-northwest, the Fast Flux Test Facility located 7.7 km (4.8 mi) southeast, and the H.J. Ashe Electrical Substation located 7.2 km (4.5 mi) east. There is a proposed waste disposal site located approximately 4.0 km (2.5 mi) west-southwest. The closest airport is Richland Airport, 22.0 km (13.7 mi) south-southeast. The largest airport within a 48.3-km (30-mi) radius of the proposed site is Tri-Cities Airport located 34.6 km (21.5 mi) southeast.

Although the staff has not completed its safety review of the proposed site, the staff concludes that, based on its review to date as well as previous review experience, additional safety considerations with respect to nearby industrial, military, and transportation facilities at the proposed S/HNP site would not require the expenditure of substantial additional sums to make the proposed site licensable.

For each of the proposed alternative sites, the staff has examined reconnaissance level information regarding proximity of major industrial, military, and transporation facilities. Each of the alternative sites has transportation routes such as railroads, highways, and waterways in their vicinity that may carry explosive or toxic shipments.

With regard to shipments of explosives along highways and railroads, the staff judges, based on past review experience, either that such traffic would be sufficiently infrequent, or that the plant safety structures could readily be located at sufficient separation distances from such routes [a distance of about 442 m (1,450 ft) and 640 m (2,100 ft) would be required for most highways and railroads, respectively]. Therefore, the shipments of explosives along highways and railroads would not likely be consideration in the licensability of the plant for any of the alternative sites.

Because of the larger separation distances required when explosives are frequently shipped along major waterways [about 2,680 m (8,800 ft) separation from the plant structures might be required], sites along major waterways would require an in-depth analysis regarding explosives movement and might require substantial additional capital costs to ensure licensability.

With the exception of the Cherry Point site, none of the alternative sites are located sufficiently close to major waterways that shipments of explosives would be a consideration. The Cherry Point site is located close to oil tanker traffic in the Strait of Georgia. Because of this proximity, the staff judges that an in-depth analysis would be required and that substantial additional capital cost could possibly be required, depending on the outcome of the analysis, to insure the licensability of the Cherry Point site.

With regard to shipments of toxic material along highways, railroads, or waterways, the staff concludes that additional expenditures to make the plant licensable from a safety standpoint (such as installation of toxic gas detectors) would cost much less than 5 percent of total capital project costs, even if such expenditures were required. Similarly, the presence of pipelines carrying hazardous materials would not present an obstacle to the licensability of the plant for any of the alternative sites, since pipeline relocation, even if required, would cost much less than 5 percent of total capital project costs.

The staff has examined each of the proposed alternative sites with regard to proximity to major airports and aircraft impact. None of the proposed alternative sites are within 8 km (5 mi) of a commercial airport. The Skagit and Pebble Springs sites are located near flight training areas used by the U.S. Navy. When both sites were analyzed with respect to aircraft hazards, it was concluded that neither site would require that a plant built there be designed to withstand an aircraft impact. On these bases, the staff concludes that potential aircraft hazards is not a consideration in the licensability of the plant for any of the alternative sites.

The staff also examined each of the proposed alternative sites with regard to proximity of very large industrial activities representing fixed sources of explosive or toxic materials. Examples of such activities include major chemical factories and storage facilities, and ammunition and explosives storage depots. With the exception of the Cherry Point site, which has an oil refinery in close proximity, none of the alternative sites have such facilities nearby.

The staff concludes, on the basis of the reconnaissance level information used, that none of the proposed alternative sites, with the possible exception of the Cherry Point site, would require the expenditure of substantial additional sums to make the plant licensable from a safety standpoint in regard to industrial, military, and transportation facilities.

3.2.1.4 Comparison of Proposed Site With Alternative Sites

Once candidate sites are determined to be acceptable on the basis of evaluations conducted in previous sections, a comparative review of the proposed site to the eligible alternatives will be conducted to determine whether an obviously superior alternative exists. This will be determined by a sequential two-part analytical test. The first part gives primary consideration to hydrology, water quality, aquatic biological resources, terrestrial resources, water and land use, socioeconomics, and population to determine whether any alternative sites are environmentally preferred to the proposed site. The second part overlays consideration of project economics, technology, and institutional factors to determine whether, if such an environmentally preferred site exists, such a site is, in fact, an obviously superior site.

Consumptive Water Use and Water Quality

Consumptive water use of the project in part depends on the degree of cooling water reuse which, in turn, is dependent on cooling tower makeup water quality. Since ambient water quality conditions vary between many of the sites, the consumptive water use would vary between these sites. Engineering design variation between the sites would also influence the consumptive water use. More precise consumptive use data calculated by the applicant is available only for the Skagit and the proposed Hanford sites (Puget Sound Power and Light Company, 1974; S/HNP ASC/ER, 1981). The Skagit site average consumptive water use was reported to be 1.80 m^3/s (63.5 cfs); maximum use was 2.21 m^3/s (78.0 cfs) 1974) (Puget Sound Power and Light Company, 1974). The projected S/HNP site average consumptive use is 1.59 m^3s (56.2 cfs); the intake structure is designed for a maximum flow of 2.65 m^3/s (93.6 cfs) (S/HNP ASC/ER, 1981). These figures are considered also valid for Hanford Sites 22-1, 22-2, 23, and Eltopia since cooling tower makeup water quality for these sites is anticipated to be comparable to the proposed S/HNP s Table 3.5 presents consumption data for the sites.

The average and maximum values of 1.59 m^3s (56.2 cfs) and 2.65 m^3/s (93.6 cfs), respectively, were used to compare the sites consumptive uses in Table 3.5. Based on the data in Table 3.5, all of the Hanford alternative sites, the Eltopia, Pebble Springs South, and Centerville sites are comparable to the proposed site, with a slightly lower consumptive use effect for the Pebble Springs South and Centerville site. The Skagit site has a higher consumptive

Table 3.5 Effect of consumptive use on river discharge

	Stream Flow (cfs)		Stream Flow Consumed (%)		
Site Alternative	Average Flow	30-Day/ 20-Year Minimum Flow	Average Consumption/ Average Flow	Average Consumption/ Minimum Flow	Worst-Case Consumption/ Minimum Flow
Hanford 22-1	120,000	24,000	0.05	0.23	0.37
Hanford 22-2	120,000	24,000	0.05	0.23	0.37
Hanford 23	120,000	24,000	0.05	0.23	0.37
Eltopia 24a	120,000	24,000	0.05	0.23	0.37
Pebble Springs South	185,000	37,000	0.03	0.15	0.25
Centerville 49a	185,000	37,000	0.03	0.15	0.25
Skagit	16,200	3,170	0.35	1.77	2.95
Goshen	3,240	880	1.73	6.39	10.64
Ryderwood	6,550	2,000	0.86	2.81	4.68
Cherry Point	Marine Source		N/A*	N/A*	N/A*

*Not Applicable

Sources: Letter, June 27, 1977; Regional Siting Program, 1980; Puget Sound Power and Light Company, 1974; S/HNP ASC/ER, 1981.

use effect than the proposed site; however, the staff believes it is still comparable with the proposed site. The Ryderwood site also has a higher consumptive use effect than the proposed site, and, because its effect is even greater than for the Skagit site, the staff believes that it is less desirable than the proposed site. The Cherry Point site has a significantly lower consumptive use effect than the proposed site and is therefore preferable to the proposed site. Because the Goshen site does not meet the proposed water consumption threshold criterion (see the previous section), the staff considered it to be less desirable than the proposed site.

The comparisons among the sites are based on an assumption of identical physiochemical characteristics of the discharges and reflect the State of Washington Water Quality Classifications of the receiving stream and stream flow (Regional Siting Program, 1980; Puget Sound Power and Light Company, 1974; S/HNP ASC/ER, 1981; letter, June 27, 1977) available for dilution. The Skagit and Goshen sites have a more restrictive water quality classification (Class AA) and lower flows than the proposed site. Therefore, these sites are not considered preferred alternatives. Ryderwood (Cowlitz River) has a State water quality classification equivalent (Class A) to the proposed S/HNP site but its flow is considerably lower; therefore, it is not preferred. The Cherry Point site using water from the Strait of Georgia in Puget Sound, has a classification (Class AA) exceeding that of the proposed S/HNP site and cannot therefore be considered preferable. The remaining alternative sites (Hanford Sites 22-1, 22-2, and 23, Eltopia, Pebble Springs South, and Centerville) have equivalent water quality classifications (Class A) and equivalent or greater river flows. As such, they can be considered comparable to the proposed S/HNP site.

Aquatic Resources

The proposed S/HNP site is located on the free-flowing Hanford Reach of the Columbia River. Chinook salmon and steelhead trout are known to spawn both upstream and downstream of the proposed site but little or no spawning is thought to occur in the immediate vicinity or "zone of influence" of the proposed intake and outfall structures (NUREG-75/025; Regional Siting Program, 1980). Adults of other species of anadromous salmonids, shad, resident rainbow trout, sturgeon, and various other fishes are known to migrate through the area as well as out-migrating juvenile salmonids (Puget Sound Power and Light Company, 1974; (NUREG-75/025; Regional Siting Program, 1980). Although no specific nursery areas for important resident or anadromous fishes have been identified in the immediate vicinity of the proposed project zone of influence (Regional Siting Program, 1980), such areas are known to exist nearby (NUREG-75/025). These areas would probably not be significantly affected by the project, however.

Because the Hanford 22-1, 22-2, 23, and Eltopia sites are also on the Hanford Reach of the Columbia and therefore share many common aquatic environmental characteristics, they will be compared collectively with the proposed site. Of these sites, Hanford 22-1 and 23 are closest to the proposed site, and their environmental consequences relative to aquatic resources would be nearly identical to those of the proposed site. The Hanford 22-2 site is slightly upstream; the Eltopia site is slightly downstream of the proposed site. These sites appear to be closer to known spawning areas for chinook salmon and steelhead trout, especially the Eltopia site, and to nursery areas for resident game fish. They present some greater risk to these aquatic resources than the proposed site; both sites are, therefore, slightly less desirable than the proposed site.

The Pebble Springs and Centerville sites are located on impounded reaches of the Columbia River and have many common aquatic environmental characteristics. They will therefore be compared collectively with the proposed site. Although more information was supplied concerning the Pebble Springs site, the sites are judged to be substantially similar. No anadromous fish spawning habitat is known to exist anywhere near either site. Although juvenile salmon and steelhead migrate past both the Pebble Springs and the Centerville sites, none of these fish emerge near the sites and the probabilities of newly emerged fry being affected by intakes is less than at the proposed site. Unlike the proposed site, which is on the uniquely free-flowing Hanford Reach, the Pebble Springs and Centerville sites are located on impounded reaches of the Columbia that contain no obviously unique habitat features. On balance, the Pebble Springs and Centerville sites pose less threat to newly emergency fry, would create less overall habitat disturbance, are further from known spawning habitats, are less unique, and would therefore pose less adverse impact on the Columbia River and its important biological resources than the proposed site. Because of that, they are judged to be preferable to the proposed site from an aquatic biological resource perspective.

Several comparisons can be made between the proposed site and the Skagit site. Both sites are relatively near salmon and/or steelhead spawning grounds (NUREG-75/025; Regional Siting Program, 1980). Since the Skagit is a smaller river, it is possible that locating the intake and discharge structures in a way that would not affect spawning habitat would be more difficult. Newly emergent fry would be present in both systems, but the smaller cross section of the Skagit may make these fish more susceptible to adverse impacts of the plant. With respect to loss of aquatic habitat, the relative sizes of the two rivers suggest that a proportionately greater loss could be incurred at Skagit than at Hanford, but differences would probably be slight, especially considering the Skagit rainey intake well, which would have no adverse impacts (NUREG-75/025; Puget Sound Power and Light Company, 1974). A similar comparison holds for construction effects.

The potential effects of heated discharge at the Skagit site are somewhat greater than at the Hanford site because of the smaller stream cross section at the Skagit site and the latest nozzle design proposed for the S/HNP site. The potential for cumulative adverse effects at Hanford due to other nearby nuclear plants, however, suggest that the net thermal effects at the two sites would probably be roughly comparable.

The potential for adverse effects on aquatic resources associated with the Goshen and Ryderwood sites are also somewhat higher than for the proposed site. Potential sedimentation impacts due to intake and discharge structure construction and effluent discharge impacts at the Ryderwood site make that site slightly less desirable than the proposed site (NUREG-75/025). The smaller stream cross section and significantly lower stream flows of the Nooksack River compared to the water source of the proposed site make the Goshen site potentially more susceptible to loss of aquatic resources and therefore less desirable than the proposed site.

The Cherry Point site was judged by the staff to be comparable to the proposed site with respect to aquatic resources, assuming care was taken to mitigate thermal and effluent discharges. The Cherry Point site lies adjacent to the Strait of Georgia, an area of abundant commercially and recreationally important marine life (Puget Sound Task Force, 1970), and development at this site could add to cumulative aquatic resource impacts of this and other industrial and municipal facilities in the area.

On balance, in the staff's judgment, only Pebble Springs and Centerville are preferable to the proposed S/HNP site from the standpoint of aquatic resources.

Terrestrial Resources

The terrestrial resources of the alternative sites were compared to the terrestrial resources of the proposed site using nine terrestrial resource criteria. These criteria were: habitat disruption, transmission line length, new road or highway length, new rail line length, distance to water source, the number of stream or river crossings, and the presence of any unique biotic communities. For each criterion, each alternative site was compared with the proposed site and given a preferable, comparable, or less desirable rating. The criteria ratings were then summed to a composite rating without employment of signficance factors. The results of this analysis are discussed in the following paragraphs.

Habitat Disruption

Pebble Springs South and Goshen would require a cooling reservoir, thus requiring considerably more area than the preferred site. The Cherry Point site would not require any cooling towers; thus, this site would require the least area. All other sites are comparable with the proposed site (Skagit FEIS, 1974; Pebble Springs, Supp. 1, 1980).

Transmission Line Length

The proposed site requires the shortest right-of-way [5.1 km (3.2 mi)] and Pebble Springs South the longest [48.3 km (30 mi)]. The remaining sites are ranked in the following orders: Hanford 22-1 < Ryderwood < Skagit < Goshen < Hanford 23, Eltopia < Hanford 22-2, Centerville < Cherry Point (NRC, Testimony of Leech et al., 1977; Regional Siting Program, 1980).

Highway Length

The proposed site would require 8.8 km (5.5 mi) of new highway, whereas seven of the alternative sites would require fewer kilometers of new highway construction. They rank in the following order: Hanford 22-2 - Goshen - Hanford 22-1 - Pebble Springs South, Skagit - Centerville - Cherry Point. Three of the alternative sites would require slightly more kilometers of new highway than the proposed site. They are in order or ranking: Eltopia, Ryderwood, Hanford 23 (NRC, Testimony of Leech et al., 1977; Regional Siting Program, 1980).

Miles of New Railroad Track

The preferred site would require 6.4 km (4 mi) of railroad track as would the Ryderwood and Skagit sites. Six alternative sites would require fewer kilometers of railroad track, they are: Hanford 22-2 < Hanford 23 < Pebble Springs South, Cherry Point, Goshen < Centerville. Two remaining alternative sites would require more kilometers of new railroad than the proposed site: Eltopia < Hanford 23 (NRC, Testimony of Leech et al., 1977; Regional Siting Program, 1980).

Distance to Water Source

This criterion provides an estimated length of needed intake and discharge pipeline. The preferred site is the farthest from a source of cooling water.

Number of Streams and Rivers Crossed

This criterion provides only an approximation since the exact routing has not been determined for all sites. Transmission lines for the preferred site and the Hanford 22-1 and 22-2 sites would not cross any rivers. All other site transmission lines would likely cross one or more streams or rivers.

Wild and Scenic Rivers

The Skagit River, beginning at the City of Sedro Woolley, has been designated as a Wild and Scenic River. The Hanford Reach of the Columbia River has the potential for designation as a Wild and Scenic River. Therefore, the preferred site, three other Hanford sites, and Eltopia site would all have intake and discharge pipelines in the Hanford Reach portion of the river. In addition, the Hanford 23 and Eltopia sites would require transmission lines to cross the Hanford Reach of the Columbia. The other five alternative sites are not on rivers designated as Wild or Scenic (Regional Siting Program, 1980).

Biotic Communities

Neither the preferred nor any of the alternative sites support unusual biotic communities and therefore are all comparable (NRC, Testimony of Leech, et al., 1977; Regional Siting Program, 1980).

Occurrence of Federally Listed Endangered and Threatened Species

The bald eagle (Haliaeetus lencocephalus), a Federally listed threatened species, uses the Hanford Reach portion of the Columbia River and its shoreline during winter. Therefore, the only impact on the bald eagle for the preferred site and the Hanford 22-1 and 22-2 sites would be during the construction of the intake and discharge pipelines. This would also be the case for the Hanford 23 and Eltopia sites. However, because these sites would require transmission lines to cross the Columbia River within the Hanford Reach, existence of the transmission lines would represent a minor, but continuous, hazard to the bald eagles. The Skagit site is used by bald eagles for nesting and wintering. None of the other sites host Federally listed endangered and threatened species.

Composite Rating

Based on the above described comparisons, only the Ryderwood site is equivalent to the preferred site. The Skagit site is somewhat less desirable, whereas the Hanford 23 and Eltopia sites are considerably less desirable than the preferred site. The remaining alternative sites are all better choices than the proposed site from a terrestrial ecology viewpoint, with the Cherry Point site being the best choice, primarily because once-through cooling requires less land area than required for cooling towers.

Land Use

The proposed S/HNP site lies in the Hanford Reservation, an area of nearly 1560 km^2 (600 sq mi) that has been dedicated for use for nuclear-related activities for nearly of 30 years (Regional Siting Program, 1980). A small portion of the area is intensively used for nuclear activities with the remainder left relatively undisturbed due to its restricted access. Because of this unique existing use, the Hanford Reservation is ideally suited for additional nuclear activities.

The alternative sites, Hanford 22-1 and 22-2, are comparable to the proposed site due to their close proximity to each other on the reservation. The Hanford 23 site is located on a portion of the reservation to the east of the Columbia River that is under revocable lease to the Washington Department of Game as a Wildlife Recreation Area and is therefore judged by the staff to be less preferable than the proposed site.

Zoning classifications for the alternative sites range from unclassified to heavy impact industrial. The Hanford sites and the Ryderwood site all lie in unclassified zoning areas. The Eltopia, Pebble Springs South, Centerville, and Goshen sites are all zoned for agricultural use (Franklin County zoning ordinances for 1980; Portland General Electric Company, 1975; Klickitat County Plan, 1979), whereas the Cherry Point site is zoned for heavy industrial impact (Whatcom County zoning maps, 1981); the other Skagit site is zoned for forestry and rural use (Skagit County zoning ordinances, 1979).

Shoreline master plan designations for the alternative sites range from no designation for the Hanford sites (Washington State, Department of Ecology, 1978) to rural for the Ryderwood and Skagit sites (S/HNP ASC/ER, Amendment 4, 1981). The Goshen and Cherry Point sites are designated as conservancy shorelines (Whatcom County, 1978), whereas the shoreline designations of the Eltopia and Centerville site would be either rural or conservancy, depending on the exact locations of intake and discharge structures.

With respect to zoning and shoreline master program designations, the staff believes that none of the alternative sites is preferable to the proposed site because either zoning variances or conditional use permits would be required for the alternative sites.

For all the remaining alternative sites, except for Cherry Point, construction of a nuclear power plant would represent an intrusion of a major industrial facility into areas characterized by agricultural, forest-related, and/or recreational values.

The Cherry Point site lies in an area designated for an industrial use and is adjacent to an existing oil refinery. Because of this, it can be considered comparable to the proposed site on that basis.

Socioeconomics

The proposed Hanford site is located within commuting distance of the Tri-Cities area (Richland, Pasco, and Kennewick, Washington) that currently contains a labor force experienced in nuclear power plant construction and operation. This fact acts to reduce labor force in-migration and overall socioeconomic impacts. The Hanford 22-1, 22-2, and 23 sites and the Eltopia site are generally comparable with the proposed site. However, labor force access to the Hanford 23 site is more difficult and several residences would likely have to be relocated in the vicinity of the Eltopia site (Regional Siting Program, 1980).

Although no residences would have to be relocated at the Pebble Springs South site, its distance [113 to 129 km (70 to 80 mi)] from Tri-Cities; 241 km (150 mi) from Portland from skilled labor sources would probably require a construction camp (Regional Siting Program, 1980). This fact makes it less desirable than the proposed Hanford site.

The Centerville site would also probably require a construction camp due to excessive commuting distances from the Tri-Cities and Portland areas. Limited housing would be available in Centerville and Goldendale; however, laborers relocating to these communities would cause impacts on local facilities. These facts and the necessity to relocate six to eight residences would make this site less desirable than the proposed site (Regional Siting Program, 1980).

The Ryderwood site is not preferable to the proposed site for several reasons. The labor force would have to come from the Portland area, which is approximately 113 to 129 km (60 to 70 mi) from the proposed site. As a result, a portion of the construction and operations labor forces would most likely relocate to the area into small communities less well equipped to handle added population influx. Ryderwood is a community of retired people with little capacity to manage impacts associated with rapid and large increases in local population (NRC, Testimony of Leech et al., 1979).

The Cherry Point and Goshen sites are also less desirable than the proposed site. Although both are close to Bellingham, Washington, which has a significant labor pool, it is likely that a major portion of the construction and operations work forces would have to relocate to Whatcom County communities from outside the area.

The Skagit site is less desirable socioeconomically than the proposed site. Labor force availability would be greater at the proposed site due to present construction of the Washington Public Power Supply System nuclear plants on the Hanford Reservation. In addition, although severe adverse community impacts might not occur at the Skagit site, the agricultural, scenic, and recreational aspects of the Skagit area make it more susceptible to impacts.

Aesthetics

The proposed Hanford site is located within several kilometers of several existing power plants and other structures including high-voltage transmission lines. The site is not visible from any public highways. However, it would be visible from the Columbia River, which has been proposed for study as a Wild and Scenic River, and from a Washington Department of Game Wildlife Refuge on the eastern side of the river.

The Hanford 22-2 and 23 sites are aesthetically similar but less desirable than the proposed site. The Hanford 22-2 site is visible from State Highways 24 and 240 and the Columbia River (Regional Siting Program, 1980). Transmission lines would also be visible. The Hanford 23 site, located on a Washington State Department of Game wildlife-recreation area, would be visible from adjacent agricultural areas and the Columbia River. Transmission lines would be visible from significant distances. For both sites, 29 km (18 mi) of transmission corridor could be developed along an existing corridor (Regional Siting Program, 1980).

The Hanford 22-1 site is comparable to the proposed site, and cannot be seen from public highways. The Eltopia site would be visible from surrounding agricultural areas and possibly from State Highway 395, a scenic highway located 12.9 km (8 mi) from the site. This site's transmission corridor would be visible, passing over relatively flat terrain and crossing the Columbia River. Existing transmission corridors on the Hanford Reservation could be utilized for part of the total length (Regional Siting Program, 1980).

The Pebble Springs South site is located 6.4 and 11.3 km (4 and 7 mi) south of Interstate 80 and State Highway 14, respectively. Although State Highway 14 is designated a scenic highway by the State of Washington, visual impacts to either highway could be minimal because they are several hundred meters lower than the plant site (Regional Siting Program, 1980). Approximately 48 of 51 km (30 of 32 mi) of transmission lines could be located along existing lines. Although the community of Arlington, Oregon, is located 6.4 km (4 mi) from the site, only a portion of the transmission lines would be visible (Regional Siting Program, 1980).

The Centerville site and associated transmission lines would be visible from U.S. Highway 97 and adjacent agricultural areas. Although U.S. Highway 97 has an excellent view of Mt. Adams, the site will not intrude on this view. Low hills would reduce the visual impacts of the transmission lines (Regional Siting Program, 1980).

Of the remaining alternative sites (Ryderwood, Goshen and Skagit), Ryderwood is judged to be comparable with the proposed site. Although a nuclear plant facility would dominate the valley in the vicinity of Ryderwood, hills would obstruct its visual impact from outside the valley and transmission lines would be only 4.8 km (3 mi) in length (Puget Sound Power and Light Company, 1974). In contrast, the Skagit site would visually impact adjacent agricultural land and scenic qualities of the river. Such a facility at the Skagit site would also be less consistent with the visual nature of the Skagit area than at the proposed site, where nuclear facilities and transmission facilities already exist (NRC, Testimony of Leech et al., 1979). A plant at the Goshen site would visually impact the adjacent agricultural areas. Located on relatively flat terrain, transmission lines would also visually adversely impact adjacent areas (Puget Sound Power and Light Company, 1974).

Archaeology and Historic Preservation

The proposed site and the 10 alternative sites are not equal in the level of information available on cultural resources. Although archaeological reconnaissance has been conducted at certain areas associated with some candidate sites, the majority of the sites have not been professionally surveyed.

Professional surveys are not customarily included in the reconnaissance level information, and are not required to be performed on candidate sites.

The review is necessarily complicated by imprecise locations of intake and discharge lines and transmission corridors. The following assessments were made by consulting the National Register of Historic Places.

There are no cultural resources listed in the National Register of Historic Places at any candidate site. Such a determination for associated areas cannot be made because specific alternate routes have not been identified. However, from that standpoint, all alternative sites, with the exception of Skagit, are equal. Based on available information, none of the alternative sites reviewed is judged by the staff to be preferable on the basis of potential impact to cultural resources.

The following material gives site-specific considerations:

Centerville

The site area is considered to have medium potential for containing archaeological and historic resources. The intake and discharge lines have high potential along the portion near the Columbia River. No professional survey was performed.

Cherry Point

One archaeological site, 45WH52 (see records in Washington State Office of Historic Preservation, 1982), and two recorded sites exist in the immediate area. Topographically, this alternate site is likely to contain 4,000- to 7,000-year-old material. The already high potential of this area might be increased, dependent on the location of the discharge and intake lines. The eligibility of the recorded sites to be listed in the National Register of Historic Places has not been evaluated.

Goshen

The site contains high potential along terraces on the northern and southern portion of the indicated plant area for 4,000- to 7,000-year-old cultural material. The intake and discharge lines would traverse the Nooksack River floodplain, which also has a high potential for cultural resources. No professional survey was performed.

Hanford 22-1, 22-2, 23, Proposed S/HNP, and Eltopia

Some of the associated areas may have been previously surveyed (Rice and Chavez, 1980). These candidate sites are being considered together. The Eltopia plant site has a low potential for significant cultural resources; the others have high potential. The more critical factor in assigning a high potential to each of these sites is the high density of known and potential cultural resources along the Columbia River (Rice and Chavez, 1980; Washington State Office of Historic Preservation, Olympia, WA). One archaeological site (45BN266) has been identified within the proposed site. The staff has determined the site to not be significant.

Pebble Springs South

A nearby spring, coulee-like character of the plant site, intake and discharge line locations at the Columbia River and crossing the John Day River with a transmission line, all combine to designate this site as containing high potential. No professional surveys were performed.

Ryderwood

Surveys of similar valleys nearby (Washington State, Office of Historic Preservation, 1982) indicate that this plant area has a high potential for containing archaeological and historical resources. No professional survey was performed.

Skagit

Existing mitigation plan for this site indicates that, although no cultural resources were identified, sufficient potential remained to require monitoring by a professional archaeologist of the clearing and grubbing operations (Washington State, Office of Historic Preservation, 1982). The intake and discharge lines extend along the Skagit River floodplain for a considerable distance, crossing numerous old meanders. The associated areas alone would identify this candidate site as containing high potential for archaeological and historic resources.

Population Density

Population densities for the Cherry Point, Skagit, and Goshen sites shown in Table 3.4 are slightly higher than those for the proposed S/HNP site and are therefore are less desirable. All other sites are judged by the staff to be comparable to the proposed site.

Licensability from the Safety Standpoint

The staff's geologic evaluation of the ten alternative sites was based primarily two parameter: (1) proximity to capable faults (assumed or previously determined) or faults of unknown (unresolved) capability, and (2) an estimate of the degree of difficulty of dating the identified faults. To some degree, the potential for volcanic ash fall was also considered. With respect to the first parameter, the three preferred alternative sites are 13 km (8 mi) (Eltopia), 58 km (36 mi) (Centerville), and 74 km (46 mi) (Pebble Springs South) from the nearest faults of either assumed capability or undetermined capability (Slemmons et al., 1980; NUREG-0013; PSP&L S/HNP PSAR, Am. 23, 1981; WPPSS WNP-2, Am. 18, 1981). The S/HNP site, on the other hand, is within approximately 8 km (5 mi) of a fault of unknown (undetermined) capability and within approximately 16 km (10 mi) of a fault (WPPSS WNP-2, Am. 18, 1981) assumed by NRC to be capable.

The staff considers the Eltopia site, because of apparently unfaulted Quaternary and older deposits (Slemmons, et al., 1980; WPPSS WNP-2, Am. 18, 1981), and the Pebble Springs South and Centerville sites, because of dated noncapable faulting (NUREG-0013; Pebble Springs PSAR, 19), to be preferable to the S/HNP site. Investigators at the S/HNP site are currently determining the age relationships of geologic formations overlying a buried fault within 8.8 km (5.5 mi) of the site vicinity (PSP&L S/HNP PSAR, Am. 23, 1981).

Because of its remoteness from volcanic sources (Crandell, 1976), the S/HNP site considered preferable to both Centerville and Pebble Springs South and comparable with Eltopia in terms of ash fall (WPPSS WNP-2, Am. 18, 1981).

For the following geologic considerations, the remaining alternative sites are considered less preferable than the S/HNP site: (1) proximity to faults of undertermined capability; (2) absence of geologic formations amenable to age dating; and (3) complexity of the nearsite tectonic environment.

The staff's evaluation and comparison of alternative sites from the standpoint of seismology was based on the following:

(1) The location of the site with respect to known or inferred capable faults from which earthquakes may be generated.

(2) The proximity to other sources of seismic activity.

The alternative sites located closer to the Pacific Coast (Cherry Point, Goshen, and Skagit) are less desirable because of their proximity to a zone of relatively higher seismicity and the discovery of possibly capable faults underlying the Strait of Georgia, which may be the source of seismic activity.

Hanford 22-1 is located on the Southeast Anticline Fault, which may be assumed to be seismogenic, pending the results of further investigations. Hanford 22-2 and 23 lie within 6.4 km (4 mi) of the Gable Mountain structure, which is assumed to be seismogenic. The proposed site is 12.1 km (7.5 mi) from Gable Mountain. Eltopia is comparable to S/HNP because it lies about 12.8 km (8 mi) from the Southeast Anticline Fault, which may be assumed to be the source of seismic activity pending further investigations. Ryderwood is located in an area that may be a seismogenic zone, which would require detailed investigation.

Based on present information, the staff concludes that Pebble Springs South and Centerville are preferable to S/HNP because they are located at greater distances [74 and 58 km (46 and 36 mi), respectively] from a possible seismogenic source than the proposed site, which is 16 km (10 mi) away from another possible seismogenic source.

Based on considerations of pumping costs, litigation of flood effects, and water availability, the staff finds Cherry Point, Hanford 22-1, and Hanford 22-2 preferable to the proposed site. The remaining alternate sites are considered by the staff to be less desirable from the standpoint of hydrology.

The eastern sites (S/HNP, Hanford 22-1, 22-2, and 23) already have detailed meteorological information available as do the Skagit and Pebble Springs South locations. The remaining sites would require a monitoring program to assess dispersion conditions peculiar to the site vicinity. Such a monitoring program would add a very small incremental cost. In summary, all alternative sites may be comparable, depending on the incremental cost of assuring the plant capability, to withstand the design-basis tornado for Region II at eastern locations (Cherry Point, Goshen, Skagit, and Ryderwood) and whether this incremental cost exceeds about 5 percent of the total project capital cost.

From the standpoint of industrial, military, and transportation facilities, the staff finds the Cherry Point site less desirable than the other sites because of its potential for incurring additional costs due to its proximity to an oil refinery and a major waterway. All other alternative sites are judged to be comparable with the S/HNP site.

Table 3.6 shows intermediate evaluation of alternative sites regarding the five components relating to safety evaluation.

Table 3.6 Comparison of licensability of alternative sites from the safety standpoint

	Considerations					
Site	1	2	3	4	5	Composite Rating
Skagit	-	-	-	θ	0	-
Goshen	-	-	-	Xθ	0	-
Ryderwood	-	-	-	Xθ	0	-
Cherry Point	-	-	+	Xθ	-	-
Hanford 22-1	-	-	+	0	0	0
Hanford 22-2	-	-	+	0	0	0
Hanford 23	-	-	-	0	0	-
Eltopia	+	0	-	0	0	0
Pebble Springs So.	+	+	-	0	0	0
Centerville	+	+	-	X0	0	0

Legend:

1 - Geology
2 - Seismology
3 - Hydrology
4 - Meteorology
5 - Industrial, military, and transportation facilities

\+ = Preferable
0 = Comparable
\- = Less desirable
X = Information not available
X0 = Meteorology measurements needed to assess comparability
Xθ = Greater tornado effect
θ = Comparable with greater tornado effect

3.2.2 Staff Conclusions

3.2.2.1 Adequacy of Reconnaissance Level Information

It is the opinion of the staff that the information provided by PSP&L, and supplemented with additional data obtained by the staff, was generally adequate to reach the conclusions regarding potential sites contained in the applicant's site-selection process and in this report. More information would have been desirable on hydrology for Hanford 23, Eltopia, and Centerville; on terrestrial ecology for the Goshen and Cherry Point sites; and on aquatic ecology for the Goshen, Cherry Point, and Ryderwood sites. However, considering the hydrological, terrestrial, and aquatic characteristics of the S/HNP site, it was the opinion of the staff, based on its general knowledge of the ROI, that none of the previously mentioned alternative sites is likely to be environmentally preferable to the proposed site and that these minor informational deficiencies are not critical to the staff's conclusions.

3.2.2.2 Size of Region of Interest

The ROI utilized in the applicant's site selection process/studies was of sufficient size to reasonably ensure that a diversity of water and land resources were considered in selecting a slate of candidate sites and the proposed site.

Water sources and their associated physiographic characteristics included Puget Sound (a marine source), the upper- and mid-Columbia River (a freshwater source characterized by free-flowing and impounded stretches), the Nooksack and Skagit Rivers (originating in the North Cascades and having "extraordinary" water quality), and the Cowlitz River (a river having a relatively regulated flow and originating in the Southern Cascades).

Land resources encompassed by the proposed and alternative sites included a coastal area (Cherry Point), hilly/partially forested areas (Goshen, Skagit, Ryderwood), largely flat agricultural areas (Centerville, Eltopia), semi-arid, flat, seasonal pastureland (Pebble Springs South), and arid desert areas (proposed site and Hanford 22-1, 22-2, and 23). Five of the fifteen physiographic units contained in the ROI when the site searches were conducted are represented in the final slate of candidate sites. Based on its analysis of information on aquatic and terrestrial resources, the staff believes that expansion of the ROI beyond the one considered by the applicant would not yield significant additional new alternatives for limiting environmental impacts and, therefore, it need not be enlarged.

3.2.2.3 Adequacy of Slate of Candidate Sites

Most of the alternative sites in the final slate of candidate sites met most of the environmental threshold criteria contained in the proposed rule, especially when mitigation measures could be considered. For example, mitigation of effluent discharges could reasonably be anticipated to lessen water quality impacts and measures to safeguard intake and discharge system impacts could also be assumed to lessen impacts on aquatic resources. As a result of the analyses conducted in this report, it is the opinion of the staff that, with the exception of Goshen (water consumption) and Hanford 23 (land use), all of the remaining sites meet the candidate site criteria contained in

Section VI.2.6 of the proposed rule (see Appendix H of this EIS for proposed Appendix A), and, therefore, are among the best that could be reasonably be found.* It should also be noted that, although Pebble Springs South meets all of the proposed environmental threshold criteria, it can be effectively eliminated by institutional constraints.

3.2.2.4 Comparison of Proposed Site With Alternative Sites

The results of the first part of the sequential two-part analytical test performed by the staff to determine existence of an obviously superior alternative site are presented in Table 3.7. The table presents the results of the staff environmental comparisons of the alternative sites to the proposed site. It is the opinion of the staff that none of the alternative sites are environmentally preferable to the proposed site.

Only upon identification of an alternative site that is environmentally preferable to the proposed site would the second part of the two-part test be conducted to determine whether such a site is, in fact, obviously superior when economics of the project, technological and institutional factors are considered. Since no alternative site was found to be environmentally preferable, the staff concludes that no alternative site are obviously superior to the proposed S/HNP site.

3.3 ALTERNATIVE PLANT AND TRANSMISSION SYSTEMS

3.3.1 Heat Dissipation Systems

Analysis of alternative heat dissipation systems includes the following:

(1) Round mechanical-draft evaporative cooling (proposed system)

(2) Rectangular mechanical-draft evaporative cooling (primary alternative)

(3) Once-through cooling

(4) Natural-draft evaporative cooling

(5) Mechanical-draft dry (extended surface) cooling

(6) Mechanical-draft wet/dry evaporative cooling

(7) Evaporative cooling pond

(8) Spray cooling ponds

The criteria used by PSP&L for selecting a cooling system are that the systems (1) are feasible for construction and operation at the proposed site; (2) are

*On February 16, 1982, the applicant notified NRC that, in the next amendment to the ER, PSP&L intended to drop Goshen and Hanford 23 sites from the slate of candidate sites.

Table 3.7 Comparison of environmental attributes of alternative sites with those of the proposed site

Site	Considerations 1	2	3	4	5	6	7	8	9	Composite Rating
Skagit	-	0	-	-	-	-	0	-	-	-
Goshen	-	-	+	-	-	-	0	-	-	-
Ryderwood	0	-	0	-	-	0	0	0	-	-
Cherry Point	-	0	+	0	-	0	0	-	-	0
Hanford 22-1	0	0	+	0	0	0	0	0	0	0
Hanford 22-2	0	0	+	0	0	-	0	0	0	0
Hanford 23	0	0	-	-	0	-	0	0	-	0
Eltopia	0	0	-	-	0	0	0	0	0	0
Pebble Springs South	0	+	+	-	-	0	0	0	0	0
Centerville	0	+	+	-	-	-	0	0	0	0

Legend:

1 - Water resources (consumption & quality)
2 - Aquatic resources
3 - Terrestrial resources
4 - Land use
5 - Socioeconomics
6 - Aesthetics
7 - Archaeology and historic preservation
8 - Population
9 - Cost of safety considerations

+ = Preferable
0 = Comparable
- = Less desirable

not prohibited by local, State and Federal regulations; (3) are consistent with the Federal Water Pollution Control Act (FWPCA), as amended; and (4) can be judged as practical from a technical standpoint with respect to the proposed dates of S/HNP construction and operation.

(1) Round Mechanical-Draft Evaporative Cooling--The applicant proposes to use round mechanical-draft cooling towers for the project. Fans are the primary cause of movement of air through mechanical-draft cooling towers. Optimal use of such towers requires 11 fans per tower, three towers per unit. Tower heights about 18.2 m (60 ft), which is much lower than that required for natural-draft cooling, and the diameter is 76.2 m (250 ft). Water will be recycled ten times prior to blowdown. Because of the mechanical assistance in air movement, the size of mechanical-draft towers is less than natural- draft. The proposed system is designed to cool 29.5 m^3/s (468,000 gpm) of cooling water per unit, rejecting 9.0×10^9 Btu/hr to the environment.

(2) Rectangular Mechanical-Draft Evaporative Cooling--Operating on the same principal as round mechanical-draft cooling towers, rectangular mechanical-draft cooling towers are the primary alternative. The project would require five towers per unit and nine cells per tower. Each tower is designed to be approximately 15 m (50 ft) high, 18 m (60 ft) wide, and 148 m (486 ft) long. Because a one-tower-length separation is required, the five rectangular mechanical-draft towers require an area of approximately 8.9 ha (22 acres), nearly four times the area required for three round mechanical-draft towers. Performance characteristics of the rectangular towers can be considered equivalent to the round towers. The costs of three round mechanical- draft towers or five rectangular mechanical-draft towers are similar. However, increased land area costs and increased piping and excavation would increase costs by $2 million per unit (S/HNP ASC/ER, 1981).

(3) Once-Through Cooling--Once-through cooling is a direct intake process in which large volumes of water are withdrawn (from the Columbia River), passed directly through the condenser with a temperature increase of 11 to 17°C (20 to 30°F), and returned to the river. The major difference in this system is that heat is rejected to the water and to the Columbia River by direct heat transfer rather than being rejected to the atmosphere by vaporization. Thermal load to the receiving water source is therefore much greater.

Thermal effects of discharge include avoidance and temporary behavior imbalance that can increase predation rates. Intake effects include impingement and entrainment. Because of the lengthy exemption procedures required to install a once-through system and because of Washington State Water Quality Standards prohibiting such thermal increases (WAC 173-201, "Water Quality Planning"), the applicant did not consider it a feasible design alternative. The staff concurs with this consideration.

(4) Natural-Draft Evaporative Cooling--Natural-draft evaporative cooling towers currently in operation range up to about 152 m (500 ft) in height, with a base diameter of about 137 m (450 ft). A tower of this size at the project site would fail to operate adequately during periods when the temperature was very high and the relative humidity was very low. This problem arises from the generally arid conditions in the area where the project is to be located. The low relative humidity means that the ambient air has low density and thus produces a low driving force. This condition leads to low air flow and a corresponding increase in outlet water temperature, which can significantly affect plant performance.

The staff concurs that natural-draft evaporative cooling could not operate well at the S/HNP site with its high summer temperatures and low relative humidity.

(5) Mechanical-Draft Dry Cooling--A totally closed-cycle system, using dry cooling towers, transfers heat primarily by convection and radiation. No water is lost by evaporation and drift. Dry cooling towers would not discharge chemicals or waste heat into the Columbia River. However, a dry cooling tower has significantly lower thermal efficiency than a mechanical-draft wet cooling tower of comparable design, because the cooling process is dependent on the dry bulb air temperature instead of the lower wet bulb air temperature. The lowest temperature achievable is the dry bulb temperature of the air.

The advantage of dry cooling includes the elimination of draft, fogging and icing, and blowdown discharge.

The use of dry cooling has historically been restricted to relatively small generating plants, and costs much more than a wet cooling tower of similar heat dissipation capability. In addition, necessary high back-pressure turbines are not readily available. But even if these turbines were available, dry cooling tower systems typically incur a 10 to 12 percent loss in plant efficiency during the hottest summer days, with a 6 to 8 percent energy loss. Other studies of dry cooling towers for application at nuclear plants have concluded that dry cooling towers are not feasible (NUREG-75/012; USAEC, FEIS Hanford #2, 1972; WPPSS NP #2, ER, Amendments 1 and 5; WPPSS NP #1 and #4, Amendments 1 and 4). After considering the environmental advantages of dry cooling with their disadvantages in energy loss and associated costs, the staff concludes that dry cooling towers are not a preferred alternative for the proposed mechanical-draft towers.

(6) Mechanical-Draft Wet-Dry Cooling--Wet-dry towers use dry surface heat exchangers in combination with wet evaporative cooling tower sections. During the summer when cold water is most vital to electrical output, the dry section is bypassed to produce the coldest water possible. This is also the period when evaporative water loss is greatest; thus, there is no economic saving in the purchase of equipment required to supply makeup water. Correspondingly, this is also a period of low river flow; thus, such a system effects no change in the design of the project's discharge system. Any savings in water would occur in the winter, not summer.

Wet-dry towers are not considered to be a primary alternative for condenser cooling. Costing much more than conventional mechanical-draft towers, wet-dry towers occupy approximately twice the land area. If sized to be effective for water conservation, they have a substantial effect on net output through increased auxiliary power consumption (NUREG-75/012; NUREG-0405; NUREG-0522).

The staff has concluded that wet-dry towers are not preferable to the proposed system.

(7) Cooling Pond--A pond could dissipate condenser cooling water heat to the atmosphere by evaporation and conduction. It would require about 707 ha (1,750 acres) of surface area. A major drawback is the possibility of rising groundwater levels. A mathematical model developed of the groundwater beneath the Hanford Reservation indicates that a significant increase in the height of the water table could result from continuous percolation of only a few thousand liters per minute of water from an unlined pond into the ground. Substantial time and effort would be required to assure there are no undesirable effects from a rise in the water table under the Hanford Reservation (NUREG-75/012; USAEC, FEIS Hanford #2, 1972; WPPSS NP #2, ER, Amendments 1 through 4; WPPSS NP #1 and #4, ER, Amendments 1 through 3). This is especially sensitive due to the potential for radioactive contamination. The terms of the sales agreement for the site between the DOE and PSP&L prevent the use of groundwater as the source of cooling water.

Because the integrity of a lining that would seal the pond and prevent seepage cannot be assured, the use of a cooling pond for the project was rejected. The staff concludes that cooling pond alternative is not preferred to the proposed system.

(8) Spray Pond--The use of a spray pond was rejected for the same reason that use of a cooling pond was rejected, i.e., the potential problems created by a raised water table in the environs of the canal due to seepage (NUREG-75/012; USAEC, FEIS Hanford 2, 1972). The staff concurs with this decision.

Conclusion

Considering both the environmental impacts and economic costs of various cooling methods, the staff concluded that the round mechanical-draft cooling towers would provide an acceptable method of heat dissipation.

3.3.2 Other Water Systems

3.3.2.1 Intake Systems

The applicant evaluated in-river (proposed), conventional, infiltration, and offstream canal inlets. Construction impacts from each structure would be similar and would include some bottom disruption and turbidity. Construction impacts for the offstream canal would perhaps be less. However, there would be more operational impacts for this structure. Siltation would occur in the canal. The canal intake would be in a more productive habitat (submerged shoreline) than the midriver intake.

Operational impacts from the other two systems include turbidity from occasional backwashing of the infiltration system and egg and larval entrainment of the in-river intake pipes. The staff feels that infiltration bed system is environmentally superior to the proposed because it avoids all entrainment; however, the limited impact of the proposed system results in an insignificant difference. Based on the environmental report for WNP-1 through -4, the infiltration bed would cost approximately $350,000 more than the in-river system, which includes nearly $100,000 in power consumption penalty.

Alternative Sources of Water

In addition to the above, the staff investigated the possibilities of a well system at the Hanford Reservation using groundwater as a makeup water source.

The glaciofluvial aquifer and the aquifers in interbedded basalt have the potential to supply water to the S/HNP site. A groundwater supply system must be capable of delivering 149,372 lpm (39,460 gpm) to meet water use demands for both Units 1 and 2 of the facility.

A well in the glaciofluvial aquifer has the potential ability to deliver 1,893 to 3,785 lpm (500 to 1,000 gpm) for limited periods of time. Four collective wells consisting of ten 3,785 lpm (1,000 gpm) wells, each producing 37,854 lpm (10,000 gpm), would be required to meet plant-supply requirements. A groundwater supply system of this design would have a major impact on the groundwater régime at the Hanford Reservation.

The initial impact would be the creation of a major pressure sink in the glaciofluvial aquifer. A preliminary estimate indicates that, in time, the drainage sink would expand to encompass a great part of the Pasco Basin. This would cause a general depletion of the aquifer, eventually resulting in loss of well deliverability despite some water leakage from the confined aquifer layer.

The aquifers in interbedded basalt are composed of permeable basaltic sands deposited between basal flows. These aquifers are currently being used for construction operations at the WNP-1, -2, and -4 facilities. A single well is presently producing an average of 549 lpm (145 gpm). Reservoir tests show that these units would not have the ability to supply the 149,372 lpm (39,460 gpm) required for the S/HNP units. Impact from such withdrawal would eventually result in flow of waste fluids from the 200 East and 200 West areas into the wells, a condition that is environmentally unacceptable.

It is concluded that both the glaciofluvial aquifer and the aquifers in interbedded basalt could provide a portion of the necessary domestic water supply to the S/HNP but that, because of potential impacts to other wells, the threat of movement of contaminated aquifers and the limitations of the resource, neither type should be considered as a source of water.

Additionally, as mentioned in the previous section, the terms of the sales agreement for the site between DOE and PSP&L prevent the use of groundwater as the source of cooling water.

Prior Water Rights

An alternative administrative source for obtaining the water supply would be to contract for storage water from the U.S. Bureau of Reclamation's Franklin D. Roosevelt Lake in Northeastern Washington. The required 283 m^3/s (100 cfs) flow would be delivered continuously by the Columbia River to the proposed intake site. The State of Washington authorizes all rights, permits, and withdrawals from the Columbia River above the confluence of the Snake River. All new water rights are subject to the instream flow requirements of the State of Washington.

PSP&L is considering the possibility of entering into a water service contract with the U.S. Bureau of Reclamation under which PSP&L would acquire the water to be withdrawn from the Columbia River pursuant to the above-requested water withdrawal authorization from the State of Washington. If such a contract with the Bureau were entered into, it would not change the quantity of water to be withdrawn from the Columbia River for S/HNP or the design or location of the water intake system. Neither would it eliminate the need for the above-requested water withdrawal authorization from the State, which would still be required. The purpose of such a contract with the Bureau would be to further support the State authorization, and to receive an earlier priority date on the water supply.

The description included here is based on the material provided by the U.S. Bureau of Reclamation as part of their effort as a cooperating agency.

The U.S. Bureau of Reclamation holds the rights, permits, and withdrawals issued by the State of Washington totaling 708 m^3/s (25,000 cfs) for irrigation (Columbia Basin Project) and 8,778 m^3/s (310,000 cfs) for power generation. The amount of water to be used for irrigation includes 327 m^3/s (11,550 cfs), which is allocated for future development of 173,316 ha (429,000 acres) of the Columbia Basin Project land. The water use for power generation operates the three power plants of Grand Coulee Dam and two existing pump turbine generating units. Four additional pump turbine generating units are currently being installed. Rights for an additional 1.47 m^3/s (52 cfs) for thermal power generation are pending.

Since the construction of the third power plant at Grand Coulee Dam and the increased requests for water from Franklin D. Roosevelt Lake, the Bureau has required all municipal and industrial users of reservoir water to enter into water service contracts with the agency. These contracts allow the agency to receive compensation for use of the reservoir water.

One hundred eighteen applications, permits, and withdrawals from FDR Lake were on file with the Washington State Department of Ecology as of June 1980. Only two of the users were registered as having or seeking rights to divert more than 283 liters per second (10 cfs).

The remainder of the registered water rights for the FDR Lake are for small-volume uses [less than 283 lps (10 cfs)]. These registered rights total 3.26 m^3/s (113.636 cfs), and pending applications account for an additional 284 lps (10.04 cfs). This water is used for irrigation, livestock watering, frost and fire control, and domestic, municipal, and industrial applications.

Large and small users of FDR Lake water collectively have appropriations of 9492.3 m^3/s (335,215.63 cfs), and there are applications pending on an additional 1.75 m^3/s (62.04 cfs). Other possible claims to water rights could be made by the Colville and Spokane Indian Tribes. In addition, the Mt. Tolman Molybdenum mining operation on the Colville Reservation and The Washington Water Power Company's Creston Steam Electric Generating Station are projected major users of FDR Lake waters.

Potential Impacts of Using FDR Lake as the Water Supply Sources

Water released from FDR Lake to satisfy the needs of the S/HNP would have a relatively minor effect on power production at Grand Coulee Dam or at other mid-Columbia hydroelectric facilities since the required amount [2.83 m^3/s (100 cfs)] is considerably less than the average flow. In any event, the instream flow and below the Hanford Reach would not be less under this alternative than would otherwise prevail since releases up to the 2.83 m^3/s (100 cfs) consumptive requirement could be made from FDR Lake to match the applicant's diversions.

Even in worst-case circumstances during low water years and high power demand, the relatively small amount of water released and resultant draw on FDR Lake should not significantly affect fish, wildlife, or recreation. The total amount of water appropriated from FDR Lake, excluding the irrigation water for the Columbia Basin Project, is less than 0.5 percent of the average flow of the Columbia River at Grand Coulee Dam.

3.3.2.2 Discharge Systems

The applicant considered three discharge systems for the S/HNP: namely, a single-point discharge, diffuser pipes, and a seepage pond. There are no significant differences in the effect on power consumption between the alternatives. Estimated capital cost for a seepage pond would exceed that for the other two alternatives by about $6 million. The single-point discharge system would have the least capital cost, which is about $0.2 million less than the diffuser pipes. Although the seepage pond resulted in no water quality impact to the Columbia River, a major concern of this alternative is the potential for rising groundwater levels and undesirable chemical effects. In the staff's judgment, this alternative is not worth the additional cost and associated risk to groundwater supplies. Environmental differences between the proposed single-point discharge and diffuser pipes are negligible. The staff believes that there is no environmentally preferable discharge system to the proposed single-point discharge.

3.3.2.3 Chemical Waste Treatment Systems

The proposed system treats oil and suspended solids and neutralizes the pH of the wastewater and discharge with blowdown. Alternative treatment systems could include desalination and an evaporation pond. Power requirements for any alternative are small and none would affect the plant capacity factor.

Neither of the two alternatives has environmental effects on the river since no chemical wastewater is discharged. The chemicals returned to the river by the proposed system consist primarily of salts originally present in the river, as detailed in Section 4.2.3. The increase in concentration of dissolved solids in the river is insignificant outside of the dilution zone as discussed in Section 4.2.3. The desalination system would have an annualized cost of approximately $12,000 more than that proposed. The evaporation pond would cost approximately $122,000 more annually than the proposed system. The staff does not feel that environmental advantages of either of the alternatives are significant. Because of the cost factor, the proposed treatment system is preferable.

3.3.2.4 Sanitary Waste Systems

Alternative methods for the treatment of sanitary wastes include activated sludge, offsite treatment, biological filtration, oxidation pond, and open sand filtration.

The proposed activated sludge system is a biological treatment process that uses aerobic microorganisms for waste reduction. Package-type units have been commonly used. Aeration, supplied by either mechanical or diffused-air systems, results in a high-energy demand in relation to some treatment methods. The process is reliable with biological oxygen demand (BOD_5) removals ranging from 85 to 95 percent.

Disposal of sanitary sewage off site to either the WPPSS Waste Treatment Plant or to the City of Richland Municipal Waste Treatment Plant would require construction of a minimum of 8 km (5 mi) of sewers. This would require acquisition of significant amounts of land.

Biological filtration systems (trickling filter or rotating disc) use a fixed biological growth for waste treatments. The trickling filter consists of either a plastic or rock bed of media, attached to the filter media, to degrade organic substances in the wastewater. The process has limited flexibility, long recovery times are often required following upsets, and odor problems can occur. BOD_5 removal efficiencies vary from 80 to 90 percent.

The totaling disc is a biological filtration system consisting of plastic media mounted on a horizontal shaft and placed in a tank. A biological film develops on the media. The disc is slowly rotated as wastewater flows through the tank. The process is moderately reliable with BOD_5 removal efficiencies varying from 80 to 90 percent.

Oxidation ponds, a third type of biological treatment system, are classified as aerobic, anaerobic, or facultative, depending on the nature of the biological activity used for treatment. The most commonly used type of facultative ponds consist of an anaerobic bottom layer, an aerobic surface layer, and an intermediate zone in between. These ponds may experience reduced treatment efficiency in very cold climates. Odors can occur when the system is overloaded. BOD_5 removal efficiencies generally vary from 75 to 95 percent.

The open sand filter system uses primary treatment (Imhoff tank) for solids removal. Secondary treatment is provided by the open sand filter in which biological growths provide the desired biological oxidation. Generally, this alternative requires minimal operation and maintenance. However, odor and soil clogging problems may occur.

Each alternative has advantages and disadvantages in construction and operation cost, operational reliability and flexibility, and treatment efficiency. The staff concludes that the activated sludge system, rotating biological contactor, or oxidation pond are the most viable alternatives, but agrees that the applicant has made a reasonable choice in selecting the package-type activated sludge system.

3.3.2.5 Biocide Treatment System

Circulating water treatment is generally necessary to control condenser tube fouling from algal or bacterial growth. The four following systems were considered:

(1) Sodium hypochlorite
(2) Chlorination
(3) Ozonation
(4) Organic biocide

From an environmental standpoint, sodium hypochlorite and chlorination are similar in the way both yield a chlorine residual when used. Chlorine was eliminated by the applicant because of its hazardous handling and storage characteristics.

Ozone is also an effective biocide and has less impact than chlorine because it is short-lived and generally has no residual. Because of this, the applicant has stated that it is difficult to maintain an ozone residual throughout the cooling towers. Furthermore, generating costs are high.

Other biocides (acrolein, chlorinated biphenols, and bischiocyanates) were reviewed. The applicant has indicated problems with these in that they cannot be automatically monitored, or are more expensive. Acrolein is listed as a priority pollutant. Total annual cost of the organic biocide option was estimated at $9.1 million more than sodium hypochlorite and mechanical cleaning. Ozone costs exceed the proposed system by $8 million.

The staff feels that sodium hypochlorite is a suitable option but that dechlorination be considered to avoid the chronic and acute effects of such discharge. The staff recommends that the monitoring program include fish effect observations and, if necessary, discharge concentrations of chlorine residual be reduced, through dechlorinating, to 0.1 mg/l.

3.3.3 Transmission System

3.3.3.1 Alternative Routes

The discussion of alternative transmission routes was prepared by Bonneville Power Administration (BPA), a cooperating agency, as part of the contribution to this Environmental Impact Statement. This discussion is contained in Appendix J to this EIS.

3.3.3.2 Alternative Design, Construction, and Maintenance

The alternative designs and construction are discussed in Appendix J.

4. PROJECT DESCRIPTION AND AFFECTED ENVIRONMENT

4.1 PLANT DESCRIPTION

4.1.1 External Appearance and Plant Layout

Figure 4.1 shows a plan of the plant site, indicating relative placement of the various facilities and buildings of the Skagit/Hanford Nuclear Project. Figure 4.2 shows an artist's sketch of the proposed project.

The project will consist of two, similarly placed, 1275 MWe nuclear generating units with associated facilities. The plant structures will be of functional design with an effort to achieve aesthetically pleasing appearance.

The 46.2-m (140-ft) diameter and 72.7-m (220-ft) high reactor building will be made of reinforced concrete. The adjacent, 30.4-m (92-ft) high fuel building and the 28.1-m (85-ft) high auxiliary building will have an exterior of metal siding with color and texture compatible with the surroundings. The 13.3-m (40-ft) high diesel generator building and the 31.7-m (96-ft) high control building, located north of the auxiliary building, will have similar exterior finishes.

On the east side of the auxiliary building, the 46.6-m (141-ft) high turbine building will be faced with precast concrete panels and metal siding. Two mechanical-draft cooling towers on a common basin, serving as an ultimate heat sink, will be located about 115.8 m (350 ft) south of each reactor building. The radwaste building, common to both units, will be built about 115.8 m (350 ft) south of the Unit 1 turbine building.

The three mechanical-draft cooling towers, each 83.6 m (253 ft) in diameter and 19.8 m (60 ft) high, will be located about 330 m (1,000 ft) south of each turbine building.

4.1.2 Reactor and Steam-Electric System

The S/HNP is a two-unit electric generating plant. The S/HNP will utilize two light-water-moderated boiling-water reactors (BWRs) supplied by the General Electric Company and two turbine generators supplied by the Westinghouse Electric Corporation. Each of the two S/HNP units is designed for an operating life of 40 years.

In the BWR, water circulates through the reactor core, absorbing heat at a rate equivalent to the nuclear steam supply system (NSSS) power level. The heated water boils, and the resulting steam, which accumulates at the top of the reactor vessel, is piped to the turbine. In going through the turbine, the steam expands, loses energy, and cools. The steam is then condensed in the main condenser into liquid (condensate) and is treated in the condensate demineralizers to remove any impurities it may have picked up in the pipes, turbine or condenser. The treated liquid, called feedwater, is then heated and pumped back for use in the reactor, once again becoming reactor coolant.

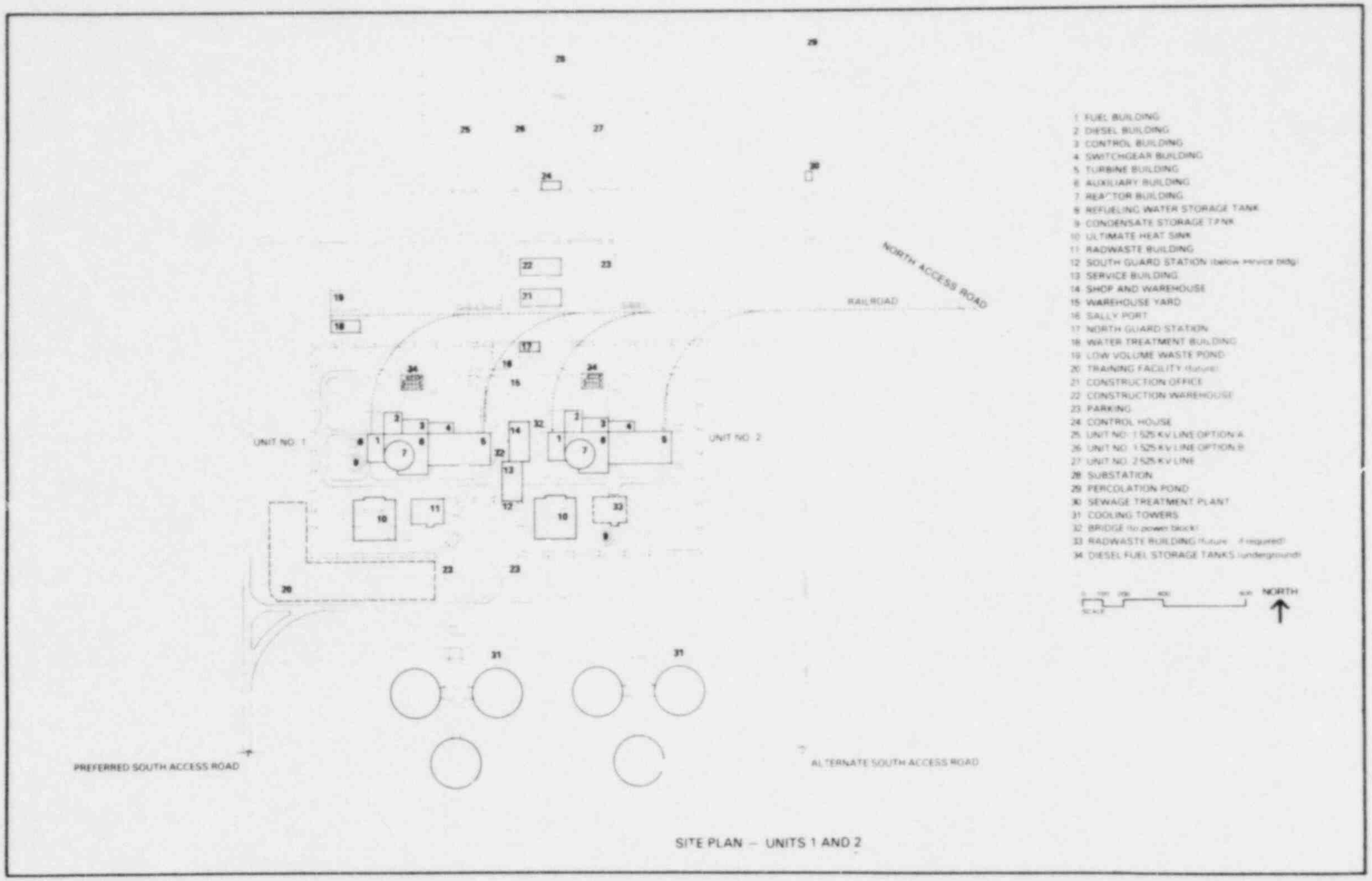


Figure 4.1 Project structures and facilities (S/HNP ASC/ER, 1981)

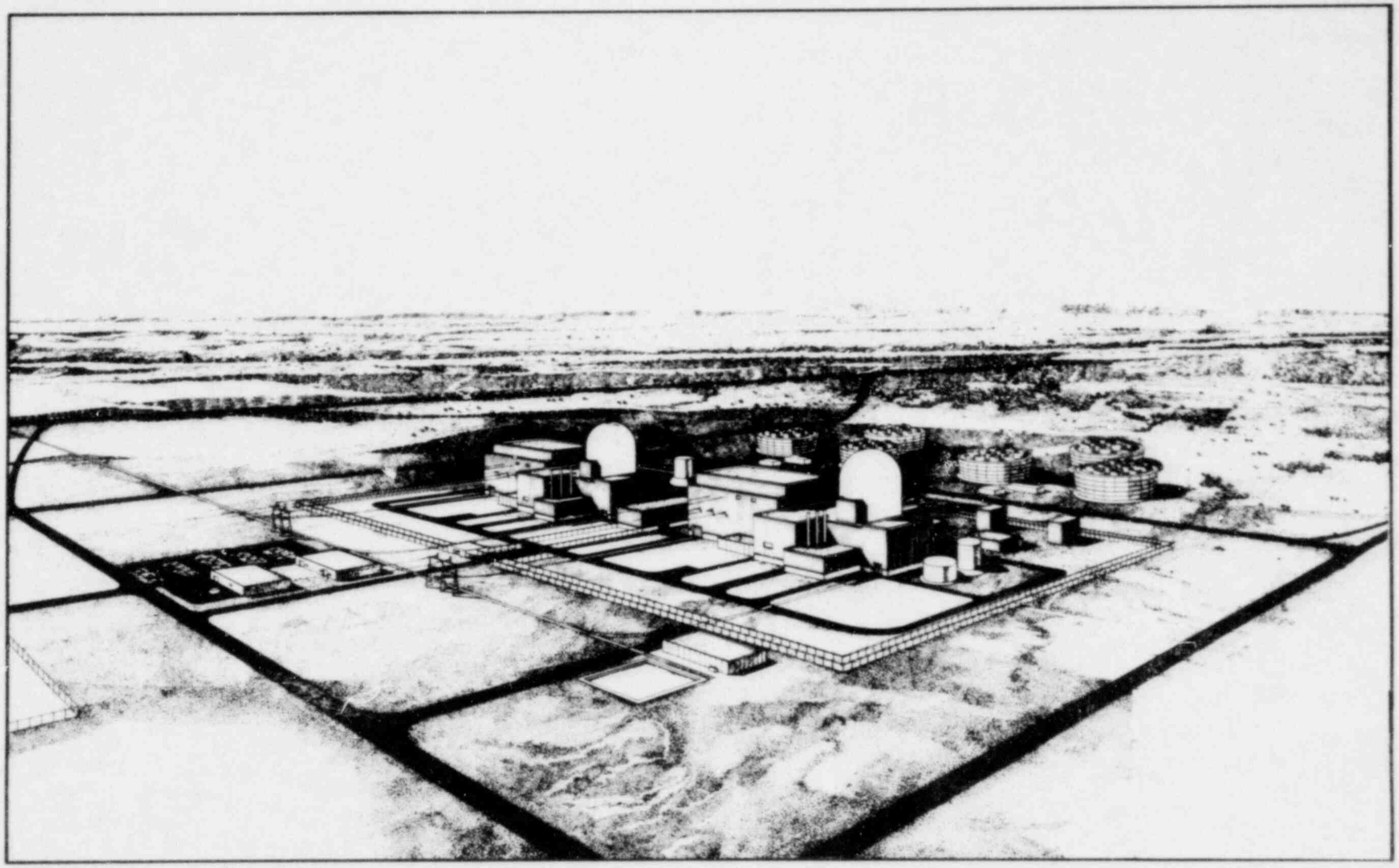


Figure 4.2 Graphic representation of the plant (S/HNP ASC/ER, 1981)

The Bechtel Power Corporation is the architect/engineer for the design, procurement, and construction management of the S/HNP.

Each NSSS consists of a BWR/6 reactor system, auxiliary systems (including systems to ensure the ability to safely shut down the reactor under adverse conditions), and appropriate instrumentation. The reactor system has a licensed core power level of 3800 MWt, with a core rated power level of 3833 MWt.

The fuel for each nuclear reactor is uranium enriched in U-235. Uranium dioxide powder, compacted and sintered into cylindrical pellets, is enclosed in Zircaloy-2 tubes, which are evacuated, backfilled with helium, and sealed with welded end plugs. A fuel bundle is composed of 63 fuel rods and one water-spacer capture rod in an 8 by 8 array. The fuel bundle is contained within a fuel channel, which guides reactor coolant flow. The fuel channel and the fuel bundle are collectively referred to as a fuel assembly. A total of 848 fuel assemblies will comprise the core. The initial core will contain fuel bundles having a common average enrichment, ranging from approximately 1.6 to 2.2 percent by weight U-235, depending on initial fuel cycle requirements. Selected rods in each initial assembly will be blended with additional gadolinium burnable poison. The reload fuel will contain fuel bundles having an average enrichment in the range of 2.4 to 3.0 percent by weight U-235. The Zircaloy-2 fuel assemblies will confine fission fragments and their decay products to the fuel assembly, thereby keeping the concentration of radioactivity in the coolant at low levels.

Reactivity and thermal power are controlled during normal operation by the control rod drive system and flow control of the recirculation water. The primary reactor control elements are the control rods. The control rods are used primarily for power distribution shaping and for shim control of long-term reactivity changes that occur as a result of fuel irridiation. A control rod consists of a sheathed cruciform array of stainless steel tubes filled with boron-carbide powder. The boron in the control rod captures neutrons, thus limiting the nuclear chain reaction. There are a total of 205 control rod assemblies in the core. The recirculation flow control system will regulate the steam volume within the core to follow rapid load changes. The volume of steam within the core will control the amount of neutron moderation and the rate of the nuclear chain reaction. The recirculation flow control system will be used to automatically vary the reactor power level by 25 percent or less for rapid load changes.

Each of the turbine-generator units consists of the turbine, generator, exciter, controls, and required subsystems. The turbine is an 1800-rpm, tandem-compound, six-flow machine, with one high-pressure turbine and three low-pressure turbines. Exhaust steam from the high-pressure turbine will pass through moisture separator-reheaters before entering the three low-pressure turbines. A portion of the steam from the high-pressure and low-pressure turbines is extracted for feedwater heating.

The generator is a direct-driven, three-phase, 60-Hz, 1800-rpm, conductor-cooled, snychronous generator rated at 1480 MVA at a 0.90 power factor. The generator rotor is cooled by circulating hydrogen that, in turn, is cooled by water. The generator starter is cooled by the water of a closed-loop cooling system.

The turbine-generator design rating is 1331.8 MWe gross at throttle conditions of 975.5 psia and 1190.8 Btu/lbm, and at a low-pressure turbine exhaust pressure of 1-in. HgA in each condenser shell. For the rated condition, the turbine cycle use power is 3838.5 MWt, and the associated core thermal power is 3833 MWt. With valves wide open, the turbine generator gross electrical rating is 1387.6 MWe.

The turbine exhaust steam enters the condenser where it is condensed and recirculated to the reactor. The condenser is a three-shell multi-pressure condenser with type 304 stainless steel tubes and a total heat transfer area of 111,510 m^2 (1,239,000 sq ft).

Those gases that do not condense are drawn from the condenser and processed in the off-gas system. The circulating water system will cool the condenser. Water from the mechanical-draft cooling towers will be pumped through the condenser and returned to the cooling towers.

In-plant electrical consumption, including transformer losses and cooling tower makeup pump requirements, will be approximately 57 MWe when a unit is running. The net electrical generation for distribution outside the plant will be approximately 1275 MWe for each unit at rated conditions.

4.1.3 Plant Water Use

An average of 1.77 m^3/s (62.4 cfs) of makeup water [2.65 m^3/s (93.6 cfs) maximum] would be required for plant operation. Table 4.1 gives a breakdown of the estimated plant water uses for various operating conditions. This water would be withdrawn from the Columbia River at river mile 361.5.

The quantity of makeup water is primarily dependent upon water losses from the circulating water system in the form of cooling tower evaporation, drift, and blowdown (see the section on heat dissipation system in Section 4.1.4.2 for the description). The water balance of the plant involves the following systems:

(1) circulating water system

(2) raw water pretreatment system

(3) makeup demineralizer system

(4) domestic water system

(5) standby service water system

(6) fire protection system

(7) plant irrigation system

(8) liquid radwaste system

Figure 4.3 shows water use for normal operation.

Table 4.1 S/HNP water use estimate of flow rates

Operating Conditions	Maximum(1)	Average(2)	25% Power(3)	One-Unit Shutdown (maximum)(4)	Both Units Shut Down(5)
Cooling tower evaporation and drift	33,400	25,200	6,300	16,700	0
Cooling tower blowdown	5,500	2,800	700	2,800	0
Cooling tower makeup water	38,900	28,000	7,000	19,500	0
Primary treatment	510	37	37	510	510
Plant irrigation	50	4	4	4	4
Domestic water	10	5	5	90	180
Low volume waste	60	17	17	60	17
Makeup for ultimate heat sink	---	---	---	525	1,050
Makeup demineralizers	450	20	20	420	330

(1) Maximum: Summer condition during plant operation at maximum thermal output of NSSS (Nuclear Steam Supply System).

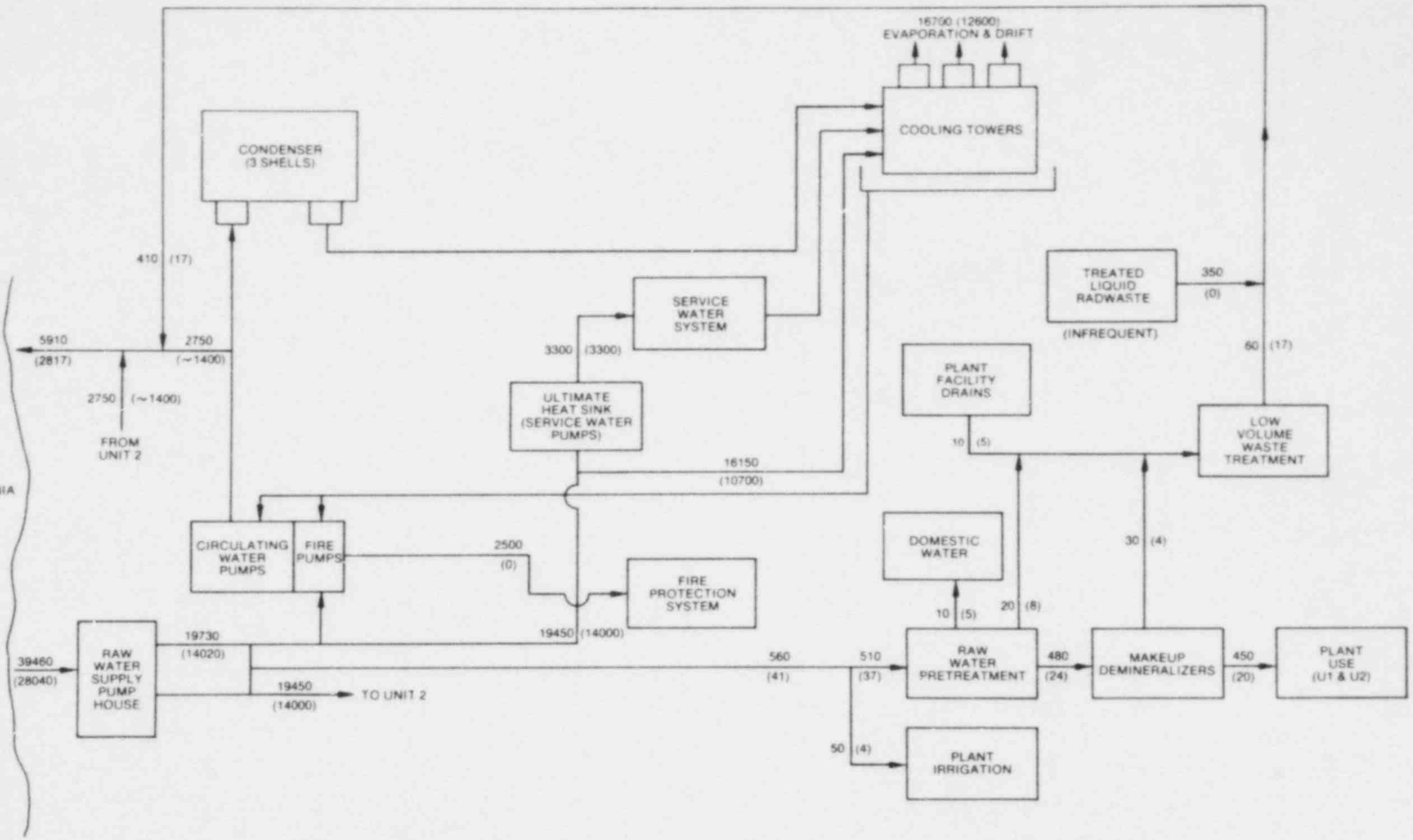
(2) Average: Weighted average during plant operation at maximum thermal output of NSSS (Nuclear Steam Supply System).

(3) 25% Power: Average values based on both units operating at 25% power. Evaporation assumed to be 0.25 times average evaporation.

(4) It is assumed that when one unit is shut down, the flow rates given are for maximum capacity NSSS operation of the other unit.

(5) Maximum requirements that exist shortly after shutdown--minimum two-unit shutdown withdrawal rate is 500 gpm.

Source: S/HNP ASC/ER, 1981.



NOTES 1) ALL VALUES ARE IN GPM, VALUES IN PARENTHESIS ARE AVERAGE. OTHERS ARE MAXIMUM
2) FIRE PROTECTION FLOW NOT INCLUDED IN MAXIMUM RAW WATER FLOW DUE TO INFREQUENT USE

SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.3 Water use diagram

4.1.3.1 Water Consumption

The consumption losses in the plant water use would be in the form of cooling tower evaporation and drift and would average about 95,390 lpm (25,200 gpm) or 47,695 lpm (12,600 gpm) for each unit), of which 378 lpm (100 gpm) would be due to the drift loss. Approximately 10,600 lpm (2,800 gpm) of the makeup water would be returned to the Columbia River as a result of cooling tower blowdown (S/HNP ASC/ER, 1981).

4.1.3.2 Water Treatment

The raw Columbia River water would be treated by the raw water pretreatment system. The raw water pretreatment system would consist of a clarifier and filters. The clarification step involves the addition of aluminum sulfate and a polyelectrolyte, such as Separan (Dow®). The filters that follow the clarification step would be backwashed periodically. This system would provide clarified and filtered water to the domestic water supply and sanitary facility, the demineralization system, and the circulating water pump bearings and seals. The sludge from the clarifying and the filter backwash would be routed to the low-volume waste treatment system.

The domestic water supply would be disinfected by adding sodium hypochlorate to make it suitable for human consumption and for sanitary purposes. The filtered water would be treated in the demineralization system to provide makeup cooling water systems. The demineralization system would consist of two trains, each having an activated carbon filter, a cation bed demineralizer, an anion bed demineralizer, and a mixed-bed polisher.

When exhausted, the cation and anion resins in the demineralizer units would be regenerated with sulfuric acid and sodium hydroxide, respectively. The regenerant waste would be collected in a neutralization tank and neutralized. The neutralized waste would flow to the low-volume waste treatment system. The waste water collected by floor drains in nonradioactive areas throughout the plant would be treated by the low-volume waste treatment system.

The low-volume waste treatment system would consist of a lined sedimentation settling basin for oil and solids separation, a parallel plate separator and a cartridge emulsion breaker for secondary oil separation, and pH adjustment equipment to maintain pH values of treated effluent within a range from 6.5 to 8.5. Effluent from the low-volume waste treatment system would be pumped to the plant discharge line.

The sanitary wastewater would be treated by a package sewage treatment plant with a percolation pond. The package sewage treatment plant could be a typical package activated sludge system that consists of a primary sedimentation tank, an aeration tank, and a secondary sedimentation tank. The primary sedimentation tank would remove solids, which can settle, from the raw sewage water. Then, the effluent would enter the aeration tank and be subject to treatment by activated-sludge organisms. During this time period, absorption, flocculation, and various oxidation reactions would take place. The effluent from the aeration tank would be passed on to the secondary sedimentation tank where the flocculant microorganisms would settle out. The final effluent from the secondary sedimentation tank would be clear and low in BOD. The applicant has stated that the overall treatment efficiency and effluent quality would comply with the guideline of 40 CFR 133, "Secondary Treatment Information" (S/HNP ASC/ER, 1981). The final effluent would be discharged to a percolation pond for disposal.

During the initial phase of construction, chemical toilets would be provided and serviced by a contractor. These toilets do not use an external water supply, nor do they discharge any liquids or solids. The units are self-contained, unbreakable, and leak resistant. The waste from the toilets would be disposed off site by a licensed sanitary disposal contractor. The staff recommends that the applicant ensure that the licensed sanitary disposal contractor selected has facilities that treat, store, or dispose of waste materials in conformance with Washington State Department of Ecology Dangerous Waste Regulations [Washington Administrative Code (WAC) 173-303)].

4.1.4 Cooling System

4.1.4.1 System Description and Operational Modes

A mechanical-draft cooling tower system utilizes evaporative cooling by contacting the warm water with air. The water is cooled both by sensible and by evaporative heat transfer. The cooled water is collected in a basin at the base of the tower.

During this cooling process, a small percentage of the total water inventory is lost due to evaporation and drift. In addition, water is discharged from the system through system blowdown, which is required to limit the concentration of naturally occurring river salts in the closed cycle resulting from the evaporation process.

4.1.4.2 Component Descriptions

Heat Dissipation System

The heat dissipation systems for each unit are designed to cool 29.6 m^3/s (468,000 gpm) of cooling water, rejecting 9.0×10^9 Btu/hr to the atmosphere. Round mechanical draft cooling towers would be used. The heat load for the cooling towers comes almost entirely from the 27.7 m^3/s (439,000 gpm) flow through the condenser (travel time across the condenser is approximately 35 sec). The temperature rise across the condenser would be about 16.5°C (40.3°F). The only other major heat dissipation subsystems are the circulating water booster system and the service water system. These systems provide cooling water for plant heat exchangers, cooling coils, and result in less than 2 percent of the heat load on the cooling towers.

Three mechanical-draft cooling towers are proposed for each unit. Each cooling tower would be approximately 18.2 m (60 ft) high to the top of the fan stacks with diameter of approximately 76.2 m (250 ft). Each tower is provided with 11 fans used to induce the draft required (approximately 58.6×10^4 m^3/s) to operate the tower. The discharge velocity from the fan stacks would be approximately 5.5 mps (18 fps).

Cooling water for condensing the turbine exhaust is supplied to the condenser by circulating water pumps located in the circulating water pumphouse. These pumps take suction from the tower basins and are designed with sufficient hydraulic head to pump through the condenser back to the cooling tower distribution system.

Water is lost from the heat dissipation system by evaporation, drift, and blowdown. To balance these losses, makeup water from the Columbia River is required. Air quality impacts from operations are discussed in the section on air quality (see Section 4.2.10.2).

The design values used for blowdown are based on a dissolved solids concentration factor of ten in the water of the cooling tower as compared with river water. The blowdown rates calculated for normal operation vary from about 4,160 to 14,000 lpm (1,100 to 3,700 gpm). A higher rate [that is, up to 20,650 lpm (5,500 gpm)] may be needed on occasion to lower the concentration of dissolved solids in the circulating water system. The compositions of the Columbia River and blowdown water are given in the section on water quality (see Section 4.2.3.2).

Expected values of evaporation, blowdown, and drift rates are given in Table 4.2 as a function of time of year. Each value given is an expected average value during a month.

The following listing gives approximate values of both maximum and annual average water use for the heat dissipation system. The results from experimental methods, such as the isokinetic sampling method and the particle instrumentation via the laser light scattering (PILLS) method used to measure the drift rate for cooling towers under operation, indicate the drift loss of about 0.005 percent of circulation water flow (Thomas and Shatner, 1971). Consumptive use consists of losses due to evaporation plus drift. Required makeup compensates for losses resulting from evaporation plus drift plus blowdown. There would be ten cooling cycles prior to blowdown.

Type of Water Use	Maximum Values (lpm)	Annual Average Values (lpm)
Consumptive use	126,430	95,390
Blowdown	20,820	10,600
Required makeup	147,250	105,990

The design makeup water capacity is approximately 158,990 lpm (42,000 gpm).

Each unit is provided with an ultimate heat sink (UHS) for emergency cooling. Each ultimate heat sink consists of a concrete basin and two mechanical-draft cooling towers. In accordance with present requirements, the water inventory in each basin is adequate for emergency cooling for a period of 30 days at worst-case meteorological conditions. Each basin is approximately 60.9 m (200 ft) square and about 9.5 m (31 ft) deep, allowing 0.3 m (1 ft) of depth for sedimentation.

Table 4.2 Monthly cooling tower evaporation, blowdown, drift, and blowdown temperatures for one unit

Month	Wet-Bulb Temp.(°F)	Relative Humidity(%)	Evaporation (gpm)	Blowdown (gpm)	Drift (gpm)	Columbia River Water Temp.(°F)	Blowdown Temp.(°F)
January	27.9	76.0	10,683	1,162	25	39.2	60.3
February	33.6	69.7	11,343	1,235	25	37.9	62.7
March	37.3	55.0	12,026	1,311	25	39.9	64.3
April	42.8	46.4	13,034	1,423	25	45.0	66.8
May	49.1	41.8	14,101	1,542	25	51.4	69.7
June	54.5	39.4	14,400	1,575	25	56.5	72.3
July	57.9	31.5	15,935	1,746	25	61.5	74.0
August	57.3	34.9	15,695	1,719	25	64.9	73.7
September	52.6	39.9	14,628	1,600	25	63.7	71.4
October	45.4	57.7	13,046	1,425	25	59.2	68.0
November	36.4	72.6	11,619	1,266	25	52.3	64.9
December	31.2	80.8	10,707	1,165	25	45.3	61.7

NOTES:
(1) Wet-bulb temperature and relative humidity are monthly averages for 1950-1970 (from WNP-2 FSAR Table 2.3-20)
(2) Table values based on 100% unit load.
(3) Blowdown rate calculated at 10 cycles of concentration.
(4) Drift rate calculated as 0.005% of water flow through cooling towers.
(5) Columbia River water temperatures are monthly averages near Priest Rapids Dam for 1965-1974 (from WNP-2 FSAR Table 2.4-7).
(6) Blowdown temperature based on 5% recirculation.

Source: S/HNP ASC/ER, 1981.

Intake System

The raw water supply system pumphouse would be constructed to supply makeup water to both units and is located on the west shore of the Columbia River, approximately 11.3 km (7 mi) from the site. The pumphouse would contain three 39,750 lpm (10,500 gpm) pumps for each unit. Two pumps would supply maximum water requirements for each unit, with the third pump acting as a spare. Two 1,890 lpm (500 gpm) pumps per unit would also be provided to supply makeup water required by a unit when that unit is not operating.

The intake would be a system consisting of three water inlets, located above the river bottom, and three inlet lines approximately 335 m (1,100 ft) long running below the riverbed to the pumphouse sump. The river depth at the intake point is estimated to be 4.3 m (14 ft) during a minimum river flow of 1,019 m^3/s (36,000 cfs). The intake and discharge configurations are shown on Figure 4.4.

The water inlets would be designed to limit openings to a maximum of 0.95 cm (3/8 in.) and intake velocity to a maximum of 15.2 cm/s (0.5 fps). This design velocity is expected to be well below the acceptable limit required for suitable protection of small fish when water is being taken into the system.

The river velocity would always be greater than the inlet velocity [70.7 cm/s (2.32 fps) or more] and would be along the faces of the inlets, thus tending to wash fish and debris clear. Because the design inlet velocity assumes maximum makeup water flow, any condition resulting in reduced makeup water flow would reduce intake velocity to even smaller values.

Undesirable debris is not expected to pass through the inlets with these very low velocities. The inlets would be designed to reduce the potential for debris collection and to permit complete removal for periodic inspection, cleaning, repair, and replacement.

At full-load conditions, all three circulating water pumps, condenser shells, and cooling towers must be in operation. If one of the three circulating water pumps is out of service, a unit can operate at a load up to about 75 percent.

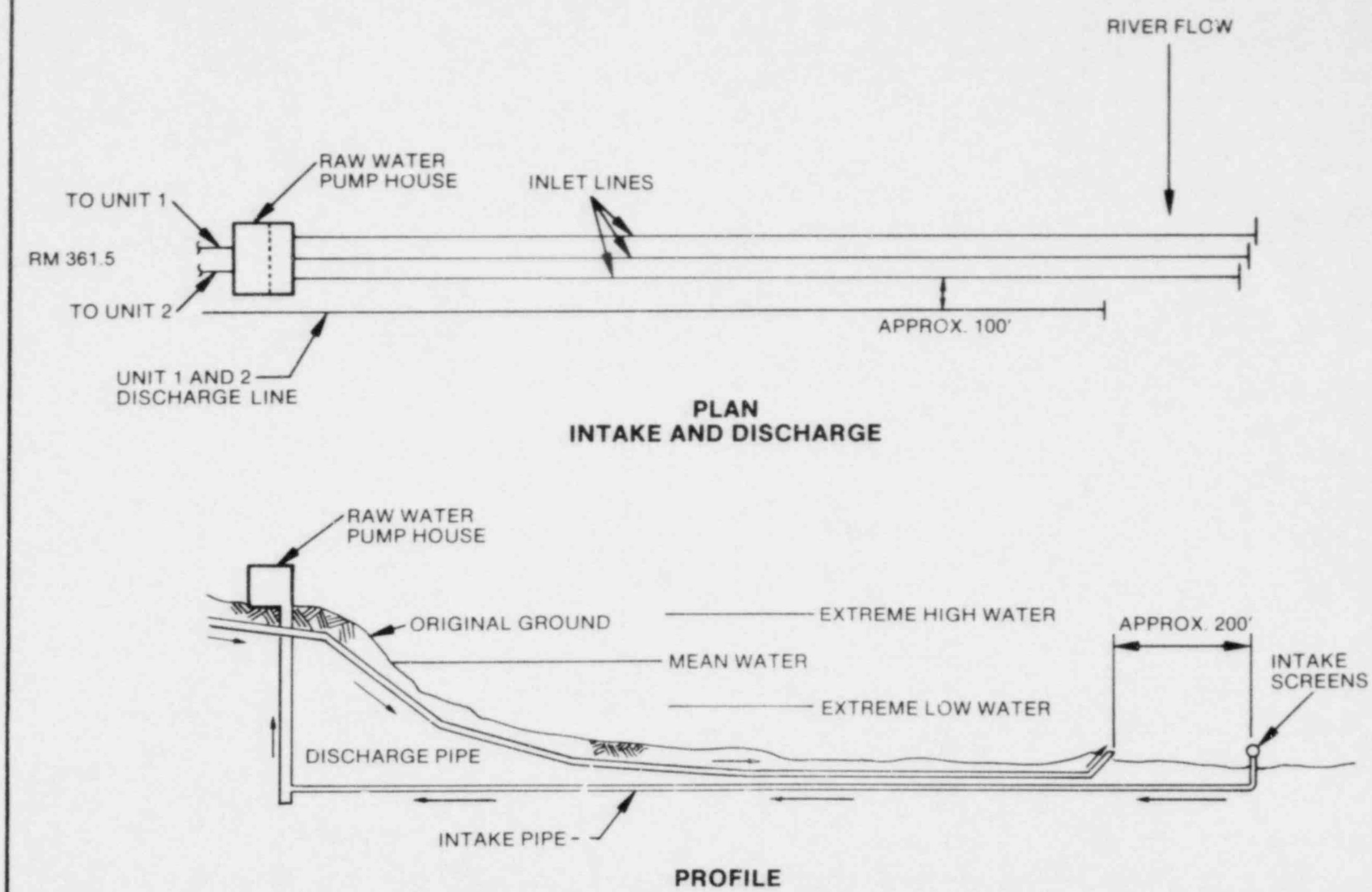
Discharge System

The discharge system would consist of a single pipe running adjacent and parallel to the makeup lines from the two units to the Columbia River. The pipe would enter the river approximately 30.5 m (100 ft) downstream of the intake, at about river mile 361.5. It would then continue out along the river bottom and terminate in a single discharge nozzle about 167.6 m (550 ft) from the river low water line. The round discharge nozzle would be oriented approximately at right angles to the river flow and angled upwards at about 15 degrees. Adequate riprap would be placed to prevent pipe movement or riverbed scour. Figure 4.4 shows a profile of the discharge line.

The average discharge flow rate would be 10,663 lpm (2,817 gpm). However, the discharge line would be designed to accommodate a maximum discharge rate of 22,372 lpm (5,910 gpm). Should it become necessary to blow down the coolant at lower cycles of concentration, the capability to discharge at higher rates is provided. The anticipated physiochemical characteristics of the discharges are discussed in the section on nonradioactive liquid-waste systems (see Section 4.1.6). Any algae and slimes would be removed by the cooling tower blowdown. Discharge of cooling tower blowdown to the river would not occur during chlorination.

4.1.5 Radioactive Waste Management Systems

Under requirements set by 10 CFR 50.34a, an application for a permit to construct a nuclear power reactor must include a preliminary design for equipment to keep



SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.4 Intake and discharge configurations levels of radioactive materials in effluents to unrestricted areas as low as is reasonably achievable (ALARA). The term ALARA takes into account the state of technology and the economics of improvements in relation to benefits to the public health and safety and other societal and socioeconomic considerations and in relation to the utilization of atomic energy in the public interest. Appendix I to 10 CFR 50 provides numerical guidance on radiation dose design objectives for light-water-cooled nuclear power reactors (LWRs) to meet the requirement that radioactive materials in effluents released to unrestricted areas be kept ALARA.

To comply with the requirements of 10 CFR 50.34a, the applicant provided final designs of radioactive waste (radwaste) systems and effluent control measures for keeping levels of radioactive materials in effluents ALARA within the requirements of Appendix I to 10 CFR 50. In addition, the applicant provided an estimate of the quantity of each principal radionuclide expected to be released annually to unrestricted areas in liquid and gaseous effluents produced during normal reactor operations, including anticipated operational occurrences.

The NRC staff's detailed evaluation of the radwaste systems and the capability of these systems to meet the requirements of Appendix I will be presented in Chapter 11 of the staff Safety Evaluation Report, which is to be issued in June 1982. The quantities of radioactive material that the NRC staff calculates will be released from the plant during normal operations, including anticipated operational occurrences, are presented in Appendix D of this statement, along with examples of the calculated doses to individual members of the public and to the general population resulting from these effluent quantities.

The staff's detailed evaluation of the solid radwaste system and its capability to accommodate the solid wastes expected during normal operations, including anticipated operational occurrences, will be presented in Chapter 11 of the SER.

As part of the operating license for this facility, NRC will require Technical Specifications limiting release rates for radioactive material in liquid and gaseous effluents and requiring routine monitoring and measurement of all principal release points to ensure that the facility operates in conformance with the radiation-dose-design objectives of Appendix I to 10 CFR 50.

4.1.6 Nonradioactive Liquid-Waste Systems

The nonradioactive liquid-waste system in the plant would consist of the following waste streams.

(1) low-volume waste treatment system

(2) circulating water system

(3) service water system

(4) sanitary system

The low-volume waste treatment system wastes consist of wastes from the raw water pretreatment system, demineralization system, and plant facility floor drains. The low-volume waste system and sanitary system are described in Section 4.1.3.2. Sulfuric acid would be added continuously into the circulating water system for scale and pH control. Sodium hypochlorite would be added intermittently into the circulating water system and standby service water system to control biological fouling. Blowdown would not occur at this time until residual chlorine dropped to less than 0.38 mg/l (S/HNP ASC/ER, 1981). These chemicals would be continuously discharged from the system as a part of the cooling tower blowdown.

4.1.6.1 Wastes Containing Chemicals or Biocides

Chemicals (or biocides) would be used in the plant for the control of water quality, scale control, corrosion inhibition, regeneration of demineralizers, and the control of biological fouling. The chemicals, treatment system, purposes, and amounts are listed in Table 4.3.

These chemicals, with the exception of corrosion inhibitors, would be discharged to the Columbia River. Table 4.4 gives the sizes of these various waste flows. Table 4.5 gives the estimated maximum and nominal (average) daily chemical loads discharged to the Columbia River via the plant discharge line.

4.1.6.2 Sanitary System Wastes

The sanitary system wastes consist of nonradioactive wastes from sanitary facilities, such as toilets, showers, sinks, and food-dispensing facilities. Total flow during construction would range from 30,280 to 234,690 liters per day (8,000 to 62,000 gallons per day), with a maximum of 51.7 kg (114 pounds) of BOD and suspended solids being generated.

During the plant operation, the sanitary wastes would be treated by a package sewage treatment plant and the final effluent would be disposed of in a percolation pond. Perhaps as many as four package treatment plants would be used during the construction and these plants would be removed as the construction diminishes. Estimated chemical concentrations in the final effluent of the package sewage treatment plant are shown in Table 4.6.

The presently estimated size of the percolation pond is 24.4 m (80 ft) long by 24.4 m (80 ft) wide by 1.2 m (4 ft) deep and its final size will be determined after the soil tests for percolation characteristics have been performed.

4.2 PROJECT-RELATED ENVIRONMENTAL DESCRIPTIONS AND IMPACTS

4.2.1 Site Location

The Skagit/Hanford Nuclear Project site is located in the southeast area of the U.S. Department of Energy's Hanford Reservation in Benton County, Washington. The S/HNP site is approximately 8 km (5 mi) west of the Washington Public Power Supply System's (WPPSS) Nuclear Project No. 2 unit (WNP-2). It is approximately 12.9 km (8 mi) west of the Columbia River, 11.3 km (7 mi) north of the Yakima River at Horn Rapids Dam, and 14.1 km (12 mi) northwest of the City of North Richland. Figures 4.5 and 4.6 show the S/HNP location with respect to roads, highways, rivers, and population centers.

Table 4.3 Chemical additions in the nonradioactive liquid-waste system

Chemical	System	Purpose	Daily		Annual	
			Maximum	Nominal	Maximum	Nominal
Aluminum sulfate	Raw water pretreatment clarifier	Water clarification	99 lb	37 lb	15,365 lb	10,130 lb
Separan	Raw water pretreatment clarifier	Water clarification	6 lb	2.2 lb	1,217 lb	602 lb
Sulfuric acid 66° Be)	Makeup demineralizer	Demineralizer regeneration	760 lb	95 lb	41,000 lb	26,000 lb
Sodium hydroxide (100%)	Makeup demineralizer	Demineralizer regeneration	638 lb	81 lb	34,700 lb	22,200 lb
Sulfuric acid (66° Be)	Circulating water system	Scale and pH control	14,924 lb	9,267 lb	3.54×10^{6} lb	2.54×10^{6} lb
Sodium hypochlorite (1% solution)	(a) Circulating water system	Prevent biological fouling	21,195 gal	7,065 gal	3.19×10^{6} gal	2.86×10^{6} gal
	(b) Service water system	Prevent biological fouling	150 gal	150 gal	27,000 gal	20,250 gal
Sodium hypochlorite (1% aqueous solution)	Domestic water	Disinfection	5 gal	3 gal	1,260 gal	945 gal

Table 4.4 Variable waste flows (values are given for two units)

Type of Flow	Maximum Flow (gpm)	Nominal Flow (gpm)
Cooling tower blowdown	5500	2800
Treated filter backwash water	20	8
Neutralized demineralizer wastewater	30	4
Sanitary sewage effluent*	10	5
Plant facility floor drains	10	5

* Effluent from the onsite sewage treatment plant will be discharged to a percolation pond for disposal.

Table 4.5 Discharge to the Columbia River from contributions of added chemicals

Source	Sulfate		Chloride		Sodium	
	Max. (lb/day)	Nominal (lb/day)	Max. (lb/day)	Nominal (lb/day)	Max. (lb/day)	Nominal (lb/day)
Circulating water system	13,362	8,460	3,738*	1,246*	2,421*	807*
Service water system	--	--	27*	9*	18*	6*
Raw water pretreatment	42.7	16	--	--	--	--
Demineralizer regeneration wastes	694	87	--	--	367	47
Domestic water treatment	--	--	3.5*	1.9*	2.3*	1.3*
TOTAL (Rounded)	14,100	8,560	3,770	1,260	2,810	860

* A 1-percent solution of sodium hypochlorite (containing 0083 lb of chlorine per gallon of solution) will be generated on site by direct electrolytic conversion of sodium chloride brine. Based on vendor information, assuming the added sodium and chloride ions are from the sodium chloride used in the electrolytic process, 3.5 lb of sodium chloride are required to produce 1 lb of chlorine equivalent.

Table 4.6 Sanitary waste treatment plant effluent quality*

Effluent	Measurement	Effluent	Measurement
Calcium, as Ca	38 mg/l	Nitrate, as N	10 mg/l
Magnesium, as Mg	10 mg/l	Phosphate, as PO_4	24 mg/l
Sodium, as Na	68 mg/l	Ammonia, as NH_3	15 mg/l
Potassium, as K	1 mg/l	pH	6.5 to 8.5
Bicarbonate, as HCO_3	168 mg/l	TDS	402 mg/l
Sulfate, as SO_4	41 mg/l	TSS	30 mg/l
Chloride, as Cl	76 mg/l	BOD_5	30 mg/l
Silica, as Sio_2	29 mg/l		

* The calculated effluent quality is based on domestic use of Columbia River water. Note that the incremental concentrations for the constituents above Columbia River water quality are taken from Table 1-4, page 4, of the text by R.L. Culp, G.M. Wesner, and G.L. Culp, "Handbook of Advanced Wastewater Treatment," 2nd ed., Van Nostrand Reinhold Co. (1978).

The centers of reactors of Units 1 and 2 will be located approximately at the following geographical coordinates:

Unit	Latitude	Longitude
1	46° 29' 15"	119° 26' 4"
2	46° 29' 15"	119° 25' 51"

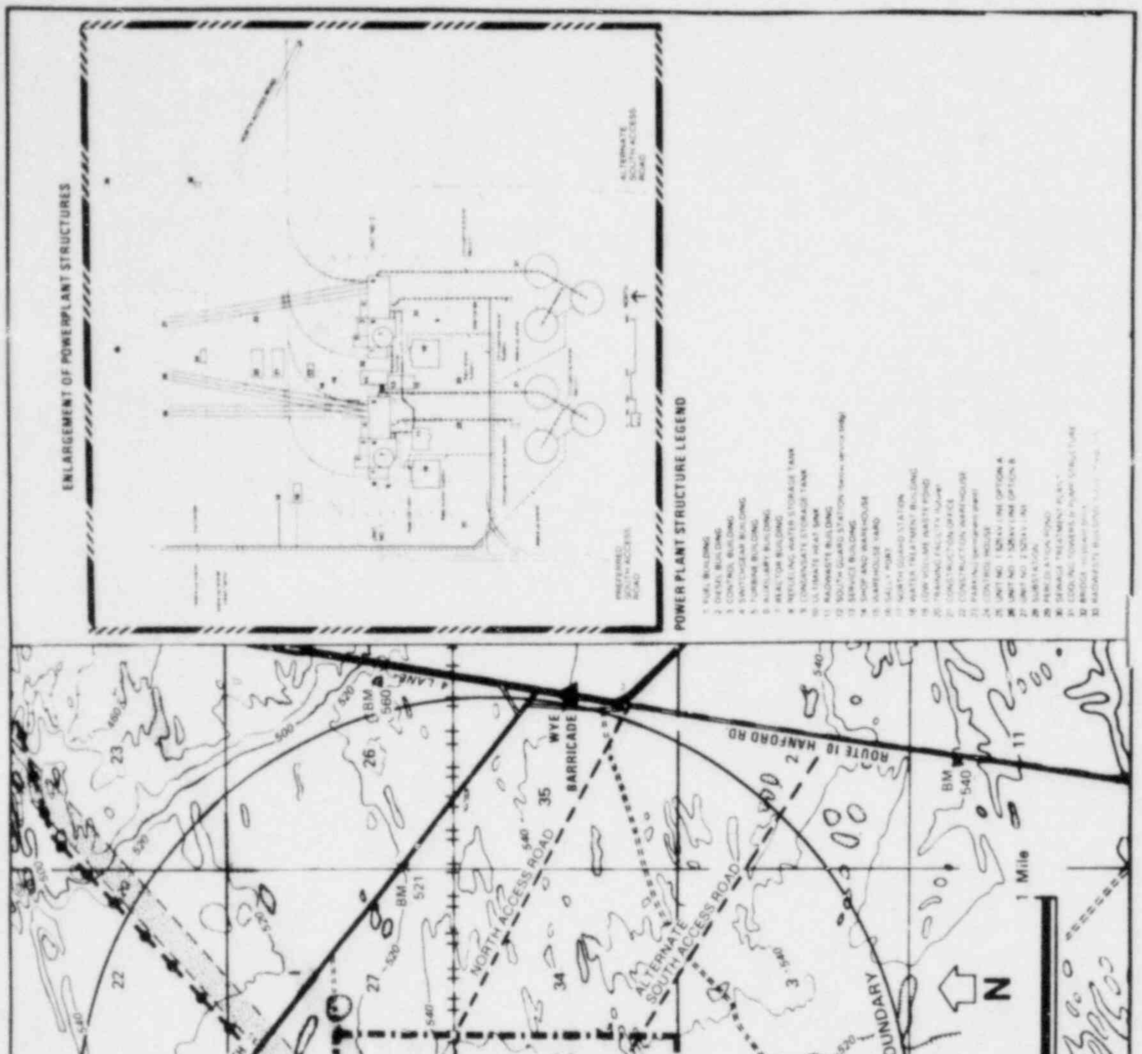


Figure 4.5 Site area map

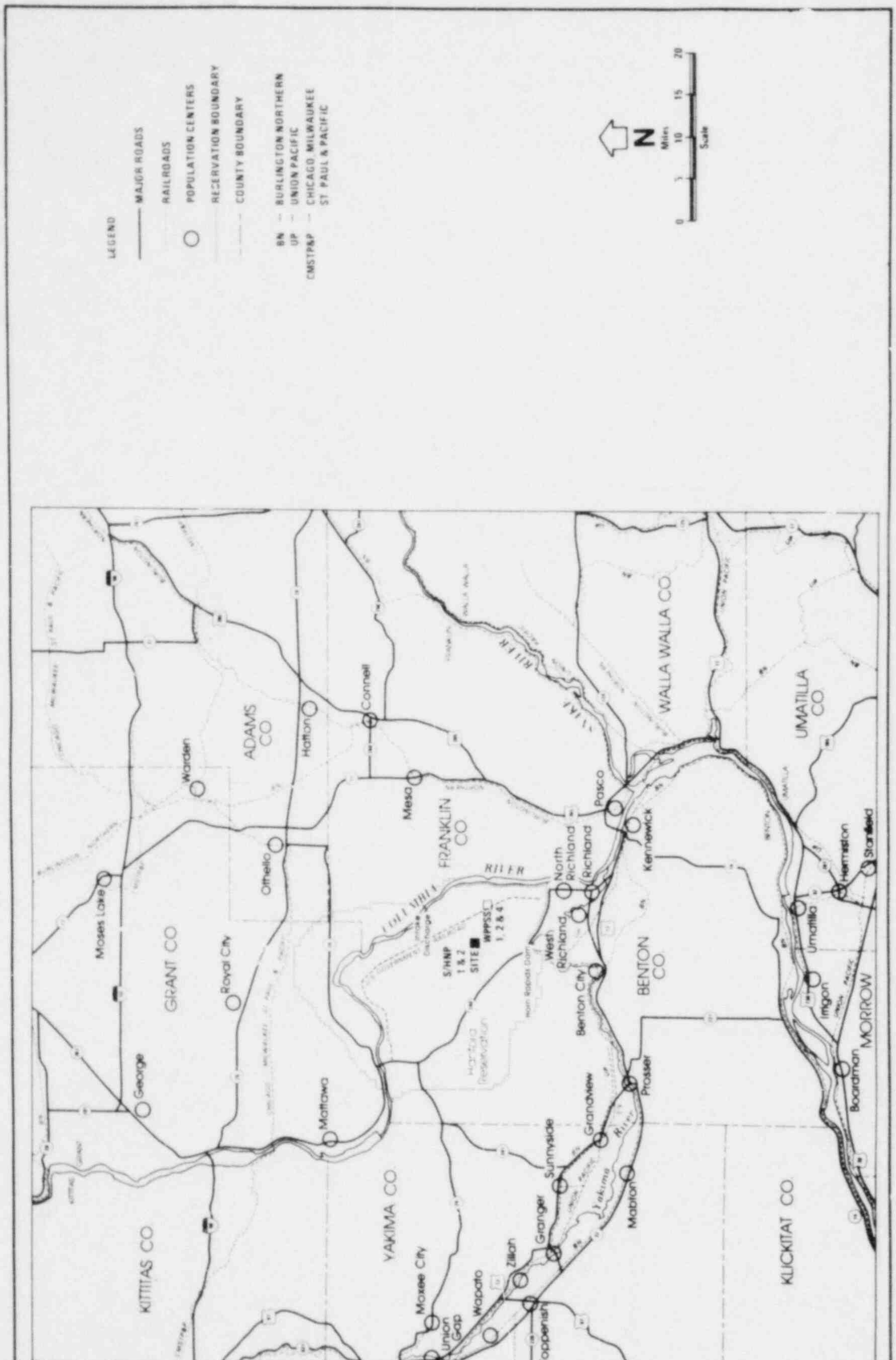


Figure 4.6 Regional map

Figure 4.6 shows the S/HNP site and its topographic features, and the location and orientation of the principal plant structures. No public roads or railroads cross the site. The S/HNP land requirements consist of the site, where the major S/HNP facilities will be located, and associated areas where supporting facilities, such as transmission lines, intake and discharge pipelines, railroad, and access roads, will be located.

The site and associated areas will require approximately 485 ha (1200 acres); for 258 ha (640 acres) of which, a title will be acquired, and for the remaining 226 ha (560 acres), easements will be obtained. Owned land will be comprised of Section 33 of Township 12 North, Range 27 East of the Willamette Meridian. The easement area will be the south half of Section 28, the west quarter of Section 34, and the west half of the southwest quarter of Section 27 of Township 12 North, Range 27 East of the Willamette Meridian.

4.2.2 Land Use

4.2.2.1 Existing Conditions

This section discusses both present and planned land uses, zoning for the proposed project site, transmission corridor alternatives, alternate railroad routes, and the surrounding area that may be affected by the proposed facility. The impact discussion includes the findings from the land use hearings held by EFSEC. Beyond the direct land use impact findings of EFSEC, secondary or growth-related impacts are discussed.

Proposed Plant Site, Water Intake and Discharge System, Transmission Line Corridor

The proposed plant site, water intake and discharge pipeline route, and transmission line corridor are presently rangeland used by wildlife. Sage and native grasses predominate the surface of the site (see Section 4.2.4.1, "Terrestial Ecology"). The site is presently owned by the Federal government, managed by the U.S. Department of Energy, and is part of the 1482-square-kilometer (570-square-mile) Hanford Reservation, which continues to be used primarily for nuclear research, power production, and waste disposal. Prior to the Federal government taking possession of the Hanford Reservation, it was used for grazing and some agricultural crop production (Benton Regional Planners Commission, 1966).

The Hanford Reservation is contained within Benton County. The Benton County Land Use Plan (August, 1966) leaves the Hanford Reservation unclassified. The land uses designated closest to it are identified for agriculture--specifically for the Columbia Basin Irrigation Project (Benton Regional Planners Commission, 1966).

Benton County has zoned the Hanford Reservation as an "Unclassified District." According to the definition, "all current and energy related uses on the Hanford site shall be permitted" (Benton County Commissioners, 1981).

The Benton County Shoreline Master Program does not designate the shoreline use for the intake or discharge pipeline. The pipelines are located on Federal property. All Federal lands are excluded from Washington State's coastal management zone and Shoreline Management Act (Washington State Department of Ecology, 1978).

The archeological and historical sites that could be affected are identified in the archeological and historical section (see Section 4.2.6.15, "Historic and Archaeological Sites and Natural Landmarks").

Project-Related Impact Area

The surrounding area adjacent to the site for several kilometers is primarily range and cropland. There is no residential population within 8 km (5 mi) of the site (S/HNP ASC/ER, 1981). The urban concentration of the Tri-Cities area is approximately 16 km (10 mi) from the site. Within a 40-km (25-mi) radius, several cities with a substantial concentration of people are located. The major cities of Richland, Kennewick, Pasco, and Yakima are within the 40-km (25-mi) radius. These surrounding cities and the counties of Benton, Franklin, Adams, and Yakima have a mix of uses including urban, residential, rural, recreation, wildlife refuge, industrial, commercial, agricultural, and unclassified use. Energy-related industry and agriculture dominate both the economy and the land use of the Tri-Cities area (NRC, Testimony of Leech et al., 1979). The presence of Hanford and irrigated agricultural land limits the direction of urban growth (NRC, Testimony of Leech et al., 1979).

The accelerated population growth in the last 10 years within the area has largely been reversed by the slow economy and the decision to terminate the construction of a WPPSS nuclear power plant on the Hanford Reservation.

There is a high unemployment and vacancy rate in the Tri-Cities area now. This is discussed in the employment, population, and housing sections (see Section 4.2.6.1, 4.2.6.2, and 4.2.6.3). The area's commercial support facilities have vacant housing and unused capacity.

4.2.2.2 Environmental Impacts

Proposed Plant Site, Water Intake and Discharge System, Transmission Line Corridor

The proposed plant site, water intake and discharge pipeline route, and transmission line corridor is all on the Hanford Reservation and is used by wildlife (Section 4.2.4), but is not developed for human use. The proposed power plant and associated facilities are consistent with the Benton County Land Use Plan and zoning ordinance. The construction of the proposed project would not directly affect residential and other sensitive areas because it is located a considerable distance from them. Light, glare, and noise associated with construction of the facilities would not be detected off the Hanford Reservation with the possible exception of some noise and traffic congestion in North Richland from construction trucks moving to and from the site.

As a result of EFSEC land use hearings held on February 17, 1982, in Richland, Washington, EFSEC found the power plant intake and discharge pipelines, and power transmission corridors associated with the project to be consistent and in compliance with the comprehensive plans and zoning ordinances.

Project-Related Impact Area

There would be no land use changes or secondary land use impacts in the surrounding cities and towns to accommodate the construction and permanent labor force with additional housing and support facilities. The S/HNP construction would employ many of those contruction workers who were laid off as a result of the termination of one of the WPPSS nuclear power plants on the Hanford Reservation. Many have remained in the Tri-Cities area. Any additional employees that might be required would find housing and commercial support services available to accommodate them in the area. There would be no need to develop support facilities as has often been the case for projects in other areas.

The staff anticipates no unavoidable adverse impacts on land use.

4.2.3 Water

4.2.3.1 Hydrology

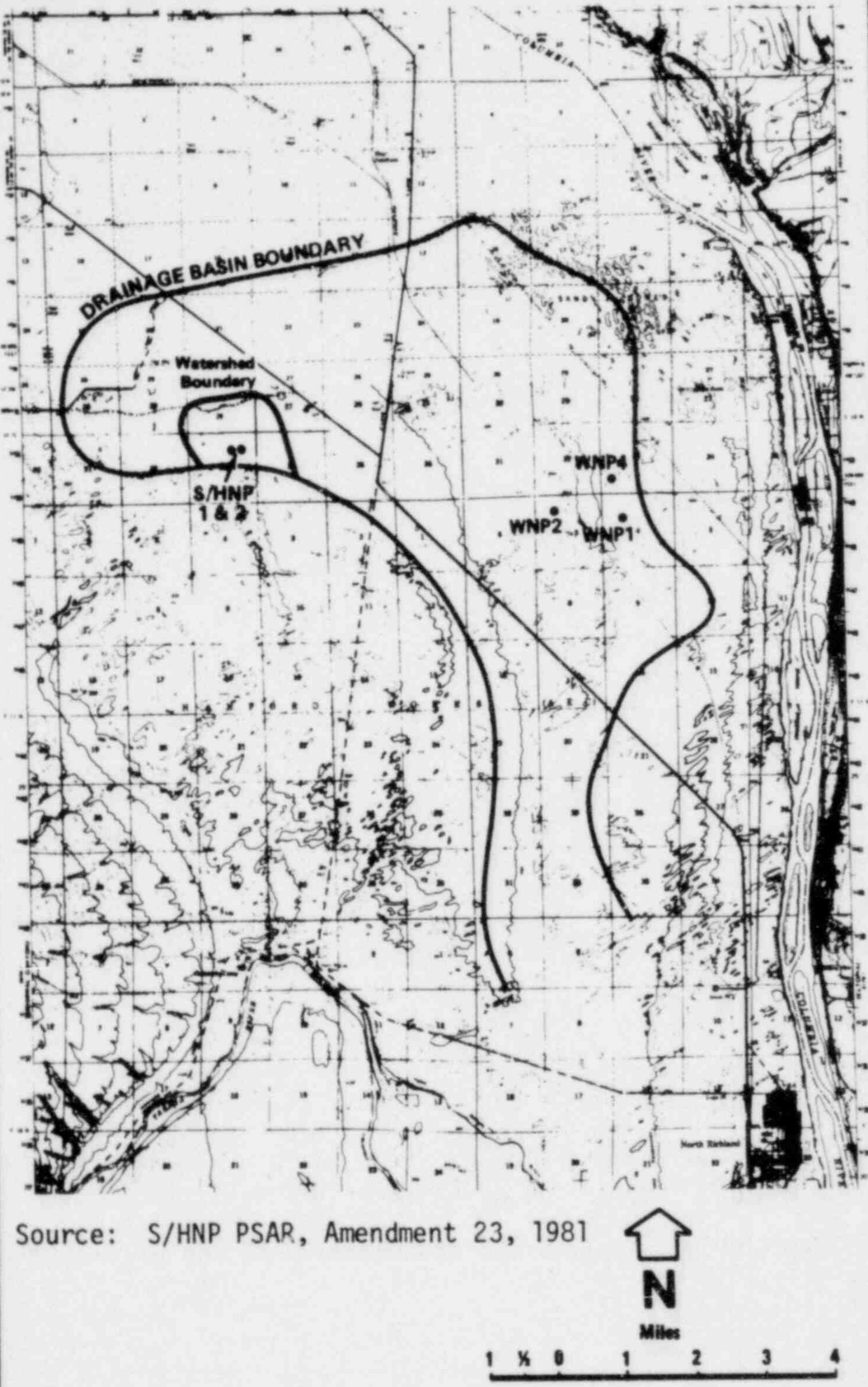
Existing Conditions

Surface Water Hydrology

The S/HNP site is located within a small watershed [485 ha (1,200 acres] that lies in a small drainage basin (Figure 4.7) that contains the WPPSS Nuclear Projects Nos. 1, 2, and 4 and drains to the Columbia River. The watershed elevation ranges from about 157 to 162 m (516 to 530 ft) at mean sea level (msl). There are no perennial streams or lakes in or near the watershed. The S/HNP site is fairly level and has no well-defined drainage channels (S/HNP PSAR, 1981).

Average annual precipitation in the region is about 15.7 cm (6.3 in.), with 37 percent occurring during November, December, and January, and 10 percent occurring during July, August, and September. The average annual runoff in this area is very low, generally less than 1.3 cm (0.5 in.) (S/HNP PSAR, 1981).

The main surface water that could be affected or influenced by the plant construction and operation is the Columbia River. The stretch of the Columbia River nearest the S/HNP site is known as the Hanford Reach. It stretches from Priest Rapids Dam (river mile 397.1) to the head of Lake Wallula (river mile 354.0). No major tributary enters between the dam and the lake. Flow variation in Hanford Reach results from the normal seasonal variation and regulation by upstream dams. Priest Rapids Dam provides an active storage of 55,508,000 m^3 (45,000 acre-ft). The minimum daily discharge at Priest Rapids Dam is administratively set at 1,019 m^3/s (36,000 cfs) by the Federal Energy Regulatory Commission (WDE, 1980). As the result of power generation by Priest Rapids Dam, daily flows during the late summer, fall, and winter can vary from a low



Source: S/HNP PSAR, Amendment 23, 1981

Figure 4.7 Local watersheds

of 1,019 m^3/s (36,000 cfs) to as much as 4,530 m^3/s (160,000 cfs) during each day. The instantaneous minimum discharge of the Columbia River at Priest Rapids was recorded to be 116.7 m^3/s (4,120 cfs) in 1936 before the construction of Priest Rapids Dam, which was built in 1956. In the last 20 years (1960 to 1979), the instantaneous minimum discharge at Priest Rapids has ranged between 801 to 1,135 m^3/s (28,300 to 40,100 cfs) (S/HNP ASC/ER, 1981).

A low-flow analysis for the Columbia River below Priest Rapids Dam using the last 20 years of record (1960-1980) shows that the lowest mean flow of 7 consecutive days with a return refrequency of 10 years (or 7 day-10 year low flow) is 1,356 m^3/s (47,899 cfs) (S/HNP ASC/ER, 1981).

The largest known flood on the Columbia River occurred on June 7, 1894. The maximum discharge was estimated at 20,950 m^3/s (740,000 cfs) below Priest Rapids Dam. The water surface elevation estimated for this flood at river mile 361.5 is 118 m (388 ft) msl, 42 m (139 ft) below the plan basement (S/HNP ASC/ER, 1981).

Groundwater Hydrology

The S/HNP site is situated in the west-central portion of the Pasco Basin hydrologic regime. The Pasco Basin is underlain by sedimentary deposits and basalt flows. The basalt bedrock consists of the Elephant Mountain Member of the Saddle Mountain Basalt Formation. The overlying permeable materials are fluvial deposits of the Ringold Formation; glaciofluvial pre-Missoula flood deposits; glaciofluvial deposits of the Missoula floods; and eolian sands, which overlie the Missoula gravels throughout much of the study region. The sedimentary units vary from a total thickness of zero at the boundaries of the Pasco Basin to about 213 m (700 ft) at the S/HNP site.

The geological formations at the S/HNP site have been divided into seven geohydrologic units according to hydrologic character and properties (Figure 4.8). The upper confining layer, the unconfined glaciofluvial aquifer, and the unsaturated zone are the only geohydrologic units on which the S/HNP facility could possibly have an impact.

The upper confining layer is composed of interbedded silts and gravel. Its thickness ranges from 0 m (0 ft) at the Pasco Basin boundaries to about 15.2 m (50 ft) at the S/HNP site. This unit appears to be in pressure communication with the overlying glaciofluvial aquifer as observed in the piezometric surface maps for the two units (S/HNP PSAR, Amendment 23). However, there is no indication of a mixing of fluids between units.

The glaciofluvial aquifer and unsaturated zone are the units that would be primarily affected by the S/HNP facility. These units are composed of fine-grained sands and gravels, the boundary between units being the water table. The glaciofluvial deposits range in thickness from a few meters at the Pasco Basin boundaries to over 122 m (400 ft), with a thickness of about 18 m (60 ft) at the S/HNP site. The unsaturated zone has a thickness of approximately 43 m (140 ft) at the S/HNP site. The unsaturated zone may be partially saturated from percolation of precipitation and from saturation by capillary pressure from unconfined aquifer fluids. However, the evaporation rate versus the annual precipitation rate for the S/HNP study region is sufficiently high to prevent recharge from rainfall.

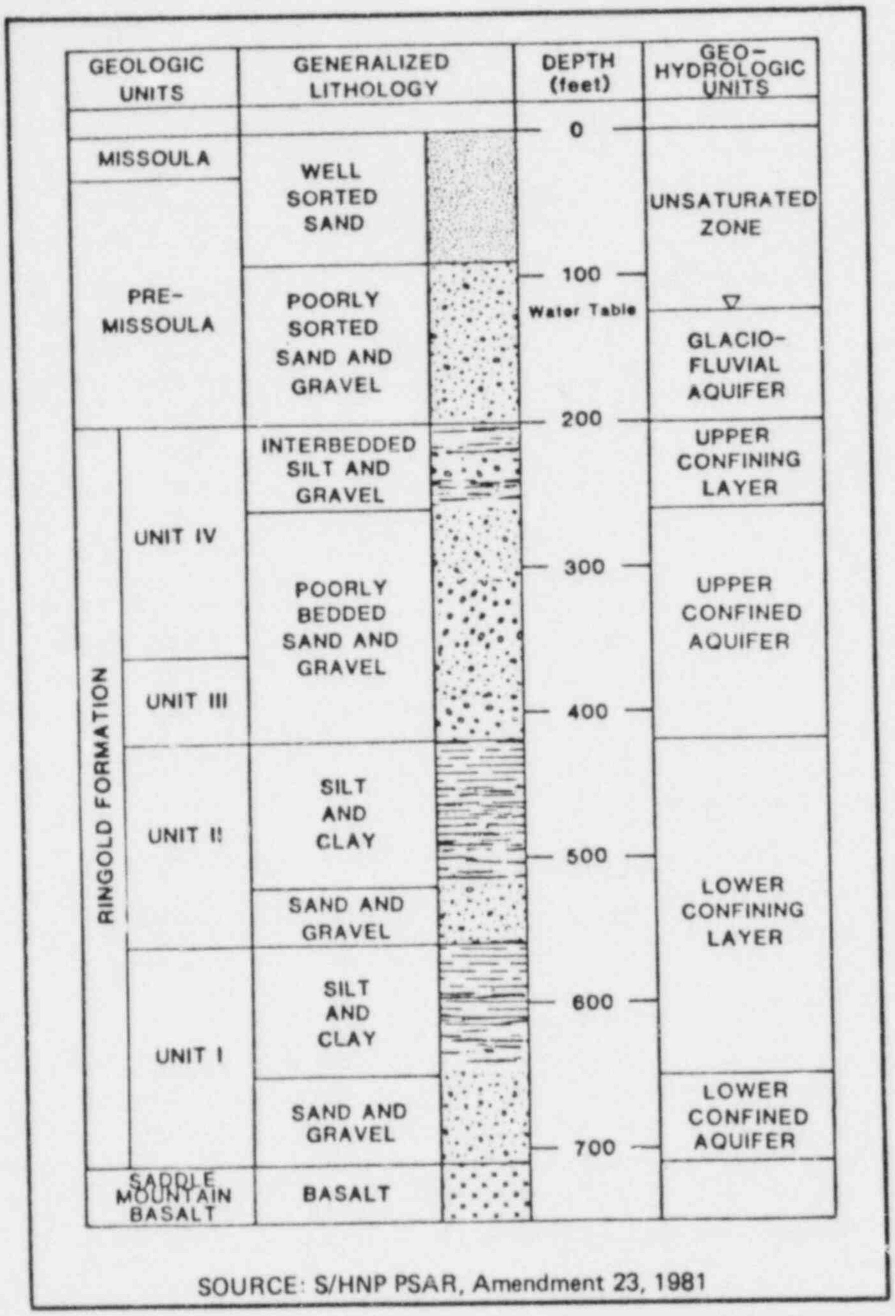


Figure 4.8 Generalized geologic and geohydrologic column

The hydraulic properties and the quality of the groundwater of the geohydraulic units were determined from studies of well tests and analyses of water samples from the numerous wells on the Hanford Reservation. The glaciofluvial aquifer generally exhibits a hydraulic conductivity between 305 and 3,050 m (1,000 and 10,000 ft) per day, whereas the hydrologic units of the Ringold Formation generally have a conductivity of 40 m (130 ft) per day that can reach the 2440 m (8,000 ft) per day observed in well 699-24-33 (S/HNP PSAR, Amendment 23). Site-specific hydrologic conductivities determined from onsite pump tests indicated 35 to 143 m (116 to 470 ft) per day for the glaciofluvial aquifer and 1.5 to 2.3 m (5.0 to 7.6 ft) per day for the unconfined aquifer. However, these results should be considered general because testing was short term; transient and partial well-penetration effects were not evaluated. The range of storage coefficient values was estimated to be 0.006 to 0.35 for the glaciofluvial aquifer for the Hanford area, but the quality of measurement is poor (S/HNP PSAR, Amendment 23).

The groundwater tables for 1944 and 1980 for the Hanford Reservation reflect the direction of groundwater flow and the effects of natural and artificial recharge and withdrawal. The water table for 1980 is illustrated in Figure 4.9. The water level elevations in the glaciofluvial aquifer at the S/HNP site range from 121.63 m (400.09 ft) msl at the northeastern edge of the site to 121.11 m (399.39 ft) msl at the southern edge. The water table at the S/HNP site in 1944 had a measured depth of 115.5 m (385 ft) msl, which is 6 m (20 ft) below the present water table, indicating the impact of artificial recharge at the Hanford Reservation.

The natural recharge to the glaciofluvial (unconfined) aquifer occurs from small stream, high flows of the Columbia and from upward leakage from lower aquifers (S/HNP PSAR, Amendment 23).

Artificial recharge and groundwater withdrawal, as they would affect the S/HNP site, occur within the glaciofluvial aquifer from waste injection operations in the 200 East and 200 West areas of the Hanford Reservation, from irrigation in Cold Creek Valley, and from withdrawal of water at the Hanford Reservation facilities.

Artificial recharge from these sources has dramatically affected groundwater at the Hanford Reservation, as is indicated by the 6-m (20-ft) rise in the water table at the S/HNP site. For example, waste disposal operations from the Purex UO_3 plant at the U Pond site have resulted in a 26-m (85 ft) rise in the water table over the last 35 years. This recharge has resulted in a regional increase in gradient from 0.75 to 0.95 m/km (4 to 5 ft/per mi) in 1944 to 1.32 to 1.52 m/km (7 to 8 ft/mi) in 1980. Directions of flow from these disposal facilities through the S/HNP site and from the site to the Columbia River have been simulated in the streamlined flow lines for the U Pond shown in Figure 2.9-35 of the applicant's PSAR (S/HNP PSAR, Amendment 23).

Minor amounts of groundwater are being produced from the wells at the fast flux test facility (FFTF) and at WNP-1, -2, and -4. These are the major production wells at the Hanford Reservation. The WNP facilities have a reported groundwater usage of 946 m^3 (250,000 gallons) per month or 22.7 lpm (6 gpm) (WNP FSAR), most of which comes from aquifer beds in the basalts. These amounts of water withdrawal will have little or no impact on the S/HNP site.

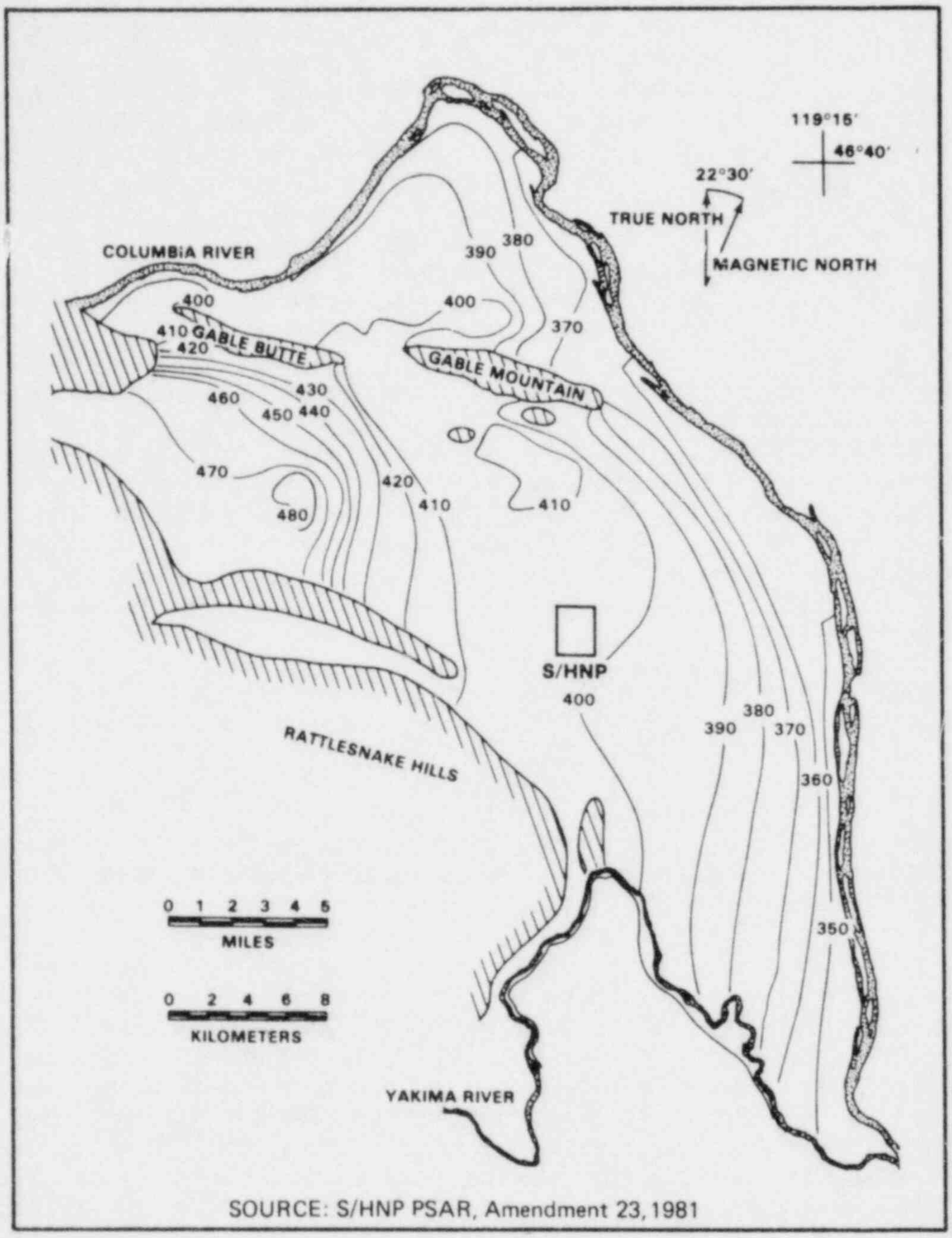


Figure 4.9 Water table map for the Hanford Reservation

Environmental Impacts

Surface Water Hydrology

A major impact of construction and operation would be the modification of the hydrologic regime in the site area. Because of construction, cleared vegetation and compacted ground would increase surface runoff substantially. Under the existing conditon, the runoff factor, a measure by the ratio of the average annual runoff [1.27 cm (0.5 in.)] over the average annual precipitation [16 cm (6.3 in.)], is 0.08. During and after the facility construction, the runoff factor for the site in general would be increased to 0.2 to 0.5, and would be higher at the S/HNP facility and access roads. This means that 20 percent to 50 percent of rainfall would run off.

Assuming that the major impact areas of 517 ha (1280 acres) (all disturbed areas excluding areas for pipelines and transmission) would have an approximate runoff factor of 0.5, the average annual precipitation of 16 cm (6.3 in.) would generate an annual runoff volume of 573,578 m^3 (465 acre-ft). This amount would have little effect on the hydrologic condition of the Columbia River. However, the peak rate of runoff at the site from a severe storm could be high enough to cause erosion.

As a result of the open and dry nature of the area and sandy granular soil type (precipitation readily infiltrates into the soil), surface drainage is potentially good. The applicant has stated (S/HNP ASC/ER, 1981) that the runoff would be controlled by grading away from the power block area and by constructing ditches if necessary. Dewatering is not expected to be a problem because the water table is below any anticipated excavation point.

Groundwater Hydrology

The only conceivable impact on groundwater that the S/HNP facility could have during construction or operation would be from an accidental release of fluids to the groundwater. However, the S/HNP facility would be situated in sediments that are more than 33.5 m (110 ft) above the water table. Moreover, the facility would not utilize groundwater at any time during its construction or operation. The accidental release of fluids is a safety-related issue and is discussed in the applicant's Preliminary Safety Analysis Report.

In the staff's judgment, no measures to mitigate impacts on surface or groundwater in the study area are necessary, and no unavoidable impacts on the surface or groundwater of the study area would result from construction or operation of the S/HNP facility.

4.2.3.2 Water Quality

Existing Conditions

Surface Water Quality

The Columbia River from Grand Coulee Dam to its mouth, which includes the Hanford Reach, is classified by the State of Washington as Class A WAC 173-201 ("Water Quality Planning"). Present and potential water uses and established water quality criteria of this class are specified by WAC 173-201 ("Water Quality Planning") and include a special temperature condition for this reach.

Water quality observed in this reach (WAC 173-201) from 1957 to 1979 generally meets State water quality standards. Temperature standards are exceeded during the late summer due to natural conditions, impoundment, thermal wastes discharges, irrigation return flows, and other causes (S/HNP ASC/ER, 1981).

Groundwater Quality

Waste disposal operations have resulted in the contamination of the glacio-fluvial aquifer with nitric oxide, beta particles (RU_{106}), and tritium. The areal distribution of the concentrations of these contaminants would continue to be monitored. Because the project is not expected to affect the groundwater near the site, further analysis and water quality characteristics are not discussed.

Environmental Impacts

Surface Water Quality

Federal Effluent Guidelines--Federal effluent limitations for "New Sources" (40 CFR 423) limit the discharge of total suspended solids, oil and grease, pH, polychlorinated biphenyls, chlorine, and corrosion inhibitors, as well as heat.

Washington State has received approval from the Environmental Protection Agency to administer the National Pollutant Discharge Elimination System (NPDES) Permit Program (WAC 173-220). In the case of steam electric power plants, the Washington State Energy Facility Site Evaluation Council (EFSEC) has been designated as the NPDES permitting agency.

Washington State Water Quality Standards (WAC 173-201)--The Washington State Department of Ecology has established water quality standards for receiving waters based on designated use. The WDE has designated waters of the Columbia River between Priest Rapids Dam (river mile 397) and the Washington-Oregon border (river mile 309) as Class A, Excellent, waters. The following special temperature condition has been established for this section of the river.

Water temperature shall not exceed 20.0°C due to human activities. When natural conditions exceed 20.0°C, no temperature increase will be allowed which will raise the receiving water temperature by greater than 0.3°C, nor shall such temperature increases, at any time, exceed:

$$t = \frac{34}{(T + 9)}$$

where:

t = permissive temperature change across the dilution zone (°C).

T = highest existing temperature in this water classification outside any dilution zone (°C).

These standards are applicable in receiving waters except within immediate dilution zones surrounding a wastewater discharge. The total area of a dilution zone is calculated on a case-by-case basis and is described in an NPDES discharge permit. The dilution zone is anticipated to be similar in dimension to those granted WNP-1, -2 and -4 (WAC 173-201):

(1) The boundaries in the vertical plane would extend from the receiving water surface to the riverbed.

(2) The upstream and downstream boundaries would be 15.2 and 91.4 m (50 and 300 ft), respectively, from the centerline of the discharge.

(3) The lateral boundaries would be separated by 30.5 m (100 ft).

The discharge of wastewaters from the S/HNP is not expected to affect the water quality of the Columbia River.

Effects of Thermal Wastes

The applicant has conducted plume dispersion analysis for S/HNP for a combination of conditions that are considered representative of worst-case and average situations (S/HNP ASC/ER, 1981). The three cases that were analyzed are given in the following:

- Case 1 - Regulatory Limiting Case

  This case would occur with a combination of extreme discharge temperature and flow [22,370 lpm (5,910 gpm)], regulated extreme low river flow, and ambient river temperature resulting in the most restrictive regulatory criterion.

- Case 2 - Average Case

  This case would occur with a combination of the average temperature and flow, discharged into the average water temperature and median river flow.

- Case 3 - Large Excess Temperature Case

  This case would occur with a combination of average discharge temperature and flow, discharged into average river ambient temperature in the winter and regulated extreme low river flow.

Table 4.7 gives the S/HNP discharge and river parameters, and regulatory limits corresponding to the three cases.

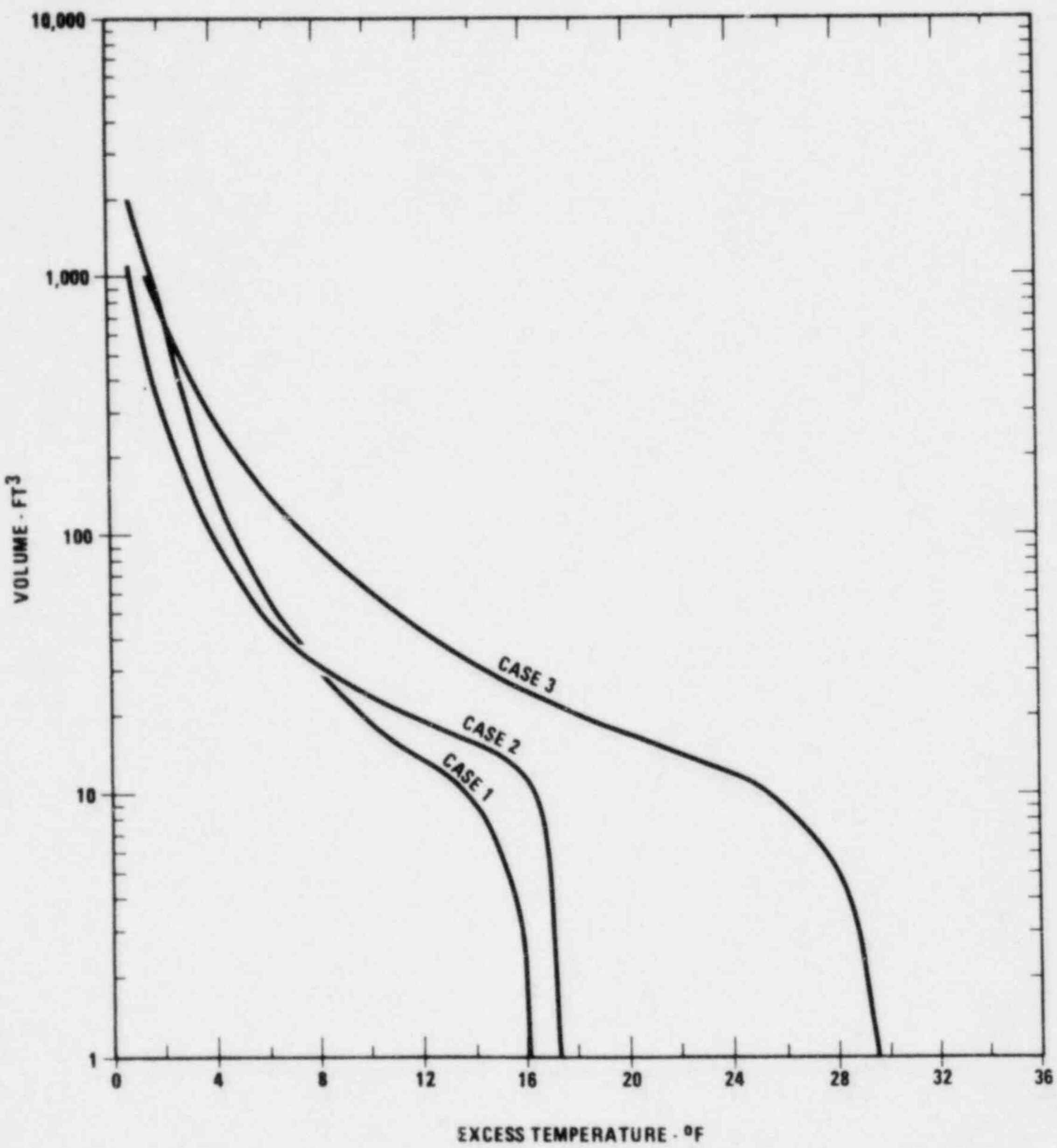
Results of the analysis are shown in Figures 4.10, 4.11, and 4.12, which illustrate the downstream penetration, surface area, and volume of the plume as a function of excess temperature for the three cases.

Table 4.7 Chemical concentrations in the project discharge before and after dilution compared with ambient levels

Chemical Constituent	Units of Measure	End of Pipe Conditions: Columbia River[a] Ambient Conditions Avg	Max	End of Pipe Conditions: Combined Project Effluent Concentrations[b] Avg	Max	Receiving Water Conditions: Concentrations[c] at Edge of Dilution Zone Avg	Max	Washington State WQ Standards for Class A waters	US Environmental Protection Agency WQ Criteria 24-hr Avg	Max
Calcium, as Ca	mg/l	19.7	24.0	196.2	309.4	20.0	25.5			
Magnesium as Mg	mg/l	4.3	5.7	42.8	73.4	4.37	6.1			
Sodium, as Na	mg/l	2.3	3.1	31.3	116.6[d]	2.35	3.7			
Potassium, as K	mg/l	0.8	1.1	7.7	13.9	0.8	1.17			
Bicarbonate, as HCO_3	mg/l	67.5	82.0	16.9	14.6[e]	67.4	81.6			
Sulfate, as SO_4	mg/l	12.8	19.0	659.0	1,088.5[e]	14.0	24.6	250.01[f]	-	250.0[g]
Chloride, as Cl	mg/l	1.5	5.4	23.2	179.1[f]	1.53	6.3	250.01[f]	-	250.0[g]
Silica, as SiO_2	mg/l	4.8	6.6	47.8	85.3	4.88	7.0			
Total alkalinity, as $CaCO_3$	mg/l	55.3	67.0	13.8	12.1[g]	55.2	66.7			20.0[g]
Hardness, as $CaCO_3$	mg/l	66.9	82.0	666.0	1,076.0	68.0	87.2			
Non-carbonate hardness, as $CaCO_3$	mg/l	11.4	22.0	--	--	--	--			
Specific conductance	umho/cm	135.0	170.0	1,382.0	2,498.0	137.3	182.3			
pH	Units	--	8.8	6.5-8.5	6.5-8.5	--	8.8	6.5-8.5	-	6.5-9.0[g]
Dissolved solids	mg/l	81.5	109.0	834.0	1,602.0	82.87	116.9	-	1,000.0[g]	
Color	(Pt-Co Units)	10.0	15.0	--	--	--	--			
Suspended solids	mg/l	3.7	24.0	36.9	309.7[h]	3.76	25.8			
Turbidity	NTU	1.7	4.9	--	--	--	--	5.0 over background		
Fecal coliform	#/100 ml	2.0	13.0	--	--	--	--	100		200.0[g]
Dissolved oxygen	mg/l	11.9	15.8	8.52[i]	7.74-9.6[j]	11.9	15.8	8.0	5.0	
Total cadmium, as Cd	ug/l	1.3	3.0	12.9	38.4	1.32	3.19		0.016	2.5
Total chromium, as Cr	ug/l	3.0	20.0	29.9	257.4	3.05	21.2		-	100.0[g]
Total copper, as Cu	ug/l	10.3	28.0	102.6	360.4	10.5	29.7	1,000.0[f]	5.6	18.4
Total iron, as Fe	ug/l	117.3	290.0	1,165.3	3,735.0	118.9	308.1		-	300.0[g]
Total lead, as Pb	ug/l	16.9	73.0	168.3	939.7	17.2	77.6		1.49	135.0
Total mercury, as Hg	ug/l	0.17	1.0	1.69	12.87	0.177	1.06		0.00057	0.0017
Total zinc, as Zn	ug/l	38.2	90.0	380.5	1,159.2	38.8	95.6	5,000.0[f]	47.0	272.6
Ammonia nitrogen, as N	mg/l	0.01	0.1	.996	0.9	0.10	0.07			0.5[g]
Nitrate nitrogen, as N	mg/l	0.01	0.14	0.099	1.8	0.01	0.15	10.0[f]	-	10.0[g]
Ortho-phosphate, as P	mg/l	0.01	0.04	0.099	0.51	0.01	0.04		-	0.1[g]
Total phosphorus, as P	mg/l	0.03	0.11	0.299	1.42	0.03	0.12			
Total residual chlorine	mg/l	0.0	0.0	0.2	0.38	0.003	0.002		-	0.002[g]
Oil and grease	mg/l	0.0	0.0	--	--					

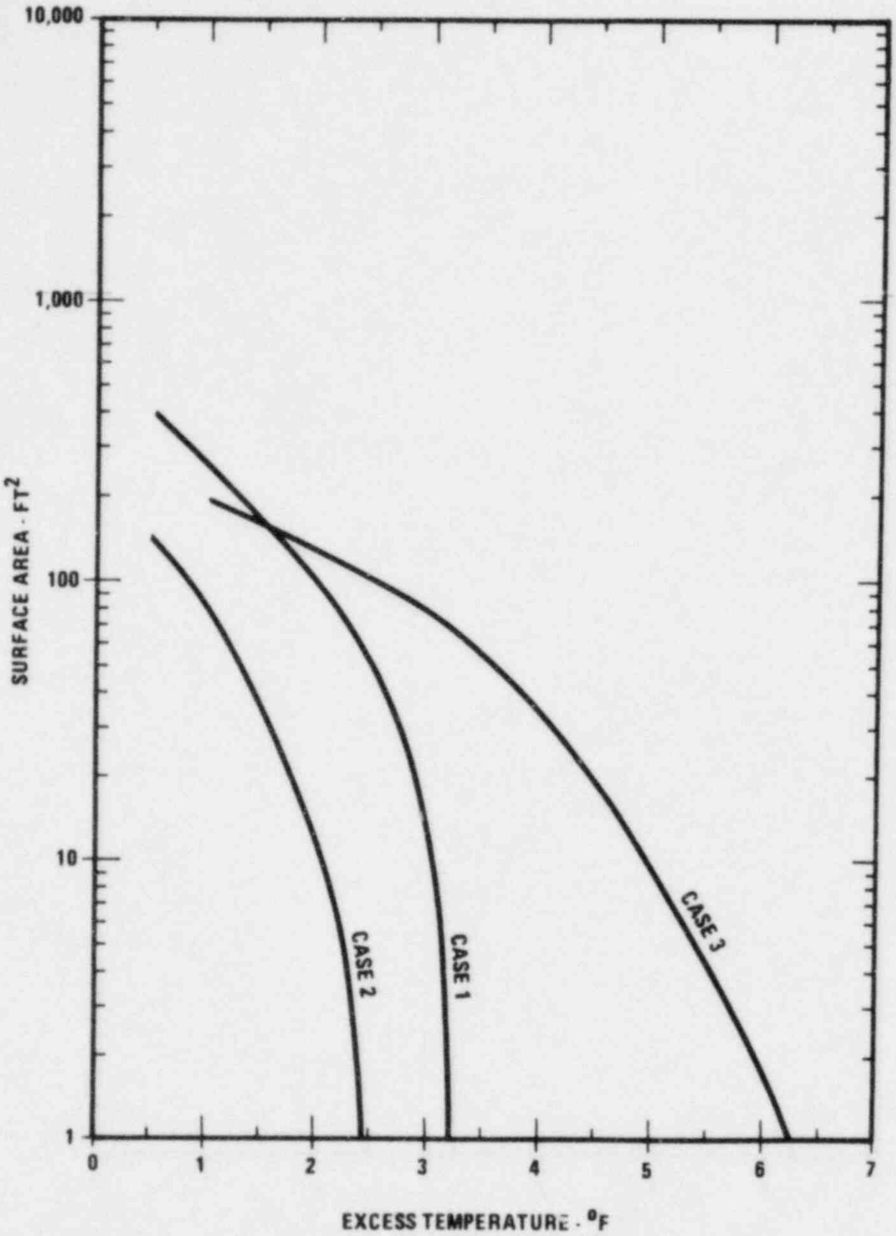
NOTES:
(a) Concentrations of Columbia River water are developed from USGS data, October 1977 to October 1980, for Vernita Bridge near Priest Rapids Dam, Washington.
(b) Effluent concentrations developed by Bechtel, Inc. (see ER Section 3.6).
(d) At a point 300 ft downstream of the discharge (edge of the mixing zone).
(e) Includes increase in sodium and chloride due to addition of sodium hypochlorite.
(f) Addition of sulfuric acid increases sulfate and reduces bicarbonate and alkalinity.
(g) Washington State Department of Social and Health Services, Board of Health regarding public water supply, Heath Service Division.
(h) Values from the U.S. EPA "Red Book", 1977.
(i) Does not include airborne dust and suspended solids settled in the cooling tower basin.
(j) Dissolved oxygen figure based on 68.9°F time weighted average blowdown water temperature.
(k) Dissolved oxygen figures based on 84.5°F and 59.4°F, corresponding to maximum and minimum blowdown water temperatures.

Sources: S/HNP ASC/ER, 1981; WAC 173-201-045.



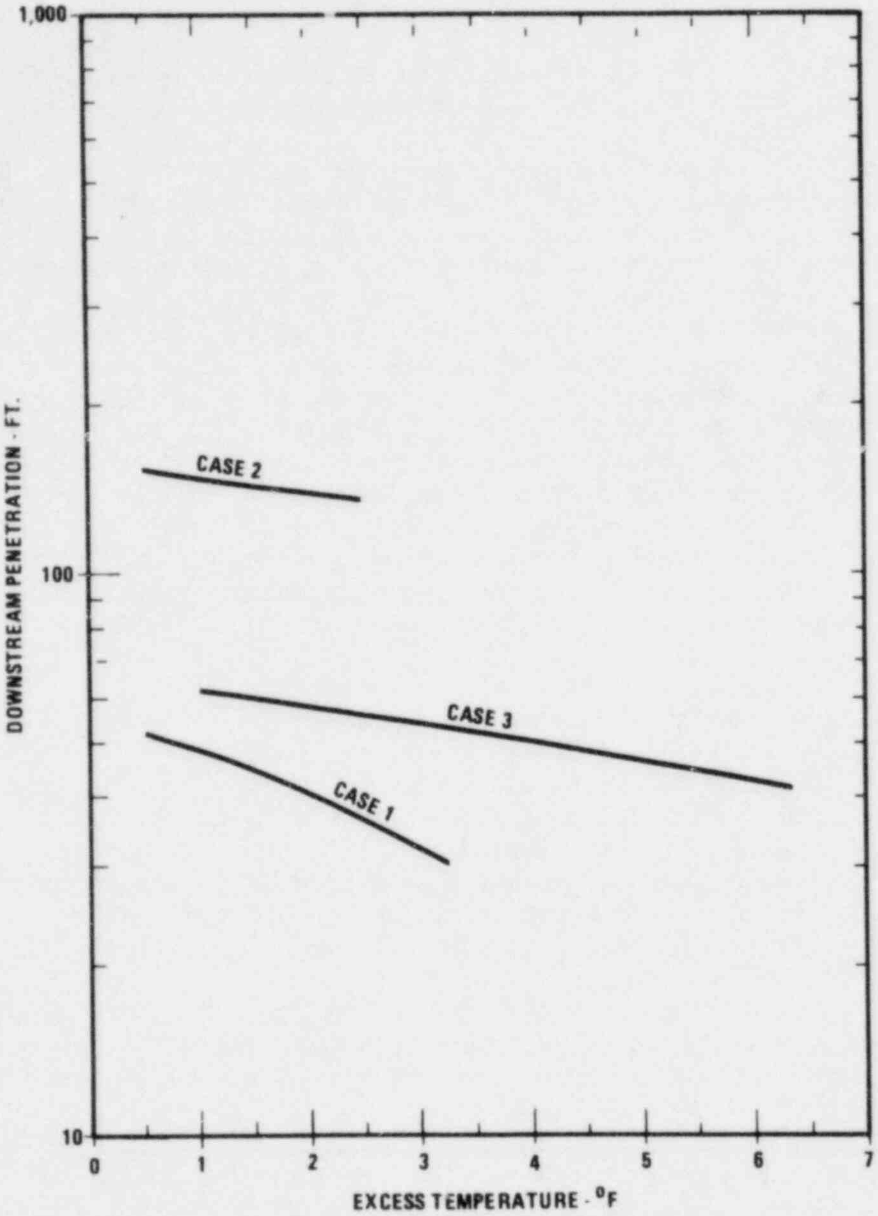
SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.10 Volume vs. excess temperature



SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.11 Surface areas vs. excess temperature



SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.12 Downstream surface penetration vs. excess temperature

Under the worst-case condition, Casc 1, the temperature increase 91.4 m (300 ft) downstream of the discharge is estimated to be 0.05°C (0.09°F), well below the 0.3°C (0.54 °F) limit specified by the water quality standards.

Effects of the Intake/Discharge System

The primary effects of S/HNP construction on aquatic resources would be associated with construction of the intake and discharge systems at river mile 361.5.

A clamshell bucket or similar equipment would be used for trenching and placing, and bedding and anchoring the pipelines with riprap. Approximately 49,700 cubic meters (65,000 cubic yards) would be excavated below the high waterline. No coffer dams or channel improvements are planned during construction.

Increases in suspended and settleable materials from excavation and backfill activities may affect water quality in several ways. Materials carried in suspension may create turbid waters with a subsequent reduction in light penetration. Microbial decomposition of organic materials associated with suspended sediments could impose a short-term oxygen demand and thereby decrease dissolved oxygen levels downstream. However, organic content of Hanford Reach bottom sediment is low. The material is mostly mineral, and any increased oxygen demand resulting from suspended sediments would be minimal. Suspended materials may also release or absorb dissolved substances affecting pH, nutrients, trace metals, and pesticide concentrations in the water (S/HNP ASC/ER, 1981).

The applicant stated that the past excavation operations in the Hanford Reach indicated that elevated levels of suspended solid concentrations were infrequently observed 152 m (500 ft) downstream from the construction site during excavation. Deposition of settleable material reduced numbers of periphyton and macroinvertebrates for about 152 m (500 ft) downstream; however, there were no observable effects on these organisms 610 m (2,000 ft) downstream from construction. The impacts were expected to be transient and the affected area represented approximately 13 percent of the river cross section.

Since the nearest known salmon spawning areas are located approximately 4.8 km (3 mi) upstream and 8 km (5 mi) downstream from the intake/discharge structure, no siltation or oxygen effects on spawning grounds are expected from construction.

The raw water pumphouse construction is at an on-shore location and would not adversely affect river conditions. The riverbank at river mile 361.5 is considered stable and slope protection requirements are not anticipated by the applicant.

During excavation, a dewatering system would discharge water into a nearby filtration pond. The local groundwater elevation would be temporarily lowered during dewatering operations. No groundwater users are within the proposed zone of influence. The pumphouse operating floor would be above the Standard Regulated Project Flood elevation.

The plume modeling analysis indicates that no intake-discharge recirculation would occur as a result of wastewater discharge by S/HNP (S/HNP ASC/ER, 1981).

The ratio of the designed discharge velocity to the river velocity would be relatively low for the S/HNP. The river dominates the flow regime and no impact from the discharge could be expected on such velocity-induced phenomena as turbidity, scouring, erosion, or sedimentation.

Effects of Chemical and Biocide Discharge

The S/HNP wastewater discharge would contain constituents originally present in the river water, as well as chemicals and biocides added for normal plant operation and other treated wastes generated during operation.

The S/HNP would discharge a maximum of 22,372 lpm (13.2 cfs) of water to the Columbia River. Of this amount, approximately 99 percent would consist of cooling tower blowdown. The remaining 1 percent would be low-volume treatment wastes from demineralizer regenerant wastes, pretreatment wastes, filter backwash, and plant facility floor drainages.

A comparison between Washington State Water Quality Standards (WAC 173-201) for Class A, Excellent, waters and the chemical concentrations at the mixing zone boundary indicates that all regulated parameters are in compliance. A similar comparison of Columbia River water quality at the mixing zone boundary with the U.S. Environmental Protection Agency's Water Quality Criteria (1976) indicates that all regulated parameters are less than the Federal criteria, with the exception of certain trace metals: cadmium, copper, iron, lead, and mercury.

Ambient values for these metals in the Columbia River, upstream of the S/HNP intake, occasionally exceed Federal criteria. Trace metals would not be introduced from plant operation or from corrosion products of the stainless steel condenser tubes. However, the metals originally present in the river would be concentrated tenfold, on the average, in recirculated cooling water prior to being returned to the Columbia River. Following worst-case dilution [river flow of 102 m^3/s (3,600 cfs)] on the order of 1,660:1 at the edge of the mixing zone, metal concentrations are estimated to be nearly equivalent to ambient levels.

Sodium hypochlorite (NaOCl) is the preferred biocide for treatment of the cooling towers. The receiving water criterion for total residual chlorine (TRC) is 0.002 mg/liter, as specified by the U.S. Environmental Protection Agency (1976). Assuming worst-case conditions, the total residual chlorine level in the S/HNP discharge would be reduced in the Columbia River to within the Federal criterion level [91 m (300 ft) downstream from the discharge)]. The dissolved solids concentration in the S/HNP discharge would be higher than ambient concentrations in the river as a result of:

(1) Concentration in the cooling tower.

(2) Sulfuric acid and sodium hypochlorite addition in the circulating water system.

(3) Regenerant chemicals (sulfuric acid and sodium hydroxide solution) used in ion exchange regeneration.

Most of the dissolved solids concentrations in the S/HNP discharge would be expected to be greater than the ambient river water by a factor of about ten, except for sodium, bicarbonate, sulfate, and chloride. Bicarbonate concentrations in the S/HNP discharge would be less than ambient river water due to the depletion of bicarbonate through the addition of sulfuric acid. The maximum sodium, sulfate and chloride concentrations in the S/HNP discharge would be expected to be greater than ambient water by factors of 38, 57, and 33, respectively. The incremental increases in sodium, sulfate, and chloride concentrations in the river at the edge of the mixing zone would not be expected to cause detrimental effects to aquatic biota. Increases in any of the dissolved solid concentrations would not be expected to cause long-term buildup in the sediments or in the biota. The maximum concentration of total dissolved solids (TDS) in the S/HNP discharge (1,602 mg/l) would require dilution on the order of only 3.8:1 to comply with the receiving water TDS criterion (500 mg/l) established by Washington State Department of Social and Health Services.

In view of the negligible increases in chemical constituents near the discharge location, as described in this section, the impact of chemical or biocide discharges to downstream domestic or agricultural water supplies would be negligible.

Effect of Sanitary Wastes

No sanitary wastes would be discharged to the surface water. The sanitary wastes would be treated by a secondary treatment and the effluent would be discharged into a percolation pond. Water discharged into the pond would penetrate to the water table within a period of 1 to 2 months. The only wells that exist within approximately 8 km (5 mi) of the S/HNP site are used only for sampling an aquifer that is not connected to the site; therefore, the percolation pond would not affect any wells. Percolation tests would be conducted prior to construction and their results incorporated in the final percolation pond design. If there is a problem of water penetration reaching the aquifer, then the percolation pond should be lined to prevent this problem.

Mitigating Measures

The applicant has committed to implement the following mitigating measures:

(1) Percolation tests would be conducted prior to construction and their results incorporated in the final percolation pond design.

(2) Surface runoff would be controlled by grading away from the power plant area and by constructing ditches, if necessary (S/HNP ASC/ER, Section 4.1-11, 1981).

(3) During construction, contractors would be required to maintain drainage and erosion control around the construction areas, especially in areas of excavation or fill. Controls would be employed to ensure proper embankment slopes. Onsite borrow pits would be prepared by grading to minimize wind and water erosion and to conform, where possible, with the natural topography (S/HNP ASC/ER, Section 4.5-1, 1981).

(4) To ensure that no residual chlorine would be discharged to the Columbia River, cooling tower blowdown would be terminated during the addition of sodium hypochlorite if the circulating water has dropped to less than 0.38 mg/l. (This concentration and a minimum dilution ratio 190:1 would meet the Federal water quality criteria.) Chlorination of the two units would not occur simultaneously (S/HNP ASC/FR, Section 3.6-6, 1981).

In the staff's judgment, the following additional mitigating measures are required:

(1) The emergency overflows from the percolation pond should be contained.

(2) Drainage courses downstream from the plant should be defined and protected from potential erosions.

(3) A plan should be developed to control the chemical leakages, and accidental or emergency spills.

Unavoidable Adverse Impacts

(1) Temporary increases in erosion and sediment transport due to construction activities would temporarily degrade the local receiving water quality.

(2) Alteration of drainage, percolation, and runoff patterns would result from project construction.

(3) 1.58 to 2.12 m^3/s (56 to 75 cfs) of water would be taken from the Columbia River at river mile 361.5 and not returned.

4.2.3.3 Water Use and Water Rights

Existing Conditions

Water Use

The most suitable source of water for the S/HNP is the Columbia River. The other potential sources are the Yakima River and groundwater. The Yakima River water has low quality and limited water availability. Groundwater is not a suitable source because the quality of water required for plant use, even with reinjection of plant discharge, would have a significant effect on the water movements in the aquifer (see Section 3.3.2).

The primary uses of Columbia River water for 80 km (50 mi) downstream of the S/HNP intake and discharge location are irrigation and the municipal water supplies for the cities of Richland, Pasco, and Kennewick.

Water Rights

Rights for surface water and rights for groundwater were considered to be part of the land and therefore real property. These rights were not registered with the State. The 1917 Washington State Water Code was enacted to require surface waters to be appropriated by obtaining a permit from the State, currently the Washington State Department of Ecology (WDE). Groundwater was included in the requirements in 1945.

Currently, to obtain water rights in the State of Washington, the prospective water appropriator must apply to the WDE for a permit. The application is made public and the WDE investigates the availability of the requested water. If a sufficient quantity of the resource (surface or groundwater) is unappropriated, the WDE will grant the water right and issue a permit. EFSEC also has the authority to allow water withdrawal for projects under its license jurisdiction.

The acquisition of water rights can be obtained for diversion and beneficial use of the resource. There are two general categories of water use. Water diverted and put to beneficial use but not returned to the water resource is classified as a consumptive use. Water used for cooling of a thermal power plant would fall into this category since it is lost by evaporation and not returned to the resource to be available to other users. Nonconsumptive uses include hydroelectric projects in which the volume of water is affected minimally.

The Washington legislature passed the Water Rights Registration Act in 1969. The Act required all water rights to be registered with the Department of Water Resources or the WDE unless the water right had been obtained from an authorized state agency previously. Failure to register by June 1974 would result in forfeiture of a water right. However, because of possible legal problems with the forfeiture clause, a 1979 statute was enacted to allow unregistered water rights, or those without a previously issued State permit, to be registered. Water rights eligible to be registered under the 1979 statute may not be on public record as of this date.

There may be additional water rights that are not on public record. According to the "Winters Doctrine" (Hutchins, 1977) or the "implied-reservation-of-water doctrine, Federal lands, projects, and reservations have reserved water rights that are usually not on public record. The water rights of the Yakima tribes fall into this category. The Winters Doctrine, derived from Federal case law, provides that, at the time of establishment of Federal reservation (such as an Indian reservation), rights to available waters sufficient to achieve the purposes of the Federal reservation are implicitly reserved.

The WDE adopted minimum flow regulations in June 1980. The associated statutes provide that water rights in existence when minimum flow regulations were adopted may not be affected by these regulations. However, water rights obtained after the enactment of the minimum flow regulations are subject to those regulations.

The applicant (S/HNP ASC/ER, 1981) reports that surface water and groundwater permits [within 0.8 km (1/2 mi) of the Columbia River] totaling 35.8 m^3/s (1,266 cfs) and 5.2 m^3/s (183 cfs), respectively, were issued by WDE in the Hanford Reach. Permit applications, pending on May 18, 1981, for surface and groundwater use, are totaling 7.56 m^3/s and 0.28 m^3/s (267 cfs and 10 cfs), respectively.

There were 24 surface-water rights claims and 580 groundwater rights claims recorded before 1974 (S/HNP ASC/ER, 1981). Individual or total withdrawal rates on these claims are not available. Because most of these claims pertain to irrigation uses, minimum water rights can be calculated using 1.39 lps per hectare (0.02 cfs per acre) of irrigation, which is assumed by WDE.

The State of Washington generally follows the doctrine of prior appropriation --first in time is first in right. All appropriators of water in the State, including Federal government, are required to comply with Washington's water law.

Environmental Impacts

Water Use

For use in the construction and operation of S/HNP, water would be withdrawn up to 2.8 m^3/s (100 cfs) continuously from the Columbia River in the vicinity of the river mile 361.5. The amount of water represented by 2.83 m^3/s (100 cfs) (0.3 percent of the minimum river flow) of water requested is physically available for continuous withdrawal from the Columbia River. From the data presented, the requested withdrawal is about 7 percent of all the water permits issued by WDE in the Hanford Reach.

Water Rights

Washington State's Water Rights Registration Act of 1969 required all water rights to be registered. Failure to register by June 1974 would result in forfeiture of a water right. The total withdrawal rate of those claims recorded before 1974 are not available, but, assuming all claims are for irrigation use and using 1.39 lps per hectare (0.02 cfs per acre), which is an estimate used by WDE, it is estimated that the total claim should be much less than 28.3 m^3/s (1,000 cfs). Based on the published records of water permits and rights, the requested water use would not compete with other consumptive water uses.

The water right authorization sought by the applicant, however, would pose two legal problems: (1) there may be additional water rights that are not public record (e.g. according to the Winters Doctrine, Federal lands, projects, and reservations have reserved water rights usually not of public record); and (2) the adopted WDE's minimum flow regulation (Washington State, Department of Ecology, 1980) could preclude or limit the continuous withdrawal by S/HNP during a period of low flow. However, the latter could be resolved by EFSEC because it has the authority to preempt State permit authority and thus the minimum flow regulation in licensing energy facilities. EFSEC can authorize a water withdrawal for the project.

The consumptive use of water from S/HNP would displace the nonconsumptive use of water for power generation. The applicant (S/HNP ASC/ER, 1981) estimates that the amount of water that would be used at S/HNP would allow the generation of 2,000 times as much power as the same water would generate at McNary, John Day, The Dalles, and Bonneville dams. The projected S/HNP water use per kilowatt is small relative to hydroelectric generation, and, consequently, a beneficial use (S/HNP ASC/ER, 1981). The other downstream water uses are for parks and recreation areas along the Columbia River and for boating by small pleasure craft/sport fishing boats.

In the staff's judgment, no measures to mitigate water use or water rights as in the study area are necessary.

Unavoidable Adverse Impacts

Water would be consumed from the Columbia River at river mile 361.5 at a rate of 1.58 to 2.12 m^3/s (56 to 75 cfs). This consumptive loss would preclude the use of the water downstream.

4.2.4 Ecology

4.2.4.1 Aquatic Ecology

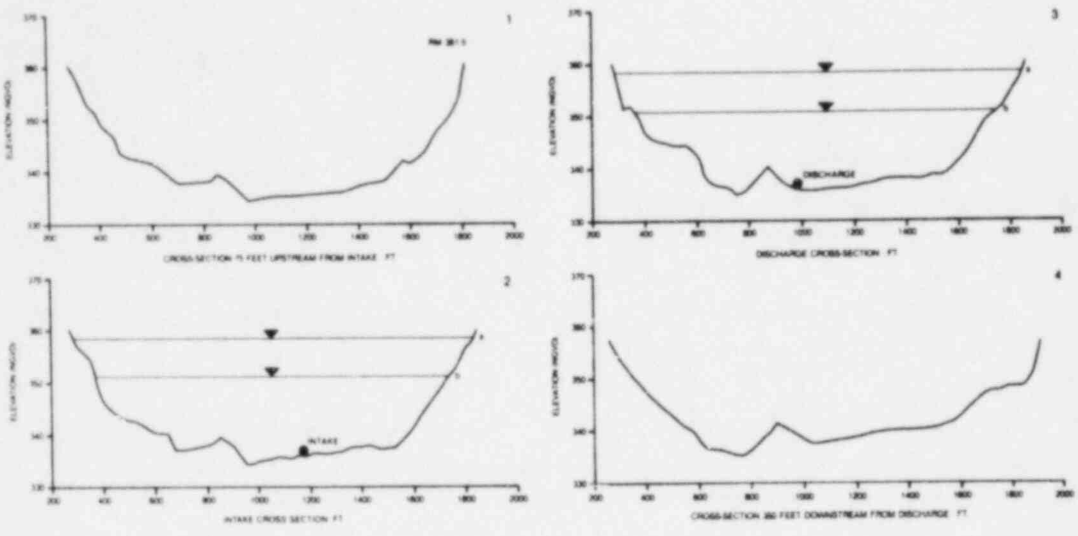
Existing Conditions

Site and Vicinity

Makeup water would be withdrawn from the Columbia River and heated blowdown and low-volume waste treatment effluent water would be discharged into the Columbia River at approximately river m' e 361.5. Cross sections of the Columbia River channel at various points in the vicinity of the proposed intake and discharge locations are shown in Figure 4.13. Contour maps of the river channel from 0.40 km (0.25 mi) upstream to 0.80 km (0.5 mi) downstream and in the immediate vicinity of the proposed intake and discharge locations are shown in Figure 4.14. The channel in this portion of the uniquely free-flowing Hanford Reach of the Columbia is about 488 m (1,600 ft) wide and relatively straight from a point about 0.80 km (0.5 mi) upstream to a point about 4.0 (2.5 mi) downstream. Maximum depth is about 4.6 m (15 ft) at the administratively established minimum discharge of 1,019 m^3/s (36,000) cfs and about 6.7 m (22 ft) at the 50 percent exceedance flow of 3,278 m^3/s (115,752 cfs). Flows are generally turbulent, and the river is well mixed throughout the free-flowing reach. Midstream surface velocities range from about 2.3 fps at the minimum discharge [1,019 m^3/s (36,000 cfs)] to more than 2.13 mps (7 fps) during periods of high discharge (S/HNP ASC/ER, 1981). A contour map at river mile 361.5 is shown in Figure 4.15.

Substrate texture in the vicinity of the proposed intake and discharge structures ranges from an unsorted, relatively compacted cobble-gravel-sand (Battelle Pacific Northwest Laboratories, 1982) to unconsolidated 5- to 12.7-cm (2- to 5-in.)-diameter gravels along the southwest shoreline (as noted during a site visit, by J.W. Buell in February 1982). Some larger boulders are present in the main channel. There are no pools or other quiet areas in this portion of the river and therefore no aggregation of rooted macrophytes. Because of the frequently changing river surface elevation, no riparian vegetation cover has become established. Instream cover is restricted to the presence of some large boulders in the main channel.

Hanford Slough, the mouth of which is about 0.80 km (0.5 mi) upstream of the proposed structures, is a quiet backwater area open to the river at its downstream end that receives flow at its upstream end from the main channel only during periods of high river discharge. It supports some macrophyte aggregations and has a much finer substrate texture than the main channel. Riparian vegetation cover is sparse.



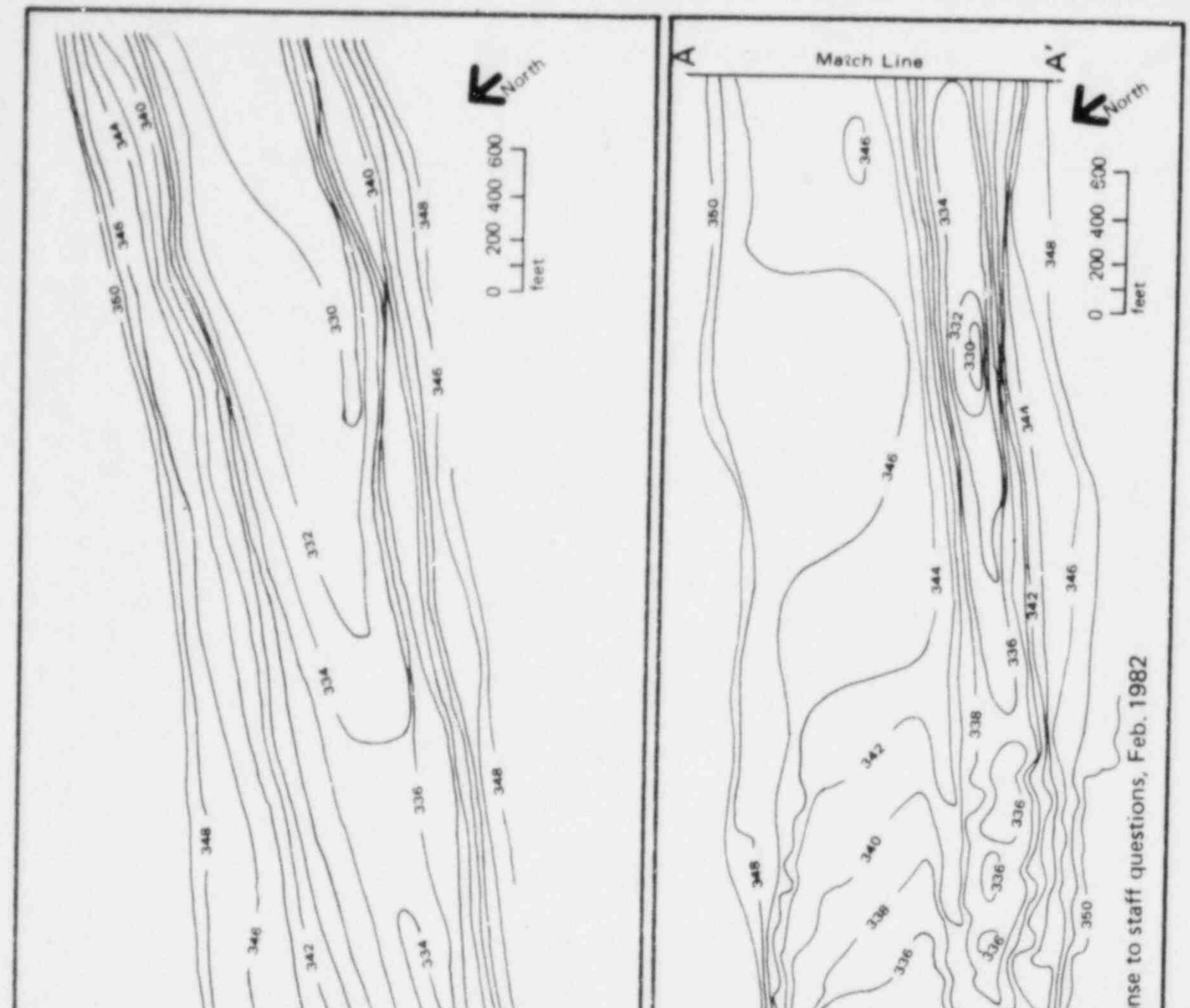
a) Regulated Average Discharge that is Equalled or Exceeded 50% of the Time -115,752 CFS.

b) Administratively Established Minimum Discharge - 36,000 CFS.

c) Cross-Sectional views looking upstream. Distances are in feet from the west bank (Benton County shoreline).

SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.13 River cross-sections in the vicinity of the discharge structures



SOURCE: PSP & L response to staff questions, Feb. 1982

Figure 4.14 Topographic features of the Columbia River in the vicinity of the intake and discharge structures

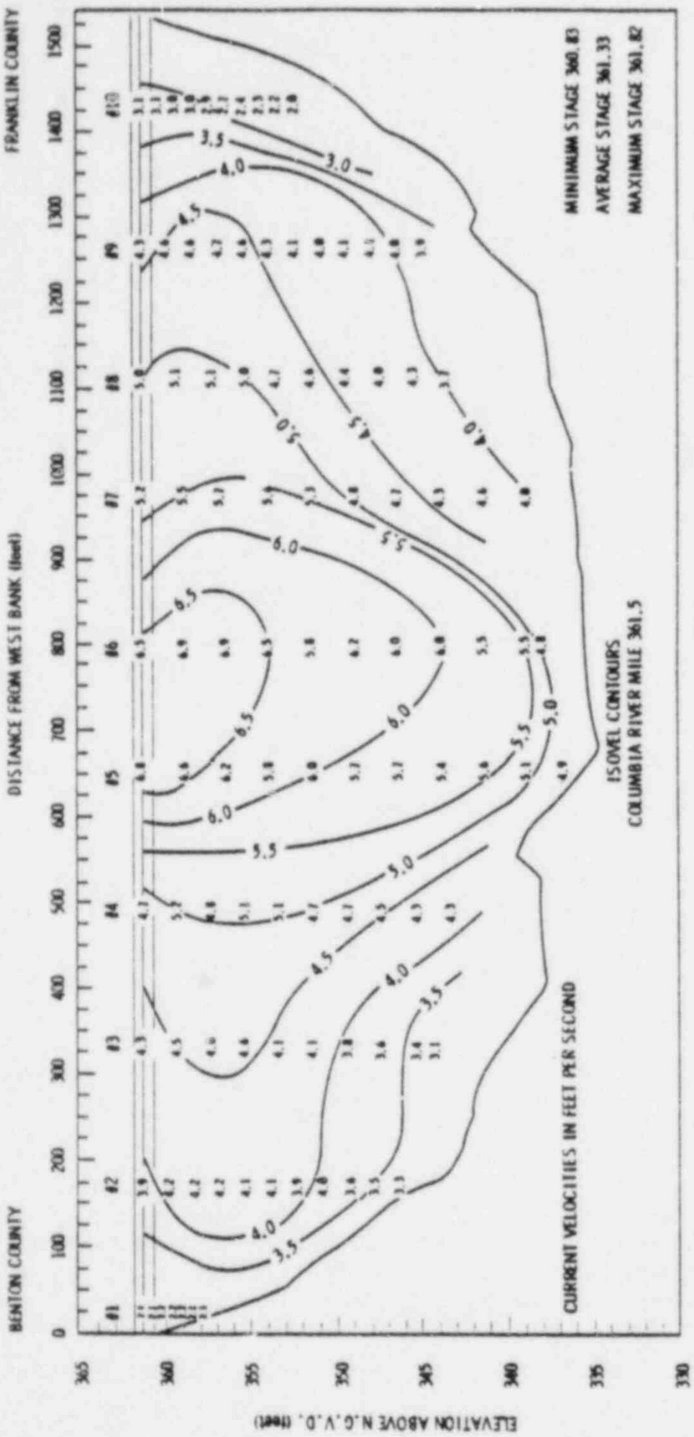
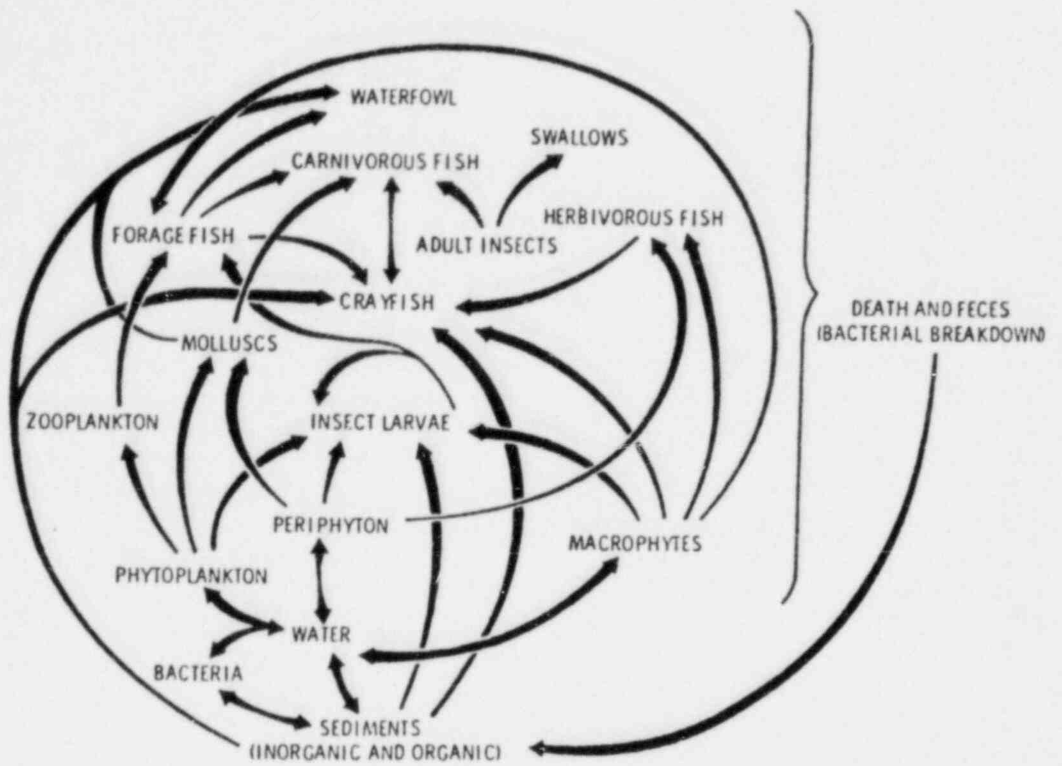


Figure 4.15 Columbia River mile 361.5 isolevel contour map



SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.16 Food web of the Columbia River

Significance of Aquatic Habitats

The aquatic habitat provided by the main channel of the Columbia River in the immediate vicinity of the proposed intake and outfall structures is representative of much of the free-flowing Hanford Reach. This portion of the reach contains no special features that would tend to increase habitat value relative to other areas. The Hanford Slough does have significant habitat value for both resident and transient fish and supports aggregations of rooted aquatic macrophytes (see Figure 4.16).

Plankton--Planktonic (free-floating) biota in the Hanford Reach include phytoplankton (algae), invertebrate zooplankton and ichthyoplankton (fish eggs and larvae). Phytoplankton dominates the planktonic community in numbers, variety, and biomass. Diatoms usually comprise over 90 percent of the algal population S/HNP ASC/ER, 1981) and are responsible for a portion of the local primary productivity. A species list for phytoplankton occurring at river mile 361.5 is presented in the applicant's Environmental Report (S/HNP ASC/ER, 1981). Peak abundance usually occurs in late spring. Minimum densities occur in midwinter.

A species list of zooplankton occurring in the Hanford Reach of the Columbia River is presented in the applicant's Environmental Report (S/HNP ASC/ER, 1981). Other studies report seasonal and annual variability in zooplankton (Gray and Dauble, 1977; Beak Consultants, 1980; Page, 1976). Dominant forms include Cyclopoid copepods (especially Cyclops spp.) in the late fall, winter and spring and the cladoceran Bosmina spp. (along with other cladocerans) in the summer and early fall (S/HNP ASC/ER, 1981; WPPSS, 1972). Other abundant forms include the Calanoids (especially Diaptomus, spp.), Daphnia and Ceriodaphnia (WPPSS, 1972). Zooplankton densities range from less than 10 individuals/m^3 (fall) to nearly 5,000 individuals/m^3 (late spring) (Gray and Dauble , 1977; Beak Consultants, 1980; Page, 1976). Conflicting reports exist concerning the importance of zooplankton as a food source for juvenile salmonids. Becker (1971) states that zooplankters are not important food items, while Dauble (1980) reports that cladocerans constitute a large seasonal dietary component for 0+ chinook. This apparent conflict can probably be resolved by noting that juvenile salmonids are opportunistic feeders and that seasonal zooplankton blooms will be taken advantage of, especially by 0+ fish. Drifting insect larvae, acknowledged to be important contributors to juvenile salmonid diets, typically constitute less than 5 percent of the zooplankton community. Peak densities of about 7 larvae/m^3 occur in mid-July (Battelle Pacific Northwest Laboratories, 1976).

Ichthyoplankton (fish eggs and larvae) has been sampled extensively in the Hanford Reach between April and July. Densities have been found to be relatively low, ranging between 0.06 to 0.26 plankters/m^3. The larvae of the freshwater sculpin Cottus asper dominate the ichthyoplankton, making up about 95 percent of the catch. No significant vertical or horizontal variations in densities or composition of the ichthyoplankton were noted.

Periphyton and Macrophytes--The periphyton community in the Hanford Reach is extensive and abundant, providing most of the local instream primary productivity. The community is composed primarily of diatom aggregations, dominated by Cocconeis, Asterionella, Synedra, Gonphonema, Achnanthes, Nitzschia, and Stephanodiscus (S/HNP ASC/ER, 1981). Data on densities occurring on natural substrates are not available.

Rooted aquatic macrophytes occur in slack water areas along the Hanford Reach, especially sloughs and other backwaters. The nearest significant macrophyte aggregations occur in Hanford Slough, about 0.8 km (0.5 mi) upstream of the proposed river mile 361.5 intake/discharge location.

Benthic Invertebrates--Insect larvae and mollusks comprise most of the benthic invertebrate fauna in the vicinity of the proposed intake and discharge structures (WPPSS, 1972). Midge (Chironomidae) and caddisfly (Trichoptera) larvae are the dominant benthic organisms, comprising about 90 percent of the numbers of individuals collected (S/HNP ASC/ER, 1981). Both of these forms have been determined to be important constituents of the diet of juvenile salmonids and salmonids and other fishes in the Hanford Reach (Becker, 1971). A species list of benthos in the vicinity of the proposed intake/outfall structures is given in the applicant's Environmental Report (S/HNP ASC/ER, 1981).

Fish--The Hanford Reach of the Columbia River supports a diverse ichthyofauna. Forty-four species of fish, five of which are anadromous and none of which are rare or endangered, have been identified in this reach (Cushing, 1964; Gray and Dauble, 1977). A complete species list is given in the applicant's Environmental Report (S/HNP ASC/ER, 1981); a list of important fish is given in Table 4.8. The criteria used to establish importance include:

- Rare or endangered status
- Commercial or recreational importance
- Ecological importance to the structure or function of the ecosystem
- Potential or existing nuisance
- Likely to be affected by the proposed action

All of the anadromous fishes present in the Hanford Reach have significant recreational value. In addition, chinook, coho, and, to a limited extent, sockeye salmon are commercially important. American shad have a limited economic importance. Of the resident fishes, white sturgeon, mountain whitefish, bluegill, and walleye are of recreational importance (see below); the northern squawfish is a predator on juvenile salmonids; the largescale sucker is considered to be a nuisance; and the prickly sculpin is ecologically significant by virtue of its abundance, especially in the ichthyoplankton, and as a competitor for the food supply used by juvenile salmonids.

The construction of hydroelectric dams on the Columbia River has left the Hanford Reach as the only remaining free-flowing portion of the river accessible to anadromous fishes above tidewater; all known mainstem natural production of anadromous salmon and steelhead trout occurs in this reach. Portions of the reach known to be used frequently for spawning by fall chinook salmon are shown in Figure 4.17 (S/HNP ASC/ER, 1981). No evidence was found that would indicate that the portion of the river adjacent to or within about 4.8 km (3 mi) upstream or about 8 km (5 mi) downstream is used for spawning by fall chinook salmon to any significant extent. Estimates of the the number of fall chinook spawning in the Hanford Reach from 1966 to 1981, based on a conversion factor of 7 fish per redd, are given in Table 4.9 (Watson, 1977). This is about 18 percent of the fall chinook escapement to the river and about 40 percent of the fall run passing McNary Dam. Spawning occurs from mid-October to late November. Steelhead trout are known to spawn in the Hanford Reach, but exact locations and spawner densities are not known. The Washington Department of Game recently estimated the total spawning population of the reach to be about 10,000 fish. Spawning extends from January through May. Productive capacity (egg-to-smolt survival) is unknown, although Fickeisen et al., have estimated overall production in the Hanford Reach to be about 1.6 million juveniles (Fickeisen et al., 1980).

American shad are known to spawn in the Hanford Reach, but most spawning is thought to occur several miles upstream of the proposed S/HNP intake/outfall location. Counts at Priest Rapids Dam since 1969 range from 1,360 to 26,500 and the population trend seems to be increasing (S/HNP ASC/ER, 1981).

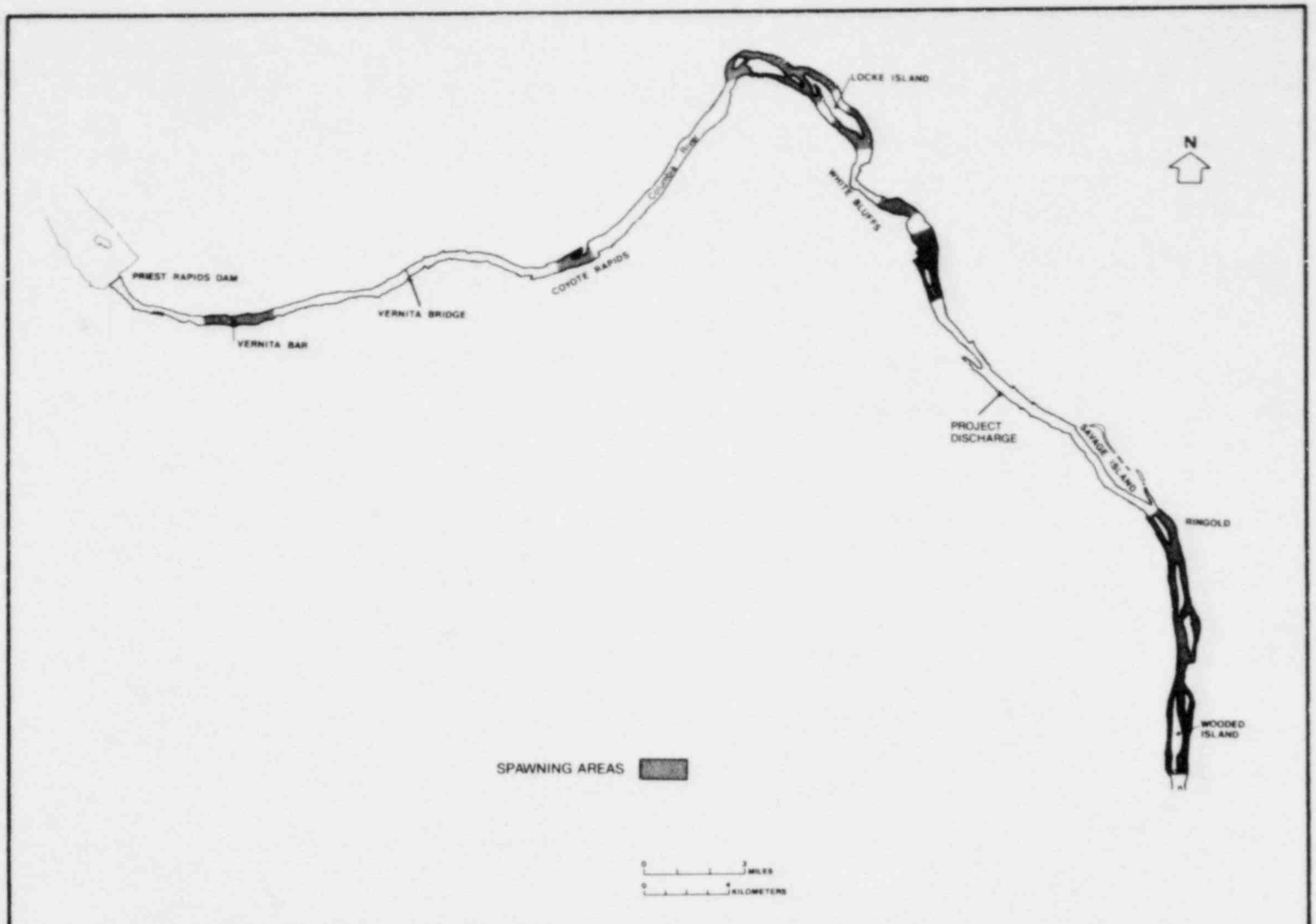
Table 4.8 Important fish species occurring in the Hanford Reach of the Columbia River near the proposed S/HNP intake/discharge location

Scientific Name	Common Name
Anadromous Fish	
Oncorhynchus tshawytscha	chinook salmon
O. kisutch	coho salmon
O. nerka	sockeye salmon
Salmo gairdneri	rainbow/steelhead trout
Alosa sapidissima	American shad
Resident Fish	
Acipenser transmontanus	white sturgeon
Prosopium williamsoni	mountain whitefish
Ptychocheilus oregonensis	northern squawfish
Catostomus machrochelus	largescale sucker
Lepomis macrochirus	bluegill
Micropterus dolomieui	smallmouth bass
Perca flavescens	yellow perch
Stizostedion vitreum vitreum	walleye
Cottus asper	prickly sculpin

Source: S/HNP ASC/ER, 1981.

None of the remaining important anadromous fishes found in the Hanford Reach use the area extensively for spawning. Adult coho, sockeye and spring chinook salmon, along with a portion of the adult steelhead trout and fall chinook found in the reach, continue migrating past Priest Rapids Dam to spawn in upriver tributaries. Adult salmonid passage counts at Priest Rapids Dam from 1966 to 1981 are given in Table 4.9. Adult salmonid movement through the Hanford Reach occurs year round, but peak movement occurs in the spring for spring chinook, from mid-June through mid-August for summer chinook and sockeye salmon, and in late summer and early fall for fall chinook, coho and steelhead. Most adults migrate along the right bank (looking upstream) (WPPSS, 1972).

Juvenile salmon and steelhead naturally produced in the Hanford Reach emerge from redds between March and June and begin feeding on zooplankton and drifting insect larvae. These fry distribute themselves initially in shallow, quiet areas along the river, especially in sloughs and backwaters, moving into deeper water and taking larger food items as they grow. Some out-migrant figures have



SOURCE: S/HNP ASC/ER, Amendment 4,1981

Figure 4.17 Fall chinook salmon spawning areas within the Hanford Reach

Table 4.9 Adult anadromous fish passage counts at Priest Rapids Dam and estimated fall chinook spawning near Hanford--1966 to 1981

Year	Chinook Salmon	Coho Salmon	Sockeye Salmon	Steelhead Trout	Chinook Spawning Near Hanford*
1966	66,915	11,903	170,071	13,006	21,707
1967	48,918	8,879	123,786	7,354	22,869
1968	48,314	13,212	108,308	10,524	24,920
1969	40,786	1,351	39,240	6,660	31,556
1970	36,978	7,076	77,288	6,450	26,775
1971	36,117	7,752	73,841	13,162	25,200
1972	33,360	5,293	44,957	6,600	6,312
1973	34,418	7,006	54,480	1,576	20,755
1974	32,390	3,045	35,435	1,781	5,096
1975	43,738	2,459	55,209	2,193	18,781
1976	40,397	2,271	32,810	9,248	13,657
1977	47,678	370	95,412	8,804	22,690
1978	44,362	579	12,009	4,288	21,196
1979	36,622	311	45,662	8,415	20,881
1980	36,706	168	52,056	8,493	10,409
1981	47,051	432	51,460	8,925	34,062

*Based on a correction factor of 7 fish per redd.

Source: Compiled from Grant Co. PUD counts.

been compiled that may serve as an index of out-migration and are presented in Table 4.10. The reservoir complex above Priest Rapids Dam appears to delay migration of upriver juveniles somewhat. Although downstream movement occurs during all hours, most movement occurs between midnight and first light.

Out-migrating salmonids feed primarily on drifting aquatic insect larvae, except for juvenile sockeye which are plankton-eaters. Several salmon and steelhead hatcheries contribute juveniles to the river, which pass through the Hanford Reach past the proposed S/HNP intake/discharge location. The closest hatchery to the site is the Ringold facility a few miles downstream, which plants about 200,000 juvenile steelhead yearly. Few juveniles are expected to move upstream to the proposed intake/discharge location. The Washington Department of Fisheries also operates a facility at Priest Rapids Dam. Stocks are mostly fall chinook, but 300,000 spring chinook yearlings should be released in 1982 along with 8,000,000 0+ fall chinook fingerlings. Upriver hatcheries are thought to contribute about 50 percent of the chinook out-migrants and a majority of coho out-migrants passing Priest Rapids Dam.

Table 4.10 Timing and estimated numbers of juvenile salmonids passing Priest Rapids Dam

Year	Timing	Fish (millions)	Timing	Fish (millions)	Timing	Fish (millions)	Timing	Fish (millions)
1976[1]	early May	2.63	early Aug	1.62	mid May	0.22	mid May	0.27
1966[1]	early May	4.10	early Aug	1.35	mid May	1.17	mid May	0.24
1967[1]	early May	0.95	early Aug	2.07	mid May	1.17	mid May	0.26
1976[2]	mid May	1.6	mid May* mid Aug**	1.6	mid May	0.6	mid May	0.4

*spring chinook
**summer/fall chinook

Sources: (1) WPPSS, FEIS HNP-2, 1972.
(2) Sims and Miller, 1977.

Important resident fishes with recreational value include white sturgeon, mountain whitefish, bluegill, smallmouth bass, yellow perch, and walleye. White sturgeon are bottom-dwelling scavengers that feed primarily on mollusks and crustaceans in the Hanford Reach, notably crayfish and freshwater mussels. These fish occur throughout the reach and undergo extensive interdam movement each spring and summer. It is conceivable that some individuals in the population become anadromous, but most evidence suggests a self-sustaining local population (Battelle Pacific Northwest Laboratories, 1978; Haynes, et al., 1978). Spawning occurs from May through July in swift currents over rocky or gravelly substrates. Eggs are demersal and adhesive; hatching is temperature dependent, probably occurring within about 2 weeks. Nursery areas in the Hanford Reach are unknown, but may include sloughs and quiet backwaters.

Mountain whitefish occur throughout the Hanford Reach. Spawning areas have not been specifically identified, but spawning probably occurs with insignificant frequency within several miles of the proposed intake/discharge location (S/HNP ASC/ER, 1981). Spawning occurs from late November through early January, with fry emergence in early April. Fry disperse throughout the river and rear predominantly in quiet areas, including the Hanford Slough. Older fish inhabit nearshore areas and deep pools.

Yellow perch, smallmouth bass, and bluegill are primarily restricted to quiet backwater areas, including the Hanford Slough, often preferring areas with aggregations of rooted, leafy macrophytes. All of these spiny-rayed game fishes spawn in spring or early summer, usually in quiet areas with aquatic vegetation. Juvenile smallmouth bass and yellow perch begin feeding on zooplankton, graduating to larger insect larvae and small fishes as they grow. Bluegill feed primarily on zooplankton and insects. Although the Hanford Slough supports significant populations of these fishes, none of them is expected to frequent the proposed intake/discharge location that is characterized by swift currents.

Little is known of the habits and distribution of walleye in the Hanford Reach. These fish are usually found in the upper part of the reach, but populations between the Hanford Slough and Richland appear to be increasing; adults are usually taken in sloughs by the Washington Department of Game. Spawning occurs in the spring or early summer. Eggs are demersal and hatch in about 2 weeks. Juveniles rear in quiet areas. Surface-oriented fry feed on invertebrates but juveniles quickly graduate to eating fishes as they grow and assume a benthic existence. Yellow perch and other recreationally important fish are known to be important dietary items when available (Scott and Crossman, 1973).

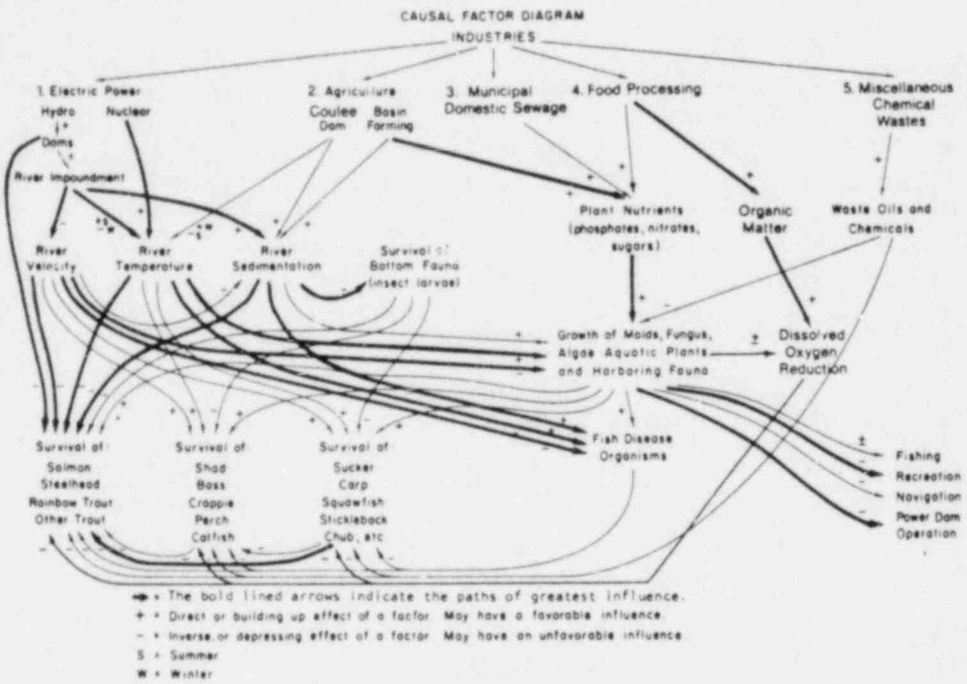
Commercial and Sport Fisheries--No commercial fisheries occur on the Hanford Reach. However, recreational fishing does occur on the Hanford Reach. The Hanford Reach recreational fishery is managed in two segments. The upstream segment extending from Vernita to the Hanford townsite is open for sport fishing from July 1 to October 15. The lower segment is open for spiny-rated game fish year-round. Significant fisheries exist in both segments.

Most angling is from the bank, usually from the right bank (looking downstream), due to ease of access, but boat angling has increased in recent years. Steelhead angling now involves about 26,500 angler-days annually in the combined Hanford, Ringold, and Priest Rapids fisheries, with 65 percent of the effort at Ringold, 20 percent at Priest Rapids, and 15 percent at Hanford. About 2,500 fish were caught in 1981 for a success rate of 0.11 fish per man-day.

The most successful sport fishery on the Hanford Reach is that for whitefish. An estimated 3,500 angler-days yielded a catch of about 12,000 fish, mostly between Priest Rapids and Vernita. The Hanford Slough, about 0.8 km (0.5 mi) upstream of the proposed intake/discharge location is accessible by boat from the opposite shore or from downstream areas and received about 4,000 angler-days of fishing pressure in 1981. It yields smallmouth bass, largemouth bass, perch, bluegill, and crappie. Walleye are occasionally taken in the Hanford Slough, and the catchable population appears to be increasing.

Environmental or Man-Induced Stresses

Several significant local environmental stresses presently exist on or are planned for the mid-Columbia region. A schematic representation of some of the interactions of these stresses with the biota of the Hanford Reach is presented in Figure 4.18. Existing impoundments have greatly modified the hydraulics of the Columbia River and have partially or completely blocked fish runs, resulting in a very serious impairment of the natural productive capacity of the river for "resource" fishes. All remaining natural mainstem anadromous fish production in the Columbia has been compressed into the uniquely free-flowing Hanford



SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.18 The effect of industry on the physical and biological complex of the Columbia River and its fish populations

Reach. Daily fluctuations in the river level along the Hanford Reach as the result of hydroelectric power production schedules upriver has resulted in productivity reductions at all trophic levels and reduced productive capacities for resource species, while favoring some nongame rough fishes.

Water withdrawal for industry, agriculture, and concomitant wastewater discharges and agricultural runoff has reduced water quantity and quality in the river. Some agricultural return discharges occur along the Franklin County bank of the Hanford Reach, contributing agricultural chemicals and their residues as well as soil leachates. Domestic and industrial effluents have added dissolved solids of various kinds and have resulted in a deleterious thermal loading of the river, especially in lower reaches. Large thermal discharges from reactors along the Hanford Reach have stressed the system locally, but most once-through reactors have been shut down or mothballed. The N-Reactor still discharges comparatively large volumes of heated water. New or planned reactors use other cooling methods and discharge relatively small amounts of heated effluent.

The planned Ben Franklin Dam near Richland, if built, would impound the last remaining free-flowing reach of the Columbia River between tidewater and the Canadian border. This would eliminate the last vestiges of natural anadromous fish production in the river and produce other dramatic changes in the aquatic ecology of the Hanford Reach.

Environmental Impacts

Site and Vicinity

Construction and operation of the proposed S/HNP would affect the aquatic environment and its biological resources as a result of installation and operations of a triple makeup water intake system and a single blowdown effluent nozzle. In the aggregate, the effect would be locally significant, relatively short term, and not easily or practically mitigatible. It is possible that these effects could be reduced by altering the construction plan, however. It is proposed that the intake and outfall structures be located at approximately river mile 361.5. These structures, their installation, and modes of operation are described in Section 4.1.4.

Construction (installation) of the three torpedo-shaped intake structures and the single discharge nozzle would involve excavation of two large trenches across about three-fifths of the river channel. One trench would enter from the stilling well beneath the proposed pumphouse about 335 m (1,100 ft) eastward to a point past the centerline of the river. This trench would contain three large pipes, terminating from beneath the three intake structures. According to the applicant's USACE Section 404 Permit Application, the bottom of this horizontal trench would be at about altitude 99.7 m (327 ft), 3.0 m (10 ft) below the elevation of the river bed, below the intake structures, or about 10.6 m (35 ft) below ordinary high water. No trench width has been specified, but it is assumed that the width at the bottom would be about 4.6 m (15 ft). If a 0.75:1 angle of repose for sideslopes can be assumed, the top of the trench at the intake structure site would be about 9 m (30 ft) wide and at the ordinary high-water line, between 24 and 30 m (80 and 100 ft) wide. This configuration would result in the direct surface area disturbance of about 1,219 m (4,000 ft).

The second trench would be located about 30 m (100 ft) downstream and contain the outfall pipe. According to the applicant's USACE permit, this trench would extend from the ordinary high-water line to a point about 213 m (700 ft) offshore. It is assumed that this trench would be less than 3 m (10 ft) deep over most of its length and between 4.5 to 6.1 m (15 to 20 ft) wide across the top over its entire length. According to this plan, about 3,050 m (12,000 ft) of substrate would be directly disturbed. The trench would be backfilled with imported sand and gravel and a minimum of 0.9 m (3 ft) thickness of protective imported riprap.

According to conversations with the applicant's engineering staff, the methods to be employed for excavation of these trenches have not been firmly established. Drag-line, clamshell dredge, backhoe (near the shore), or a combination of these methods may be used. A suction dredge would not be used. A bulkhead may be placed in the intake line trench near the shoreline so that work on the stilling well and the nearshore end of the trench can proceed under relatively dry conditions. During this portion of the excavation, a dewatering system would discharge water into a nearby filtration pond. Excavated material not used as backfill would be dry-land stockpiled and graded to drain. Drainage is expected to percolate into the highly pervious soils typical of the area and not to reenter the river except as interflow.

The substrate removal and backfilling operations in the river would be expected to produce significant short-term, relatively local increases in turbidity, localized intermediate-term deposition of fines downstream of the operations, and longer-term alteration of substrate textures. Up to about 15,240 m (50,000 ft) of the benthic habitat would be directly affected and a somewhat larger area would be indirectly affected by deposition. Studies of similar activities in the Hanford Reach indicated temporary reduction of periphyton and macroinvertebrate densities due to fines deposition to be limited to a zone extending about 152 m (500 ft) downstream (Page, 1976). No effects were detected 610 m (2,000 ft) downstream. Work conducted near Pasco indicated that sand was not redistributed during periods of low flow, but that scouring under freshet conditions was capable of transporting up to 20,000 tons of sand per day (WPPSS, 1972). The channel configuration at river mile 361.5 suggests that sand and other fine materials deposited locally because of construction activities would be easily resorted and transported out of the area during periods of high flow.

Increases in suspended and dissolved organic materials and dissolved inorganic materials may locally and temporarily reduce dissolved oxygen levels. Low-sediment biological oxygen demand (BOD) and the turbulent nature of the currents would help attenuate any potential oxygen depletion problem.

Longer term qualitative changes in benthic habitats would persist after construction activities have been completed. The layer of imported riprap placed over the backfilled trenches would result in a locally coarser substrate texture, with larger interstices. Recolonization by benthic invertebrates and scavengers is expected to occur within a short time, but interstitial spaces would tend to fill with finer material and habitats over time and their associated biota should approach nearly original conditions.

No intensive spawning of anadromous or other resource fish species is known to occur in the immediate vicinity of the proposed construction activities. Timing of construction activities, from July 15 through October 15, is intended to minimize effects on aquatic biota. This is the period of lowest flows, and siltation of benthic habitats would tend to be more localized. In addition, it is a period after most 0+ chinook would have left the area and only relatively few adult anadromous salmonids would be present. It is also after the fry of nonanadromous resource fishes that might have initially dispersed into the main channel would probably have become redistributed into quiet backwaters, away from construction influence.

The presence of the intake and outfall structures themselves are not expected to have an appreciable effect on local biota. Some very local increases in species diversity may occur.

Some of the adverse impacts discussed above could be significantly reduced by altering construction activities. According to a contour map of the river bottom developed from surroundings, the deepest part of the river and the proposed intake/discharge location is approximately midstream. This presumably could necessitate the installation of the intakes at a distance of about 274 m (900 ft) from the ordinary high-water line. At a point about 853 m (2,800 ft) downstream of river mile 361.5, the deepest point appears to be about 122 to 152 m (400 to 500 ft) from the ordinary high-water line, half the distance at river mile 361.5, and channel depth is sufficient for the structures (deeper than the proposed site). Recognizing that geotechnical and engineering feasibility has not been examined, locating the structures about 853 m (2,800 ft) downstream of river mile 361.5 would reduce aquatic environmental effects of construction because the size of excavations and the duration of excavation activities would be substantially reduced.

Impingement and Entrainment

Operation of the S/HNP would result in the withdrawal of less than 2.83 m^3/s (100 cfs) of river water through the three intake structures, as described in Section 4.1.4. The proposed structures were designed in part to minimize the threat to juvenile fishes of impingement or entrapment. The outer skin of the structures would be perforated with 0.95-cm (3/8-in.) diameter holes. The maximum design approach velocity would be 0.15 mps (0.5 fps) at the screen surface and 0.03 mps (0.1 fps) about 2.54 cm (1 in.) from the surface. Under actual maximum operating conditions, however, 2.46 m^3/s (86.7 cfs) pumping rate approach velocities would not be expected to exceed 0.13 mps (0.43 fps). Under annual average operating conditions [1.76 m^3/s (62.4 cfs) pumping rate], approach velocities would be about 0.06 mps (0.22 fps). Although river velocities under various flow conditions in the immediate vicinity of the proposed intake structures are not available, the applicant's ASC/ER states that the minimum ambient velocity under minimum regulated flow conditions would be about 0.70 mps (2.32 fps), which is over five times the approach velocities under maximum pumping conditions and over ten times the approach velocities under annual average pumping conditions. Although the longitudinal flow vector along the screen surface can be expected to be considerably less than ambient river velocities, there would be a tendency for even passively drifting small "impingeable" fishes that might come into contact with the surface to be swept clear. Darting speeds of juvenile fish large enough to be impinged rather than entrained (nonplanktonic juveniles) are well in excess of the maximum design approach velocity of 0.15 mps (0.5 fps). According to WPPSS information, divers who inspected operating intake structures at WNP-2 similar to those proposed for S/HNP observed no impingement of small fishes, even though they were known to be present in the area.

Drifting biota (phytoplankton, zooplankton and ichthyoplankton) would be subject to entrainment through the 0.95-cm (3/8-in.)-diameter openings in the intake structures. Although all entrained biota would be expected to perish, no measurable or significant reductions in populations of these organisms would be expected to result. Under maximum pumping conditions, assuming no avoidance, about 1,100 prickly sculpin larvae per hour would be entrained and lost during periods of maximum abundance. This number is trivial when compared to the total population. No change in population dynamics of this or any other species is anticipated. Fry of most resource fishes, including salmon, steelhead, bass, perch, and bluegill, prefer shoreline or backwater areas, and susceptibility of these forms to entrainment would be thereby reduced. A study conducted to evaluate similar structures at WNP-2 failed to detect any entrainment of fish eggs or larvae, even though about 30 percent of the total water pumped for about 1 year was sampled using a large cage with 2.0-mm mesh size. It is possible that some pelagic eggs (e.g., shad eggs) were entrained and escaped detection because of their size.

In addition to the potential environmental effects of impingement and entrainment, operation of the S/HNP would result in a consumptive use of Columbia River water, which would have a very small but incremental biological effect. Net water consumption with maximum pumping [2.45 m^3/s (86.7 cfs)] and maximum discharge [0.37 m^3/s (13.2 cfs)] would be about 0.2 percent of the minimum regulated flow of 1,019 m^3/s (36,000 cfs)] and would have no local effect on aquatic biota, but must be added to all other consumptive water use along the Columbia River in the consideration of present and future water allocation, including fish flows at hydroelectric dams.

Thermal Discharges

Operation of S/HNP would result in the continuous discharge of heated blowdown into the Columbia River through a single-port nozzle located about 210 m (700 ft) offshore of the ordinary high-water line and about 30 m (100 ft) downstream of the intake structure. Maximum discharge volume would be about 0.37 m^3/s (13.2 cfs) and maximum temperature differential would be about 16.6°C in winter and 9.4°C in summer. The thermal plume was modeled for three operating and discharge conditions:

(1) "Regulatory case"--minimum river discharge [1,019 m^3/s (36,000 cfs)]; maximum effluent volume [0.37 m^3/s (13.2 cfs)]; maximum effluent temperature (29.2°C); restrictive river temperature (20°C).

(2) "Average case"--median river discharge [3,278 m^3/s (115,752 cfs)]; typical effluent volume [0.18 m^3/s (6.28 cfs)]; typical effluent temperature (20.5°C); typical river temperature (10.8°C).

(3) "Lower excess temperature case"--minimum river discharge [1,019 m^3/s (36,000 cfs)]; average effluent volume [0.18 m^3/s (6.28 cfs)]; average effluent temperature (20.5°C); typical winter river temperature (3.9°C).

Graphic representations of modeling results show surface isotherms and long-section plume isotherms in Figures 4.19 through 4.21. Although these cases do not include worst-conceivable conditions for aquatic biota, they are representative of conditions that could reasonably be expected to occur during various seasons and under recurring operating conditions.

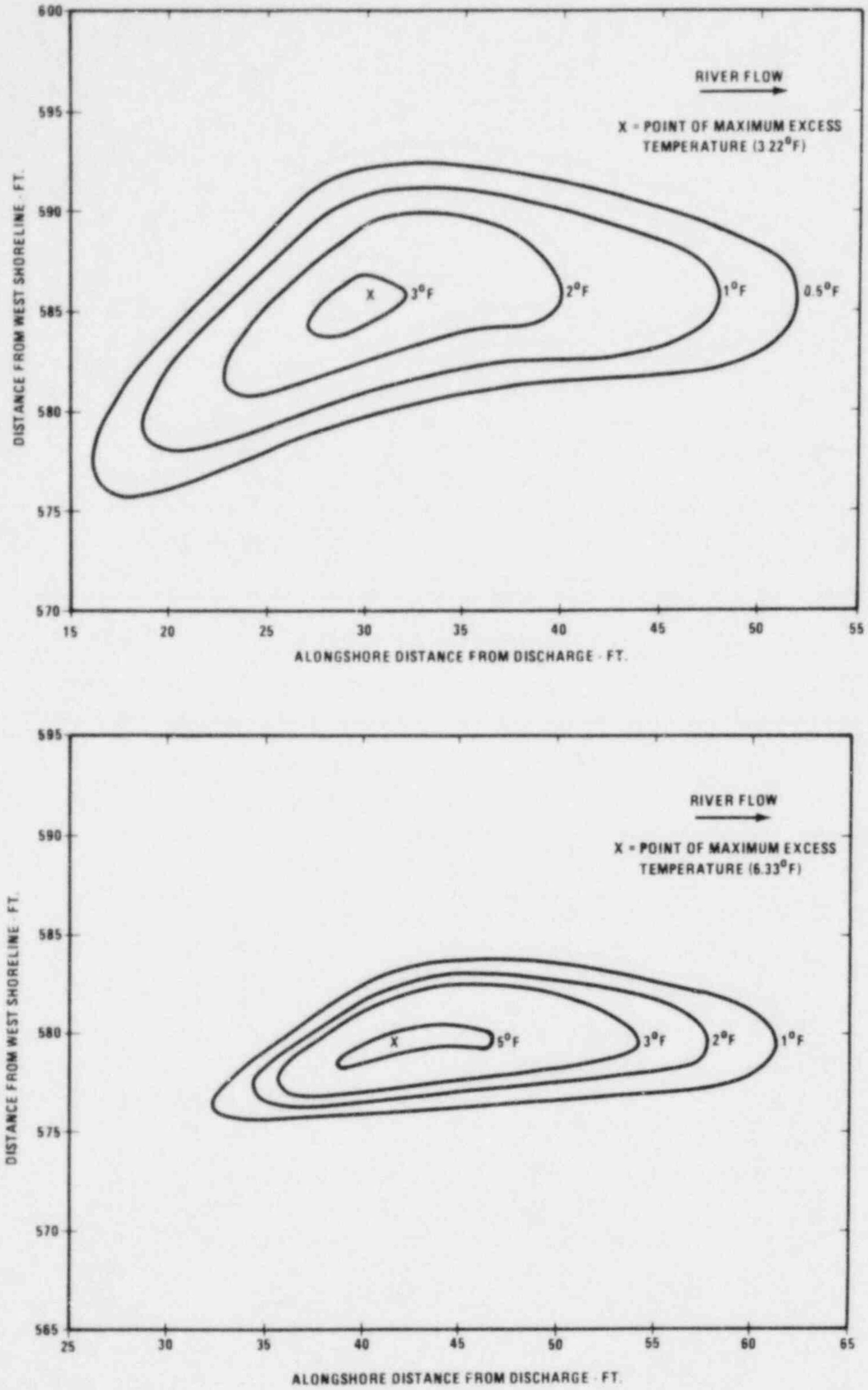
The effects of thermal discharges on aquatic biota vary according to ambient river conditions, primarily discharge and temperature, and the differences in temperature between the effluent and receiving water. General reviews of information on the effects of thermal discharges on aquatic biota occur in the applicant's Environmental Report (S/HNP ASC/ER, 1981), the WPPSS Final Environmental Statement for WNP-2 (WPPSS FEIS, HNP-2, 1972), and the WPPSS Draft Operating License Environmental Report for WNP-1/4 (WPPSS, 1982). Much of the work reviewed in these documents was conducted on the Hanford Reach, and is particularly germain to the issue of potential environmental effects of the proposed S/HNP thermal discharge.

Plankton--Because that portion of the plume producing a 0.3°C or greater increase in temperature would occupy less than 1 percent of the cross-sectional area of the river under worst-case (low flow, high thermal discharge) conditions, a very low percentage of the plankton community in the river would be exposed to elevated temperatures even for a short period. Therefore, no significant temperature effects on plankton, including phytoplankton, are expected. Effects on community structure and function are expected to be negligible.

Periphyton and Macrophytes--No macrophytes exist in any area that will come under the direct influence of the proposed thermal plume. Therefore, no thermal effect can be anticipated for these forms. The periphyton community would be affected to the extent that the benthic substrate on which it grows would come under the influence of the thermal plume. Only a very small portion of the benthic substrate immediately adjacent to and a short distance downstream of the heated pipe would experience elevated temperatures. In spite of the changes discussed above, no significant changes would occur that would affect the structure and function of the overall periphyton community.

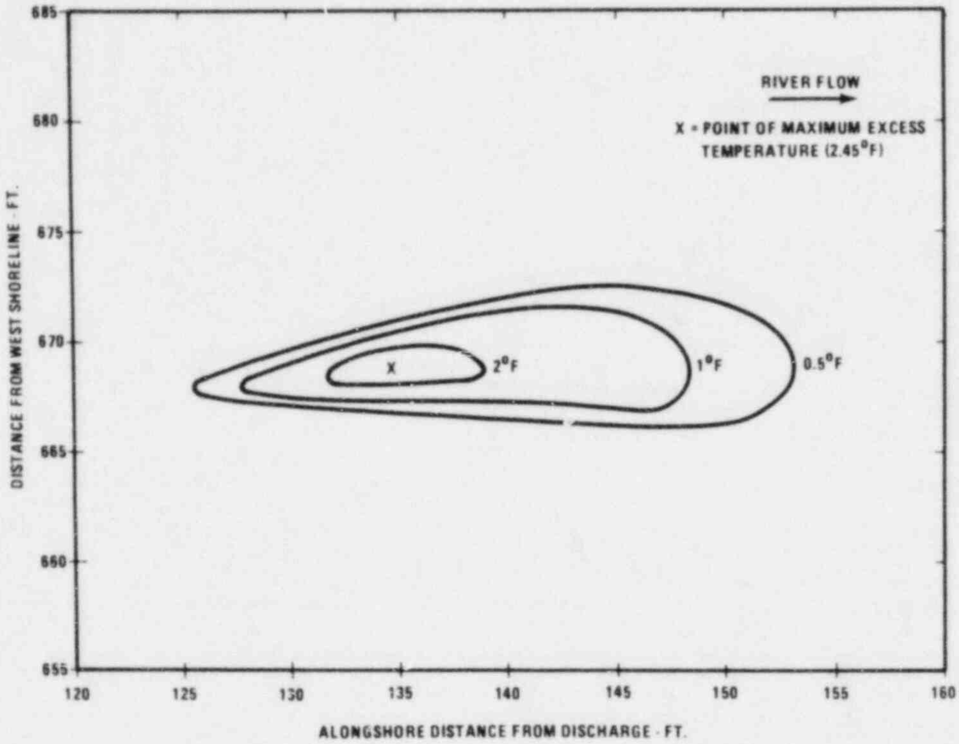
Benthos--The anticipated effect of heated discharge from S/HNP on the benthic invertebrate community would be similar to that anticipated for the periphyton community. The very small percentage of the substrate to be affected and the upward-pointing nature of the proposed outfall, directing the warmest portions of the plume away from the bottom, ensure that local effects would be slight.

Fish--Temperature is an important mediating influence on the fish resources of the Columbia River. The fish populations most sensitive to thermal stress are coincidentally the most important commercial and recreational species present: the anadromous salmonids.



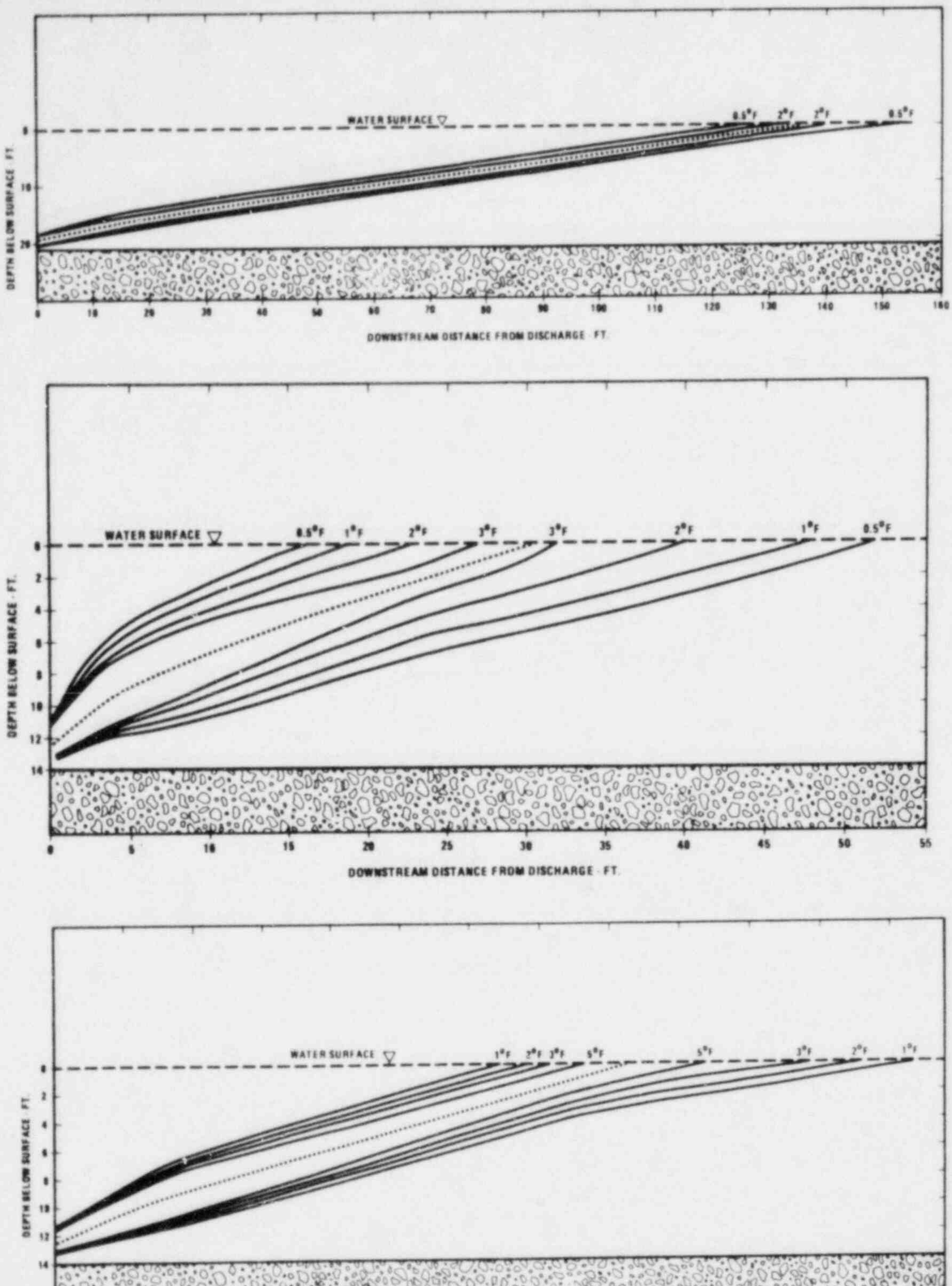
SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.19 Surface excess temperature isotherms (for 3.22°F and 6.33°F)



SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.20 Surface excess temperature isotherms (for 2.45°F)



SOURCE: S/HNP ASC ER, Amendment 4, 1981

Figure 4.21 Vertical excess temperature isotherms along the plume centerline

Those life stages of anadromous salmonids most likely to encounter the heated effluent plume are outmigrating juveniles, dispersing newly emergent fry and upstream-migrating adults. Spawning and incubation apparently do not occur in any area that would come under the influence of the plume, and rearing juveniles are known to prefer shallow shoreline areas and quiet sloughs and backwater areas, rather than swift, deep areas like the location of the proposed S/HNP outfall. Adult salmonids migrating through the Hanford Reach are known to prefer the right side of the river (looking upstream). These fish are also known to actively avoid temperatures that are potentially dangerous to them. Given these behavioral characteristics and the projection from plume modeling that under worst-case conditions, the portion of the plume representing a temperature elevation in excess of 0.3°C would occupy less than 1 percent of the river cross-section, no significant effect of locally elevated temperatures would be expected to accrue to upstream-migrating adult anadromous salmonids.

Dispersing newly emergent salmonid fry can be expected to occupy most portions of the river near spawning grounds, but these fish seek sheltered, shallow areas soon after initial dispersal. The closest upstream spawning area for anadromous salmonids is several miles upstream, sufficiently far for most fry to have selected preferred habitat before the main river current would carry them past the plume. Nevertheless, some fry may pass directly through the area proposed for outfall location. Likewise, actively outmigrating juveniles are known to disperse in the river somewhat (S/HNP ASC/ER, 1981; WPPSS, 1972), although the tendency is to stay relatively near the shore, and some individuals could be carried through the plume area by the current. Analyses of thermal dose required to elicit death or direct adverse physiological effects, such as equilibrium loss in light of expected passive travel time through the plume, indicate that no significant direct effects on juvenile salmonids would result from passage through the plume. Under worst-case conditions, the juvenile would receive about 18 percent of the median equilibrium-loss dose (S/HNP ASC/ER, 1981), well above that required to elicit an increased predation rate under laboratory conditions. Two major factors argue against this scenario being repeated with significant frequency under conditions that could be expected to exist in the river. First, juveniles, especially small (0+) ones, tend to be distributed near the shoreline, not where the plume would be. Second, it is improbable that even very small fish would enter the plume and remain in its centerline with no avoidance behavior long enough to receive a maximum thermal dose. It is conceivable that some small increase in predator-related mortality would occur; however, the magnitude of such an effect is not likely to cause significant reductions in juvenile salmonid populations.

Chemical Discharges

Operation of the proposed S/HNP would lead to some chemical alterations in the water discharge at the outfall. Most of these changes would result from concentrating effects of the cooling system. Some of the changes would result from additions of certain chemicals to control corrosion, scale formation, algal growth, etc. Details of processes leading to changes in water quality are discussed in Section 4.2.3.2.

Of the average 0.18 m^3/s (6.3 cfs) [maximum 0.37 m^3/s (13.2 cfs)] discharged, 99 percent would be cooling water blowdown and less than 1 percent would be composed of treated wastewater from demineralizer regenerant wastes, pre-treatment wastes, filter backwash, and plant facility floor drains, collectively referred to as low-volume waste treatment effluent.

The concentrating effects of the operation of the S/HNP on most of the dissolved and suspended substances in the Columbia River is not expected to have any significant effects on aquatic biota. The ambient concentrations of certain heavy metals (notably cadmium, copper, and mercury) exceed EPA maximum criteria under existing conditions, and concentrations of these metals would be elevated slightly (4 to 6 percent) at the edge of the mixing zone. It should be noted, however, that EPA standards are generally at least an order of magnitude below observable threshold concentrations and that standards in the cases of cadmium and copper are and would continue to be only slightly exceeded. No biological consequences of any increased concentrations of these metals would be expected. In the case of mercury, maximum EPA standards would be greatly exceeded (three orders of magnitude), but the ambient river concentration would be elevated only slightly at the edge of the mixing zone (6 percent) and very slightly after full dilution (0.43 percent). Because the biological effects on which EPA bases its standards occur only after relatively long-term exposure, and because the presence of elemental mercury is mediated biologically to some extent in freshwater systems, no perceptible or significant biological effects of increases in mercury concentrations due to the operation of S/HNP are expected.

Addition of sodium hypochlorite, however, may have biological consequences. Although blowdown would not be discharged during chlorination and until total residual chlorine (TRC) levels fall to 0.38 mg/l, nominal (average) concentrations in the discharged water would be 0.2 mg/l. Concentrations of this magnitude are known to have serious biological consequences. EPA comments on the proposed characteristics of the WNP-2 discharge (WPPSS, 1972) indicate that recommended concentrations of TRC should not exceed 0.1 mg/l for a period not exceeding 30 minutes per day or 0.05 mg/l for a period not exceeding 2 hours per day. In addition, the nominal concentration at the edge of the S/HNP mixing zone would be 0.002 mg/l, precisely the maximum permissible level, leaving no room for errors in estimation of dilution patterns or for operational errors (i.e., accidental overuse or discharge of blowdown with greater than 0.38 mg/l TRC).

EPA pointed out that adult rainbow trout exhibit avoidance behavior when exposed to 0.001 mg/l TRC (50 percent of the proposed concentration at the edge of the mixing zone) and that trout fry are killed instantly at 0.3 mg/l TRC, which is less than the proposed nominal periodic concentration in the S/HNP discharge, which would occur three times per day during the summer months (S/HNP ASCER, 1981), and only slightly greater than the 0.2 mg/l nominal continuous (average conditions) concentration in the effluent. In addition, the proposed S/HNP effluent would be heated, synergistically increasing the anticipated effects of exposure to TRC. Both direct and indirect effects would be expected. For example, those organisms not killed outright by exposure to the discharge plume would experience greatly increased susceptibility to predation (see previous section, "Fish"). It must be concluded that the combined (synergistic) conditions of heat and TRC in the discharge plume would present a localized threat to aquatic biota, especially juvenile fishes. Since the plume occupies about 0.7 percent of the river cross-section during minimum regulated discharge conditions, a proportionate significant threat to any evenly distributed organisms would be expected. This threat should be considered incremental and cumulative with respect to similar discharges or other environmental perturbations on the Columbia River.

Mitigating Measures

Certain measures undertaken to protect aquatic biological resources are not specified, but are implicit in the proposed S/HNP design and are often required by Federal or State statute. The use of a cooling tower instead of once-through cooling is an example of this kind of measure. The applicant has not prepared a list of special considerations for the protection of or the reduction of adverse consequences to aquatic biota, but a few such considerations have received passing reference in the applicant's Environmental Report (S/HNP ASC/ER, 1981). These include:

(1) Use of perforated pipe, midstream intake structures with low approach velocities.

(2) Timing of construction activities.

(3) Location of intake and discharge structures away from important spawning and rearing areas.

(4) Delivery of sanitary sewage effluent to a percolation pond instead of the river.

(5) Nondischarge of cooling system blowdown during chlorination and until TRC falls to or below 0.38 mg/l.

In the staff's judgment, the following additional measures to further reduce adverse consequences to aquatic biota are required:

(1) Reduction of TRC to levels below 0.38 mg/l.

(2) Use of an alternative to sodium hypochlorite for antifouling purposes (ozone or bromine gas have been suggested).

(3) Since naturally occurring suspended silt concentrations in Columbia River water are apparently high enough to scour the plumbing and keep it clean, antifouling agents should not be used.

(4) Consider relocation of the intake/discharge site to a point about 762 to 1,219 m (2,500 to 4,000 ft) downstream of the proposed location. Between 762 to 1,219 m (2,500 and 4,000 ft) downstream of the proposed location, maximum river depth is within about 122 m (400 ft) from the ordinary high-water line, and the channel depth is as great or greater than at the proposed location. Locating the structures in this area would require excavations less than half the size of those proposed. In addition, the

proposed location is in an area where the main current crosses from the northeast to the southwest side of the channel and, judging from the channel conformation, an area where turbulence and predominating flow vectors would have a tendency to vary greatly with discharge. No such variations in channel configuration are evident at the suggested downstream location.

4.2.4.2 Terrestrial Ecology

Site and Vicinity

Existing Conditions

The Hanford Reservation is a semi-arid area that supports a shrub-steppe type of vegetation. The plant site, the transmission line corridor, and the pipeline corridor are primarily within two vegetative community types: sagebrush-bitterbrush/cheatgrass and sagebrush/cheatgrass (see S/HNP ASC/ER Figure 2.2-1). The sagebrush-bitterbrush/cheatgrass community supports a greater number of plant species than the sagebrush/cheatgrass community.

The northern end of the pipeline corridor and the pumping facilities are located in the old Hanford townsite in which Siberian elm, black locust trees, and a number of non-native and native herbaceous species grow. A riparian community occupies the banks of the Columbia River. This vegetative community is characterized by a few shrub species and a variety of grasses and forbs. The main species occurring in each community are given in Appendix K. Part of the plant site has experienced range fires, which generally cause the elimination of the shrub species, an increase in cheatgrass, and a lower diversity in the other herbaceous species.

Some of the animal species that are found on the Hanford Reservation occur exclusively in the sagebrush-bitterbrush/cheatgrass or sagebrush/cheatgrass community types. Other animal species occur only or predominantly in the riparian community or in the old Hanford townsite. The old Hanford townsite is unique in that trees planted by the settlers have remained and provide nesting and perching sites for a number of bird species, especially the raptors. These trees also provide browse and are an important fawning area for mule deer.

About 60 species of birds are found on the Hanford Reservation. Some are only occasional visitors, like the snowy owl, whereas ducks flock there by the thousands during the winter. The waterfowl and raptors are found primarily along the river, whereas steppe birds and upland game birds occur mostly in various brush/grass plant communities. Appendix L includes a table listing the names of waterfowl and fish-eating bird species and a table giving the number of adult raptors successfully nesting on the Hanford Reservation.

Thirty-nine mammalian species occur on the Hanford Reservation, but not necessarily on the S/HNP site. A list of these species, which includes 12 bat species, is given in Appendix M.

The four major reptilian species that occur on the S/HNP site include the western yellow-bellied racer, gopher snake, side-blotched lizard, and sagebrush lizard. Some amphibian species probably occur in the riparian community. There are at least 14 species of grasshoppers on the Hanford Reservation. During occasional grasshopper population outbreaks, other ecological patterns are seriously disrupted.

Hunting is not allowed on the S/HNP site or associated areas; therefore, this will not be a factor in the control of animal populations. However, the area identified as the S/HNP site boundary in ASC/ER Figure 2.1-2 will be fenced by a 1.8-m (6-ft) chain link fence.

The Hanford Reservation soil types are shown in Figure 2.2-1 (see Figure 2.2-2 of the ASC/ER) and described in Appendix N. The Ephrata sandy loam, which occurs in a small portion of the S/HNP site, is the only soil type onsite that, if irrigated, is classified as "prime farmland soil" by the U.S. Soil Conservation Service (letter, March 3, 1982).

Environmental Impacts

Twenty-four hectares (60 acres) will be used for permanent site facilities, and 356 ha (880 acres) will be needed for temporary construction and laydown areas. The sand borrow will be located away from the site but within the Hanford Reservation and will require 105 ha (260 acres).

Because the largest plants onsite are shrubs, clearing and grubbing can be easily done by bulldozers. Excavation and fill volumes will be approximately balanced. Any excess excavated material will be disposed of in the spoils area located within the site boundary south of the principal plant structures. Because the soil is porous, no significant runoff is expected. However, the sandy soils of the Hanford Reservation are highly susceptible to wind erosion, especially during the spring.

The plants and most small animals occupying the 485 ha (1,200 acres) to be cleared will be removed. Bird species are expected to find suitable habitat in areas adjacent to construction. The 1.8-m (6-ft) fence around the site will effectively control mule deer from ranging on the site.

Hunting or other recreational pursuits are not permitted on the S/HNP site or associated areas; therefore, no impact to these activities is expected to result from the S/HNP construction or operation. The S/HNP will use only a small portion of the Hanford Reservation; thus, the loss of such a small amount of habitat will not have a detrimental effect on the species occupying the S/HNP site. The mechanical-draft cooling towers will only be 19.8 m (60 ft) high, and are therefore not considered to be an obstacle to migratory or resident bird species.

The north access road will cross a soil type classified, if irrigated, as "prime." However, since DOE does not permit agricultural use of the Hanford Reservation, this fact will not reduce any potential use of this land for agriculture.

The staff concludes that the adverse impacts of constructing and operating the S/HNP on the biological communities of the site and vicinity will be minor and any detrimental effects that might occur can be easily mitigated.

Mitigating Measures

To mitigate detrimental effects of wind erosion caused by construction activities, the applicant committed to the following. In areas where grading by itself is not sufficient to control wind erosion, gravel over the surface of eroding areas will be used for stabilization. If necessary, chemical stabilizing agents (resinous adhesives, dust palliatives, etc.) will be used after review of the impacts for any toxicity.

Transmission Corridors and Offsite Areas

Existing Conditions

All transmission corridors, intake and discharge water pipelines, railroad spurs, access road, switchyard, and pump house are located on the Hanford Reservation. Therefore, the terrestrial ecology information given in Section 4.2.4.1 also applies to these areas. Except for the pipeline crossing the old Hanford townsite and riparian community, these corridors do not cross any other significant biological community types.

Environmental Impacts

The environmental impacts resulting from the construction of the transmission corridors are contained in Appendix J prepared by the Bonneville Power Administration.

The estimated areas of land needed for offsite facilities are as follows: 54 ha (134 acres) for intake and discharge pipeline, 19 ha (42 acres) for the railroad, and 21 ha (52 acres) for access roads.

The construction of access roads, a railroad spur, and a pipeline from the site to the Columbia River will destroy the plants and kill many of the small animals inhabiting these rights-of-way. The access roads and railroad spur will remain at least for the life of the S/HNP, but the pipeline will be covered and the area revegetated. The applicant has agreed to select a pipeline route so that it will not destroy any of the trees in the old Hanford townsite. Therefore, the disturbance to the plants and animals will be temporary for the duration of construction activities and until the corridor is revegetated.

The staff concludes that the impacts of constructing and utilizing these corridors on the biological communities will be minor, any detrimental effects will be temporary, and that no mitigative measures are necessary.

4.2.5 Endangered and Threatened Species

4.2.5.1 Existing Conditions

Vegetation

Rorippa calycina var. columbiae, a candidate for listing as threatened or endangered by the U.S. Fish and Wildlife Service (U.S. Fish and Wildlife Service, 1980), has twice been reported in the area of the intake structure (S/HNP, ASC/ER, 1981; Fickeisen et al., 1980) at the Hanford Slough. The species was found during surveys on April 10, 1981 from the Hanford Slough downriver of the intake location. The population was limited to a narrow strip of shoreline above the winter high-water line on cobble and sand substrate. Over 100 small plants were seen scattered along approximately 1.6 km (1 mi) of shoreline. They were in bloom and some had nearly mature fruits (S/HNP ASC/ER, 1981). In 1980, the plant was also reported just north of the intake structure (Fickeisen et al., 1980). The Washington Natural Heritage Program 1981 list of endangered, threatened, and sensitive vascular plants (Washington Natural Heritage Program, 1981) recognizes Rorippa calycina var. columbiae as threatened. The Washington State Department of Natural Resources is in the process of adopting this list. Astragaulus sclerocarpus, which is common in much of the Hanford Reservation, and Cryptantha leucophaea, which is found in sand blowouts of the proposed project site, are recognized as sensitive by the Washington Natural Heritage Program (S/HNP ASC/ER, 1981; Washington Natural Heritage Program, 1981). The designation "sensitive" includes species with small populations or localized distribution within the State whose populations and habitats will be jeopardized if current land use trends continue.

Terrestrial Wildlife

Two animal species listed as threatened or endangered by the U.S. Fish and Wildlife Service are known to occur within the Hanford Reservation (Fickeisen et al., 1980): bald eagles and peregrine falcons. Bald eagles are endangered throughout the 48 coterminous states except in Washington, Oregon, Minnesota, Wisconsin, and Michigan, where they are listed as threatened (43 CFR 4310-55). The peregrine falcon is considered endangered throughout the United States.

Bald eagles are winter residents of the Hanford Reservation, although sporadic nesting attempts have been made in the past. They generally arrive in mid-November and are present through February (Fitzner and Hanson, 1979). During this period, bald eagles can be found perching in trees along the Columbia River. The roosting site most commonly used is the old Hanford townsite, located 1.2 km from the proposed pumphouse location. During the winter, bald eagles rely on waterfowl and salmon carcasses that are found in the Hanford Reach of the Columbia River (Fitzner and Hanson, 1979). The wintering population of the Hanford Reservation has increased over the years from 2 to 6 birds in the 1960s to over 20 birds in the late 1970s (Fitzner and Hanson, 1979).

Even though the bald eagle occurs primarily along the Columbia River, this raptor also uses sagebrush/cheatgrass habitat for hunting. Presently, little data exists on daily movement patterns of bald eagles on the Hanford Reservation and little is known about their use of various habitats for feeding and nesting.

Peregrine falcons require a nesting cliff greater than 30 m in height, within 1 km (0.6 mi) of water, and an open foraging area (Bond, 1946; Call, 1978). Relatively little of this type of habitat exists within the Hanford Reservation and nesting peregrines have not been reported in this area. The only published record of peregrine falcons in the Tri-Cities area is of winter migrants (Fickeisen et al., 1980). This indicates that winter or migratory sightings of the falcons can be expected near the proposed project. However, these sightings are not viewed as significant because peregrines range over an area of up to 40 km per day, and the Hanford Reservation does not appear to be prime habitat for this species.

Aquatic Species

There are no threatened or endangered aquatic organisms on Federal lists that are known to occur within the Hanford Reach (S/HNP ASC/ER, 1981).

The Hanford Reach provides important habitat for several species of concern (S/HNP ASC/ER, 1981), as listed by the Washington Department of Game. These species, the giant Columbia River limpet (Lanx nuttalli nuttalli) and the great Columbia River spire snail (Lithoglyphus columbiana) were once found throughout the Columbia and Snake Rivers. This range is now apparently restricted to the Hanford Reach (Fickeisen et al., 1980). In addition, all species of Pacific salmon (Oncorhynchus spp.) and the steelhead trout (Salmo gairdneri) are considered important species. Several races of salmon depend on the Hanford Reach, which includes the last remaining mainstem spawning areas for fall upriver bright Chinook salmon (O. tshawytscha) (S/HNP ASC/ER, 1981).

4.2.5.2 Environmental Impacts

Vegetation

During construction of intake and discharge structures, the habitat (cobble and sand substrate) of Rorippa calycina var. columbiae, a candidate for listing as threatened or endangered by the U.S. Fish and Wildlife Service (dunes, sage areas, sandy barrens) Service, may be affected. Astragaulus sclerocarpus and C. lueophae habitat may also be adversely affected by project construction and related activities.

Terrestrial Wildlife

No impacts to threatened or endangered wildlife species will result from the development of S/HNP.

Aquatic Species

No impacts to threatened or endangered wildlife species will result from the development of S/HNP.

4.2.5.3 Mitigating Measures

Disturbance of shoreline areas during construction of intake and discharge structures should be monitored and minimized to reduce the disturbance of Rorippa calycina var. columbiae and the noted aquatic species of concern.

Should this species become listed as threatened or endangered prior to construction, formal consultation with the U.S. Fish and Wildlife Service pursuant to the provisions of the Endangered Species Act, as amended (16 USC 1536), would be required. Where possible, construction activities should be directed to avoid disturbing Astragaulus and Cryptantha habitat areas.

4.2.6 SOCIOECONOMICS

The study area chosen for socioeconomic analysis included Benton and Franklin counties and six cities in the counties. This area and the jurisdictions within constitute the location of most of the population expected to be associated with the proposed project and would receive the most significant impacts. The choice of this study area does not preclude the possibility of impacts in other nearby areas.

4.2.6.1 Employment and Income

Existing Conditions

Employment

Based on 1981 Washington State Employment Security Department (WESD) (1981) estimates, activities related to the Hanford Reservation, agriculture, and food processing constitute the primary economic base of the Tri-Cities Standard Metropolitan Statistical Area (SMSA) (Benton and Franklin County). Dominant sectors in the economy include services (26 percent of employment), contract construction (17 percent), wholesale and retail trade (19 percent), and government (17 percent). Together, these four sources of employment constitute 79 percent of the jobs. Numerically, these four sectors have also accounted for the major part of the increase (86 percent) in number of jobs since 1973. Increases in employment in the Tri-Cities, as elsewhere in the country, were greater than increases in population in recent years as birth rates declined and the labor force participation of the population, especially women, increased. The percentage increase in employment in the Tri-Cities area was considerably greater than for "the state as a whole" or the United States.

Since 1973, the primary reasons for the dramatic increase in employment have been the Hanford Reservation related activities of the U.S. Atomic Energy Commission (AEC) and successor agencies and the development of Washington Public Power Supply System (WPPSS) Nuclear Power Plants 1, 2, and 4. From 1977 to 1980, WPPSS employment increased by 4,010 persons (37.0 percent). While Federally funded employment generated by DOE remained relatively constant during this period, it was nonetheless a dominant part of the employment base (20 to 25 percent). These two categories of employees accounted for nearly one-third of all employment in the Tri-Cities SMSA during this period (Washington State, Employment Security Department, 1981). Support activities and local government also increased rapidly during this period to provide goods and services for the expanding population base.

Employment and industry in an economy may be classified into basic and nonbasic (or secondary) categories. Basic activities are those activities producing goods or services that are exported from the area. Power-generating facilities like WPPSS plants, the power from which is transmitted outside the area, are basic activities. Federal employment serving the nation rather than the region is basic. The relationship between basic and secondary employment in the Tri-Cities was recently estimated to be 1:0.85 (Williams, Kuebelbeck and Associates, 1981). An earlier study estimated the relationship at nearly the same, 1:0.8 (Community Development Services, 1979). If one assumes that the ratio 1:0.8 is correct, the number of basic employees in the Tri-Cities SMSA was about 31,700 in 1980. Employment by DOE and WPPSS, all basic, constituted 59 percent of basic employment.

Employment for construction of WPPSS nuclear power plants, estimated at 9,790 in 1981, is expected to decline to a 620-person operational work force in the next 3 years. This reduction, 16 percent of total employment (based on 1980) and 29 percent of basic employment, will result in overall reduced economic activities unless other developments or other sectors grow significantly. Construction of the S/HNP power plant during the 1983-93 period would ease, but not eliminate, the effect of the WPPSS employment reduction as WNP-1 and -2 are completed and if WNP-4 is terminated (1981). Employment by the Federal government seems unlikely to provide relief since efforts to reduce the size of the public sector continue. Other projects provide some potential for development, but their fates and timing are uncertain. Other such projects include:

(1) Basalt Subsurface Hazardous Waste Disposal Site--Hanford Reservation, 3,000 work force, could start 1987 if this site, one of three considered nationally, is chosen.

(2) Priest Rapids and Wanapum Dam Expansion Project--Grant County, within commuting distance, 1,100 employees at peak, scheduled to start in 1983 and be completed in 1988.

(3) Others--A grain terminal, food packaging plants, ethanol distilling, electronic manufacturers, etc. Too indefinite to predict effect on employment in the Tri-Cities area.

Based on available information, employment in the study area is expected to decline throughout the 1980s. The employment level in 1981 is not expected to be achieved again until the mid-1990s. This conclusion assumes normal growth in employment in the economy other than basic and secondary employment related to power plant construction and operation. The reduction in employment would be less severe with development and operation of S/HNP than without it.

Income

Per capita personal income in the Tri-Cities SMSA was $9,705 in 1979, the latest year of record (U.S. Department of Commerce, Bureau of Economic Analysis, 1981). The area ranked 40th among all 273 SMSA's in the nation. The average per capita income of the Tri-Cities exceeded the State of Washington average by $174 (Washington State, Department of Revenue, 1981) and the national SMSA average by $386 (U.S. Department of Commerce, Bureau of Economic Analysis, 1981).

The principal sources of income in the study area are services (25 percent), construction (23 percent), manufacturing (17 percent), and government (11 percent). Although the data are for 1978, the distribution of income would be approximately the same in 1981 (U.S. Department of Commerce, Bureau of Economic Analysis, 1980).

For the future, the dominant role of the construction industry is expected to decline with completion of the WPPSS projects. Construction of S/HNP would lessen the decline in construction income. Income in some secondary sectors, (e.g., trades and services) would also likely suffer.

Environmental Impacts

Employment

The focus here is on changes in existing economic conditions in the study area that would result from development and operation of S/HNP.

The procedures used in this study to evaluate likely impacts begin with the employment effect of S/HNP. A baseline employment level without S/HNP is projected and then a future with S/HNP is projected for comparison. The driving force for alternative scenarios is construction of the WPPSS power plants, because of the very large labor force involved.

Two scenarios were considered most relevant for estimating the likely employment impact of development and operation of S/HNP. Employment projections are translated into population projections in Section 4.2.6.2. In this section, the differences in expected employment levels with S/HNP compared with its absence are used to project effects on the economic base, income, and government and fiscal conditions.

- Scenario 1 - WNP-1 and -2 will be developed on schedule. S/HNP would not be developed.

- Scenario 4 - WNP-1 and -2 will be developed on schedule. S/HNP would be developed over the 1983-1993 period.

In the Potential Site Study (URS Company, 1981), two additional scenarios (#2 and #3) considered continued construction of WNP-4. Since that study was completed, WNP-4 has been terminated.

Puget Sound and Light Company Power Project Employment--Development of the Puget Sound Power and Light Company S/HNP is scheduled to begin construction in 1983, and the two units are to become commercially operable in 1991 (Unit 1) and 1993 (Unit 2). The S/HNP would have an annual work force of approximately 571 in 1983, a peak work force of 4,617 in 1988, and an operational work force of 345 by 1993 and throughout the life of the project (Table 4.11). Approximately 10 percent of the labor would be nonmanual, whereas 90 percent would be manual labor during the peak construction years (1983 to 1990).

Scenario 1--Scenario 1 represents the projection of work force requirements related to construction of a nuclear power plant on the Hanford Reservation without S/HNP (Table 4.12). In October 1981, WPPSS decided to suspend construction of WNP-4 for financial reasons. At the time of the decision, WPPSS indicated the desire to restart construction on WNP-4 by July 1983, given a favorable financial climate. A few months later, WPPSS directors terminated WNP-4 in the face of continuing financial difficulties. Scenario 1 was developed to identify the work force requirements related to development of a

Table 4.11 Estimated onsite S/HNP personnel[1]

Year	Manual	Bechtel Non-Manual	NESCO Non-Manual	Security	PSP&L O&M	Total
1983[2]	500	50	13	6	2	571
1984	1,085	125	17	26	4	1,257
1985	2,005	175	22	34	6	2,242
1986	3,020	250	28	66	9	3,373
1987	3,810	330	28	90	29	4,287
1988	4,035	380	31	116	55	4,617
1989	3,450	405	33	116	104	4,108
1990	2,075	330	28	116	168	2,717
1991[3]	1,155	212	19	116	175	1,677
1992	200	87	19	116	179	601
1993[4]	---	---	---	116	229[5]	345

(1) All entries are annual averages.
(2) Start of construction, January, 1983.
(3) Commercial operation Unit 1, January, 1981.
(4) Commercial Operation Unit 2, January, 1983.
(5) Additional personnel to support refueling included at 50 full-time equivalent employees per year.

Table 4.12 Onsite work force requirements for nuclear power plant construction, Hanford Reservation, Scenario 1 and Scenario 4

			Scenario 1		Scenario 4
Year	WNP 2	WNP 1	Total [1]	S/HNP	Total
1980[2]	2,400	4,160	6,560	---	6,560[1]
1981[3]	3,280	6,510[1]	9,790	---	9,790
1982	3,200	5,350	8,550	---	8,550
1983	1,840	3,340	5,180	570	5,750
1984	300	2,010	2,310	1,260	3,570
1985	300	800	1,100	2,240	3,340
1986	300	320	620	3,370	3,990
1987	300	320	620	4,290	4,910
1988	300	320	620	4,620	5,240
1989	300	320	620	4,110	4,730
1990	300	320	620	2,720	3,340
1991	300	320	620	1,680	2,300
1992	300	320	620	600	1,220
1993	300	320	620	350	970

(1) Includes an unknown number of workers on WNP 4 because work force estimates for WNP 1 and 4 were reported as a combined total by WPPSS. The projected division of work force requirements after 1981 are based on information from the sources identified below.

(2) 1980 estimates reflect a 22-week labor-management dispute during which the manual work force was substantially reduced. During the first quarter of 1980 there were approximately 8,460 manual and nonmanual workers on site.

(3) 1981 estimates reflect the slowdown and controlled termination on WNP 4. During the second quarter of 1981, there were approximately 11,100 manual and nonmanual workers on site. The work force on WNP 4 during the controlled termination is not shown because fewer than 10 workers were reported on the project in November 1981.

Sources: Washington State Employment Security Department, July 1981; WPPSS and Bechtel projections, August 1981.

Waterhouse and Wagner, Bechtel, personal communication, October, 1981, January 1982.

nuclear power plant on the Hanford Reservation, assuming WNP-4 is permanently terminated. Although it is realized that a work force would be required at WNP-4 to abandon the site, no data were available at the time of this study to indicate the potential work force required for termination. Therefore, to avoid unnecessary speculation, work force requirements were not projected for WNP-4 under Scenario 1. Peak work force employment related to completion of WNP-1 and -2 would occur during 1981 and 1982 for Scenario 1 (Table 4.12). This peak employment would be 9,790 employees and would decline from 1981 until commercial operation of both units was under way in 1986. Then, an operational work force estimate of 620 employees would be required at the WPPSS sites.

Scenario 4--Scenario 4 identifies work force requirements for nuclear power related projects at the Hanford Reservation with completion of WNP-1, -2, and S/HNP, and termination of WNP-4 (Table 4.12). As indicated in the discussion of Scenario 1, the peak work force requirement would be realized in 1981, 9,790 employees. Scenario 4 identifies more stable work force requirements for the nuclear-related projects at the Hanford Reservation than Scenario 1. The overall work force requirement, ranging from 5,750 in 1983 to 3,340 in 1990, is substantially higher than the work force requirements for Scenario 1. The operational work force is identified in 1993 at 970 employees, the combined requirements of WNP-1, WNP-2, and S/HNP.

Figure 4.22 shows the work force requirements for Scenarios 1 and 4, as well as the work force requirements for Scenarios 2 and 3, which included completion of WNP-4.

Tri-Cities SMSA Employment--Scenario 1 and Scenario 4 projections for nuclear power plant-related employment (manual and nonmanual) were analyzed for their overall effect on the Tri-Cities SMSA future employment growth. The projections presented below are used in this study to identify socioeconomic and transportation concerns. The Tri-Cities SMSA employment projections are based on the following assumptions:

(1) Employment associated with nuclear power plant development will remain as a leading factor in economic activity in the Tri-Cities SMSA for the foreseeable future (Washington State, Employment Security Department, 1981).

(2) Other than the PSP&L S/HNP, no major construction projects are planned within worker commute distances of the Tri-Cities SMSA that would employ persons in the manual and nonmanual categories currently associated with nuclear power plant development (see "Other Projects" below).

(3) Employment related to nuclear power plant construction and operation may be considered a basic activity resulting in secondary employment in nonbasic industries. The basic to nonbasic employment multiplier used for the analysis has been established as 1:0.85. [The actual basic to non-basic ratio experienced in the Tri-Cities SMSA from 1976 to 1980 has been calculated to be a 1:0.85 secondary employment multiplier (Williams, Kuebelbeck and Associates, 1981) and the secondary employment multiplier calculated during the first three years of the WPPSS monitoring study was 1:0.8 (Community Development Services, 1979)].

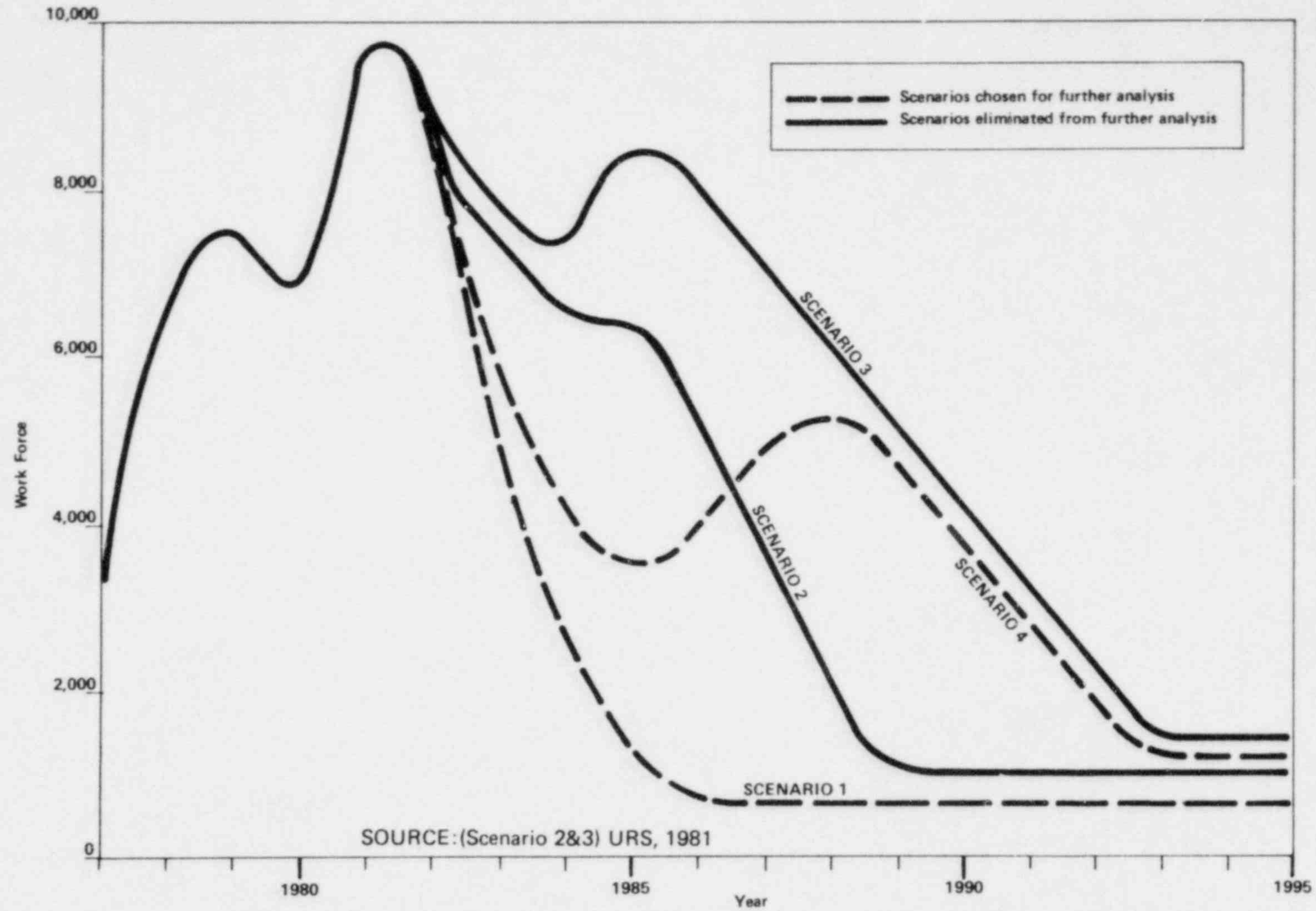


Figure 4.22 Work force requirements for nuclear power plant development at Hanford

(4) The remainder of the Tri-Cities SMSA nonagricultural wage and salary employment (employment excluding nuclear power plant related development) will grow at an estimated 2.4 percent annual growth rate. (The compounded annual employment growth rate for the Tri-Cities SMSA between 1980 and 2000 has been projected at 2.4 percent by both Bonneville Power Administration, 1979, and Benton-Franklin Governmental Conference, 1980.)

The employment multiplier discussed above was applied to the nuclear power plant construction employment in Scenario 1 to yield a total nuclear employment estimate (Table 4.13) whereas a 2.4 percent growth rate was applied to the balance of the Tri-Cities SMSA nonagricultural wage and salary employment. The total employment level then, based on Scenario 1, shows a downward trend from 1981 (61,720) to a low in 1985 (49,990), with a return to existing total employment levels in approximately 1995 (61,960). Note that the sharp drops in total employment (10,500 jobs) between 1982 and 1985 result from the completion of the WNP 1 and 2 and the subsequent loss of employment related to construction of the nuclear power plant (Table 4.13). The decline in employment reflects the dependence of the Tri-Cities SMSA economic base on the nuclear power plant construction projects. This decline of 10,500 jobs in a 3-year period can be compared with the increase of nearly 14,000 in total employment from 1977 to 1981. This rapid increase over a 4-year period primarily resulted from the large work force requirements at the WPPSS projects.

Total employment shown in Table 4.14, Scenario 4, was projected based on the above assumptions in the same manner as the total employment forecasted in Table 4.14 (Scenario 1). Scenario 4 employment is equal to that projected in Scenario 1 until the year 1983, when the S/HNP is scheduled to begin construction activity. Total employment projections fluctuate between 53,430 and 61,480 until 1995 (Table 4.14). This fluctuation is a result of varying work force requirements for development of nuclear power projects at the Hanford Reservation (WPPSS and S/HNP). The peak employment in Scenario 4 would occur in 1989 (61,480) and then decline steadily to a low of 58,890 in 1992 as the work force requirements at S/HNP become significantly reduced to operational levels. Figure 4.23 shows the total employment difference between Scenario 1 and Scenario 4.

Other Projects--The employment and population projections for the study area have been based on the assumption that no other major construction or industrial development projects would take place in the Tri-Cities SMSA during the construction of S/HNP. This assumption was made because of the uncertainty of the timing and work force requirements of other major projects that are in the planning and proposal stage for the Hanford Reservation and the Tri-Cities SMSA. The following projects (previously mentioned in the section on Existing Conditions) would potentially affect the previously discussed employment projections.

(1) Basalt Subsurface Hazardous Waste Disposal Site--This project could have a work force requirement of approximately 3,000 employees and would be located on the Hanford Reservation. However, due to uncertainties in the timing for development and the location of the project (three sites are being considered within the United States), this project was not considered in the analysis. The existing time schedule for development of the facility calls for the Nuclear Regulatory Commission to grant a

Table 4.13 Projected employment growth in Tri-Cities SMSA with WPPSS WNP-1 and -2, Scenario 1

Year	Nuclear Power Projects Related Employment at WPPSS and Secondary Employment (1.85 multiplier)	Balance of Benton-Franklin Nonagricultural Wage and Salary Employment at 2.4% Growth	Total Employment
1981	18,110	43,610	61,720
1982	15,820	44,660	60,480
1983	9,580	45,730	55,310
1984	4,270	46,830	51,100
1985	2,040	47,950	49,990
1986	1,150	49,100	50,250
1987	1,150	50,280	51,430
1988	1,150	51,490	52,640
1989	1,150	52,730	53,880
1990	1,150	54,000	55,150
1991	1,150	55,300	56,450
1992	1,150	56,630	57,780
1993	1,150	57,990	59,140
1994	1,150	59,380	60,530
1995	1,150	60,810	61,960
1996	1,150	62,270	63,420
1997	1,150	63,760	64,910
1998	1,150	65,290	66,440
1999	1,150	66,860	68,010
2000	1,150	68,460	69,610

Source: 1981 total employment represents fiscal year averages estimated by Washington State, Employment Security Department, 1981.

construction permit by January 1988 with completion of the project expected in 1996. If this project were to be developed at the Hanford Reservation during the same time that the S/HNP construction was under way, the employment and population projections for the Tri-Cities SMSA would most likely increase and result in net in-migration.

(2) Priest Rapids and Wanapum Dam Expansion Project--This construction project would require a peak work force of 1,100 and would be developed over a 3-1/2-year span. The project sponsor, Grant County PUD [located within worker commute distances of Tri-Cities, about 74 km (46 mi) one-way], originally had a proposed development schedule beginning in 1981 and

Table 4.14 Projected employment growth in Tri-Cities SMSA with WPPSS WNP-1 and -2 and S/HNP, Scenario 4

Year	Nuclear Power Projects Related Employment at WPPSS and Secondary Employment (1.85 multiplier)	Balance of Benton-Franklin Nonagricultural Wage and Salary Employment at 2.4% Growth	Total Employment
1981	18,110	43,610	61,720
1982	15,820	44,660	60,480
1983	10,640	45,730	56,370
1984	6,600	46,830	53,430
1985	6,180	47,950	54,130
1986	7,380	49,100	56,480
1987	9,080	50,280	59,360
1988	9,690	51,490	61,180
1989	8,750	52,730	61,480
1990	6,180	54,000	60,180
1991	4,260	55,300	59,560
1992	2,260	56,630	58,890
1993	1,790	57,990	59,780
1994	1,790	59,380	61,170
1995	1,790	60,810	62,600
1996	1,790	62,270	64,060
1997	1,790	63,760	65,550
1998	1,790	65,290	67,080
1999	1,790	66,860	68,650
2000	1,790	68,460	70,250

Source: 1981 total employment represents fiscal year averages estimated by Washington State, Employment Security Department, 1981.

completing in 1984. Licensing and permit processes have delayed this project. The project is now expected to start in 1983 and be completed by 1987. Due to the uncertainty associated with the start date, the relatively small construction peak work force compared to S/HNP, the short duration of the peak work force (6 months), and the size of the construction work force located in surrounding areas of this proposed project, it was assumed that the net effect of this project would be absorbed in the projected 2.4 percent annual growth rate for Scenarios 1 and 4 and would not have a significant effect on the total employment projections.

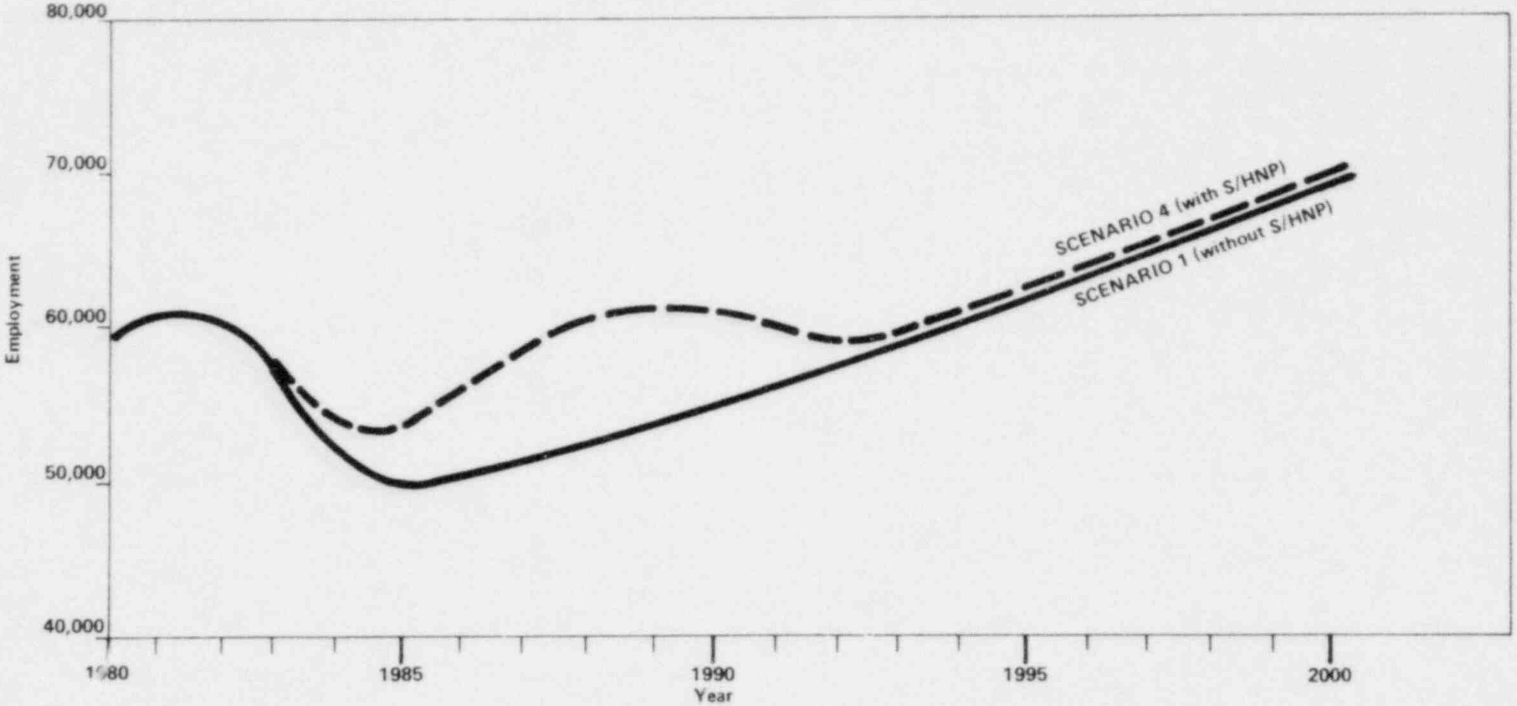


Figure 4.23 Projected nonagricultural wage and salary employment in the Tri-Cities SMSA

(3) Creston Generating Facility--This coal-fired electric generating facility has been proposed for location near the City of Creston, located approximately 233 km (145 mi) north of the Tri-Cities area. The proposed construction schedule is nearly simultaneous with the S/HNP schedule and could potentially draw from the construction labor supply presently located in the Tri-Cities SMSA. This could cause out-migration for a short period of time during initial construction of the Creston facility and then in-migration during buildup of the S/HNP. It is unlikely that workers would commute 467 km (290 mi) a day, round trip from the Tri-Cities to Creston. The overall effect would most likely not result in a net in-migration to the Tri-Cities SMSA. Labor force requirements are often a concern when there are two competing projects of a magnitude of the Creston and S/HNP facilities; however, due to the large labor force already present in the Tri-Cities SMSA and the ability of the labor unions to supply specialized craft to major projects, there appears to be little concern by the labor unions over the availability of labor supply.

(4) Other Projects--A variety of other projects, including food packaging plants, ethanol distillery, a grain terminal, electronic manufacturers, etc., have been discussed as potential industries that may locate in the Tri-Cities SMSA during the 1980s. However, these projects, along with recent annexations by some of the cities, are in the early stages of development and their actual impacts on employment in the area and are indefinite at this time. Any large development requiring a large c onstruction work force or a large operational work force would increase the employment projections presented above for the Tri-Cities SMSA.

(5) Accumulative Effect--If the above projects all had peak work force requirements that coincided with that of S/HNP, significant in-migration would be expected in the Tri-Cities metropolitan area due to the demonstrated locational preference and infrastructure availability of the cities. However, such an occurrence is considered unlikely at this time and was therefore dropped from further analysis.

Based on the above assumptions for employment projections, it does not appear likely that the Tri-Cities SMSA would experience in-migration and employment growth during the development of the S/HNP. Through the mid- to late 1970s, the Tri-Cities metropolitan area experienced rapid growth primarily due to the WPPSS project and DOE projects. However, the above information suggests that with the decline in WPPSS work force requirements there will be a decline in employment levels within the Tri-Cities SMSA throughout the 1980s. The dependence of the Tri-Cities area on Hanford labor requirements over the 1970s has resulted in a situation where local employment levels can be significantly affected by long-term decreases in Hanford employment. The potential for such declines in employment due to the Tri-Cities dependence on the Hanford Reservation has drawn concern and has been identified in previous studies (Benton County Planners Department, 1981; Washington State, Department of Commerce and Economic Development; Washington State, Employment Security Department, 1981). The above projections (Scenario 4 for Tri-Cities employment and population growth with the S/HNP) suggest less severe declines in employment and population than without the project. Although employment and population levels would still decrease, the result would be a steadier economic atmosphere in the Tri-Cities SMSA with the S/HNP than without it.

Employment Distribution--S/HNP-related employees were not distributed to study area communities, rather, the total S/HNP-related population (S/HNP employees and families) was distributed to study area communities based on analyses of location of WPPSS workers and historical population distribution. The geographic distribution of S/HNP employment and population is discussed in Section 4.2.6.2, Population.

Income

The principal source of impacts on income in the study area would be wage and salary payments to employees engaged in development and operation of S/HNP. An additional source would be local expenditures for goods and services by plant constructors and owners. Study area spending and income would be swelled by both the initial expenditures and by subsequent spending in the area. An income multiplier process will operate. As indicated previously, although the investment and operational expenditures by PSP&L would be new funds in the area, they would replace in part expenditures made by WPPSS projects in recent years. Private income impacts are considered in this section, revenues to local governments are considered in the Government Finance section.

Payrolls--Payroll during the 1983-1992 construction period would total $1,043 million, or $104.3 million per year (Table 4.15). This average is about 10 percent of all wages paid in Benton and Franklin Counties in 1980 (Washington State, Employment Security Department, 1981). Peak payroll for the project would correspond with peak employment in 1988 when employees would be paid $194.5 million. Construction employees would receive, on the average, $41,968 per year (1981 dollars), or $3,497 per month. A breakdown of classes of employment during construction and annual and monthly payroll rates (1981 dollars) follows:

	Percent of total employees	Average Payroll	
		Annual	Monthly
Manual	86	$44,073	$3,673
Nonmanual	10	31,359	2,613
Security	2	18,729	1,561
PSP&L	2	30,174	2,514

During operations, 1991-2020 or longer, an annual payroll of $9.1 million (1981 dollars) is projected for the 345 person work force (Table 4.15). Thus, the average payroll would be $26,325 per year, or $2,194 per month. The operational work force would be two-thirds operation, maintenance and refueling (annual income $30,174) and one-third security (annual income $18,729). On the average, rates of pay associated with S/HNP project would be considerably higher than average rates in the study area. For comparison, average monthly payrolls per person in the Tri-Cities SMSA in 1980 were $1,390 for all wage and salary workers. Average construction industry payrolls were $1,934

Table 4.15 Payable during development and operation of the S/HNP Tri-Cities area, 1983-2020

Year	Construction Man-Years	Construction Payroll[1]	Operation Man-Years	Operation Payroll[1]
		(1,000)		(1,000)
1983	571	$24,197	---	$ ---
1984	1,257	52,887	---	---
1985	2,242	95,369	---	---
1986	3,373	143,331	---	---
1987	4,287	181,699	---	---
1988	4,617	194,546	---	---
1989	4,108	171,088	---	---
1990	2,717	109,909	---	---
1991	1,386	58,144	345	9,082
1992	306	12,152	345	9,082
1993	---	---	345	9,082
1994-2020	---	---	345/yr.	9,082/yr.
Total	24,864	$1,043,324	10,350	$272,460
Average/Yr.	2,486	$ 104,332	345	$ 9,082
Average/ Employee (dollars)	---	$ 41,968	---	$ 26,325

(1) 1981 dollars.

Source: Puget Sound Power and Light Company, 1981. Payrolls adjusted from 1980 to 1981 dollars on basis of Consumer Price Index for Seattle-Everett.

per month, whereas the manufacturing industry paid $1,651 per month. It would be expected that, other things like family size, age and place of residence remaining equal, the S/HNP employees would spend more than the average employee in the area. The difference in spending by S/HNP employees would not be proportional to their higher pay rates, however, because they would be expected to pay more in taxes and save more than other employees in the area.

Spending of Payrolls--Projections of spending depend on assumptions regarding tax payments and savings rates. Taxes paid out of wages and salaries determine income available for savings and spending (disposable income). Savings from disposable income leaves amounts available for consumption spending. Tax and savings (or consumption spending) rates vary considerably among areas and over time and are not known for the study area. Therefore, estimates of the magnitude of spending are estimated here, using two assumptions: (1) a 35.0 percent tax rate, and (2) an 8.0 percent savings rate out of disposable income.

Applying these assumptions, consumption spending (mostly local) would be $14.5 million in 1983 (1981 dollars), would peak at $116.8 million in 1988, and average $62.6 million during the construction period of 1983-1992. Consumption expenditures per employee (and family) would be $25,180 (1981 dollars) on the average during the construction period.

During operation of S/HNP, starting in 1991, spending of the $9.1 million annual payroll would be on the order of $5.9 million (1981 dollars). The spending rate per employee and family would be about $17,240.

The types of expenditures made by families can be anticipated to some extent. Based on national averages (U.S. Department of Commerce, Bureau of Economic Analysis, 1979), major categories of personal consumption spending include food, beverages and tobacco (21.3 percent), housing (16.0 percent), household operation (14.5 percent), transportation (14.1 percent), medical care (9.7 percent), and clothing accessories and jewelry (7.8 percent). While these percentages are not entirely applicable because of the differential effects of inflation since 1979 and because they apply to the entire country, they nonetheless indicate a priority of spending patterns. Using these percentages and the spending amounts previously estimated for the S/HNP work force results in the following estimates of annual spending by type.

Commodities	Construction Period	Operation Period
Food, beverages, tobacco	$ 13,334	$ 1,257
Housing	10,016	944
Household operation	9,077	856
Transportation	8,827	832
Medical care	6,072	572
Clothing accessories, jewelry	4,883	460
Other	10,391	979
Total	$ 62,600	$ 5,900

Secondary, or multiplier, spending effects would be expected to result from initial spending of the payrolls. The multiplier effect would be subject to many variable factors, but could well be on the order of three times the spending from payrolls. Much of the initial payroll expenditure would be expected to "leak" from the area for imports of goods and services.

Local Purchases of Goods and Services by S/HNP--Most of the plant investment, aside from local labor services, would be purchased from outside the study area. The highly specialized nature of the equipment precludes local availability. Other than the purchase of land (from the U.S. Department of Energy), local purchases during construction appear to be slight (S/HNP ASC/ER, 1981).

Annual purchases for supplies and materials during operation of S/HNP have been estimated by the plant owner at $3.2 to $3.6 million (S/HNP ASC/ER, 1981). It is estimated that 10 to 20 percent of this purchase will be local. Annual purchases of services are estimated at $6 million, with 4.8 million local. These payments, like those for labor services, would result in additional local spending and incomes because of the "multiplier" effect. Annual fuel purchases during operations have been estimated at $244 million. These purchases, although not local, would be expected to be subject to local sales taxes and property tax.

Mitigating Measures

Employment

Mitigation is not proposed by the applicant because adverse effects to the residents of the study area as a result of employment at the S/HNP are not foreseen. Rather, the S/HNP would provide jobs which otherwise would not exist in the study area.

Income

Mitigation is not proposed by the applicant because adverse impacts to the residents of the study area are not expected. On the contrary, income from the development and operation of S/HNP would improve the general income level of the study area.

Based on the above analysis, the staff does not expect any unavoidable adverse impacts to occur.

4.2.6.2 Population

Existing Conditions

Population Growth

Population in the Tri-Cities SMSA (Benton and Franklin Counties) in 1980 was 144,469, with Benton County accounting for 109,444 people (75.8 percent) and Franklin County for 35,025 (24.2 percent). Within Benton County, the cities of Richland and Kennewick had 1980 populations of 33,578 and 34,397, respectively. In Franklin County, the City of Pasco had a 1980 population of 17,944. Table 4.16 gives the historical populations of the Tri-Cities SMSA from 1970-1981.

Between 1970 and 1980, the Tri-Cities SMSA population grew 54.8 percent, with Benton County growing 62.0 percent and Franklin County 35.7 percent. Of the absolute population growth in the Tri-Cities SMSA between 1970 and 1980, 82.0 percent occurred in Benton County and 18 percent in Franklin County.

Table 4.16 Tri-Cities SMSA population, 1970-1981

Place	1970[1]	1976[2]	1980[3]	1981[2]	1979-1980 Percent Growth	1979-1980 Share of Total SMSA Growth[4]
Benton County	67,540	78,700	109,444	113,400	62.0	82.0
Unincorporated Areas	20,907	21,257	32,655	34,947	56.2	23.0
Incorporated Areas	46,633	57,443	76,789	78,453	64.7	59.0
Benton City	1,070	1,422	1,980	2,150	85.0	2.0
Kennewick	15,212	21,301	34,397	34,700	126.1	38.0
Prosser	2,954	3,150	3,896	4,120	31.9	2.0
Richland	26,290	30,009	33,578	33,700	27.7	14.0
West Richland	1.107	1,561	2,938	3,783	165.4	4.0
Franklin County	25,816	27,500	35,025	36,700	35.7	18.0
Unincorporated areas	10,153	10,510	14,619	15,975	44.0	9.0
Incorporated areas	15,663	16,990	20,406	20,725	30.3	9.0
Pasco	13,920	14,618	17,944	18,200	28.9	8.0
Tri-Cities SMSA	93,356	106,200	144,469	150,100	54.8	100.0

Sources:

(1) U.S. Department of Commerce, Bureau of Census, 1970
(2) Washington State, Office of Financial Management, 1981
(3) U.S. Department of Commerce, Bureau of Census, 1980
(4) Benton and Franklin Counties share sum to SMSA, and city and unincorporated share sum to SMSA.

Within Benton County, 18.0 percent of total 1970-1980 Tri-Cities SMSA population growth occurred in the City of Kennewick whereas 14.0 percent occurred in the City of Richland. In Franklin County, 8.0 percent of total 1970-1980 Tri-Cities SMSA growth occurred in the City of Pasco whereas 9.0 percent occurred in unincorporated areas. Of the total population growth in the Tri-Cities SMSA between 1970 and 1980, 74.9 percent has occurred since 1976.

This rapid population growth in the last half of the 1970s can be attributed to the rapid growth in nonagricultural wage and salary employment in the Tri-Cities SMSA since 1975 (55.0 percent between 1975 and 1980) (Washington State, Employment Security Department, 1981).

Population Distribution

Table 4.17 gives the 1970 and 1980 population distribution within the Tri-Cities SMSA. In 1980, Benton County accounted for 76.0 percent of total SMSA population and Franklin County 24.0 percent, with Benton County increasing its proportion and Franklin County decreasing its proportion between 1970 and 1980.

Among the cities, only Kennewick and West Richland increased their proportions of total SMSA population between 1970 and 1980. Benton City and Prosser maintained their proportion, whereas Richland's and Pasco's proportions decreased. The change in population distributions, despite across-the-board increases in population, can be attributed in part to the locational characteristics of in-migrating WPPSS workers.

Environmental Impacts

Population Growth

It does not appear likely that the Tri-Cities SMSA would experience net in-migration and employment/population growth during the development of the S/HNP. Through the mid- to late 1970s, the Tri-Cities metropolitan area experienced rapid growth primarily as a result of the WPPSS nuclear projects and DOE projects. However, with the decline in WPPSS work force requirements, there will be a significant decline in employment and population levels within the Tri-Cities SMSA throughout the 1980s. The dependence of the Tri-Cities area on Hanford labor requirements over the 1970s indicates that local employment/population levels can be significantly affected by changes in Hanford employment levels. The potential for such declines in employment and population due to the Tri-Cities dependence on the Hanford Reservation has been identified in previous studies (Washington State, Employment Security Department, 1981; S/HNP ASC/ER, 1981; Williams, Kuebelbeck and Associates, Inc., 1981; Benton County, 1981; Washington State, Department of Commerce and Economic Development, 1978).

The projections of Tri-Cities employment and population growth with the S/HNP suggest less severe declines in employment and population than without the project. The result would be a steadier economic atmosphere in the Tri-Cities SMSA with the S/HNP than without it.

Population impacts on the Tri-Cities SMSA are presented in Table 4.18 and are shown in Figure 4.24 for Scenarios 1 and 4. Scenario 1 (without S/HNP) projected a population decrease of 30,740 persons between 1981 and 1986, after which Tri-Cities' population rose steadily toward 1981 levels in the late 1990s. Scenario 4 (with S/HNP) also projected population decreases, but of a lower magnitude--23,850 persons by 1985. After 1985, population levels

Table 4.17 Tri-Cities SMSA population distribution--local population, 1970-1980

Place	Percent of Total SMSA Population 1970[1]	1980[2]
<u>Benton County</u>	72.0	76.0
Unincorporated areas	22.0	23.0
Incorporated areas	50.0	53.0
Benton City	1.0	1.0
Kennewick	16.0	24.0
Prosser	3.0	3.0
Richland	28.0	23.0
West Richland	1.0	2.0
<u>Franklin County</u>	28.0	24.0
Unincorporated areas	11.0	10.0
Incorporated areas	17.0	14.0
Pasco	15.0	12.0
Tri-Cities SMSA	100.0	100.0

Sources:

(1) U.S. Department of Commerce, Bureau of Census, 1940, 1960, 1970
(2) U.S. Department of Commerce, Bureau of Census, 1980

increased with S/HNP development; peaking in 1990; decreasing slightly until 1993, then steadily increasing throughout the mid- and late-1990s. At no time during construction of S/HNP did population in the Tri-Cities area reach 1981 levels.

The population projections developed for Scenarios 1 and 4 were dependent on the anticipated employment levels for each scenario as described in the preceding section. The assumptions guiding the relationship between employment and population impacts are discussed below:

(1) The overall employment to population ratio for nonagricultural wage and salary employment to total population for the Tri-Cities SMSA is 1:2.4. [This ratio reflects the actual annual average ratio from 1976 to 1981 in the Tri-Cities SMSA and also reflects the nonagricultural wage and salary employment to population ratio projected by BPA, 1979, during the years of 1980 to 2000 (BPA, 1979).]

(2) The ratio of nuclear power plant related employment to population in the Tri-Cities SMSA is 1:2.1. [This ratio reflects the actual change in employment to change in population experienced in the Tri-Cities SMSA from 1976 to 1981 and the average family size identified during the first 3 years of the WPPSS monitoring study (Community Development Services, 1979)].

(3) As total employment declines in the Tri-Cities SMSA in the industry related to nuclear power plant construction, the population associated with that employment (2.1) would leave the area due to a lack of employment within 6 months to one year after the loss of jobs. The assumption that 100 percent of the nuclear power plant construction related population would leave the area after one year represents a worse-case out-migration scenario. The extent of work force and population out-migration would depend on several factors, most notable would be the availability of employment opportunities in the Tri-Cities area versus employment opportunities outside of the Tri-Cities area. At this time, the availability of future employment opportunities is uncertain; however, potential projects that could be developed and lessen worker and population out-migration are discussed in the section on Other Projects.

Changes in projected population for the Tri-Cities SMSA for Scenarios 1 and 4 have been calculated using the above ratios. The nuclear power plant-related (direct) employment was multiplied by the 2.1 multiplier reflecting the smaller family size and more transient nature of construction workers related to nuclear power plants. The 2.4 population multiplier was applied to the balance of the employment (indirect and operations) in the Tri-Cities SMSA to reflect a more permanent work force. The 2.4 population multiplier was applied to operations employment after 1993, reflecting the permanent nature of the operational work force at the nuclear power plant related projects.

Other studies have been conducted to project population changes arising from S/HNP development (S/HNP ASC/ER, 1981; Williams, Kuebelbeck and Associates, Inc., 1981). Although the population projects developed in these studies vary numerically from the Scenario 1 and 4 projections (due primarily to a small difference in projection techniques), they indicate also that no net in-migration would occur from S/HNP development.

Table 4.18 Population projections for the Tri-Cities SMSA

Year	Scenario 1	Scenario 4
1981	150,100	150,100
1982	142,700	142,700
1983	140,410	140,410
1984	129,870	132,100
1985	121,360	126,250
1986	119,360	128,060
1987	120,600	133,340
1988	123,430	139,740
1989	126,340	143,930
1990	129,310	144,930
1991	132,360	142,580
1992	135,480	141,670
1993	138,670	140,660
1994	141,940	143,470
1995	145,270	146,810
1996	148,270	150,240
1997	152,210	153,740
1998	155,780	157,320
1999	159,460	160,990
2000	163,220	164,760

Source: Washington State, Office of Financial Management, 1980

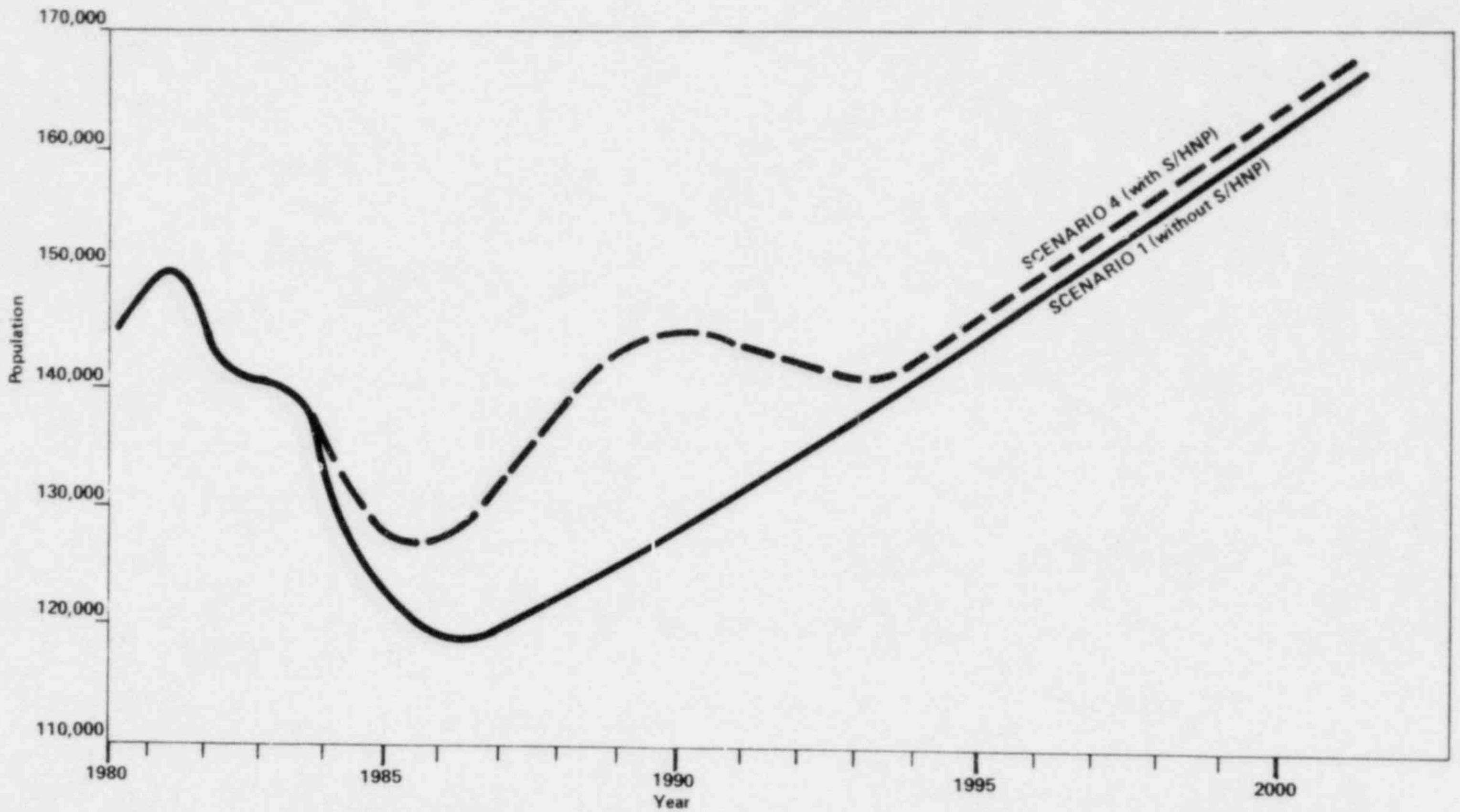


Figure 4.24 Projected Tri-Cities SMSA population

Population Distribution

Table 4.19 presents the anticipated geographic distribution of nuclear power plant related populations and the 1981 actual population distribution for the Tri-Cities SMSA. The WPPSS 3-year monitoring study estimated that 81 percent of the population related to the WPPSS Projects located in Benton County, 16 percent located in Franklin County, and that 3 percent located in other areas (Community Development Services, 1979). The theoretical population distribution produced by a gravity model [the model includes parameters such as travel time, city population, utility capacity, land value, etc. (Williams, Kuebelbeck and Associates, Inc., 1981)] identified a similar distribution without transportation improvements; 79 percent in Benton County, 13 percent in Franklin County, and 8.5 percent in Yakima County (primarily the cities of Sunnyside, Grandview, and Mabton). A different distribution of the population by gravity models was realized when transportation improvements (I-182 project and Horn Area road improvements) were used in the model. With the transportation improvements (primarily affecting travel time to the Hanford Reservation), only 70 percent were distributed to Benton County, with an increase to 24 percent distributed to Franklin County and a decrease to about 6.5 percent distributed to Yakima County. The actual 1981 distribution of population within the Tri-Cities SMSA (which excludes Yakima County) identified 75 percent of the population residing within Benton County and nearly 25 percent located within Franklin County.

The Benton and Franklin County area was selected as the primary area to evaluate socioeconomic, transportation, and economic/revenue distribution concerns. Other studies have indicated that from 3.0 to 8.5 percent of WPPSS workers locate outside the Tri-Cities SMSA (Community Development Services, 1979; Williams, Kuebelbeck and Associates, Inc., 1981). The communities located outside the Tri-Cities SMSA that would be most likely to receive population impacts include Sunnyside, Grandview, and Mabton in Yakima County. However, due to this small distribution outside of the Tri-Cities SMSA, these communities were not included in the primary study area. Although there will be in-migration and out-migration as a result of S/HNP development, the maximum population will not substantially exceed the 1981 population level in the Tri-Cities SMSA. Therefore, it is not anticipated that the population distribution for Benton and Franklin County communities would be significantly different from the 1981 distribution. The anticipated population distribution of S/HNP population, including population associated with WPPSS, is presented in Table 4.19 for each scenario.

Transportation improvements and utility improvements could alter the existing and projected population distributions in the Tri-Cities area. However, because the population projections do not indicate population levels greater than 1981 levels until after S/HNP development, it is likely that the current distribution (1981) would remain relatively unchanged.

Mitigating Measures

Mitigation of population impacts is not proposed because adverse effects to the study area arising from S/HNP-related population changes are not foreseen. The S/HNP, by providing employment opportunities, would decrease the potential for

Table 4.19 Projected population distribution in Tri-Cities SMSA for Scenarios 1 and 4

Place	Actual 1980[1]	Actual 1981[2]	1982		1983		1984	
			1	4	1	4	1	4
Tri-Cities SMSA	144,469	150,100	142,700[3]	142,700	140,410	140,410	129,870	132,100
Richland	33,578	33,700	32,250	32,250	31,730	31,730	29,350	29,850
W. Richland	2,938	3,783	3,710	3,710	3,650	3,650	3,380	3,430
Kennewick	34,397	34,700	32,820	32,820	32,290	32,290	29,870	30,380
Benton City	2,087	2,150	2,140	2,140	2,110	2,110	1,950	1,980
Prosser	4,049	4,120	4,000	4,000	3,930	3,930	3,640	3,700
Total of Benton County	109,444	113,400	107,810	107,810	106,080	106,080	98,120	99,800
Pasco	17,944	18,200	17,120	17,120	16,850	16,850	15,580	15,850
Total of Franklin	35,025	36,700	34,890	34,890	34,330	34,330	31,750	32,300

Table 4.19 (continued)

Place	1985		1986		1987		1988	
	1	4	1	4	1	4	1	4
Tri-Cities SMSA	121,360	126,250	119,360	128,060	120,600	133,340	123,430	139,740
Richland	27,430	28,530	26,980	28,940	27,260	30,130	27,900	31,580
W. Richland	3,160	3,280	3,100	3,330	3,140	3,470	3,210	3,630
Kennewick	27,910	29,040	27,450	29,450	27,740	30,670	28,390	32,140
Benton City	1,820	1,890	1,790	1,920	1,810	2,000	1,850	2,100
Prosser	3,400	3,540	3,340	3,590	3,380	3,730	3,460	3,910
Total of Benton County	91,690	95,380	90,180	96,750	91,110	100,740	93,250	105,570
Pasco	14,560	15,150	14,320	15,370	14,470	16,000	14,810	15,770
Total of Franklin	29,670	30,870	29,180	31,310	29,490	32,600	30,180	34,170

Table 4.19 (continued)

Place	1989		1990		1991		1992	
	1	4	1	4	1	4	1	4
Tri-Cities SMSA	126,340	143,930	129,310	144,930	132,360	142,580	135,480	141,670
Richland	28,550	32,530	29,220	32,750	29,910	32,220	30,620	32,020
W. Richland	3,280	3,740	3,360	3,770	3,440	3,710	3,520	3,680
Kennewick	29,060	33,100	29,740	33,330	30,440	32,790	31,160	32,580
Benton City	1,900	2,160	1,940	2,170	1,990	2,140	2,030	2,130
Prosser	3,540	4,030	3,620	4,060	3,710	3,990	3,790	3,790
Total of Benton County	95,450	108,740	97,690	109,490	100,000	107,720	102,360	107,030
Pasco	15,160	17,270	15,520	17,390	15,880	17,110	16,260	17,000
Total of Franklin	30,890	35,190	31,620	35,440	32,360	34,860	33,120	34,640

Table 4.19 (continued)

Place	1993		1994		1995		1996	
	1	4	1	4	1	4	1	4
Tri-Cities SMSA	138,670	140,660	141,940	143,470	145,270	146,810	148,700	150,240
Richland	31,340	31,790	32,080	32,420	32,830	33,180	33,610	33,950
W. Richland	3,610	3,660	3,690	3,730	3,780	3,820	3,870	3,910
Kennewick	31,890	32,350	32,650	33,000	33,410	33,770	34,200	34,560
Benton City	2,080	2,110	2,130	2,150	2,180	2,220	2,230	2,250
Prosser	3,880	3,940	3,970	4,020	4,070	4,110	4,160	4,210
Total of Benton County	104,770	106,270	107,240	108,390	109,750	110,910	112,340	113,510
Pasco	16,640	16,880	17,030	17,220	17,430	17,620	17,840	18,030
Total of Franklin	33,900	34,390	34,700	35,080	35,520	35,900	36,360	36,730

Table 4.19 (continued)

Place	1997		1998		1999		2000	
	1	4	1	4	1	4	1	4
Tri-Cities SMSA	152,210	153,740	155,780	157,320	159,460	160,990	163,220	164,760
Richland	34,400	34,750	35,210	35,550	36,040	36,380	36,890	37,240
W. Richland	3,960	4,000	4,050	4,090	4,150	4,190	4,240	4,280
Kennewick	35,010	35,360	35,830	36,180	36,680	37,030	37,540	37,890
Benton City	2,280	2,310	2,340	2,360	2,390	2,410	2,450	2,470
Prosser	4,260	4,300	4,360	4,400	4,460	4,510	4,570	4,610
Balance of Benton County	114,990	116,150	117,690	118,860	120,470	121,630	123,310	124,480
Pasco	18,270	18,450	18,690	18,880	19,140	19,320	19,590	19,770
Balance of Franklin	37,220	37,590	38,090	38,460	38,990	39,360	39.910	40,280

Sources: (1) U.S. Department of Commerce, Bureau of Census, 1980
(2) Washington State, Office of Financial Management, 1981

population out-migration. Similarly, the staff does not expect any unavoidable adverse impacts to occur.

4.2.6.3 Housing

Existing Conditions

The housing stock in the Tri-Cities SMSA, particularly in the Tri-Cities of Kennewick, Richland, and Pasco, has increased substantially during the past decade due to the rapid employment and population growth in the area. The largest increase in housing stock occurred in the Cities of Kennewick, Richland and Pasco from 1976 to 1980 (34,253 to 47,598) (S/HNP ASC/ER, 1981). Detailed data on housing stock of the Cities of Prosser, West Richland, Benton City and other small incorporated areas of Benton-Franklin Counties was not available for this study. Therefore, the analysis focused on the three large incorporated areas of the Tri-Cities SMSA.

The 1980 housing stock for the three major incorporated areas in the Tri-Cities SMSA was divided among 62 percent single-family residences, 26 percent multi-family, and 12 percent mobile homes. Kennewick had the largest housing stock of the three major cities with 21,059 units in 1980, followed by Richland with 15,458 total units and Pasco with 11,081 total housing units.

Approximately 40 percent of Kennewick's housing consisted of mobile homes and multi-family units, compared with Pasco with 39.0 percent and Richland 34.0 percent apartments and mobile homes. Apartments and mobile homes are often occupied by construction workers and other nuclear power plant-related employees due to the indefinite amount of time they may be employed at a nuclear power plant construction site. This type of housing was made increasingly available in the Tri-Cities between 1976 and 1980 due to the ease that housing may be secured by these workers in a rental situation compared to the long-term commitment required to purchase and mortgage a housing unit.

Vacancy Trends

Vacancy rates in the Tri-Cities for multi-family and mobile home units averaged 16.7 percent, and 5.2 percent, respectively, during March 1981 (S/HNP ASC/ER, 1981). These high vacancy rates may correspond to the 22-week labor-management dispute at the Hanford Reservation in 1980 and the slow buildup to peak employment levels at the WPPSS facilities (WPPSS peak employment for 1981 was realized during the second quarter; see Section 4.2.6.1). A more recent study identified an overall 8-percent rental vacancy rate in July 1981 for the entire Tri-Cities SMSA (U.S. Department of Housing and Urban Development, 1981). Although the data may not compare directly due to differences in survey techniques and sample area, the lowering in the rental vacancy rate does correspond to the peak employment experienced during the second quarter of 1981 at the WPPSS facilities. The rapid change in vacancy rates and the large buildup in rental units identified in both tables indicates the transient nature of nuclear power-related employment at the Hanford Reservation.

Environmental Impacts

Based on the above housing stock and vacancy trends in the Tri-Cities SMSA and the employment and population projections identified in Scenario 1 and Scenario 4, the demand for housing in the Tri-Cities SMSA would most likely decrease through the 1980s as a result of a decrease in employment and population in the study area. Scenario 1 would result in a larger decrease in demand for housing than Scenario 4 as a result of the projected lower employment and population levels identified through the 1980s for Scenario 1.

Because a relationship between vacancy rates for multi-family units and mobile homes and employment for nuclear power related projects at the Hanford Reservation appears to exist, the largest decrease in demand for housing could be expected in multi-family units and mobile homes throughout the 1980s. Again, Scenario 1 would result in a weaker demand for rental housing units than Scenario 4 due to the greater loss of nuclear power project related employment between the two scenarios. The demand for housing in the Tri-Cities SMSA is expected to fluctuate with corresponding changes in employment and population levels in the area. If demand for multi-family units and mobile homes decreases substantially, rents and/or prices charged for these units could also decrease.

In the early 1990s as the S/HNP becomes operational, operations employees could increase the demand for single-family and condominium residences.

In the staff's judgment, mitigation is not needed because adverse effects to study area housing markets arising from S/HNP are not expected. Similarly, no unavoidable adverse impacts are anticipated.

4.2.6.4 Transportation

Existing Conditions

Existing travel patterns and characteristics in the Tri-Cities area are heavily influenced by commuter travel generated on and near the Hanford Reservation. Figure 4.25 shows the existing street and highway system in the impact area along with 1981 daily traffic volumes.

The recent history of traffic volumes on streets in the impact area has been one of growth since the mid-1970s, generally in parallel with the pattern of employment on and associated with the Hanford Reservation. Traffic growth on the Causeway, for example, mirrors the year-by-year trend of combined DOE and WPPSS even to the "notch" occurring in 1980. Traffic volume trends on Stevens Drive and the Bypass Highway are similar. The volumes in 1981 were at the all-time peak (Washington State, Department of Transportation, 1981). Most of the arterials shown in Figure 4.25 are two lanes wide. Exceptions are Route 4 on the Hanford Reservation, George Washington Way, Stevens Drive, and Bypass Highway. These arterials are four and five lanes wide.

Traffic along these routes exhibit some unusual and extreme characteristics. Peak hour traffic near the Hanford Reservation forms a much larger portion of daily traffic (15 to 20 percent) than is usually found in urban areas. Average vehicle occupancy in this same area varies from 1.5 to 1.7 persons per car,

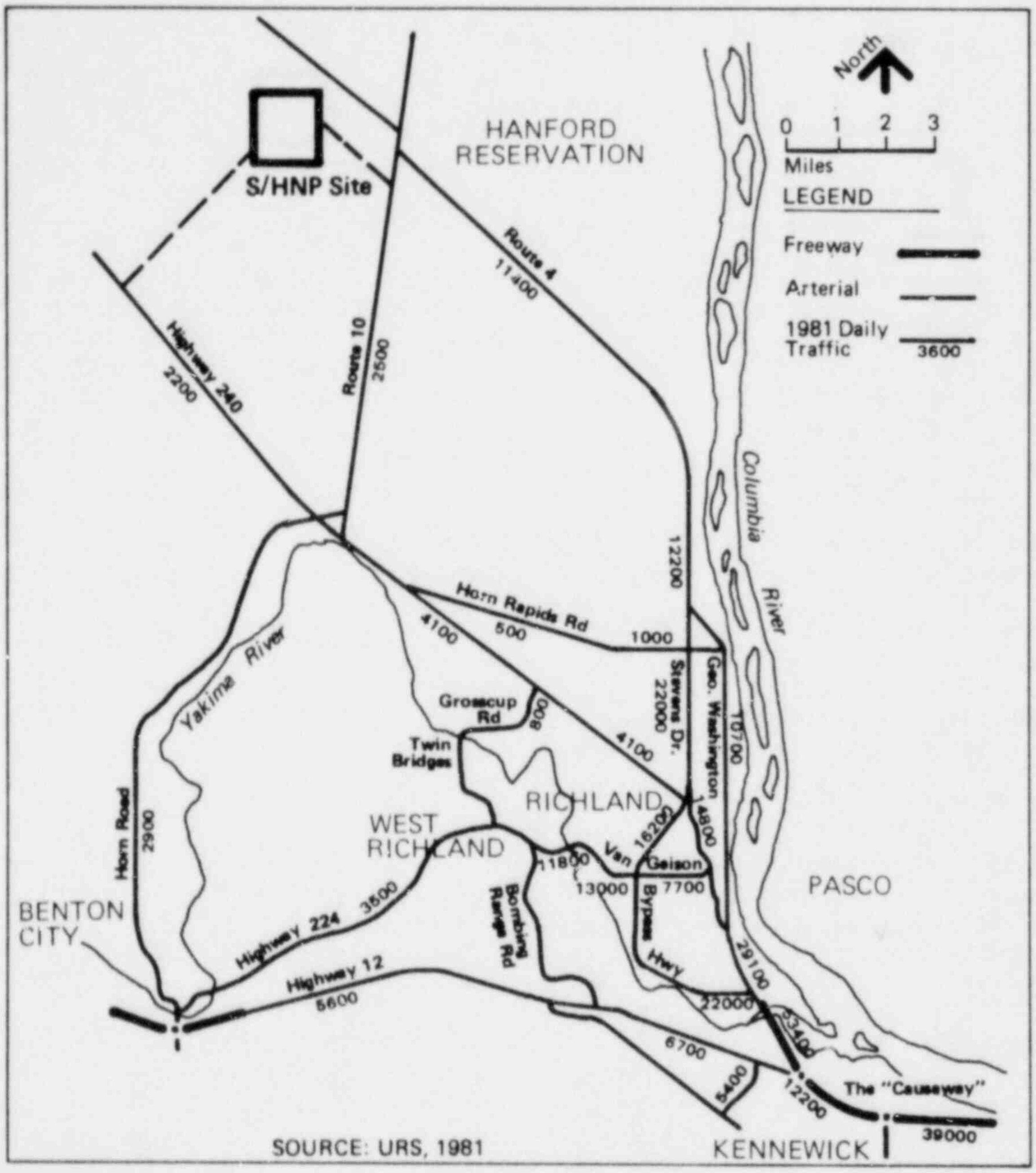


Figure 4.25 Impact area; existing streets and highways and 1981 daily traffic

well above the more usual 1.2 values. The southbound peak hour traffic volume on the Route 240 bridge across the Yakima River (the "Causeway") approaches 2,000 cars per lane per hour, near or at maximum capacity (Cottingham Transportation and Engineering, 1981).

Traffic congestion is heaviest in the evening peak hours. The most serious street capacity deficiencies were observed on Bypass Highway at its intersection with Van Giesen, and just north of the Causeway where traffic from Bypass Highway and George Washington Way merges. A more detailed discussion of congestion is included in the following paragraphs.

Present transit service is provided by crew buses serving the Hanford Reservation area (but not including construction workers) and a local charter bus operation that also serves the Reservation. The charter bus operator has recently begun limited intra-City transit within the Tri-Cities area. The Ben Franklin Transit System is a new publicly owned urban transit operation that will begin operation in the near future.

Environmental Impacts

The future impact potential of the S/HNP may involve a large number of factors. These include changes in travel volume due to expected changes in regional population and employment, comparison with and revision of regional traffic forecasts completed for 1985, and travel volume and pattern generated by WPPSS construction. The analysis of probable future S/HNP travel volumes and patterns and future peak hour conditions was focused on estimated impacts of construction traffic, since plant operation involves few employees and would not generate significant traffic impacts.

S/HNP Construction Traffic

A considerable amount of study has been undertaken in earlier years covering travel patterns and impacts distribution of WPPSS construction workers (Community Development Services, 1979). Travel survey data for WPPSS construction employees, presented in terms of percent of the construction force traveling to cities and parts of the counties, provided the basis for estimating a pattern of trips applicable to S/HNP construction workers. The percentage trip distribution for WPPSS was related to population in each of the cities and parts of the counties as well as to the estimated travel time between the WPPSS construction sites and these residential locations. The estimated travel time between the S/HNP construction site and the same destinations was then used to calculate the S/HNP travel pattern. The results showed that the principal differences between the two travel patterns, considering the influence of future I-182, was a 2 percent decrease in the number of worker-commuter destinations in Richland and Kennewick and a 2-percent increase for Benton City area. Figure 4.26 (Golladay and Spink Engineering and Surveying Inc., 1978) shows the resulting trip distribution pattern for the S/HNP site.

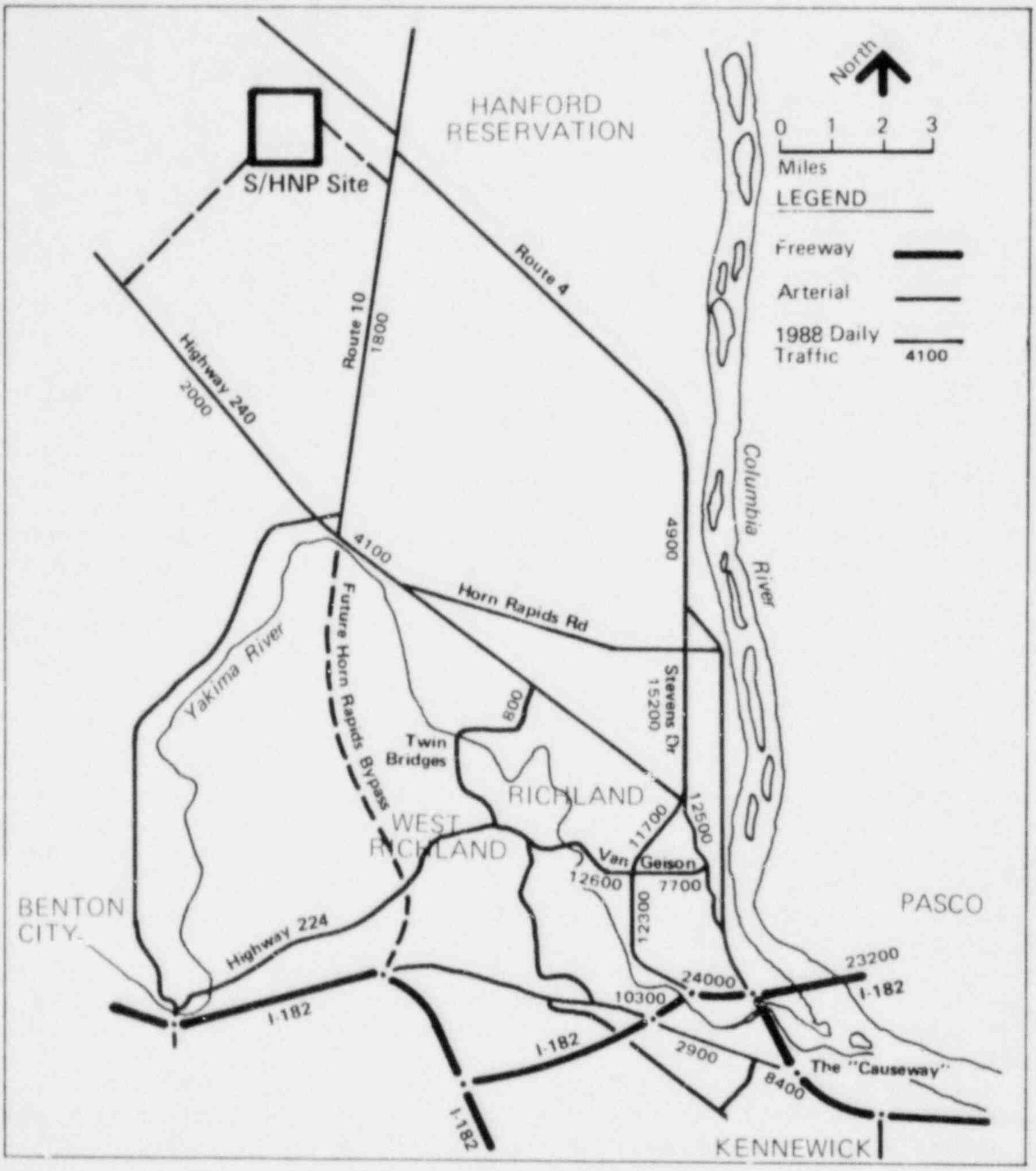


Figure 4.26 Estimated distribution of S/HNP construction worker travel

The peak home-to-work travel volumes (to which the percentages can be applied) were calculated for 1988 when construction employment would be at its highest and using estimated conditions that home-to-work travel would occur over 1.5 hours and at an average vehicle occupancy of 1.56 persons per automobile. The 4,610 employees forecast for 1988 will then generate 1,970 outbound eventing peak hours vehicle trips.

Regional Travel Forecast

The growth of nonproject traffic within the region is a key ingredient for the estimation of future impacts. This data was available in the form of a forecast of 1985 daily traffic volumes on the street and highway network of the region that was prepared by the Washington State Department of Transportation for the Benton-Franklin Governmental Conference (BFGC). Several revisions of raw data were made in this forecast. Since the forecast included the North Richland Toll Bridge (a facility not likely to exist during the impact period of S/HNP), travel allocated to that facility was reallocated to other streets and highways in the system. Also, since the forecast included as a constant employment on the Hanford Reservation, the estimated pattern of this travel was deducted from the regional forecasts and replaced by a specific estimate of employment for nonconstruction activities on the Hanford Reservation (Community Development Services, 1979; Wilbur Smith and Associates, 1979). Following these two steps, the forecasted volume of traffic moving through various corridors in the region was compared to existing traffic volumes so that traffic growth could be assessed.

Population and Employment Growth

The 1985 travel forecast discussed above was based on continuing population and employment growth throughout the Tri-Cities region. As discussed elsewhere in this EIS, a more detailed evaluation of short-term cycles in population and employment shows that employment is expected to decline through 1985 and then start to increase again parallel to the growth predicted by the BFGC. The difference betwen this declining pattern and the continued growth predicted by the governmental conference is important since the 1985 travel forecast was based on a higher employment level than that predicted by the more detailed analysis of this report. The dip in population and employment would be reflected in daily travel volumes throughout the region.

The differences between the two population and employment forecasts (and their subsequent impact on travel forecasts) can be explained. The governmental conference forecast is based on the anticipated success of the Tri-Cities in diversifying its economy as well as new construction projects related to energy development. As noted in the earlier discussions, the S/HNP provides construction employment that partially fills the gap between the two forecasts during the period 1983 to 1993. Another project of similar magnitude would come close to realizing the predicted 1990 employment levels of the BFGC. However, at this time, it must be considered doubtful that the BFGC-predicted 1985 levels of employment would be reached in view of the declining work force at the WPPSS projects and the later growth of employment at the S/HNP.

By comparing existing and forecasted employment levels, it was concluded that a reasonable estimate of 1988 travel conditions without the project could be developed by subtracting WPPSS trips from existing traffic. Only trips directly associated with the WPPSS construction project were deducted, because it is estimated that trips generated by WPPSS secondary employment would also be lost but would be balanced by the background growth in regional employment. Figure 4.27 shows the resulting 1988 baseline travel forecast. These travel volumes represent 1988 traffic conditions if S/HNP is not constructed.

Traffic Trends

Figure 4.27 shows these changes in travel patterns in the context of growth trends for a 20- to 25-year period. The historical trends of average daily traffic on the Causeway are shown from 1968 through 1981. Then, the predicted decline is shown from 1981 to 1988 as both primary and secondary employment associated with the WPPSS projects is lost and partially replaced by growth in other sectors of regional employment. Note that the traffic volumes from 1986 onward represent the sum of traffic forecasted for both the Causeway crossing of the Yakima River and the Columbia River crossing of I-182.

Also shown in Figure 4.27 is the estimated component of traffic that would be added by construction workers at S/HNP. This component increases the estimated 1988 daily traffic volume from 46,200 to 50,100. It is this increased traffic that represents the direct impact of the project, and the mitigating actions that are discussed in following paragraphs are based on this increment of traffic growth.

In addition to traffic volumes directly attributable to S/HNP there is a component of traffic that would be generated as a result of secondary employment growth. This is also shown in Figure 4.27 and increases the total estimated 1988 traffic on the Causeway and on I-182 to 55,400.

This component of daily traffic was estimated to be equivalent to approximately half of the difference between existing volumes and the 1985 daily volumes developed from the regional forecast discussed earlier.

System Changes

As can be seen in Figure 4.28, and as mentioned earlier, there are several planned additions to the street and highway system that are important for the assessment of future conditions. These include the following:

(1) The improvement of Twin Bridges and Grosscup Road from the Yakima River to Route 240. This is programmed for completion by the City of Richland and Benton County by 1987.

(2) The completion of I-82 through the Tri-Cities area by 1987.

(3) The completion by the Washington State Department of Transportation of I-182 from I-82 across the Columbia River to US 395. This is programmed for completion by 1986 and includes the partial opening of bridges across the Yakima River and the Columbia River in 1984.

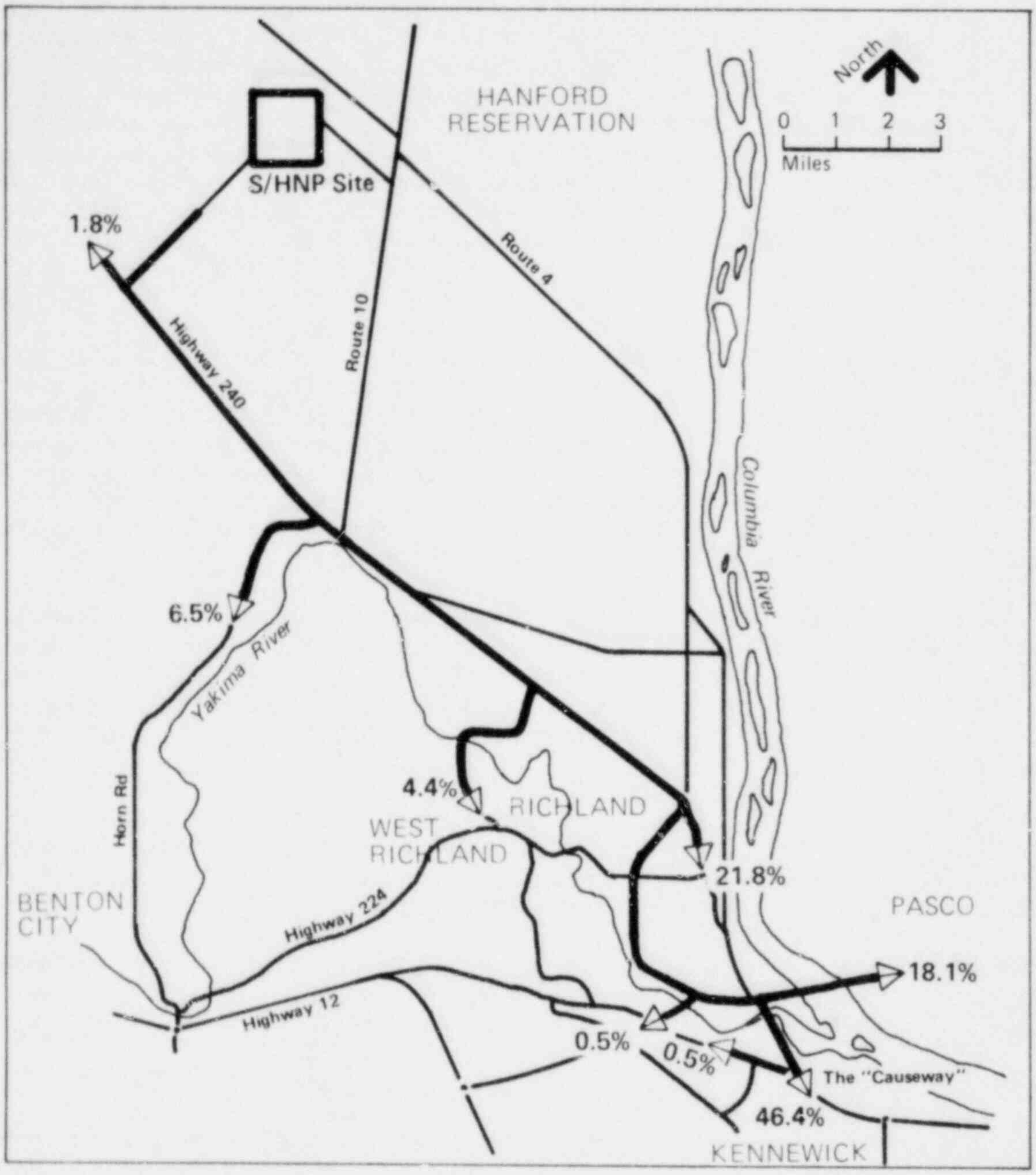


Figure 4.27 Trends and projections of average daily traffic on the Causeway

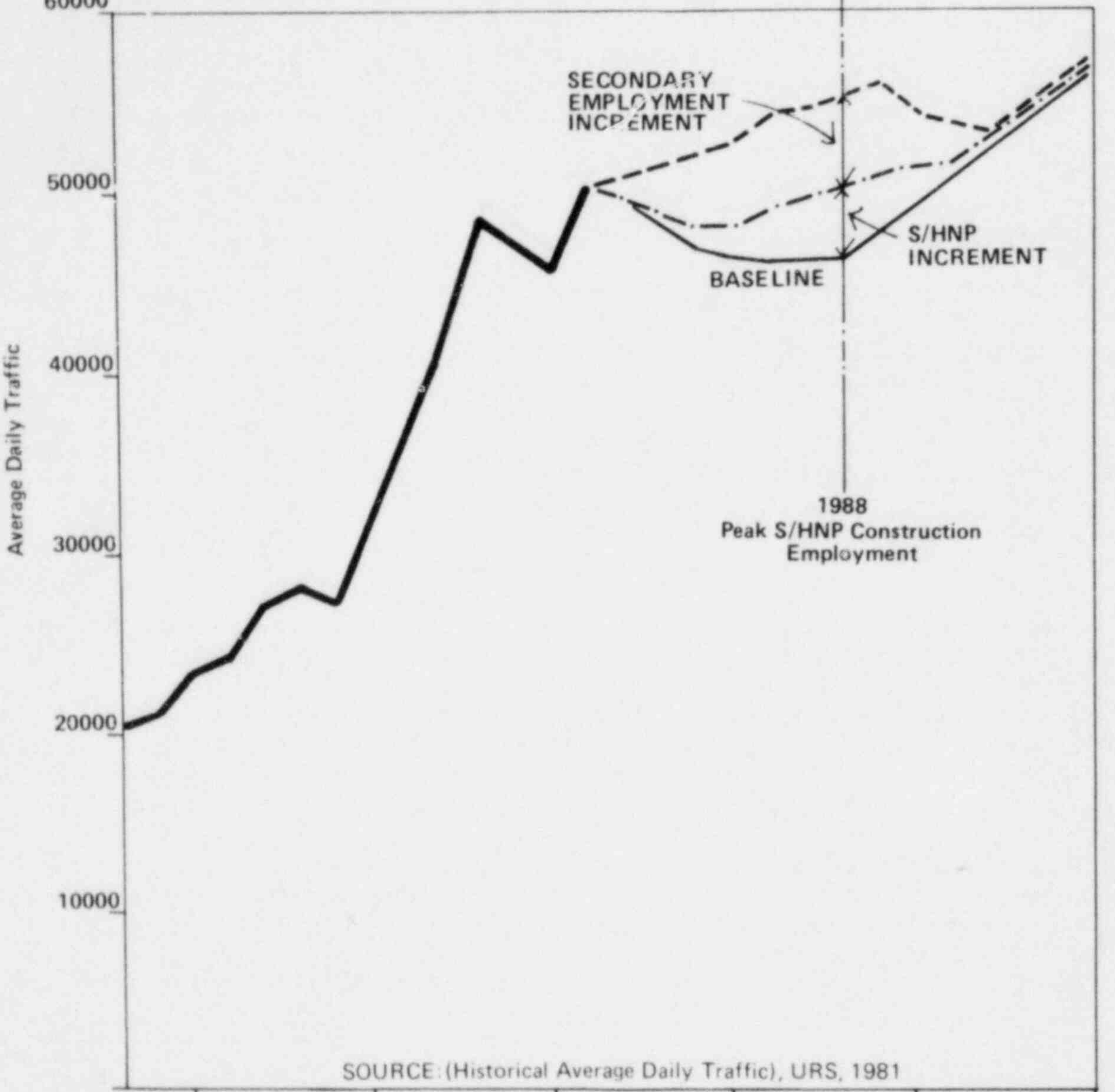


Figure 4.28 1988 baseline daily traffic volumes on the predicted 1988 street and highway system

These projects are included in the adopted Transportation Improvement Program of the Benton-Franklin Governmental Conference, the Washington State Department of Transportation, and local agencies. Another group of projects may be completed before 1988 that could serve S/HNP traffic. This group includes the Horns Rapids Bypass between Route 240 and I-82 (a north-south arterial lying between Benton City and west Richland), as well as a series of arterials connecting the Twin Bridges area, the Horns Rapids Bypass and Bombing Range Road. The early stages of the Horns Rapids Bypass is included in the Transportation Improvement Program in 1984 and preliminary discussions on the right-of-way acquisition have already occurred. The approximate location of the Horns Rapids Bypass is shown on Figure 4.28 (Golladay and Spink Engineering Surveying, Inc., 1978).

Peak Hour Conditions

Estimates of the impacts of S/HNP traffic were developed by converting the forecasted 1988 baseline daily traffic volumes to peak-hour traffic volumes at key intersections. Peak-hour S/HNP traffic was then overlayed and impacts assessed. Impacts were calculated in terms of the ratio between traffic volume and street capacity. When this ratio, called the V/C ratio, approaches and exceeds a value of 1.0, congestion is indicated. The higher the ratio, the more severe the congestion. For example, a V/C ratio of 1.09 is shown in Figure 4.29 for the intersection of Bypass Highway and Van Giesen under existing conditions for the 3:00 to 4:00 p.m. hour. This 9 percent overload reflects existing congestion at that location.

Using Figure 4.29, it is possible to trace the evolution of peak hour traffic conditions at these critical locations from 1981 through 1988 with and without the project. Two peak hours, 3:00 to 4:00 p.m. and 4:00 to 5:00 p.m., are shown since the heavy commuter traffic in the region requires more than the normal one-hour peak that is found in most other areas. The actual time that each hour starts may vary throughout the region, but the first and second peak hours are identified as the 3:00 and 4:00 p.m. peak hours for convenience.

It is a conclusion of this study that the completion of I-182 will provide sufficient additional capacity to relieve existing congestion at the Causeway. At the present time, the Causeway with two lanes in each direction must serve virtually all Pasco and Kennewick traffic. The completion of I-182 will provide two interchanges and three additional lanes in each direction for a traffic volume with only moderate predicted growth by 1988.

Inspection of the V/C ratios in the column for 1981 existing conditions reflects existing congestion at the intersection of Bypass Highway and Van Giesen. In addition, the existing congested merge north of the Causeway for southbound traffic is estimated to have a V/C ratio of 1.09.

The next column in Figure 4.29, that for 1988 baseline conditions, shows an improvement in traffic conditions as traffic volumes decrease. The decrease is greatest in the first peak hour, and concentrated on Stevens Drive, which leads directly to the WPPSS construction area. The ratios in this column reflect not only the deduction of WPPSS trips, but also an infilling of the gap left by WPPSS traffic by traffic from adjacent hours. The addition of traffic from the S/HNP leads to more severe congestion than existing conditions because of this traffic infilling effect.

		1981 Existing Conditions	1988 Baseline	1988 With S/NHP	1988 With Mitigating Actions	1988 With Secondary Traffic
3-4 PM	S/HNP Access & Route 240	N.A.	N.A.	1.09	0.83	0.99
	Route 240/Horn Road/Route 10 (west)	0.43	0.29	1.70	0.89	0.92
	Route 240/Route 10 (east)	0.31	0.31	1.61	0.92	0.95
	Route 240 & Stevens Drive	0.77	0.36	1.44	0.79	0.82
	Bypass Highway & Van Giesen	1.09	0.81	1.34	0.92	1.12
4-5 PM	S/HNP Access & Route 240	N.A.	N.A.	0.35	0.56	
	Route 240/Horn Road/Route 10 (west)	0.49	0.49	0.80	0.74	
	Route 240/Route 10 (east)	0.35	0.35	0.64	0.57	
	Route 240 & Stevens Drive	0.87	0.77	0.98	0.87	
	Bypass Highway & Van Giesen	1.04	0.94	1.14	0.90	

Figure 4.29 Volume/capacity ratios at critical locations existing and without/with S/HNP

Logical operations planning would schedule project traffic to replace that of WPPSS in the traffic system so that the impacts are concentrated in the first peak hour. The values shown, well in excess of 1.00, reflect the total inadequacy of existing streets and roads to absorb these peak loads.

Mitigating actions are discussed specifically in subsequent paragraphs. However, the fourth column of Figure 4.29 shows the result and effectiveness of the suggested actions in relieving the predicted congested conditions with the project.

As stated earlier, the impact of the project (and the development of mitigating actions) is based on comparison of the 1988 baseline conditions with the direct traffic impacts generated by construction workers at S/HNP. Figure 4.27 showed that, in addition, traffic volumes would be generated by secondary employment and population supporting S/HNP. The mitigation of these impacts, however, would be logically placed as a responsibility of projects generating that component of total traffic. The V/C ratios for 1988 have been estimated, however, to illustrate what forecasted conditions would be with total traffic on the system, both primary and secondary components.

Mitigating Measures

A number of logical and appropriate mitigating measures have been described for S/HNP. The applicant has proposed a 2-lane reversible access road connecting the S/HNP site with Route 240. This access road would be used for commuting access and egress by construction workers. An additional access road for noncommuter use would connect the site with Route 10 on the Hanford Reservation. Ridesharing and staggered hours programs are also proposed (Cottingham, Transportation Engineering, 1981).

Among measures being considered are the widening of Route 240 and intersection improvements.

Based on the peak-hour capacity analysis whose results are tabulated in Figure 4.29, the staff suggests the following additional mitigating actions:

(1) Schedule construction shift times so that access and egress travel is spread over a 1.5-hour period, starting with the afternoon outbound traffic at 3:00 p.m. Of course, this measure would be most appropriate during the years of peak construction work force, and could be relaxed for times of reduced onsite construction work force.

(2) Conduct ridesharing matching, promotion, and incentive programs to produce an average vehicle occupancy of at least 1.6. Incentive programs should include preferred parking for carpools and exclusive high-occupancy vehicle (HOV) lanes.

(3) Develop the proposed 2-lane reversible commuter roadway between the S/HNP site and Route 240.

(4) Develop the intersection of the commuter access road and Route 240 with dual left turns from the access road for the afternoon peak and matching dual right turns inbound to the site for the morning peak. This intersection could be controlled either with temporary traffic signals or manual police officer control.

(5) Implement the improvement to Route 240 under consideration, consisting of the widening of Route 240 between the site access road and Stevens Drive to four lanes. The outside lanes would be reserved for high-occupancy vehicles (a driver and at least one passenger). This improvement should include widening of intersections and the railroad crossing west of Stevens Drive. Temporary signals or officer control may be required at the intersection with Grosscup Road, and at the intersections serving the Richland industrial areas west of Stevens Drive.

(6) At the intersection of Route 240 and Stevens Drive provide a dual right-turn lane for eastbound-to-southbound traffic and a matching dual left-turn lane for northbound-to-westbound traffic. Signal modifications, including a separate left-turn phase, may also be necessary.

(7) At the intersection of Bypass Highway and Van Giesen provide a dual left-turn lane for northbound-to-westbound traffic, widen both approaches on Van Giesen to provide for two through lanes, provide two westbound lanes on the west leg across the railroad tracks, and make appropriate signal modifications.

The mitigating measures listed above and the estimated impacts of these measures described in Figure 4.28 are based on a street network including I-82 and I-182 freeways as well as the improvement of Grosscup Road and Twin Bridges. I-182 alters construction worker travel patterns by providing an alternative and shorter pathway to Pasco and Franklin County. The improvement of Grosscup Road and Twin Bridges facilitates access to the west Richland area (but is not estimated to attract a significantly increased volume of commuter trips). If, in addition to these improvements, the Horns Rapids Bypass is implemented in time to serve S/HNP commuter traffic, it could serve as a viable alternative route (via I-82 and I-182) for traffic desiring to cross the Columbia River on I-182 or the Yakima River on the Causeway. It is estimated that this route could divert as much as half of the S/HNP commuter traffic away from Route 240 and Bypass Highway. From this standpoint, the Horns Rapids Bypass is a viable mitigating measure. However, the estimated cost of the new Bypass Highway would be two to five times that of the mitigating measures listed above.

Specific mitigating measures associated with travel by modes other than the automobile have not been listed. It is doubtful that scheduled transit service would be available to the S/HNP site during construction, but special charter bus operations have been successful in employment centers and would contribute to the achievement of the average vehicle occupancy goal of 1.6.

Also, bicycling could not be relied upon as a significant impact mitigation measure, although provisions for cyclists on access and egress roads are desirable and should be included where possible. However, along Route 240, dense commuter traffic moving at high speed would make cycling undesirable, although the HOV lane in the nonpeak direction would be unused or used only by low volumes of traffic. This lane could serve cycling traffic during the peak hours, and both HOV lanes would be relatively free of traffic and available to cyclists during off-peak hours.

Unavoidable Adverse Impacts

The unavoidable adverse impacts associated with S/HNP construction traffic are those related to increased traffic volumes and roadway construction:

(1) High volumes of commuter traffic on the site access road, Route 240, Bypass Highway, and other facilities would cause increased noise and air pollution of the types commonly associated with traffic movement.

(2) The construction of the site commuter access road, the widening of Route 240, and intersection improvements would commit construction materials and other resources which would not be retrievable after completion of project construction.

4.2.6.5 Public Water Supply

Existing Conditions

The six incorporated areas are presently experiencing maximum daily water usage less than the capacities of their water systems (URS Company, 1981). The City of Richland has the largest water supply system capacity in the area with an ability to supply 178.8 million liters per day (mld) while experiencing a maximum daily use of 140.0 mld. Pasco currently has a water supply capacity of 73.8 mld per day and treatment capacity of 70.0 mld while experiencing a maximum daily use of 56.0 mld. Kennewick's water treatment facility is designed for 113.6 mld and is currently operating at 28.4 mld with wells producing 54.9 mld, for a total system capacity of 83.3 mld. Maximum daily use of water in Kennewick is currently 69.3 mld. The three smaller cities in the study area have municipal water systems that supply total in excess of 22.7 mld, while experiencing a maximum daily usage total somewhat larger than 15.1 mld.

Although the capacity of the existing water supply systems in the incorporated areas of the study area appear to be adequate at this time, the various jurisdictions have identified improvements to their water systems that are currently needed (URS Company, 1981). Kennewick has identified a need to develop new water transmission lines within their jurisdiction. Richland would need to develop transmission lines to the recently annexed Horn Rapids Triangle Area and upgrade the water storage capacity if growth were to occur in this area. Pasco has identified a need to upgrade their water filtration treatment capacity to meet the existing pump capacity of the system, increasing the total water supply system capacity to 73.8 mld. Prosser currently has three underground reservoirs and has identified a need to create additional storage at higher elevations to better serve their transmission system. West Richland has current needs to replace existing water transmission pipes and to develop two 1,892,700-liter water storage reservoirs for their supply area. Benton City's water storage system is presently operating at about 50 percent capacity, although the jurisdiction has identified a need for an additional water storage tank to meet fire flow requirements.

Improvements currently needed in the water supply systems in the six incorporated areas are a result of the substantial employment and population growth in these areas during the late 1970s.

Environmental Impacts

Based on the employment and population projections developed for Scenarios 1 and 4, current water supply systems of the six communities, including the identified improvements, should be adequate to meet future demands for either scenario. Water supply systems would have greater excess capacity under Scenario 1 than Scenario 4 due to the larger employment and population decline forecast under Scenario 1.

In the staff's judgment, no mitigating measures are necessary and no unavoidable adverse impacts are expected.

4.2.6.6 Wastewater Disposal System

Existing Conditions

The major incorporated areas of the study area are served by municipal wastewater treatment systems, whereas the unincorporated areas of Benton and Franklin Counties are served by onsite septic systems. The type of wastewater treatment supplied by the various jurisdictions include both primary and secondary treatment. Three of the jurisdictions are presently operating at or near capacity, and all the jurisdictions have identified improvements that are currently needed in their systems (URS Company, 1981).

Kennewick has a system capacity of 32.9 mld and experiences a maximum daily use of 23.8 mld. A need to comply with EPA regulations to screen out green algae at their wastewater treatment plant has been identified. Richland's wastewater treatment plant has a system capacity of 22.7 mld and experiences a maximum daily use of 21.6 mld. The city has identified a need for a new treatment plant and a new interceptor in the northern portion of the city. Pasco's wastewater treatment system capacity is 15.9 mld, and their maximum daily use is 7.9 mld. Pasco is currently planning to upgrade and expand their treatment plant facilities. Prosser has a system capacity of 9.5 mld and maximum daily use of 3.8 mld. However, they are presently violating Federal clean water standards by discharging 3,400 kg (7,500 pounds) of decomposing effluent into the river daily. Federal and State officials have ordered that the discharging be restricted to 500 kg (1,100 pounds), although the city is appealing the Washington State Department of Ecology to raise the limit to 1,134 kg (2,500 pounds) per day (Tri-Cities Herald, September 27, 1981).

West Richland is presently operating its wastewater treatment system at maximum capacity, 1.44 mld. The City has identified a need for a new sewage treatment facility to meet current demand. Benton City operates a wastewater treatment system capable of handling 9,085 liters gallons of sewage per day and presently is operating at capacity. The City has identified a current need to improve the wastewater treatment facility and plans to extend the sewer mains from the treatment lagoons to the edge of the City and to add new aerators to the lagoon.

Nearly all of the jurisdictions discussed above have identified a current need to improve their wastewater treatment facilities. These improvements range from minor treatment plant improvements and expansion to major development of wastewater facilities. The need for these improvements has resulted from the large employment and population growth during the past decade. Improvements to the wastewater treatment facilities have been identified by the various jurisdictions and are either under development at this time or are in the planning process. These planned improvements to the wastewater treatment facilities would enable the jurisdictions to better serve the existing populations in their areas and allow for some future growth.

Environmental Impacts

Based on the employment and population projections developed for Scenarios 1 and 4, current municipal wastewater treatment systems, including the identified improvements, would have adequate capacity to meet future demands through the mid-1990s.

The staff does not require that any mitigating measures be instituted and believes that there will be no unavoidable adverse impacts.

4.2.6.7 Solid Waste Disposal System

Existing Conditions

Solid waste disposal in the Tri-Cities area is currently supplied largely by the local jurisdictions through contractual agreements with private disposal companies. The City of Richland is the only jurisdiction to operate its own solid waste disposal service. Benton County currently contracts with Basin Disposal, Incorporated, to provide service to the unincorporated areas of the county, while Franklin County also contracts with Basin Disposal for service to unincorporated areas and to collect refuse from coin-operated drop boxes located at Kahlotus, Merrill's Corner, Connell, and Basin City (Benton-Franklin Governmental Conference, 1977). Among Tri-Cities area communities, Kennewick and Prosser are currently served by Kennewick Disposal. Benton City and West Richland are served by Ed's Disposal, whereas Pasco's solid waste disposal is contracted to Basin Disposal.

Two major landfills are utilized for disposal purposes. They are the Richland Sanitary Landfill, located northwest of Richland in the "Horn Rapids" Triangle; and the Pasco Sanitary Landfill, located in Franklin County near the intersection of Route 12 and the Pasco-Kahlotus Road. Current capacity in these landfills is adequate to meet existing and future needs through 1990 (Benton-Franklin Governmental Conference, 1977).

Environmental Impacts

Based on the employment and population projections of Scenarios 1 and 4, current solid waste disposal systems have adequate capacity to meet future demands. If resource-recovery techniques are implemented by local jurisdictions, capacities of existing landfills can also be expanded appreciably (Benton-Franklin Governmental Conference, 1977).

In the staff's judgment, no mitigation is needed and no unavoidable adverse impacts are expected.

4.2.6.8 Fire Protection

Existing Conditions

Mutual aid agreements have been established between the five incorporated areas in Benton County, Pasco, and rural areas of Benton and Franklin Counties to supply fire protection service in the study area. Most notably, the Tri-Cities Mutual Aid Agreement (September, 1980) was developed between the cities of Pasco, Kennewick, Richland, and Benton County Rural Fire District Nos. 1, 2, 3, Franklin County Rural Fire District No. 3, Walla Walla County Rural Fire District No. 5, and the Rockwell Hanford Fire Protection Department (S/HNP ASC/ER, 1981). The mutual aid agreements allow jurisdictions to reinforce each other during emergency situations. Therefore, a specific fire protection unit is capable of offering better fire protection service to its jurisdiction because of the availability of backup personnel and equipment from the neighboring fire protection units.

The Cities of Kennewick, Richland, and Pasco maintain large full-time fire personnel staff, whereas Prosser and Benton and Franklin County Rural Fire Districts typically have one full-time person on the staff and are aided by volunteer staff (S/HNP ASC/ER, 1981). Generally, the fire protection staff has increased over recent years as has the number of fire emergency calls (Williams, Kuebelbeck and Associates, Inc., 1981). The increase in staff levels and fire calls is a result of population growth in the study area during recent years.

Environmental Impacts

Fire protection services have increased proportionally with population growth in the Tri-Cities area during recent years. The future demand for fire protection services would decrease for Scenario 1 and Scenario 4 proportional to the difference in their population projections. The demand for fire protection services greater than that currently being experienced in the Tri-Cities study area would be realized by the mid-1990s for Scenario 1 and Scenario 4.

The staff concludes that no mitigation measures are called for and that no unavoidable adverse impacts will occur.

4.2.6.9 Police Protection

Existing Conditions

The six incorporated areas identified in the study area are serviced by municipal police departments and Benton and Franklin Counties are served by their respective Sheriff Departments. The larger cities of Kennewick, Richland and Pasco maintain the largest police personnel staffs with 56, 55 and 37 personnel, respectively (S/HNP ASC/ER, 1981). The smaller cities of Prosser, West Richland and Benton City maintain police personnel staff of 8, 9 and 5, respectively. Benton County Sheriff Department has a staff of 25 police personnel and the Franklin County Sheriff Department has a staff of 32 police personnel. Of the incorporated areas, West Richland maintains the largest police personnel per thousand population (2.4/1,000), whereas Kennewick and Richland have the lowest police personnel per thousand population (1.6/1,000). A ratio of 2.0/1,000 is generally considered the appropriate level of service. Nearly all of the incorporated areas are near the 2.0/1,000 ratio, whereas Benton County Sheriffs are understaffed with a 0.7/1,000 ratio (URS, 1981).

The police staffs in the various jurisdictions and counties have increased over recent years with population growth as have the number of total police calls (S/HNP ASC/ER, 1981). The increase in police personnel and total police calls is a result of increased population growth in the area. When the rate of crime per hundred thousand residents for selected SMSAs in the State of Washington is compared, the Tri-Cities SMSA has more than 150 less total crimes than the State of Washington and substantially less than Yakima and Spokane SMSAs (S/HNP ASC/ER, 1981). Although this difference in rate of total crimes per hundred thousand residents in the selected SMSAs may be attributed to many different factors, it indicates that police protection in the Tri-Cities SMSA is good.

Environmental Impacts

Police protection services have increased in the study area in proportion to population growth during recent years. The demand for police protection would be less in future years for Scenario 1 than for Scenario 4. With the exception of rural Benton County, most of the study area is adequately protected compared to a desirable level of service ratio of 2.0/1,000. A demand for police protection services greater than that currently being experienced in the study area would occur in the mid-1990s.

In the staff's judgment, no mitigation is required and no unavoidable impacts are expected.

4.2.6.10 Education

Existing Conditions

The study area is basically comprised of seven school districts serving the six incorporated jurisdictions and the adjacent unincorporated areas of the counties (Table 4.20). The Kennewick School District had the largest enrollment in 1980-1981 (10,604) and was followed by the Richland (8,308), Pasco (5,535), and Prosser (2,007) school districts. These school districts are located in their respective jurisdictions and the relatively large enrollment compared to the outlying school districts corresponds to the cities larger population. All of the seven school districts offer first- through twelfth-grade education. The school districts also offer other educational opportunities beyond basic education, such as athletics, drama, and music programs.

The overall comparison of the average annual full-time equivalent (FTE) pupils per total certified staff during the 1979-1980 school year in the primary study area indicated that the ratio compared favorably to the State of Washington school ratio (S/HNP ASC/ER, 1981). During that school year, the State of Washington had 17.2 FTE pupils per certified staff staff member, whereas the school districts in the primary study area ranged from a low of 16.5 pupils per certified staff member in the Columbia School District to a high of 19.8 FTE pupils per certified staff member in the Kiona-Benton School District. The largest school district in the primary study, the Kennewick School District, experienced the same ratio of FTE pupils per certified staff as the state ratio (17.2), whereas the next three largest school districts, Richland, Pasco, and Prosser, had ratios ranging from 17.3 to 17.6. This favorable comparison between the FTE pupils per certified staff member between the local school districts and the State of Washington, plus the excess capacity shown in Table 4.20 suggests that the school districts are keeping up with the demand for educational needs in the study area.

Table 4.20 Enrollment and capacity of local school districts in the study area.

School District	Enrollment Data 1979-80	Enrollment Data 1980-81	Current Capacity	Excess Capacity 1980-81
Columbia (#400)[1]	885	886	1,129	243
Finley (#503)[2]	903	902	1,163	261
Kennewick (#017)	10,767	10,604	11,290	686
Kiona-Benton (#052)[3]	1,164	1,163	1,625	462
Pasco (#001)	5,490	5,535	7,016	1,481
Prosser (#116)	2,012	2,007	2,312	305
Richland (#400)	8,559	8,308	10,103	1,795

(1) Burbank (Pasco) Area
(2) Kennewick Area
(3) Benton City - West Richland Area

Sources: Office of the Superintendent of Public Instruction, September, 1981.

S/HNP, ASC/ER, 1981.

Environmental Impacts

Enrollment levels at the various school districts have increased proportionally to population growth during recent years. Based on the above school district information and the employment and population projections for Scenario 1 and Scenario 4, the demand for education and school services would decrease through the 1980s as would enrollment levels. Although the number of school age children per family varies with demographic characteristics and fertility rates, existing levels of school district enrollment could be expected by mid-1990s for Scenario 1 and Scenario 4. The excess capacity in the study area school districts (Table 4.20) could adequately meet increased enrollments beyond the mid-1990s.

The staff believes that no mitigation measures are required and that no unavoidable adverse impacts will result.

4.2.6.11 Health and Social Services

Existing Conditions

There are numerous health facilities and services offered within the study area including four general hospitals located in Richland, Kennewick, Pasco, and Prosser; a bi-county medical health facility operated by the Benton-Franklin

District Health Department; a medical clinic in Benton City; a mental health facility in Richland; and the Hanford Environmental Health Facility in Richland. There is a large range of medical specialties among physicians in the Tri-Cities areas. The general hospitals in Kennewick, Prosser, and Pasco are operated by public entities in the form of hospital districts directed by elected board members, and the Richland Hospital is a privately owned and operated facility. The Mid-Columbia Mental Health Center is a private, nonprofit corporation providing inpatient and outpatient medical health care and is partially funded by the Benton-Franklin Community Mental Health Retardation and Health Board. This facility provides mental health services to residents of both Benton and Franklin Counties. As with other service categories, there has been a general trend towards increasing staff levels at the various hospitals as a result of population growth in recent years (Williams, Kuebelbeck and Associates, Inc., 1981).

Social services in the Tri-Cities area are offered for a broad range of services. Benton and Franklin Counties cooperatively provide extension programs, health services, and emergency services. Each of the Tri-Cities also has a senior citizens center.

State human service offices in the Tri-Cities include the job services offices of the Employment Security Department, Food Stamp offices, the Division of Developmental Disabilities, Financial and Medical Assistance, the Child Protective Service, Emergency Medical Service, a Senior Companion Program, Vocational Rehabilitation and various Farm Workers Programs. The Federal Government maintains local Social Security offices.

In addition to these public human programs, the area is also served by a large number of private agencies and voluntary human service organizations. Various organizations provide counseling programs on family problems, family planning, alcohol abuse, legal aid, behavioral difficulties, child placement, and aid to persons affected by various physical, emotional, and learning disabilities (S/HNP ASC/ER, 1981).

Environmental Impacts

Health services have increased proportionately to population in the study area during recent years. There would be less of a demand for health services for Scenario 1 and Scenario 4 during the 1980s in the Tri-Cities area than is currently being experienced. The current level of demand for health services would not be reached until the mid-1990s for Scenario 1 and Scenario 4. If the demand for health services based on Scenario 1 or 4 population projections decreases proportionately, health care system financing could be strained due to underutilization. The S/HNP development would help ease this potential situation.

Based on the employment and population decreases projected in Scenarios 1 and 4, the demand for social services would increase or decrease depending on the type of service affected. Personal and employment services demands could increase due to the worsening economic climate projected in Scenarios 1 and 4. The demand for other services, such as family planning, alcohol abuse, and legal aid, may drop as population declines. Overall social services could be adversely affected in the short term due to fewer financial contributions and out-migration of volunteer staff.

The staff concludes that no mitigation is called for and that no unavoidable adverse impacts will occur.

4.2.6.12 Library Services

Existing Conditions

The Mid-Columbia Library District serves Benton and Franklin Counties from a main library located in Kennewick and maintains branch libraries in Benton County, West Richland, and Pasco. A bookmobile maintains a scheduled route throughout the rural areas of the library district offering service to residents outside the incorporated areas. The Cities of Richland and Prosser maintain their own library systems.

Workload trends have increased for the Mid-Columbia Library District as a result of population growth in the Tri-Cities area. Increased demand for library services has created a need for greater and upgraded facilities in previously sparsely populated areas such as West Richland and Benton City (Williams, Kuebelbeck and Associates, Inc., 1981). Although populations served by the Mid-Columbia Library District have increased by more than 28,000 persons between 1977 and 1980, the total number of volumes of library material has only increased by approximately 2,500 volumes over the same period (Williams, Kuebelbeck and Associates, Inc., 1981). Although the demand for library systems increased proportional to the population growth in the area over recent years, the total number of volumes has not kept pace with this demand, indicating a need for increased volumes of library materials.

Environmental Impacts

The volumes of library materials have not kept pace with the demand for these materials in recent years. In spite of a projected decrease in population for Scenario 1 and Scenario 4, the apparent need for an increase in volumes of library materials would continue to exist. Demand for library services currently needed in the study area would be matched by the mid-1990s for Scenario 1 and Scenario 4. S/HNP development would benefit the Mid-Columbia Library District directly through increased property tax revenues.

The staff concludes that no mitigation is needed and that no unavoidable impacts will result.

4.2.6.13 Recreation

Existing Conditions

Indoor Recreation

Many indoor recreation opportunities are available to residents in the study area. Indoor tennis courts are available at the Tri-City Court Club. Bowling lanes are provided in each of the three major cities. Private and public swimming pools offer recreational activity as do roller and ice skating rinks in the study area. Other opportunities are available at the more than 10 movie theaters throughout the study area. Art attractions, plays, opera, and symphonies are available to Tri-City residents at the Appleseed Gallery, the

Richland White Opera and the Mid-Columbia Symphony. Indoor entertainment is also available in the Tri-Cities area in the form of radio, television, and local college and high school athletic events.

Outdoor Recreation

Numerous tennis courts, ball fields, and six golf courses offer outdoor recreation to residents in the Tri-Cities area. Camping facilities are abundant within a short driving distance of the Tri-Cities area as are numerous lakes and rivers offering steelhead, trout, sturgeon, and other types of fishing. The Columbia River Basin is a popular area state-wide for migratory waterfowl and upland game bird hunting, whereas the Blue Mountains to the east and the Cascade Range to the west offer opportunities for big game hunters. Spectators can enjoy automobile, horse, and boat racing activities in the Tri-Cities area, most notably at the Tri-City Raceways, Sundowns Race Track and annual hydroplane racing events on the Columbia River (URS Company, 1981).

There are 134 outdoor recreation sites under local jurisdiction (county, city, schools, port districts, etc.) and 18 state sites and seven Federal sites in the study area. The local sites are comprised of 2,230 ha (5,519 total acres) with 725 developed ha (1,795 acres), whereas the State and Federal sites combined in the study area represent 139,317 total acres with 80 ha (198 developed acres. There are over 2,060 ha (5,100 acres) of local parkland in Benton County alone, with over 560 ha (1,400 acres) representing local developed parks. A shortage of 43 ha (106 acres) of developed park land in Benton County has been identified and a need to develop some of the more than 1,454 ha (3,600 undeveloped acres) of park land in Benton County (Benton-Franklin Governmental Conference, 1977).

Environmental Impacts

Based on the above information and the employment and population projections for Scenario 1 and Scenario 4, the demand for recreational facilities and activities would decrease through the 1980s. There are numerous recreational activities available to the residents of the Tri-Cities area although there may be a slight shortage of developed parkland acreage. The projected decrease in population for both Scenario 1 and Scenario 4 may indicate a lessening of demand for developed park acreage in the study area. Current demand levels experienced in the study area would be reached in the mid-1990s for Scenario 1 and Scenario 4.

In the staff's judgment, no mitigation is required and no unavoidable adverse impacts are expected to occur.

4.2.6.14 Government Finance

Existing Conditions

Local governments in the study area provide a broad range of services to the residents. The services and levels of expenditures vary between governmental bodies (Table 4.21). City governments spend more than twice as much per person than county governments. City governments spend a larger proportion of the budgets on security and physical environment, whereas county governments put a larger proportion of their revenues into general government and transportation.

Among towns and cities, expenditures per capita were lowest in 1979 for West Richland and highest for Pasco. Between the counties, expenditures per capita were higher in Franklin than Benton.

Operating expenditures of local governments increased rapidly from 1977 to 1979 (URS Company, 1981). This increase was principally the result of population in-migration during this period and greatly increased demands for public services. Operating expenditures of cities in the study area (Richland, Pasco, Kennewick, West Richland, Benton City, and Prosser) in the study area increased, in 1981 dollar terms, by 36 percent from 1977 to 1979 (Table 4.21). Benton and Franklin Counties experienced an increase of 16 percent during the same period. Between 1979 and 1980, real operating expenditures increased only slightly and then declined between 1980 and 1981 (Figure 4.30). Population continued to increase throughout the 1977-1981 period, resulting in a peak cost per capita for cities in 1979 ($365) and for counties in 1978 ($160). After these dates, cost per capita declined (Table 4.22). Likely factors responsible for the slowdown in the level of local government expenditures in the past few years included: a recession in the national economy; lower construction because of high interest rates; and the Washington law, effective since 1973, which limits the annual increase in property tax revenues from regular levies to 6 percent of the previous year revenues. New construction is excepted.

Property tax is a major source of revenue to counties (26 percent of total) and cities (15.5 percent) in the study area. Among other revenue sources, the sales/use tax is relatively more important to cities than to counties, whereas intergovernmental revenues are relatively more important to counties than to cities (Table 4.23).

Starting in 1978, impact payments of $4.7 million were distributed to local governments in the Tri-Cities area by WPPSS to mitigate costs of local government attendant with development of the WPPSS power plants. An additional $1.7 million was paid by WPPSS to Tri-Cities area schools. For the most part, these payments were used for capital improvements rather than operating expenditures.

Fiscal conditions in the study area can be projected only with considerable uncertainty. Many factors affect the future picture. With declining employment and population for the next 10 to 15 years, it will be difficult to sustain governmental revenues. The 106 percent limitation law will be more effective than previously in limiting revenues under the likely condition of limited construction in most jurisdictions. On the positive side, WPPSS generation tax payments will begin in a few years with the completion of WNP-2 and enlarge when WNP-1 is completed a few years later. These payments will total about $12 million per year. Local governments within 55.8 km (35 mi) of the Hanford Reservation gate will receive $6 million with the state retaining the remainder. Utility tax payments to cities with such tax systems will be larger as power rates increase. Expenditures by government are difficult to assess for the future, and they depend, among other factors, on inflation, bond rates, the taxpayer revolt, and legal revenue restrictions.

Table 4.21 Operating expenditures[1] of selected local governments, Benton and Franklin Counties, 1979

	Operating Expenditures (thousands of dollars)								Average %	
Description	Benton County	Franklin County	Richland	Pasco	Kennewick	West Richland	Benton City	Prosser	Counties	Cities
General Government	3,217	2,196	2,510	873	1,290	149	104	165	35.2	20.5
Security	1,716	800	2,735	1,816	2,773	263	88	239	16.3	32.0
Physical Environment	343	107	1,679	700	1,451	106	11	128	2.9	16.4
Transportation	3,160	2,076	1,179	1,811	2,543	30	217	463	34.0	25.1
Other	1,520	260	913	94	272	30	70	105	11.6	6.0
Total Expenditures	9,955	5,439	9,017	5,294	8,329	578	489	1,101	100.0	100.0
Expenditures per Capita (dollars)[2]	$102	$171	$269	$326	$279	$219	$257	$291	$119	$282

(1) The figures shown here are from operating funds and exclude capital projects (although debt service is included), enterprise funds and special assessments.

(2) Total expenditures of the jurisdiction divided by its population. Population estimates from Office of Financial Management, 1980.

Source: Washington State, Auditor's Office, 1979

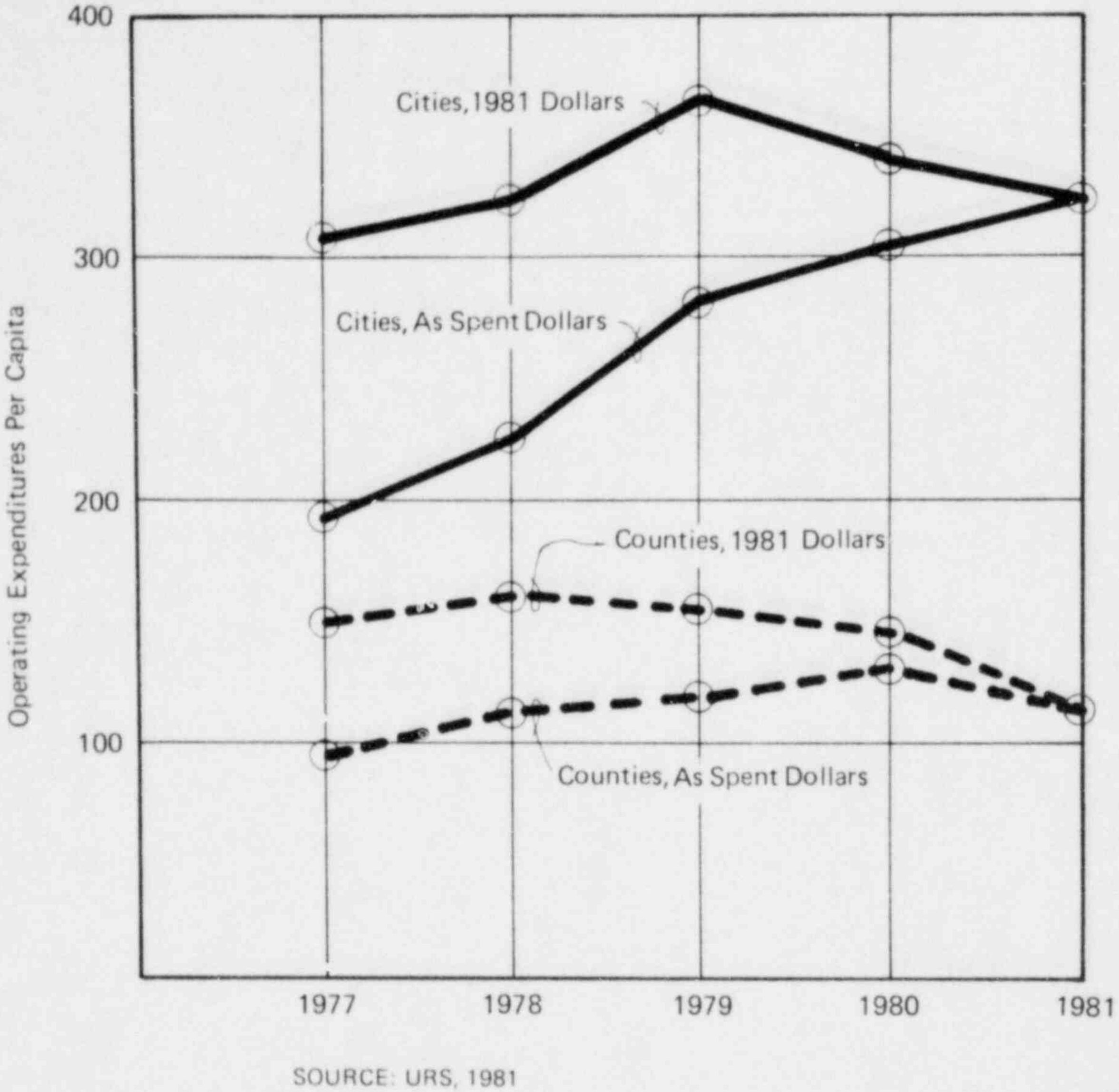


Figure 4.30 Operating expenditures per capita for study area governments, 1977-1981

Table 4.22 Operating expenditures of county and city governments in the Tri-Cities area, 1977-1981

Jurisdiction	Expenditures 1977	1978	1979	1980	1981
Cities[1]					
Expenditures (1,000)					
When Spent Dollars	15,122	18,446	24,845	28,966	31,384
1981 Dollars	23,654	26,441	32,162	32,303	31,384
Expenditures Per Capita					
When Spent Dollars	196	224	282	305	325
1981 Dollars	307	321	365	340	325
Counties[2]					
Expenditures (1,000)					
When Spent Dollars	11,004	13,486	15,394	18,920	17,413
1981 Dollars	17,212	19,331	19,928	21,100	17,413
Expenditures Per Capita					
When Spent Dollars	96	112	119	131	116
1981 Dollars	150	160	154	146	116
All Governments[3]					
Expenditures Per Capita					
When Spent Dollars	228	264	311	332	325
1981 Dollars	357	378	403	370	325

(1) Includes Richland, Pasco, Kennwick, West Richland, Benton City, and Prosser.

(2) Includes Benton and Franklin Counties.

(3) Costs per capita for all governments cannot be simply derived by adding costs of cities and counties because city residents also are county residents and receive services from both governments.

Sources: Washington State, Auditor's Office, 1979; Washington State, Office of Financial Management, 1981; Williams, Kuebelbeck and Associates, Inc., 1981.

Table 4.23 Taxes and other revenues[1] of selected local governments, Benton and Franklin Counties, 1979

Types	Taxes and Revenues (thousands of dollars)									
	Centon County	Franklin County	Richland	Pasco	Kennewick	West Richland	Benton City	Prosser	Average % Counties	Average % Cities
Property tax	2,814	1,835	1,273	836	1,313	47	28	118	26.1	15.5
Sales/use tax	3,762	376	812	986	1,425	39	44	129	23.2	14.7
Other tax	128	129	1,681	561	1,186	42	18	110	1.4	15.4
Inter gov. rev.[2]	2,849	2,377	2,571	2,142	2,903	161	488	355	29.3	37.1
Other revenue	2,678	884	1,801	758	1,189	137	58	96	20.0	17.3
Total revenue	2,231	5,601	8,138	5,283	8,016	426	636	808	100.0	100.0
Revenue/capita[3] dollars	$126	$176	$243	$323	$261	$161	$335	$213	$138	$265

(1) The figures shown here are from operating funds and exclude capital projects (although debt service is included), enterprise funds and special assessments.

(2) Includes revenues from many taxes collected locally and returned by the state, e.g, motor vehicle fuel tax, motor vehicle excise tax and liquor excise tax. It also includes other federal and state shared revenues.

(3) Population estimates from Office of Financial Management, 1980.

Source: Washington State, Auditor's Office, 1979

Government Expenditures

In this section, the likely governmental expenditures* associated with the S/HNP population are estimated. These expenditures are estimated by the governmental jurisdiction where these people are expected to be living during plant development and operation. As discussed in Section 4.2.6.2, the focus of this socioeconomic analysis has been Benton and Franklin Counties because of the small proportion of individuals involved in nuclear related employment residing outside of those counties. It should be noted, however, that, although the discussion of government finance is limited to selected jurisdictions in Benton and Franklin Counties, other jurisdictions (such as Sunnyside, Grandview, and Mabton) may receive fiscal impacts due to S/HNP project development.

If the S/HNP is developed in Benton County at the proposed site, a larger population would reside in the study area. (Compare Scenario 1 and Scenario 4. Note, however, that population stays below current 1981 levels until at least 1995 for both scenarios.) This larger population would require governmental services and, therefore, governmental expenditures would in all likelihood be greater.

The expenditure for the S/HNP-related population in any year was estimated as the projected difference in population between Scenarios 1 and 4, times projected expenditure per capita. In the projections, 1981 expenditure per capita was used. The average for all jurisdictions was $325.

Expenditures are distributed over jurisdictions in the study area on the basis of the 1981 distribution of population (see Section 4.2.6.2) and average cost for jurisdiction.

Expenditures per capita by jurisdiction were assumed to be the following approximate 1981 levels.**

*These estimates, from the Washington State Auditor's annual reports, Local Government Comparative Statistics, include general and current expense, special revenue, and some debt service funds. They do not include capital projects, enterprise, and special assessments.

**Based on data from Williams, Kuebelbeck and Associates, Inc., except Benton County, estimated by Economic Consulting based on State Auditor data.

Jurisdiction	Dollars
Richland	348
Kennewick	339
Pasco	317
West Richland	200
Benton City	217
Prosser	220
Benton County	100
Franklin County	165

The sum of projected expenditures for the S/HNP related population for the 1984-2000 period is $35,346,000 (Table 4.24). This results from the projection of 108,770 additional persons (an average of 6,308 persons per year) living in the study area during the 1984-2000 period at an average cost of $325 per person. These expenditures are distributed over time and governmental jurisdictions as shown in Table 4.24.

Direct and Indirect Tax Revenues

Development and operation of the S/HNP on the Hanford Reservation in Benton County would result in payment of large sums to local and state governments through existing tax systems. The objective here is to identify the major taxes affected by the project and to illustrate the operation of the tax systems that would result in the bulk of the revenue.

Table 4.25 gives a list of taxes that would apply to the project and the level of government that would receive the revenues. Direct tax payments would be made, primarily to the State and Benton County, by the plant owners and their contractors on land and materials at the plant site and on purchases and labor payments. Indirect taxes would be paid as employees and others receiving funds due to plant development and operation pay taxes and respend these funds in various ways. For the most part, these indirect taxes would be distributed among the cities.

The law limits the annual increase in property taxes on regular levies to 106 percent of the previous year tax plus taxes on new construction. The amount of property tax paid on assessed value would depend on tax rates applied by the State, county, and other tax districts (Table 4.26). The 1981 levy for the area where the plant would be located is $8.2571/$1,000 assessed value with a regular levy of $6.4886. The maximum allowed by law for regular levies is $9.15/$1,000. Future rates are speculative but may change only slightly without a change in laws because of the large addition to the tax base represented by the plant. Special levies are a mechanism available to local government to exceed regular levy limits. The sales/use tax rate is 6.3 percent, 5.5 percent going to the State, 0.5 percent to the county or city where the sale is made, and 0.3 percent to the Benton-Franklin Transit Authority. Counties receive 15 percent of the sales tax returned to cities by the State.

Table 4.24 Local government operating expenditures[1] of S/HNP related population at constant 1981 per capita expenditures, Tri-Cities area, 1983-2000

Year	Expenditures (thousands of dollars)								
	Total Increased Expenditure	Richland	West Richland	Kennewick	Benton City	Prosser	Benton County	Pasco	Franklin County
1983	722	174	10	173	7	13	168	86	91
1984	1,590	383	24	383	15	31	369	187	198
1985	2,830	682	46	678	28	55	654	333	351
1986	4,137	999	66	993	41	77	963	485	513
1987	5,300	1,281	84	1,271	54	99	1,232	621	658
1988	5,719	1,385	92	1,370	56	108	1,329	669	710
1989	5,077	1,228	82	1,217	50	97	1,180	593	630
1990	3,325	804	54	797	33	62	772	390	413
1991	2,015	487	32	481	22	40	467	235	251
1992	650	157	10	156	7	13	150	76	81
1993	498	118	8	119	4	11	115	60	63
1994	504	122	8	122	4	9	116	60	63
1995	501	118	8	122	4	11	117	60	61
1996	499	122	8	119	7	9	116	57	61
1997	496	118	8	119	4	9	117	60	61
1998	494	118	8	119	4	11	116	57	61
1999	497	122	8	119	4	9	117	57	61
2000	492	118	8	119	4	9	116	57	61
Total[2]	$35,346	$8,536	$564	$8,477	$348	$673	$8,217	$4,143	$4,388

(1) Product of difference in population between Scenarios 1 and 4 and 1981 expenditure per capita.

(2) Will not add due to rounding.

Table 4.25 Tax systems affected by S/HNP and government receiving revenues

Revenues	State	County	City	Other[1]
Direct[2]				
Property Tax	X	X		X
Sales/Use Tax	X	X		
Business & Occupation Tax	X			
Public Utility	X			
Indirect[3]				
Property Tax	X	X	X	X
Sales/Use Tax	X	X	X	
Business & Occupation Tax	X		X	
Real Estate Excise Tax	X	X		
Other		X	X	

(1) Taxes paid by Puget Power or its contractors during construction and operation of the plant.

(2) Taxes paid by employees of the plant and others as a result of spending by the employers and payments to non-employees.

(3) For example, library, port, fire, etc., taxing districts.

Direct Tax Revenues

In this section, tax revenues are estimated for spending on plant construction and operation. The tax systems discussed in the last section are applied to estimates of spending for plant construction and assessed values during construction and operation.

Plant Investment and Spending

Plant investment, including initial fuel loading and transmission costs, is estimated to be $5,560.7 million (Table 4.27). Part of the cost is price inflation. The 1981 dollar value is $3,383.2 million. This investment has already begun with expenditures for planning, design, and some components. Investment at the site of the plant would begin in 1983 when a construction permit is expected to be obtained.

Other items used in the construction process would be subject to assessment and taxation. However, the values are unknown at this time and have not been estimated by the applicant.

Table 4.26 Levy for 1981 property taxes in taxing district 1400 of Benton County, and limit set by law

Taxing Distribution	1981 Levy[1]	Limit[1]
State	$3.5743	$3.60
County	.9800	1.80
County road	1.3619	2.25
Rural library	.2955	.50
Port of Benton	.3238	N/A
School District 400	1.7217	N/A
TOTAL	$8.2571	$8.15[2]
Regular[3]	6.4886	
Special	1.7686	

(1) In dollars per $1,000 of assessed value. Increase in taxes on regular levies limited annually to 6% of previous year tax receipts, exclusive of new construction.

(2) Limit for unincorporated areas is 9.15; may be exceeded by special vote.

(3) Includes state, county (0.9331), county road, Port of Benton, and rural library.

Source: Benton County Assessor, 1981.

Table 4.27 Direct expenditures for S/HNP

Plant and land	$5,301,221
Fuel	232,426
Transmission	27,024
Total	$5,560,671
1981 Dollars	$3,383,167

Source: Puget Sound Power and Light Company estimate in 1980 dollars adjusted to 1981 dollars by use of Consumer Price Index for Seattle-Everett

During operations, it is estimated that an inventory of supplies, materials and mobile equipment would have a value of $11.2 million (1981 dollars) at the site. Annual purchases of supplies and parts would total $3.2 million to $3.6 million (also 1981 dollars) during operations. Ten to twenty percent of these purchases may be local. Purchases of services during operations would average about $6 million annually, with the local share about $4.8 million. In addition, annual fuel purchases would total $132.2 million (1981 dollars) during plant operation.

Taxes During Development

Revenues during construction for the sales and use tax, property tax, and business and occupation tax are estimated at $519.6 million (Table 4.28). The largest share of these taxes, 76.8 percent, would go to the State. The local area tax entities, all within Benton County except the Benton-Franklin Transit Authority, would receive the remainder with Benton County itself receiving $88.5 million, 17.0 percent of the total.

Table 4.28 Estimated additional tax revenues payable during development of S/HNP, 1983-1993

	Recipient ($1,000)			
Tax System	Benton County	State	Other	Total
Property tax[1]	$63,484	$ 98,812	$17,036[2]	$179,332
Sales, use tax[4]	25,034	275,248	15,008[3]	315,290
Business & occupation[4,5]	--	25,023	--	25,023
Total	$88,518	$399,083	$32,044	$519,645
1981 Dollars	(53,848)	(242,809)	(19,500)	(315,798)

(1) For regular levies only (See table 15). The addition of special levies would add an amount that can only be speculated upon for the future. An additional one percent of total tax for special levies would add more than twice the amount expected from special levies in the absence of the plant. Tax distributed according to 1981 regular tax levy distribution.
(2) Includes Port of Benton and Mid-Columbia Library District.
(3) Benton-Franklin Transit Authority, 1981.
(4) Some part of these amounts would likely leak from the local area and state. Assumes 90 percent of construction cost is taxable.
(5) Based on assumed rate of 0.45 percent of total value of plant. This may be somewhat overstated because it is based on total value of plant and fuel, whereas some direct purchases by plant owners would not be subject to the tax.

The time distribution of tax revenues to Benton County is illustrated in Table 4.29. The table shows tax revenues beginning in 1983. This would happen only if some activities at the site began in 1983 as projected.

The remainder of this section considers Benton County tax revenues only.

Taxes During Operation

After the plant is complete, the State Department of Revenue would provide the annual assessed value to the Benton County Assessor's Office. The value of the operating plant would depend not only on cost of construction, but also on contribution to the operations of the utility owners. According to the Washington Department of Revenue (1977),

Table 4.29 Estimated distribution of increased tax revenues to Benton County during S/HNP development, 1983-1993

	Revenues ($1,000)		
Year	Sales/Use[1]	Property[2]	Total
1983	$ 1,076	$ 0	$ 1,076
1984	1,502	487	1,989
1985	2,178	1,166	3,344
1986	3,380	2,152	5,532
1987	4,206	3,680	7,886
1988	4,706	5,583	10,289
1989	2,804	7,712	10,516
1990	2,629	8,980	11,609
1991	1,527	10,169	11,696
1992	1,026	10,859	11,885
1993	0	12,696	12,696
Total	$25,034	$63,484	$88,518
1981 Dollars	($15,224)	($38,624)	($53,848)

(1) Based on the schedule of plant expenditures on site, a tax rate of 0.5 percent, and 90 percent of cost of construction subject to sales tax.

(2) Based on estimated development at the site and projected regular levy tax rates.

"...the entire system is valued as an entity without consideration to the specific value of any one of the parts....Privately owned generating facilities will almost always be part of a system valuation and the value allocated to a specific power plant can only be determined on a case-by-case basis."

Based on discussions with the Department of Revenue, a value of 70 percent of construction cost, land, fuel value, and transmission is assumed for purposes of this document. Assessed value at time of first operation is, therefore, assumed to be $3,892.5 million ($2,368.2 million 1981 dollars). Estimated property tax to Benton County would be $8.87 million per year (Table 4.30).

Purchases of a local nature or subject to local sales or use taxes include (assume 1994):

- supplies, materials and mobile equipment--$1.74 million annually ($.64 million 1981 dollars)
- fuel--$359.5 million annually ($132.2 million 1981 dollars)

Both of these items would be subject at least in part to the sales or use tax in Benton County. Tax payments to Benton County during operation (the early years) are estimated to be about $10.68 million (Table 4.30).

Indirect Governmental Revenues

Indirect governmental revenues are taxes and other revenues received by local governments in the Tri-Cities area from payroll and other expenditures related to development of S/HNP. The S/HNP employee would pay sales tax, property tax on his residence (or his landlord would pay property tax on his rental), motor vehicle fuel tax, liquor excise tax, utility tax, etc. Furthermore, because of his/her presence in the community, other jobs would be created to provide goods and services for the construction worker and family. This results in an additional round of tax payments.

A recent fiscal impact study of the S/HNP found that local governments would have to either lower services or increase revenues from the general population to compensate for the budgetary shortfall associated with the construction population (Williams, Kuebelbeck and Associates, Inc., 1981).

Estimating indirect revenues associated with the S/HNP is more difficult than for most projects due to the fact that there is no project-related in-migration expected, and the characteristics of the construction populations are not known. Although studies have been done to determine construction-related population characteristics, these generally consider cases in which there was in-migration and the construction period was of a substantially shorter duration than is planned for S/HNP. In addition, the impacts must be analyzed against existing conditions of a declining employment and population base.

The following discusses the three largest sources of local government revenue and how the S/HNP-related population might affect these revenue sources.

Table 4.30 Annual tax revenues payable to Benton County during operation of S/HNP, 1994

Property Tax		
\$3,892.5 million (\$2.28/1,00)[1]	=	\$ 8.87 million
Sales Tax		
\$361.2 million (.055)	=	\$ 1.81
Total		\$10.68 million
1981 Dollars		(\$6.06 million)

(1) Projected tax rate for Benton County, including road district, for 1994.

(1) Intergovernmental Revenue--The future of intergovernmental revenue is currently uncertain. It is a large source of local government revenue. Most intergovernmental revenue is dispersed based on complex formuli; however, the primary determinant is population. Population-based intergovernment revenues (like revenue sharing) would be higher with S/HNP than without it, assuming that in the absence of S/HNP development greater reductions in population would occur. Overall, however, it is likely that these revenues would be lower than 1981 levels, even with S/HNP development. (See Employment and Population Impacts for Scenarios 1 and 4, Sections 4.2.6.1 and 4.2.6.2.)

(2) Property Tax Revenue--Property tax revenue represents another large source of revenue to local governments. However, because of the 106 percent limitation on property tax revenues, it may shrink in the future as a proportion of governmental revenue.

In other studies, it has been assumed that construction-related populations contribute less in property taxes because a higher proportion live in lower valued residences, such as apartments and mobile homes, than the general population. However, this assumption may not hold true in this case because of the longer construction period and the fact that potential employees would be established members of the community. It could also be argued in the other direction: assessed valuations for the S/HNP population may be higher than average. The S/HNP-related population has a higher income, and could spend more on housing. Also, it is likely that they have moved to the area more recently than the average resident and may, therefore, reside in newer housing with higher-than-average assessed values.

Because of uncertainty of the population characteristics of the S/HNP-related population, there is little basis on which to make valid projections of property tax revenues.

(3) Sales Tax Revenue--Sales tax revenue attributable to the S/HNP population could be projected using the payroll and spending estimates. Income to secondary employees could also be estimated using their estimated incomes. An estimate of taxable sales by these basic and secondary employees applied to the tax rate would result in a projection of sales tax revenue. However, such an estimate would not be comparable to historical per capita trends in sales tax revenue because it would not include sales taxes paid by businesses supported by the S/HNP population or taxes paid by tourists and others residing outside the jurisdiction.

It can be stated with some degree of certainty that, because incomes for the S/HNP population are higher than average, they would also contribute more in sales tax revenue than average. The average income for a S/HNP construction employee is $42,000, whereas the average income in the Tri-Cities SMSA is about $17,100. Based on taxable expenditures of 25 percent of total income, local sales tax revenue from the S/HNP expenditures would be $53 compared to $21 for the average employee.

The above discussion indicates that per capita sales tax revenue from the S/HNP-related population would be higher than from the study area population as a whole, whereas property tax revenues might be lower (due to lower value of apartments and mobile homes), and intergovernmental revenues (on a per capita basis) approximately the same. However, overall it is likely that indirect revenues of S/HNP-related population would not be significantly different than those of the study area population as a whole. It cannot be concluded definitely that S/HNP-related indirect revenues alone would offset S/HNP-related government operating expenditures.

Revenue and Expenditure Balance

Information to make a precise comparison of revenues and expenditures of local government is incomplete. In order to make such a comparison, all governmental revenues paid by and all costs incurred by the S/HNP-related population would have to be available. This study has produced only part of the necessary information. Government expenditures could be estimated within a reasonable range of accuracy. However, government revenues pose a greater problem. Although direct tax revenues could be estimated with some degree of confidence, indirect tax revenues could not. This lack of information on indirect government revenues for the S/HNP-related population limited the conclusions that could be made regarding fiscal impacts of the proposed project.

It seems clear that Benton County government, the county road district, the Port of Benton, and Mid-Columbia Library would receive large revenues. Those revenues, under present laws, would far exceed the budget requirements of these bodies. Benton County and the other tax districts mentioned above would receive essentially all of the direct tax revenues from the project.

The population related to S/HNP would, by and large, live in the towns and cities near the Hanford Reservation project site. These towns and cities, as well as other taxing districts, would provide services to the subject population but receive no direct taxes from the project. The part of the S/HNP-related population living in Benton County could benefit from the direct taxes to some extent but those living in Pasco and other parts of Franklin County would not. The cities, towns, and other taxing districts would receive indirect tax revenues from the subject population, but it is not clear whether these revenues would be sufficient to cover their costs. A study recently conducted for the Construction Impact Group concluded that there would be a revenue shortfall in those jurisdictions and tax districts not receiving direct taxes from the project.

In conclusion, revenues would accrue largely to one county and a few of its taxing districts. This county and these districts would experience little impact from the subject population. Thus, there is a definite separation of costs and revenues with respect to the incidence of direct taxes and location of the S/HNP-related population. Costs of government to serve the S/HNP-related population would fall on jurisdictions that would receive tax revenues based on expenditures of the subject population only. The adequacy of this revenue to cover costs is not known. In this case, there may be an inter-jurisdictional imbalance of revenues and costs with respect to the incidence of indirect revenues and location of S/HNP population. The possibility of inequities in areas and jurisdictions not identified in this study also exists. For this study, revenues and expenditures of jurisdictions that would be expected to receive the most significant impacts were examined. Other jurisdictions, not specifically included in this analysis, may also be impacted.

Mitigating Measures

The applicant has proposed no mitigating measures or recognized any adverse fiscal impacts of the proposed project. Instead, the applicant proposes to identify any adverse economic impacts by means of a monitoring program. When identified, mitigation measures might include direct compensation, upgrading of facilities or expansion of capacities. In addition to the proposed monitoring program, the Construction Impact Group has made an evaluation of fiscal impacts and presented it to the applicant.

Adverse impacts, if they are found to exist, would occur in the jurisdictions that serve the S/HNP-related population, in particular study area towns and cities. Because local tax revenues associated with the project far exceed the public costs of serving the subject population, even if they paid no taxes, mitigating measures aimed at possible fiscal imbalance should emphasize jurisdictional redistribution of the direct tax revenues. A redistribution of direct tax revenues from Benton County to other jurisdictions and tax districts could insure that all jurisdictions gain.

Present means exist for redistribution of tax revenues, either through voluntary agreement or through the Interlocal Cooperation Act (RCW 39.34). In either case, the problem still remains with the parties to agree upon the proper amounts, a process that may entail considerable negotiation (Washington State, Department of Revenue, 1977). One manner in which the tax revenues could be redistributed would be similar to that provided in the Generation or Privilege Tax. Under this law, tax revenues are distributed on the basis of population to jurisdictions and taxing districts within a radius of 55.8 km (35 mi) of the main gate to Hanford Reservation. The proper amount to redistribute, if any, for the S/HNP case remains an issue. Ideally, the amounts allocated to each jurisdiction would be based on demonstrated need.

In the staff's judgment, there will be no unavoidable adverse impacts.

4.2.6.15 Historical and Archaeological Sites and Natural Landmarks

Existing Conditions

Cultural Resources Program

A four-phase cultural resources program has been designed for the S/HNP to provide for the protection and/or preservation of cultural resources pursuant to the National Environmental Policy Act and National Historic Preservation Act of 1966, Executive Order 11593, and State and Federal Agency Regulatory Guidelines.

Phases 1 and 2 of this program were carried out by the applicant to determine the presence and significance of known cultural resources within the project impact area and immediate vicinity, examine high potential areas for the presence of cultural remains, and acquire data for designing a more intensive survey. The results are reported in a document entitled, "A Cultural Resources Overview and Scenic and Natural Resources Assessment for the Skagit/Hanford Nuclear Power Project" (ERTEC, 1981).

The field survey included two survey methods. Archaeologists surveyed a 3.2-km (2-mi) corridor along the river, centered on river mile 361.5, observing archaeological and historical materials, and recording survey conditions and general observations on the survey area. The reconnaissance of the plant site consisted of walking at 24.4-m (80-ft) intervals through the northern portion of Sections 27 and 28. The two surveyors recorded cultural resources, vegetation, and topographic conditions. Field checks of the associated areas, including access roads and transmission corridors, consisted of visiting the places where those facilities crossed existing roads. In these cases, the topographic and vegetative characteristics of the environment were noted to help plan the intensive survey (ERTEC, 1981).

Phase 3 of the cultural resources program consists of intensive field survey of the areas to be impacted by construction of the plant and associated facilities, an assessment of potential project impacts to cultural resources, determinations of eligibility of properties to be affected by the National Register of Historic Places, and formulation of a detailed mitigation plan.

Phase 4 consists of implementing the mitigation plan through avoidance of significant sites or data recovery prior to construction and through monitoring of construction activities. Phases 3 and 4 have not yet been completed.

Archaeological Resources

Large permanent villages and temporary fishing stations of the Wanapum Tribe are found along the Columbia River, and small seasonal camps and activity areas are found in the dry, interior region. This pattern reflects their seasonal use of the area for spring and summer gathering of camas, other roots and bulbs, spring and fall salmon fishing, summer hunting, and fall berry harv ing.

The area between the Hanford townsite and Richland was one of the few places along the river where there were no permanent villages. There were, however, numerous villages and small camps upstream from Hanford and up to White Bluffs Canout, one of the principal Wanapam camps, and the only one reported within the cultural resources overview and survey area (ERTEC, 1981).

There are 115 cultural resource sites recorded on the reservation. Open camps, fishing stations, house pit sites, cemeteries, and flaking floors are represented by organic debris, fire-cracked rock, artifacts, and clearly discernible features such as fire hearths (ERTEC, 1981; Rice and Chavez, 1980; Rice, 1981).

Numerous cultural resource sites, districts and localities are recorded in the cultural resource study area (Fig. 4.31; Table 4.31). Eighteen have been placed on the National Register of Historic Places. These include two districts, the Wooden Island and Savage Island Archaeological Districts. The closest site is one mile from the intake structure. A number of additional cultural resources have been noted but are not formally recorded. Lithic scatters are present in the Shifting Dunes locality, northeast of the proposed plant site (ERTEC, 1981).

Three prehistoric archaeological sites are recorded in the S/HNP site and associated areas (Fig. 4.31). In addition, the field reconnaissance noted a light scatter of river mussel shell and fire-cracked rock covering the river corridor survey area.

Historical Resources

The White Bluffs-Hanford section of the Columbia River was the center of numerous important developments in the history of interiors of Washington and Idaho. In the mid-1800s, this area became a focal point for trans-shipment of goods to fur trade posts and mining claims. The quality of the grazing land in the area did not pass unnoticed, and, by the 1860s, stockmen were running their herds there.

There was a shift in valley development in 1892 when a number of homestead settlers arrived in the White Bluffs area to establish small farms. Settlements tended to be located near watercourses, primarily on the west bank of the Columbia River. A small ferry was established at Hanford.

Under the National Reclamation Act of 1902, a major irrigation project was developed in the Hanford-White Bluffs region, and the population increased drastically. The Hanford Region soon developed into one of the major orchard regions in the State. The Hanford irrigation ditch remains as evidence of this era. This channel is visible in the S/HNP project area.

In 1943, with the initiation of the Hanford Atomic Engineering Project, the residents of Hanford and White Bluffs vacated the area and all efforts were centered on the nuclear industry.

Between 1974-76, the old farming communities were leveled so that today only a few structures remain in the original Hanford-White Bluffs area. The area has since achieved fame as one of the principal sites associated with the beginning of the atomic age.

Table 4.31 Archaeological and historical sites and National Register districts located in the cultural resources overview and survey area

Site Number	Name	Location	Status	Description
45BN124 45BN134 45BN178	Hanford North district	3.5 miles north of intake and discharge facilities	Listed in the National Register	National Register District containing 12 sites including: 3 burial sites, 8 open camps and 1 open camp with housepits
45BN123	--	2 miles north of intake and discharge facilities	Unevaluated	Open campsite
45BN122	--	1.5 miles north of intake and discharge facilities	Unevaluated	Open campsite
45BN121	Hanford Island site	1 mile north of intake and discharge facilities	Listed in the National Register	Housepit site
45BN120	--	0.5 mile north of intake and discharge facilities	Unevaluated	Open campsite
45BN116 45BN119 45FR157 45FR262	Savage Island district	45BN119 is 1 mile south of intake and discharge area, the other sites facilities in this district are further south of 45BN119	Listed in the National Register	National Register District containing 10 sites including: 9 open camps and 1 housepit site
--	Shifting Dunes locality	Southeast of S/HNP site	Not recorded as sites	Contains numerous small campsites that have been deflated by wind erosion and buried by shifting sands
45BN39	--	On island opposite Ringold Ringold Flat	Unevaluated	Fishing station
45BN222	--	On island opposite Ringold Flat	Unevaluated	Fishing station

Table 4.31 (continued)

Site Number	Name	Location	Status	Description
45BN221	Ringold Island	Ringold Island	Not eligible	--
45BN223	--	On island opposite Ringold Flat	Unevaluated	Fish processing plant
45BN115	--	7.5 miles east of the S/HNP Site	--	Open campsite
45BN228	--	7.5 miles east of the S/HNP Site	Unevaluated	Fishing station
45BN227	--	7.5 miles east of the S/HNP Site	Unevaluated	Fishing station
45BN226	--	7.5 miles east of the S/HNP Site	Unevaluated	Fishing station
45BN225	--	7.5 miles east of the S/HNP Site	Unevaluated	Stone weir
45BN224	--	7.5 miles east of the S/HNP Site	Unevaluated	Fishing station
45BN257	--	WNP 1 & 4 pumphouse	Unevaluated	Hearth area
45BN266	--	In Section 33, location of main power plant	Not eligible	Flaking floor
45BN114	--	1 mile upstream from Wooden Island	---	Fishing station
45BN113	--	1 mile upstream from Wooden Island	---	Fishing station
45BN169	--	--	---	Housepit site
45BN107 45BN112	Wooden Island District	9 miles southeast of the intake and discharge facilities	Listed in the National Register	National Register District containing 7 sites, including: 3 open camps, 2 housesites, and 2 fishing camps

Source: S/HNP ASC/ER, 1981

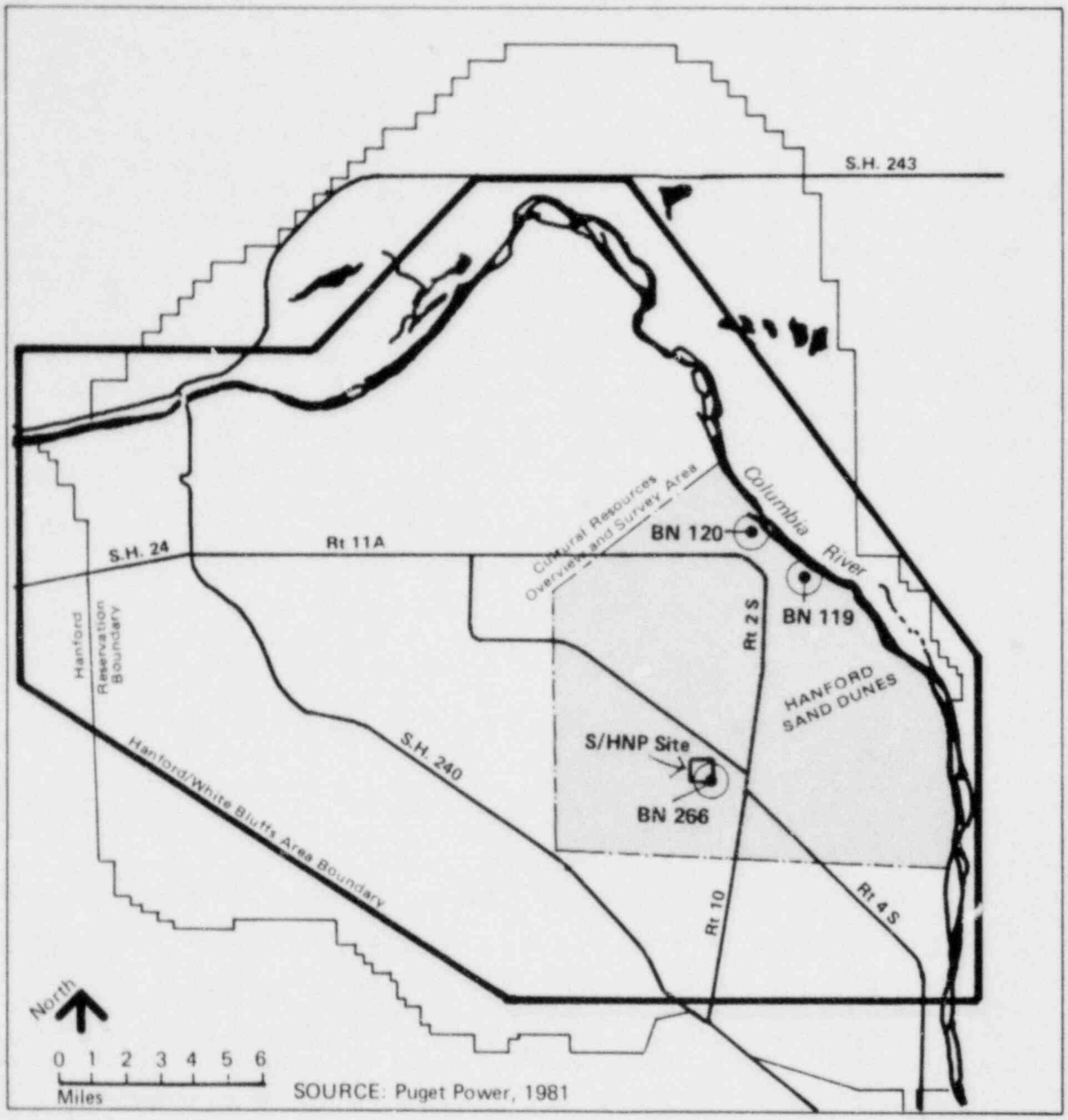


Figure 4.31 Defined boundaries and archeological sites

Three historic archaeological sites are reported within the S/HNP site and associated areas: the Hanford townsite, the Hanford irrigation ditch, and the remains of what may have been a stock corral. They are described in the overview (ERTEC, 1981).

Studies necessary for the assessment of eligibility of these properties for inclusion in the National Register of Historic Places have not been conducted. However, based on preliminary assessment, the Hanford irrigation ditch and townsite may be eligible for listing. The corral is not likely to meet the requirements for listing in the National Register.

Environmental Impacts

Impacts or effects on cultural resources of a planned undertaking may be either beneficial or adverse. Adverse impacts on National Register or eligible property may be either direct or indirect. Direct effects are caused by the undertaking and occur at the same time and place. Indirect effects are those caused by the undertaking that are later in time or farther removed in distance but are still reasonably foreseeable. The criteria of an adverse effect set forth in 36 CFR 800.3(b) may occur under conditions that include, but are not limited to, the following:

(1) Destruction or alteration of all or part of a property;

(2) Isolation from or alteration of the property's surrounding environment;

(3) Introduction of visual, audible, or atmospheric elements that are out of character with the property or alter its setting;

(4) Neglect of a property resulting in its deterioration or destruction; and

(5) Transfer or sale of a property without adequate conditions or restrictions regarding preservation, maintenance, or use.

Various S/HNP project activities have the potential to disturb or otherwise affect cultural resources. Destruction of any cultural resources would be irreversible and irretrievable. The most extensive components of the project are the plant site and associated areas, including access roads and access railroad corridors, intake and discharge pipeline corridors and a transmission system.

Additional project-related activities that have impact potential are mentioned in the Application for Site Certification but are not given sufficient consideration to determine impacts at this time. They include offsite disposal sites, borrow pits, stockpile locations, and improvements to SR 240.

This impact assessment is based on project boundaries and facilities as defined in the Application for Site Certification and on the results of Phases 1 and 2 of the Cultural Resources Program. Five known cultural resource sites might be affected by project construction. Additional resources might be discovered during Phases 3 and 4. A description of potential impacts of the major constituents of the S/HNP is presented below. A chart of impacts presented by project phase is shown in Table 4.32. Within each phase, the staff assessed

Table 4.32 Skagit/Hanford Nuclear Project: cultural resource impacts

Phase of the Project Action	Direct/ Indirect Impact	Location	Type of Impact*	Comments
Construction				
S/HNP plant site	Direct/ indirect	T12N/R27E/ Sec. 33 (all), S1/2 28, W1/2 of SW1/4 27, NW1/4 of NW1/4, SW1/4 of NW1/4, NW1/4 of SW1/4, SW1/4 of SW1/4, of Sec. 34.	1	Phase 3 of the cultural resources program discussed in the application would include an intensive survey of the plant site after construction permit is granted and before clearing and grubbing operations commence. However, the survey may not find buried cultural remains and these may be disturbed during construction.
Drainage ditches	Direct	Plant site	1	Since there are no storm sewers included in plant design, drainage ditches would be constructed and maintained to control runoff.
Access railroad	Direct	Associated areas outside site	1	Approximately 42 acres would be disturbed during construction of the access railroad; previously undiscovered cultural resources could be disturbed or destroyed during construction.
Access roads	Direct	Associated areas	1	Construction of the north access road would disturb approximately 19 acres; construction of the preferred south access road would disturb 33 acres. Road building would destroy buried materials should they exist in the area where the roadbed will be constructed or installed.
Associated intake and discharge facilities (including filtration pond, temporary intake, and pumphouse)	Direct	Associated areas	1	Construction of the pumphouse and filtration pond that are located close to the west bank of the Columbia River could disturb or or destroy presently unknown cultural resources. Incidence of known cultural resources located along the Columbia River is high, therefore, the potential for additional cultural resources here is also high.

* Key: See text for definition of impacts

Table 4.32 (continued)

Phase of the Project Action	Direct/ Indirect Impact	Location	Type of Impact*	Comments
Intake and discharge pipelines	Direct	Associated areas	1	135 acres would be used to site the intake and discharge pipelines. Disturbances or destruction of presently undiscovered cultural material could be a concomitant of this action.
Transmission facilities (includes towers, access and spur roads, laydown areas and transmission)	Direct/ indirect	Associated areas	1	Disturbance or destruction of presently unknown cultural resources could result from construction of the transmission facilities that are expected to use 50 acres maximum.
Borrow sites	Direct	Plant site and associated areas	1	Disturbance or destruction of presently undetected cultural resources could occur.
Spoil disposal	Direct	Plant site and associated areas	1	Excess excavated material from site preparation and construction would be disposed of in a spoils area located on site. This action could bury and compact presently unknown cultural resources.
Improvements to SR 240 and associated roads	Direct	Off site	1	Several improvements to existing SR 240 plus the construction of a new road connecting SR 240 to the plant site are presently under consideration. Road construction or improvement could impact cultural resources.
Disposal of construction wastes	Direct	Not specified	1	"Assorted construction wastes that are not burned, buried, or recycled will be collected and stored in containers before removal to an approved disposal area" (Application, 4.5-2). Method of final disposal is not stated. The impact of this action is dependent on location and method of disposal.

* Key: See text for definition of impacts

Table 4.32 (continued)

Phase of the Project Action	Direct/ Indirect Impact	Location	Type of Impact*	Comments
Liquid wastes	Direct	Offsite, location not specified	1	As stated above, method of final disposal and location of disposal area is not stated.
Chemical toilet wastes	Direct	Offsite, location not specified	1	Location and manner of disposal are not specified in the application. Impacts to cultural resources are contingent on site and method.
<u>Operation</u>				
Sanitary waste disposal	Direct	Not specified, but offsite	1	Sludge from the sanitary waste treatment system would be disposed offsite. The method of disposal (e.g., burial, surface deposition) is not specified in the application nor is the location of the are to be used for disposal. The impact of this action is dependent on location and method of disposal.
Environmental monitoring programs	Direct	Various	1	Description of monitoring stations and methods does not include information on possibie ground disturbance.
<u>Abandonment</u>				
Decommissioning and dismantling	Indirect	All areas used by the S/HNP facilities		The degree of dismantling and the manner of decommissioning would be decided upon at a later date. However, cultural resources could be affected by this action through burial under waste piles, or through disturbing or destruction of sites by dismantling, which could not only remove the facilities but, also destroy some of the subsurface ground at those facilities.

* Key: See text for definition of impacts

individual actions as to their potential impact on cultural resources. The results of the staff's analysis is presented in Table 4.32.

Plant Site

The development of the S/HNP site would disturb approximately 485 ha (1,200 acres) through site preparation, grading, and construction. Archaeological site 45BN266 is recorded within the S/HNP boundary. Site 45BN266 has been determined to not be eligible for inclusion in the National Register of Historic Places. It has been collected and would not be affected by project construction.

The possible corral complex is also located within the perimeter of the site and would be impacted by construction activity. Eligibility for being listed in the National Register of Historic Places has yet to be formally determined, although preliminary assessment suggests that the corral complex is ineligible.

Associated Areas

Construction of the intake and discharge pipelines and pumphouse would affect the Hanford townsite and the Hanford irrigation ditch. These impacts could include destruction of historic archaeological information and materials.

Neither property has been formally assessed for National Register eligibility. Preliminary consideration indicates that the irrigation ditch might be eligible. The disturbed condition of the Hanford townsite might exclude it from the National Register. Studies necessary to assess the significance of these properties, as well as to determine potential effects, would have to be conducted.

Archaeological site 45BN119, listed in the National Register of Historic Places, is reported approximately 1.6 km (1 mi) downstream from the proposed intake and discharge facilities. Archaeological site 45BN120 is recorded as being located at the center of the Hanford townsite. Further investigation is needed to determine the areal extent and potential effect of the project on these sites. The significance of 45BN120 should be determined.

The Hanford Island site, situated farther to the north, is also listed in the National Register of Historic Places. It would not be affected by the proposed intake and discharge pipelines, as currently sited.

There are no known cultural resources within the rights-of-way of the access roads, railroad, or transmission lines. Construction of these facilities, plus the intake and discharge pipelines, would include disturbance of an estimated 170 ha (420 acres) outside the site boundary. Previously undiscovered cultural resources could be disturbed or destroyed during construction. Although the potential for the occurrence of cultural resources, especially of subsurface materials, is somewhat lower than along the river corridor, these impact areas need to be surveyed for the presence of cultural remains.

Mitigating Measures

The following are measures to which the applicant is committed:

(1) A cultural resources overview and preliminary reconnaissance have have been completed. An intensive field survey of the areas to be impacted by construction of the plant and associated facilities would follow. The methodology proposed for the intensive survey would be presented to the Office of Archaeology and Historic Preservation staff for comments.

(2) Determinations of project effects on cultural resources and determinations of eligibility of properties to be affected would be made to the National Register of Historic Places.

(3) A detailed mitigation plan would be formulated and implemented through avoidance of significant sites, protection, or data recovery prior to construction through monitoring of construction activities.

(4) An archaeologist would be retained to inspect the S/HNP site during the excavation phase and report on the uncovering of any potential archaeological or historical sites and to recommend means to preserve or interpret any historical or archaeological sites or artifacts uncovered.

In the staff's judgment, the following additional mitigating measures shall be taken by the applicant:

(1) Appropriate studies shall be conducted to provide adequate information to the State Historic Preservation Officer (SHPO) in order to determine effect and eligibility. A detailed mitigation plan shall be formulated in consultation with SHPO (36 CFR 800.4).

(2) Field surveys of additional offsite areas where ground disturbance may occur, such as location of improvements to SR 240, disposal and borrow sites, etc., shall be conducted where appropriate in accordance with 36 CFR 800.4.

(3) If, in the course of construction, cultural remains are encountered, measures shall be taken pursuant to 36 CFR 800.7, "Resources Discovered During Construction."

Unavoidable Adverse Impacts

Inadvertent loss of, or damage to, undiscovered cultural resource would be a possible unavoidable impact concomitant of any construction project.

4.2.7 Earth

4.2.7.1 Geology

Existing Conditions

The geologic region pertinent to the S/HNP site covers a portion of the Pacific Northwest that includes Washington, Oregon, and adjoining areas of Idaho and British Columbia. The physiographic pattern of the study region, a part of the North American Cordilleran system, is a complex arrangement of mountain ranges, plateaus, and basins. These features are the result of extensive Cenozoic (the past 65 million years) volcanic activity and the accumulation of thick sedimentary deposits in structurally negative areas.

The principal physiographic elements are shown in Figure 4.32. The S/HNP site is centrally located in the Pasco Basin, which in turn is near the center of the Columbia Plateau. To the east and north, the plateau is bounded by old, Precambrian and Paleozoic isotonic rocks. The Precambrian Era ended about 570 million years ago [million years before the present (mybp)], and the Paleozoic extended from about 225 to 570 mybp. To the west and south, almost all deposits are Cenozoic (from 0.01 to 65 mybp). The Columbia Plateau was formed during Miocene time (5 to 23 mybp) when vast outpourings of basalt blanketed central Washington.

Bounding the Columbia Plateau on the west are the Cascade Mountains, the dominant physiographic feature in the region. The Cascades run nearly north and south, dividing the states of Washington and Oregon into two, quite distinct portions, with humid conditions in the west and arid-to-desert conditions in the east.

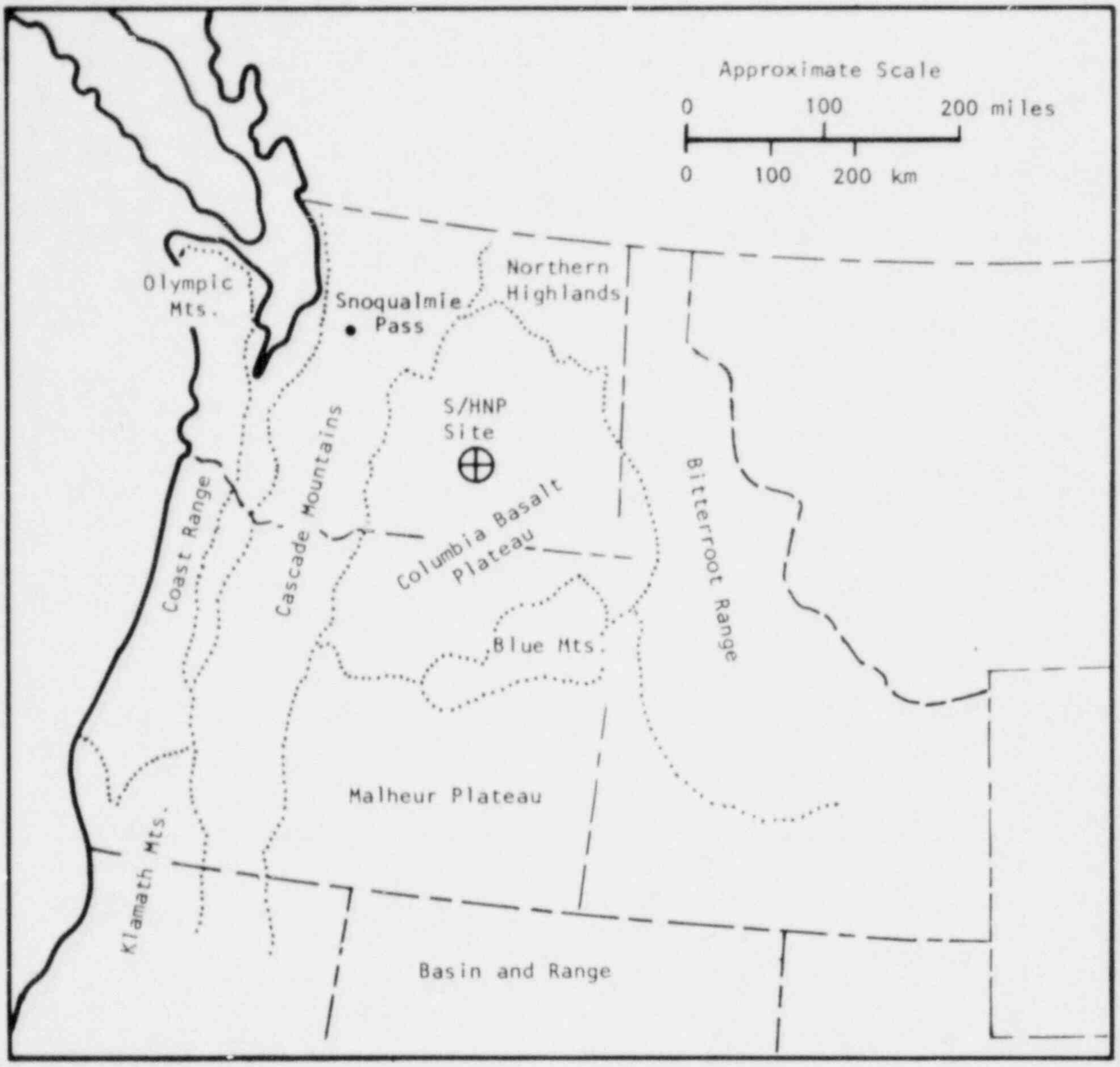
Structurally, the Cascades represent an uplift, beginning in the Miocene (about 5 to 23 mybp), on which linear series of late Pliocene (about 18 to 5 mybp) and Pleistocene (0.01 to 1.8 mybp) volcanoes were superimposed. Despite the unifying topographic expression imposed by the volcanoes, the Cascades can be separated into quite distinct northern and southern portions. North of Snoqualmie Pass, older, pre-Cenozoic, igneous and metamorphic rocks occur below the volcanoes; to the south and across Oregon, Cenozoic rocks, which are almost entirely volcanic, are found. This separation is an erosional, not a tectonic, feature. Outliers of the Cenozoic materials are found to the north of the separation; to the south, windows through the Cenozoic materials reveal exposures of the older metamorphic rocks.

To the west of the Cascades lies the Puget Lowland, which extends with minor interruptions from the Canadian border southward to the Willamette Valley in Oregon. This is a region of structural downwarping, the deeper portions of which are thickly covered by late Tertiary and Quaternary deposits. The occasional bedrock deposits in the area are metamorphosed eugeosynclinal deposits of Jurassic and later age.

The eastern boundary of the Columbia Plateau consists of Cretaceo (about 100 mybp) age granites of the Idaho Batholith, which lie to the south, and the early Proterozoic (late Precambrian) Belt Series, marked by transverse (east-west) faulting, which lies to the north. Northeast of the plateau is a complex region of older, Mesozoic (65 to 22.5 mybp), Paleozoic, and late Precambrian deposits that curves around the plateau basalts toward the east flank of the Cascades. Petrographically and topographically, these deposits are an extension of the Northern Rocky Mountain system.

Within the terrains east and northeast of the Columbia Plateau, tectonic origins have been partially masked by erosion and deposition. However, within the plateau and to the west and south, the existing physiography closely reflects tectonic origins.

Topography in the plateau country east of the Cascade Mountains is relatively subdued compared with surrounding mountainous regions. The major topographic features of the plateau are generally east-west-trending folds, anticlinal



Source: Adapted from John A. Blume and Associates, 1970

Figure 4.32 Principal physiographic elements of the Pacific Northwest ridges and monoclines, and intervening basins (see Figure 4.33). These structures are transected by rivers that locally have cut deep gorges into the layered basalt sequence. In northeastern Oregon, there is an easterly trending complex of ranges approximately 321.6 km (200 mi) long known as the Blue Mountains. The Ochoco-Blue Mountain uplift protrudes island-like through the plateau basalts. The mountains, consisting of folded and faulted rocks of Paleozoic, Mesozoic, and early Tertiary age, extend from the Rocky Mountains of western Idaho to the Oregon Cascades.

Stratigraphy

The stratigraphy of the Pasco Basin consists of three basic units of highly contrasting lithology and origin. The lowermost unit that can be identified in the region is one of basalt flows, which are overlain in the Pasco Basin by the sands, silts, and gravels of the Ringold Formation. Above the Ringold Formation are the uncemented Pasco Gravels, which are covered within 1.5 or 3 m (5 or 10 ft) of the ground surface by wind-blown sand.

The basalt flows of the plateau are generally separated by interbeds of volcanoclastic sediments. Most of the younger flows have been named and age dated, and their areal extent has been mapped. The stratigraphic section illustrating the succession of flows and overlying formations is shown in Figure 4.34. Total thickness of basalt at Pasco Basin is at least 3,000 m (10,000 ft) (John A. Blume and Associates, 1971a, b), but only the upper portion of these flows has been studied in detail. Age determinations of basalt flows vary from lower Miocene (6.5 mybp) to upper Miocene (6 mybp) (Rockwell Corporation, 1979).

The Ringold Formation consists of fine to coarse sediments containing gravels deposited by a through-flowing stream during the late Miocene and early Pliocene (10.5 to 3.3 mybp). Its thickness over the site area is about 152 m (500 ft) (S/HNP PSAR, Amendment 23, 1981).

The Pasco Gravels uncomformably overlie the Ringold Formation in the Pasco Basin. The formation consists of uncemented granular material varying in size from boulders to silt. The clasts are predominantly well rounded and are composed of granite, quartzite, gneiss, and porphyritic volcanics derived in part from the underlying Ringold Formation. The uppermost gravels are assigned an age of 13,000 ybp, and the age of the lowermost is uncertain but could be as old as 3.3 mybp. The Pasco Gravels are about 61 m (200 ft) thick at the site (S/HNP PSAR, Amendment 23, 1981).

Structure

Geologic structures in the region of the S/HNP site have been produced by tectonic deformation of the original near-horizontal basalt flows. Deformation began in upper Miocene prior to cessation of the basaltic lava outpourings. The downwarping of Pasco Basin and formation of prominent folds, anticlines, and monoclines was well developed in late Miocene time (10.5 mybp), and the basin was filled by Ringold sediments and later by Pliocene-Pleistocene Pasco Gravels.

The basin is bounded by a prominent ridge to the north called Saddle Mountains and by Rattlesnake Hills and Horse Heaven Hills to the west and south. To the

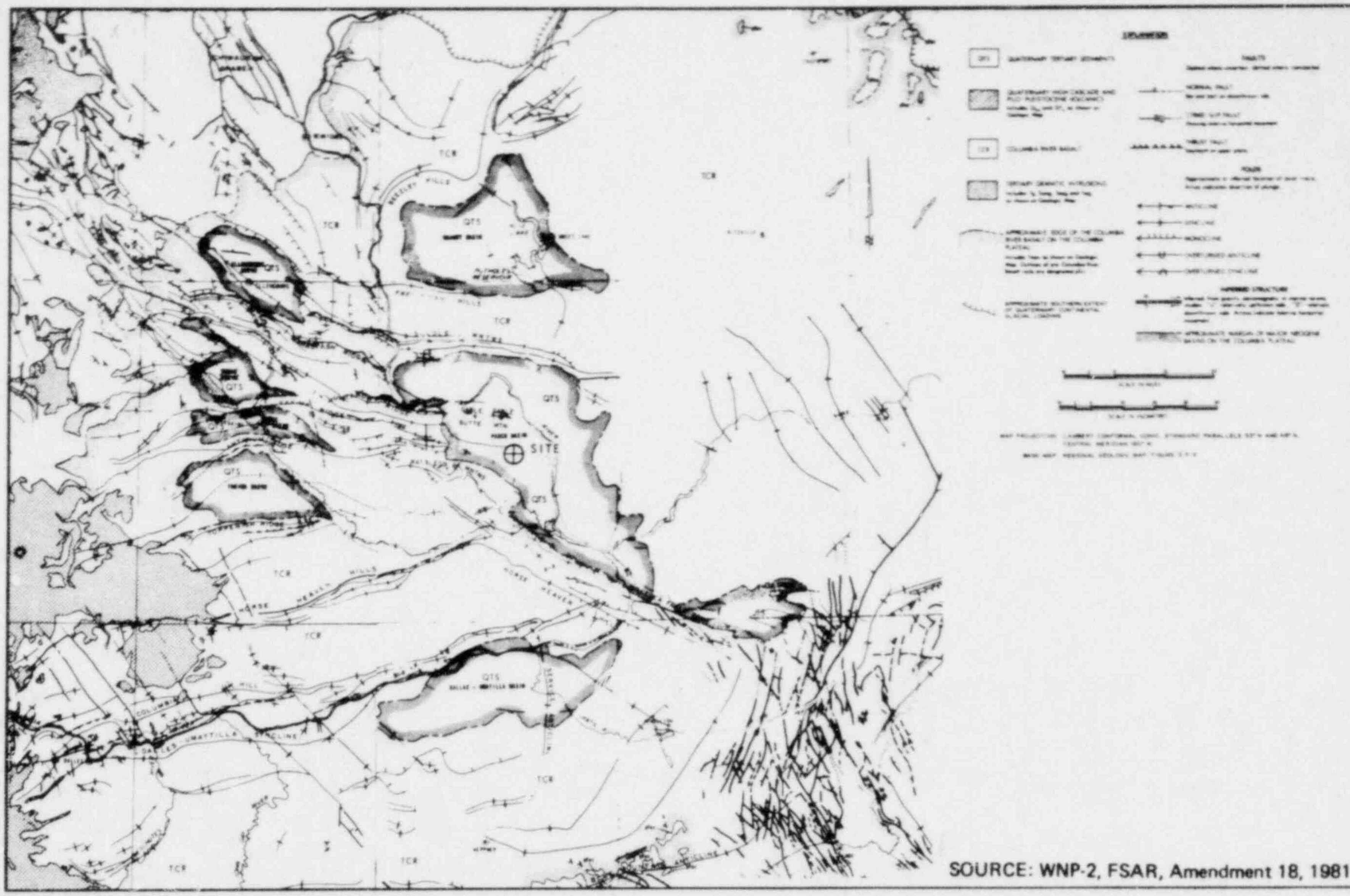
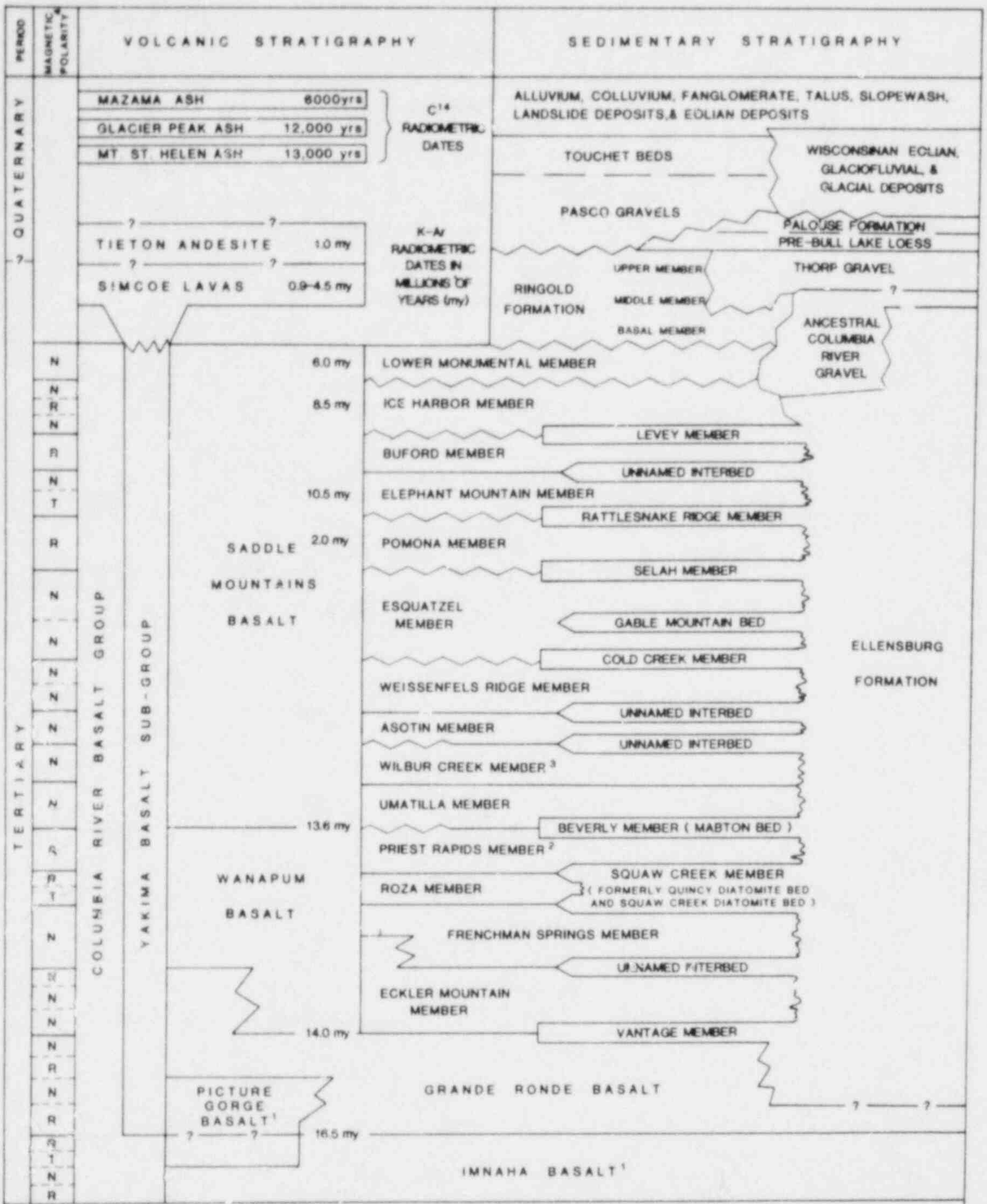


Figure 4.33 Map of regional geologic and tectonic elements of the Columbia Basin



MODIFIED FROM ROCKWELL, 1979 TABLE III-1; USGS BULL 1457-G, 1979, FIG. 2, p. G7

SOURCE: WNP-2,FSAR, Amendment 18, 1981

1. THE IMNAHA & PICTURE GORGE BASALTS ARE NOWHERE KNOWN TO BE IN CONTACT.
2. PRIEST RAPIDS MEMBER UNDERLIES, LOCALLY WITH EROSIONAL UNCONFORMITY, THE UMATILLA MEMBER.
3. WILBUR CREEK MEMBER UNDERLIES, LOCALLY WITH EROSIONAL UNCONFORMITY, THE ASOTIN MEMBER.
4. MAGNETIC POLARITY: N (NORMAL), R (REVERSED), T (TRANSITIONAL).

Figure 4.34 Late Cenozoic stratigraphy of the Columbia Plateau east, the buried basalt surface slopes gradually upward, forming a gradational boundary. Gable Mountain and Gable Butte are asymmetrical anticlines of basalt protruding through the surficial materials. Along the northwest margin of the basin, Umtanum and Yakima Ridges plunge beneath the Quaternary-Tertiary sediments of the basin and die out beneath it.

Environmental Impacts

The S/HNP facilities would have no impact on the geology of the study area during either construction or operation. For that reason, no mitigative measures are needed and no unavoidable impacts are expected to occur.

4.2.7.2 Topographic Characterization

Existing Conditions

The topography of the S/HNP site has been created by the geologic structures within the study region and the erosion of surficial geologic materials. The Pasco Basin is a gently undulatory plain mantled with Pleistocene glaciofluvial flood deposits and Holocene eolian deposits. This low-relief plain is bounded on three sides by the pronounced topographic/structural ridges of the Saddle Mountains to the north, Umtanum and Yakima Ridges to the west, and the Rattlesnake and Horse Heaven Hills to the south, as shown in Figure 4.35. The eastern topographic boundary of the basin is indistinct, with major relief being sand dunes and coulees.

The site has an average elevation of 158 m (520 ft) above mean sea level (msl), and it is situated in a slight depression with a local topographic relief about 6 m (20 ft). The local topography is further characterized by active sand dunes: a small dune several hundred meters northwest of the site and a larger, east-northeast-trending dune east of the site. The dunes are migrating northeastward, away from the site, and are not expected to change its topography.

Environmental Impacts

Implementation of the S/HNP would have short-term impacts on the topography of the area during construction:

(1) Excavation and disposal of foundation and pipeline-trench materials would temporarily alter the topography.

(2) Removal of vegetation could result in reactivation of inactive sand dunes.

The S/HNP facility would have no adverse impact on topography during operation.

Mitigating Measures

The following measures shall be instituted by the applicant:

(1) Use of the greater part of the excavated foundation and trench materials as backfill around the constructed foundation at depth of approximately 11 m (35 ft) and disposal of the excess by grading and spreading it over the site or depositing it in existing borrow areas on the Hanford Reservation would restore the topography of the area surrounding the facility.

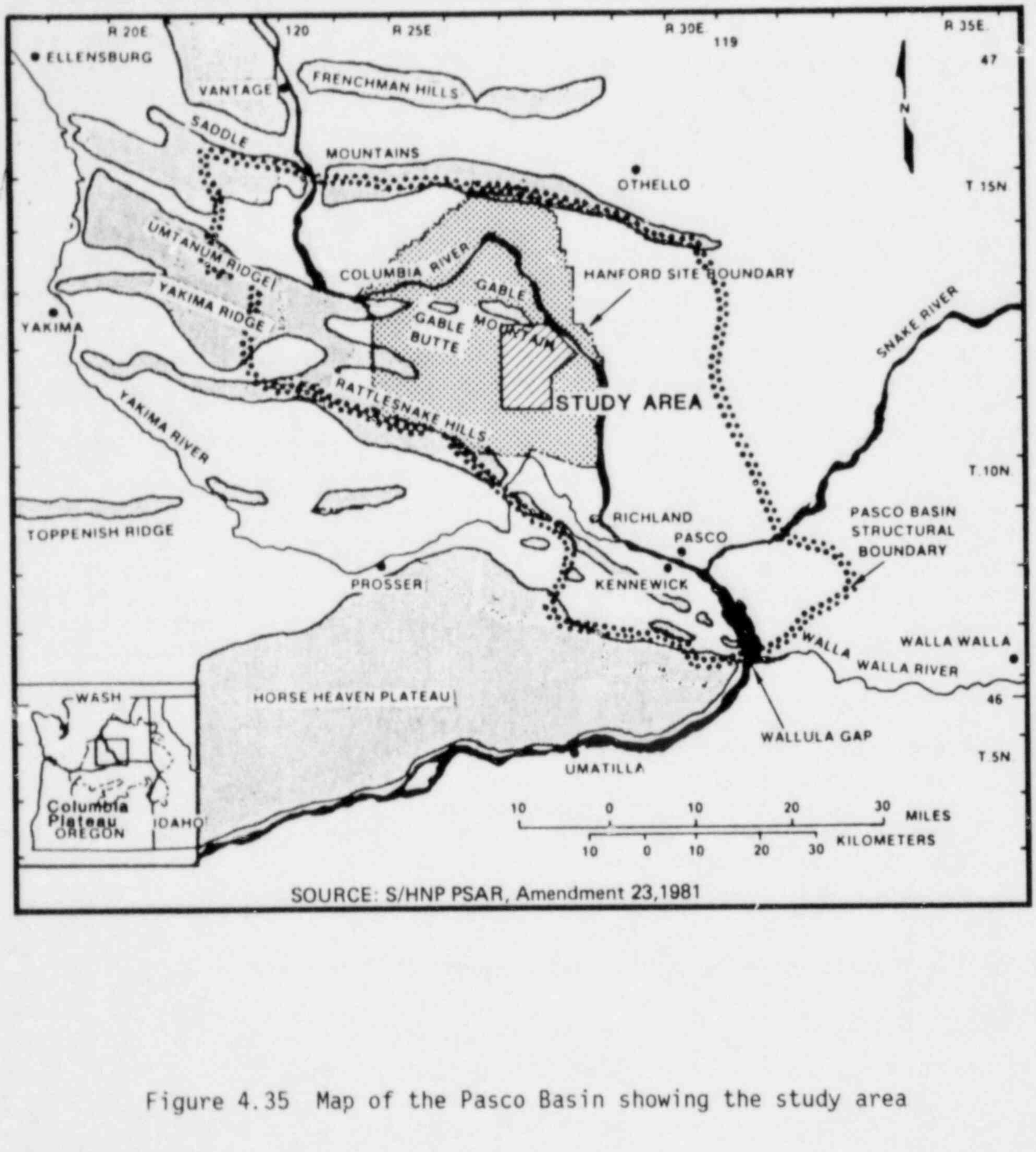


Figure 4.35 Map of the Pasco Basin showing the study area

(2) Careful selection of service road and pipeline routes to minimize removal of vegetation from dune areas and, where removal is unavoidable, revegetation of the affected dunes after construction would prevent reactivation of inactive sand dunes.

The staff concludes that there will be no unavoidable adverse impacts.

4.2.7.3 Seismicity

Existing Conditions

Historically, eastern Washington has been a region of low seismicity in comparison with western Washington and many other areas of western North America. The historical record for the Pasco Basin region is probably complete for earthquakes of modified Mercalli intensity (MMI) VII and greater that have occurred since about 1870 (Stepp, 1972; U. S. Department of Commerce, NOAA, 1973). This record indicates that earthquakes with MMI VII or greater (potentially destructive) occur at a rate of about two per century within a circular area of radius of 110 km (68.3 mi) centered at the site. The largest historic earthquake in this zone is the Milton-Freewater earthquake of 1936, with MMI VII or M_L 6.1 (WNP-2 FSAR, 1978). This earthquake has been associated with the structural trend of the Blue Mountains anticline and the Hite fault.

Existing faults include the Wallula fault zone, which coincides with the southern boundary of the basin in alignment with a fault along the north slope of Rattlesnake Mountain. This trend is part of the Olympic Wallowa lineament, extending northwest to the Olympic Peninsula. The existence of the lineament as an alignment of topographic features is well established, but its structural and tectonic significance is doubtful.

Faults of relatively limited length and displacement are associated with most geologic structures. Closest to the site is a probable fault extending about 6.4 km (4 mi) along the southwest flank of a buried easterly segment of the Umtanum Ridge-Gable Mountain structural trend. Other faults are associated with Gable Mountain, Saddle Mountain, Umtanum Ridge, and the northeast margin of the Horse Heaven Hills (John A. Blume and Associates, 1971a, b). Characteristics of these faults, such as dip, displacement, and recency of last movement, are known with varying degrees of certainty. Some displace Pleistocene materials and some do not. In most instances, the evidence is insufficient to determine whether or not the fault is capable as defined in 10 CFR Part 100, Appendix A. No faults have been found to be capable, although studies are continuing.

Since 1969, abundant swarms of microearthquakes ($M_L \leq 3.0$) in the Hanford (Pasco Basin) region have been thoroughly monitored and analyzed. About 80 percent of these shocks have had focal depths less than 3 km (1.9 mi) and may be nontectonic in nature; the remainder have occurred as deep as 25 km and may be caused by north-south crustal compression.

The relationship between seismicity and young geologic structures remains unclear despite intensive studies to establish correlations. The faults and folds of the Columbia Plateau basalts, some of which are 3 km (1.9 mi) thick, have not been linked to deeper crustal structures; perhaps structures in the basalts are thin-skinned features produced by broad warping of the basement. The only mapped fault in the Pasco Basin deemed to be capable of according to NRC criteria is the Central fault, situated on the Gable Mountain-Umtanum Ridge structural trend (WNP-2 FSAR, 1978), which is located about 12.9 km (8 mi) northwest of the S/HNP site. Other late Pleistocene faults have been mapped along this and other structural trends. Although none of these faults has a proven tectonic origin or seismogenic potential, the maximum earthquake magnitude that could reasonably be associated with them is approximately M_L 5 (WNP-2 FSAR, 1978). The project will be designed to withstand the maximum magnitude earthquake.

Environmental Impacts

Seismic characteristics of the Hanford region would not adversely impact the proposed S/HNP site, and, therefore, in the staff's judgment, no mitigative measures are called for. Also, no unavoidable adverse impacts are anticipated.

4.2.7.4 Soils

Existing Conditions

The present areal distribution of surficial soil materials in the S/HNP area can be expressed in terms of its landforms and is, in general, the result of a combination of erosional processes and the erosion-resisting properties of associated geological materials. The area surrounding the S/HNP site is in the rain shadow of the Cascade Mountains and has experienced a continuously semi-arid-to-arid climate for nearly 12,000 years. Surficial soils have undergone only limited transport since the time of initial deposition.

Most of the Hanford Reservation is underlain by sediments that were deposited by the glacial Lake Missoula floods. The soil-forming flood deposits range from (1) coarse boulder and cobble gravel in the extreme northern reaches of the Hanford Reservation to (2) sandy cobble to granule gravels in the central part of the reservation to (3) coarse sands in the southern part. These deposits have been blanketed by at least a thin veneer of sand-dune (eolian) sediments. The dune deposits can reach a thickness of 15.2 m (50 ft) and locally have infiltrated 1.5 m (5 ft) into underlying sediments.

Although, in general, distinct soil horizons have not developed in the sediments, clear A, B, and C horizons are observed in the fine-grained and poor sediments found in Cold Creek Valley.

Environmental Impacts

The S/HNP facilities would have no impact on soils during either construction or operation; therefore, no mitigation is needed and no unavoidable adverse impacts will result.

4.2.8 Meteorology

The Hanford, Washington, area is situated in a region that can be categorized as having a semi-arid climate. The area is affected by weather systems moving eastward from the Pacific Ocean. These systems that cross the Cascade mountains lose much of their moisture before reaching the desert-like east central location of the Hanford area. Precipitation amounts are usually light, totaling less than 25.4 cm (10 in.) per year. Greatest monthly precipitation amounts occur from November through April with lesser amounts during the summer.

Temperatures in the area range from an average low in January of 6.6°C (20°F) to an average high of 24.4°C (76°F) in July giving an annual average of near 11.7°C (53°F). Extremes of temperature have been observed to range from -37.7°C (-27°F) in winter to a maximum of 46.1°C (115°F) in July. Severe weather conditions occur infrequently in the site area. However, based on data from 1945 to 1970, thunderstorms are observed in every month but November. Some of these storms may produce hail and strong winds possibly a tornado. Nondamaging hail is primarily observed from February through September. Maximum winds of approximately 112 kmph (70 mph) have been measured during 1952-1970 on three levels [15.2, 61.0, and 121.9 m (50, 200, and 400 ft)] of the Hanford meteorology station tower.

Winds in the area exhibited a bimodal distribution of direction between the northwestern quadrant and a southerly direction and averaged less than (16 kmph (10 mph) during the period from April 1974 to March 1975 at the 10-m (33-ft) level.

4.2.9 Related Federal Project Activities

4.2.9.1 U.S. Department of Energy

The Department of Energy (DOE) proposes to enter into a conditional land sales contract with Puget Sound Power and Light Company (PSP&L), representing itself, Portland General Electric Company, the Washington Water Power Company, and Pacific Power and Light Company. The purpose of this contract will be to provide for the conveyance by sale of 259 ha (640 acres) of the land that is owned by the United States and under the jurisdiction of the Department of Energy at its Hanford Site at Richland, Washington, for use in construction and operation of one or more commercial nuclear power generating plants. In addition, easements totalling about 202 ha (500 acres) will be granted to PSP&L or comparable rights will be given to the Bonneville Power Administration (BPA) for transmission corridors and switching stations, and to PSP&L for access roads, railroad, and water lines and related facilities. DOE will meet PSP&L's need for an exclusion area of about 2,430 ha (6000 acres) around the generating plants; however, there will be no conveyance of land for that purpose.

DOE will be a cooperating agency in this NRC/EFSEC Environmental Impact Statement (EIS), and as such, DOE will consider the contents of the EIS before making a final decision on sale of the land. For the purpose of using the EIS in its decision-making process, the DOE has prepared an Environmental Analysis, Conditional Land Sale and Easement Contract With Puget Sound Power and Light Company, which is contained in Appendix I to this EIS.

4.2.9.2 Bonneville Power Administration

In order to integrate output of S/HNP into the power grid system, new transmission lines are needed. To integrate power from S/HNP Unit 1, the existing

Ashe-Hanford 500-kV line No. 1 must be looped into a new 500-kV substation at the plant site. When S/HNP Unit 2 is completed, the second Ashe-Hanford 500-kV line must be looped into a new substation to integrate the additional power. As a cooperating agency in this EIS with NRC/EFSEC, the Bonneville Power Administration has prepared an Environmental Analysis Report, Skagit Hanford Nuclear Project Transmission Integration (contained in Appendix J to this EIS), that BPA will use in making decisions on interconnection and transmission services. These decisions include: (1) decisions related to determine which points of interconnection are technically and environmentally viable; (2) decisions whether to wheel the output from the plant over the Federal system; and (3) decisions on Federal construction, operation, and maintenance of the interconnecting facilities.

4.2.10 Air Quality and Climate

4.2.10.1 Climate

Existing Conditions

The Hanford Reservation is located in the Lower Columbia Basin, the lowest altitude spot in Central Washington. The reservation is protected from many of the severe winter storms, coming from the northeast, by the Canadian and American Rockies. It is protected from moist air coming from the west by the Cascade Mountains.

Most of the meteorological data comes from the climatological station at Hanford (1912-1975), with recent data (1974-1976) from the meteorological tower at the WNP-2 site, approximately 7.2 km (4.5 mi) east-southeast of the S/HNP site. Since WNP-2 is close to the S/HNP site and there are no significant topographic or demographic differences between the two sites, the onsite WNP-2 data is applicable to the S/HNP site.

Precipitation is monitored at the base 134 m (441 ft) msl of the 73-m (240-ft) WNP-2 meteorological tower. Wind direction, wind speed, dry bulb temperature, and dew point temperature are monitored at 144 m (473 ft) and 209 m (685 ft). The S/HNP site is at 160 m (527 ft) msl. The terrain in the region, including both sites, is mostly flat, with gently rolling hills.

Severe weather conditions (i.e., tornadoes, thunder and lightning storms, and gales) are infrequent on the Hanford Reservation. There have been 16 tornadoes recorded in Washington State in 12 years of record. There has been an average of 12 thunder or lightning storms annually in the S/HNP area, occurring mostly in June or July. Lowest average monthly temperatures were lower than normal in Hanford during 1979 and 1980, with January temperatures ranging from -10°C (14°F) in 1979 to -4.6°C (23.7°F) in 1980 [Tri-County Air Pollution Control Authority, (TCAPCA), (1979 and 1980)].

Temperature and Precipitation

During the period from 1912 to 1970, the coldest average monthly temperature was -1.3°C (29.6°F) in January and the warmest was 24.7°C (76.5°F) in July. Maximum daily temperatures are above 90°F approximately 56 days per year; minimum daily temperatures are below 0°C (32°F) approximately 24 days per year.

Annual precipitation at Hanford averages 15.9 cm (6.25 in.) per year, falling mostly between November and January. From 1912 to 1975, the average monthly low precipitation was 0.4 cm (0.14 in) in July, and the high was 2.4 cm (0.93 in.) in January. Winter snowfall averages 32.2 cm (12.7 in.) per year; hail is infrequent, occurring about once yearly.

Fog and Relative Humidity

The average occurrence of heavy fog, with maximum visibility of 0.4 km (1/4 mi), is 24 days per year. Fog occurs mostly in December, followed by January and November, with an average duration of 3.2 hours.

The region is characterized by low relative humidities. Hanford data from 1946 to 1975 show an annual monthly average high of 80.1 percent (December) and a monthly average low of 31.8 percent (July).

Surface Winds

Winds in the Hanford area are generated usually from the northwest or west-northwest, with an annual average speed of 12 kmph (7.5 mph). Calms, with maximum speeds of less than or equal to 3.2 kmph (2 mph), are rare at Hanford (Figure 4.36). Wind and stability data are taken routinely from the 125 m (410 ft) Hanford Meteorology Station tower.

Environmental Impacts

Climate

Construction and operation of the S/HNP should have very little impact on weather phenomena. Increased frequency of freezing rain, drizzle, or fog may occur from cooling tower drift losses and vapor plumes, but this effect should be negligible beyond 0.8 km (0.5 mi) from the cooling towers. This area lies mostly within the site boundary and entirely within the Hanford Reservation; no public roads, private residences, or transportation facilities should be affected.

Temperature

Operation of the S/HNP should have no impacts on temperature beyond the immediate vicinity [0.4 to 0.8 km (0.25 to 0.5 mi)] of the plant site.

Precipitation

The S/HNP would add water to the atmosphere due to vapor and drift losses from the cooling towers. Approximately 37.8 billion liters (10.0 billion gallons)

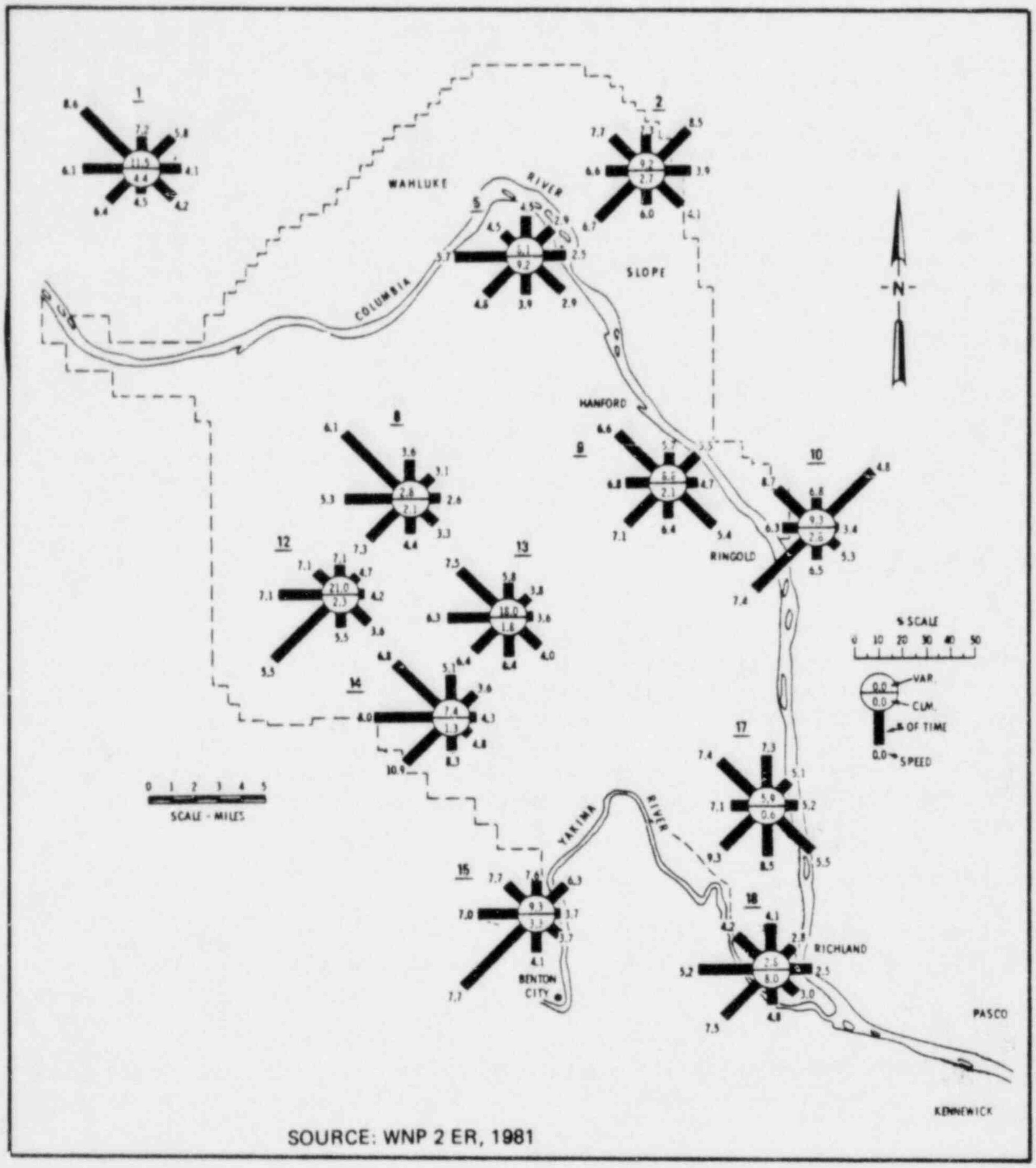


Figure 4.36 Surface wind roses for various locations on and surrounding the Hanford site, based on 5-year averages (1952-1956) (speeds in miles per hour)

of water would be discharged to the atmosphere annually [about 95,400 liters (25,200 gallons) per minute for 274 days of operations at 75 percent plant factor]. For the Hanford area, this water addition to the atmosphere is about the same as that due to evapotranspiration from an area less than 8 km (5 mi) in radius [about 20,200 hectares (50,000 acres)]. Except for slight, infrequent increases in precipitation within 0.8 km (0.5 mi) of the cooling towers, the evaporation and drift should have no noticeable effect on precipitation in the region.

Fogging and Icing

Increased fogging and icing at ground level should not occur during low wind speed conditions (below 10 mph). The warm cooling tower plumes would typically rise 152 and 457 m (500 to 1500 ft) or more above the surrounding terrain. Atmospheric fog dispersion models applied to the proposed project by the applicant (S/HNP ASC/ER, 1981) indicated that a maximum impact of 20 hours increased fogging per year on elevated terrain about 13.6 km (8 mi) southwest of the site. Increased fogging at North Richland was calculated in the same way at less than 1 hr per year.

Maximum predicted icing was a thickness of about 10 mm, occurring about 0.4 km (0.25 mi) south-southwest of the plant with an average frequency of less than 15 hr per year (S/HNP ASC/ER, 1981). Icing impacts beyond the site boundary were predicted to be less than 1 mm per year.

The nearest roads are State Route 4, about 1.9 km (1.2 mi) northeast; Army Loop Road, 2.7 km (1.7 mi) northwest; State Route 2, 3.5 km (2.2 mi) east; and State Route 10, 3.5 km (2.2 mi) east-southeast. Fog modeling estimates were for less than 1 hr per year of reduced ground level visibility for all roadways within 16 km (10 mi) of the site (S/HNP ASC/ER, 1981). Annual ice accumulations were also estimated to be less than 1 mm per year for these roadways.

The closest commercial airport to the site (Richland) is located about 22.5 km (14 mi) south-southeast. Reduced ground level visibility resulting from increased fog from the facility was estimated to occur for less than 1 hr per year (S/HNP ASC/ER, 1981) (Figure 4.37).

Salt Deposition

Maximum deposition of total solids discharged from the cooling towers (as dry particles and dissolved solids in drift losses) were calculated at 41.5 kg per hectare (37 pounds per acre) per year within 0.4 km (0.25 mi) from the towers (S/HNP ASC/ER, 1981) at approximately 1.6 km (1 mi) southeast of the towers maximum deposition would be below 11.1 kg per hectare (10 pounds per acre) per year. Figure 4.38 shows the annual deposition pattern of total solids for S/HNP. Figure 4.39 shows the annual combined deposition pattern for S/HNP and WNP-1, -2, and -4 cooling towers.

Evapotranspiration

Changes in offsite atmospheric humidity from cooling tower moisture would be so slight as not to affect the measurable level of humidity or evapotranspiration.

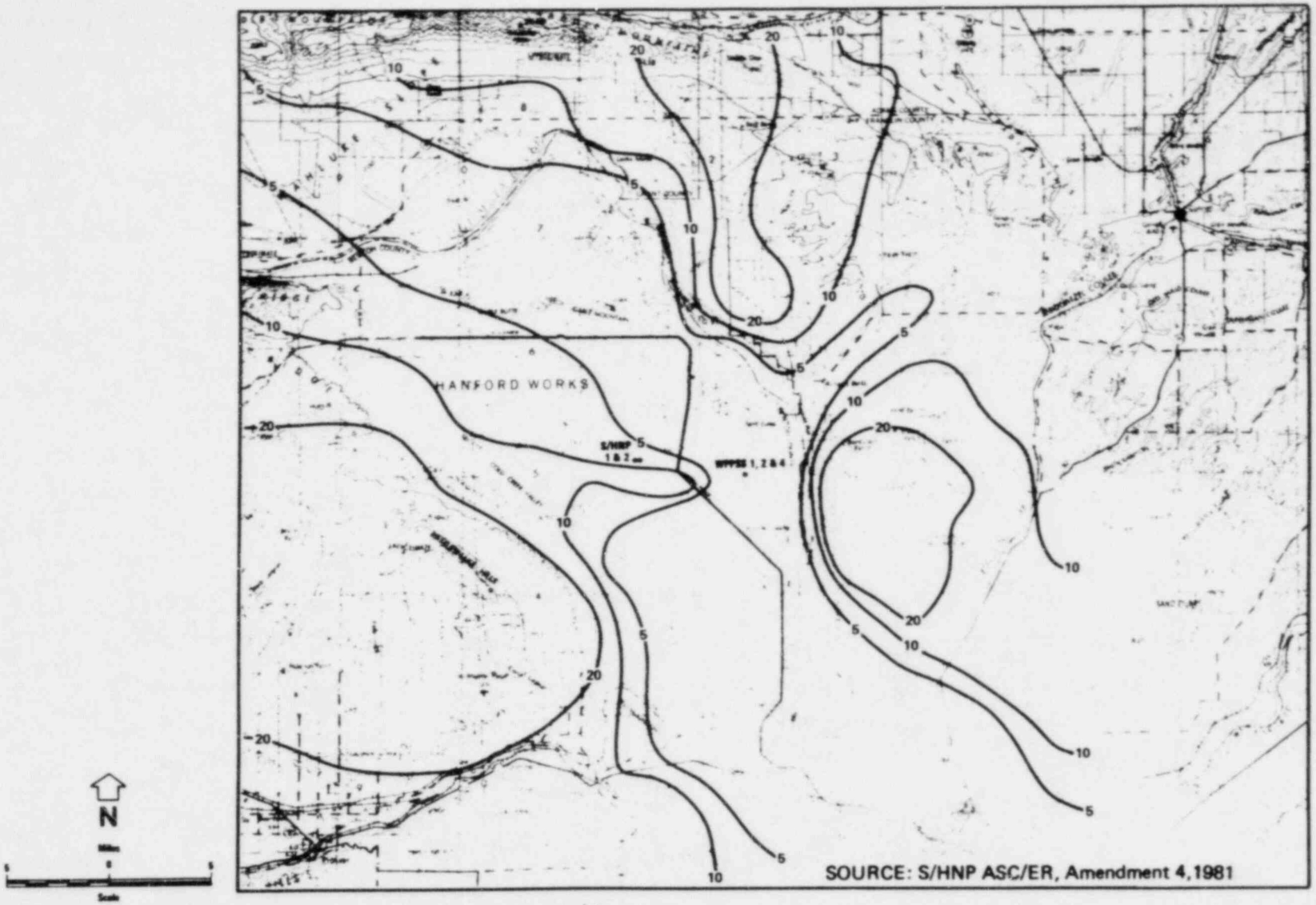
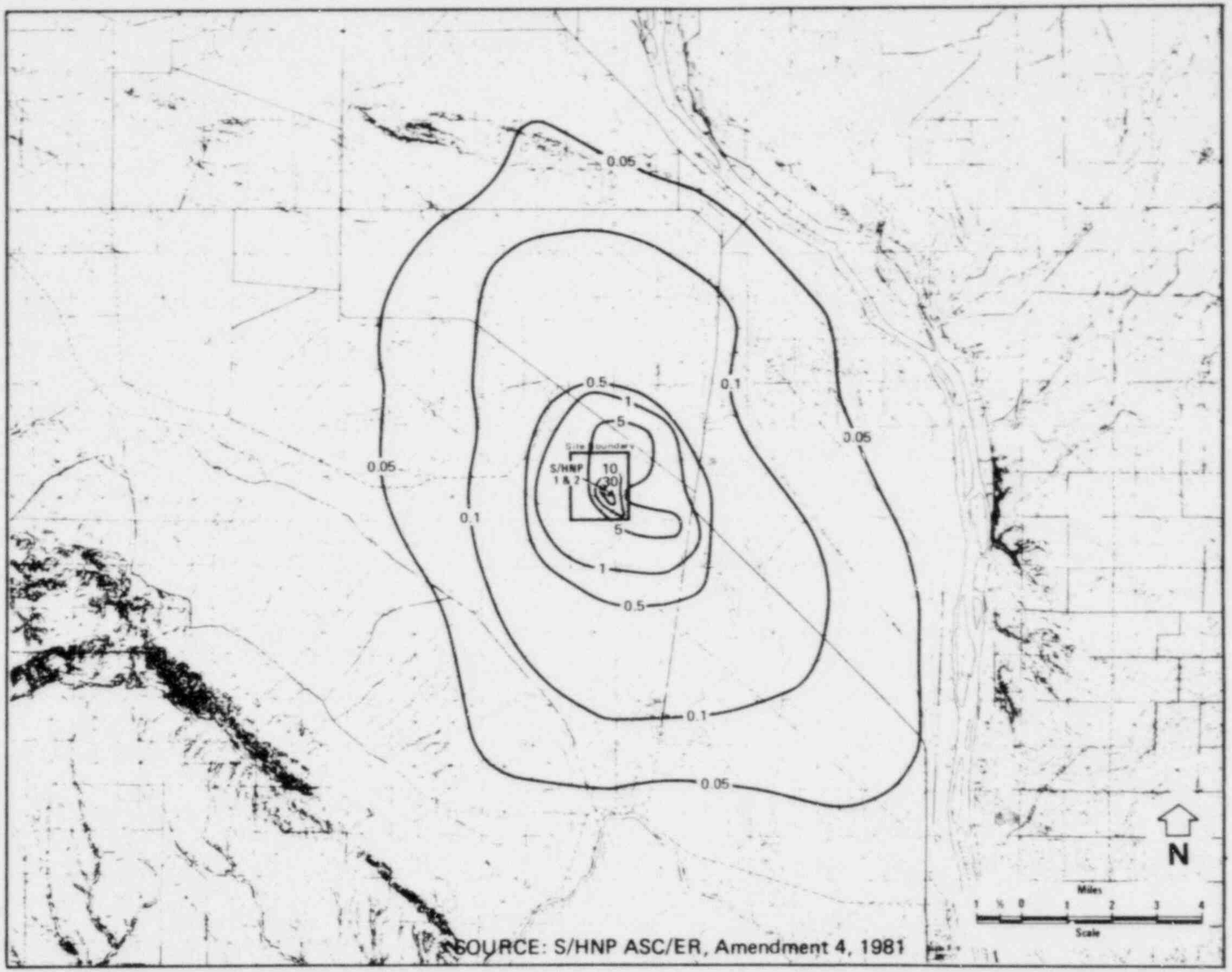


Figure 4.37 Reduced ground level visibility in hours-year



SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 4.38 Annual deposition of total solids in pounds per acre-year for S/HNP

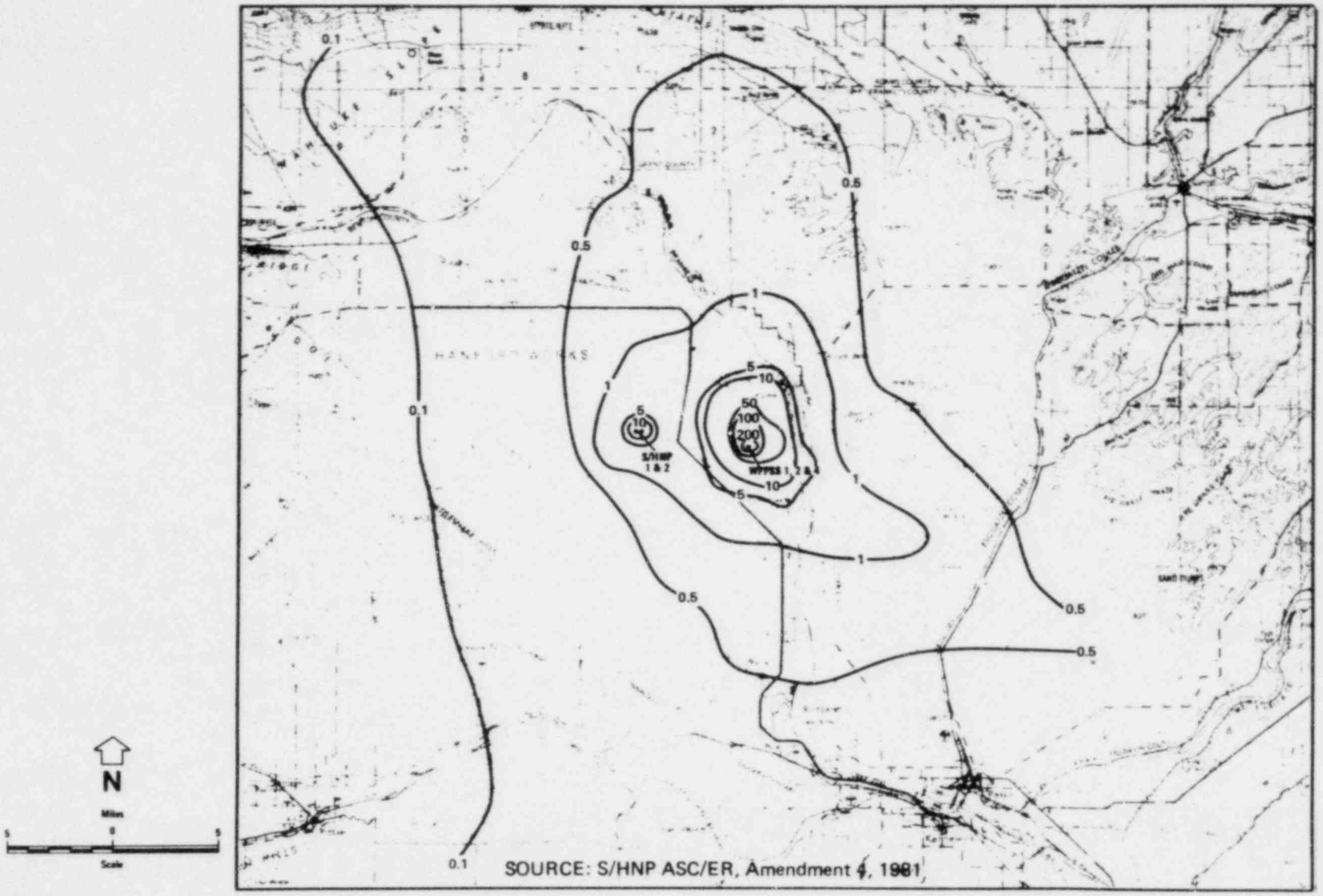


Figure 4.39 Annual combined deposition of total solids in pounds per acre-year for S/HNP, WNP-1, -2, and -4

Odor

No malodorous chemicals would be used or stored on site, and none would be created during normal operation of the facility. No environmental impacts related to odor are expected to occur.

Mitigating Measures

Meteorological Monitoring

There is an inactive meteorological measurement system on the WNP-2 site (WNP-2 DEIS, NUREG-0812 Sec. 5.4.3). The WNP-2 plans to reactivate the system when the plant fuel is loaded. Additional meteorological measurements are available from the ongoing Hanford main meteorological tower and stations around the Hanford Reservation.

The staff has concluded that the meteorological impacts due to cooling tower emissions will be small. The increased frequency of drizzle or fog from drift losses and vapor plumes will be insignificant beyond 0.8 km (0.5 mi) from the towers. There will be less than one hour per year reduced ground level visibility and less than 1 mm per year icing on all roads within 16 km (10 mi) of the site. There would be slight deposition of dissolved solids (salts) to acreages off site.

Unavoidable Adverse Environmental Impacts

(1) There would be a slight increase in the potential for fog and surface icing off site.

(2) There would be slight deposition of dissolved solids (salts) to acreage off site.

4.2.10.2 Air Quality

Existing Conditions

The prevailing wind at the Hanford Reservation is west-northwest, following the Columbia River Gorge, which is flanked by the Rattlesnake Hills to the southwest and the Saddle Mountains to the northeast. The prevailing wind in the Tri-Cities area is southwest, where westerly flow from the Pacific high-pressure coastal system comes through the Wallula Gap of the Columbia River. Most contributions to the regional ambient air quality are from the Hanford Reservation and the Tri-Cities area. Since the prevailing winds converge near the Tri-Cities, existing conditions of regional air quality were determined from measurements taken in the Kennewick-Wallula area [Washington State, Department of Ecology (WDE) and the Tri-County Air Pollution Control Authority (Jenne 1979]. In addition, in 1979, the Washington State Department of Transportation monitored carbon monoxide, nitrous oxides, and ozone from a mobile van in Kennewick (Table 4.33).

Table 4.33 Air quality standards and existing conditions

Pollutant	Average Time	Background (ug/m^3)		AAQS (ug/m^3) Federal Primary	Federal Secondary	State	PSD (ug/m^3)
SO_2	Annual	0.5		80	---	60	20
	24 hr	5.7		365	---	260	91
	3 hr	19.6		---	1300	---	512
	1 hr	49.0		---	---	655[a]	---
	1 hr	49.0		---	---	1018	---
TSP	Annual	56	36[b]	75	60	60	19
	24 hr	353	198	260	150	150	37
NO_x	Annual	20.0		100	100	100	---
CO	8 hr	6,525.0		10,000	10,000	10,000	---
	1 hr	11,795.0		40,000	40,000	40,000	---
O_3	1 hr	151.0[c]		235	235	235	---

(a) Not to be exceeded twice in 7 days.

(b) Discounting natural wind-blown dust factor.

(c) Based on the TCAPCA 1980 annual report, highest monthly value for December 1979 through November 1980.

Legend: SO_2 - sulfur dioxide

TSP - total suspended particulates

NO_x - nitrous oxides

CO - carbon monoxide

O_3 - ozone

Source: National Ambient Air Quality Standards, 40 CFR 51; WAC 173-400.

The S/HNP must meet two sets of air quality standards: Federal, State, and local Ambient Air Quality Standards (AAQS) and Federal Prevention of Significant Deterioration (PSD) requirements. PSD limits increases in levels of SO_2 and TSP to time-specific increments. PSD regulations also require that Best Available Control Technology (BACT) be applied to control plant emission sources. The S/HNP site is in a PSD "Class II" area. There are no "Class I" areas within 100 km of the site. The closest "Class I" area is the Eagle Cap Wilderness area in Oregon, about 130 km southeast of the site.

Total Suspended Particulates

The Tri-County Air Pollution Control Authority (TCAPCA) has monitored total suspended particulates (TSP) regularly at seven regional stations (Jenne, 1979). The Hanford station, established in 1976, is located about 1.6 km (1 mi) northeast of the 200-W Area at Hanford.

This station has the best air quality of the seven stations for TSP, with a monthly geometric mean below the annual standard of 60 $\mu g/m^3$. The three original stations, established in 1971, all showed downward trends of TSP levels (attributed to better dust control and fewer construction projects) until the eruption of Mount St. Helens on May 18, 1980. The station hardest hit from the eruption was Hanford, registering a high concentration of 10,568 $\mu g/m^3$; the Hanford pyrometer measured zero solrads (indicating total darkness) from 2 hr after the eruption throughout the entire day.

The pollutant TSP, which is the main concern in the Tri-County area, fluctuates seasonally. The highest levels occur from July to October and are associated with agricultural activities and slash burning. The lowest levels occur from November to February. TSP concentrations have often been in violation in Benton County, mainly because of windblown dust. EPA allows exemptions of rural fugitive dust from TSP measurements, according to methods based on National Air Surveillance Network data, in order to better estimate true ambient TSP levels.

Sulfur Dioxide

The major sources of sulfur dioxide emissions in the Tri-Counties area are Boise Cascade Pulp and Paper Company (Walla Walla County), Chevron Chemical Corporation (Benton County), and the Hanford complex (Benton County). Sulfur dioxide was not routinely measured in the Tri-Cities area prior to the Boise Cascade monitor at Wallula. Sulfur dioxide has been measured at Hanford by the Hanford Environmental Health Foundation.

Nitrous Oxides

The two significant sources of nitrous oxide emissions in the Tri-Counties area are Chevron Chemical and Phillips Pacific Chemical (Benton County). The highest average nitrous oxide concentration was 20 $\mu g/m^3$, measured during the period between 1973 and 1975 at a nuclear fuel reprocessing facility along the Columbia River located just west of Richland. The facility is not presently in operation, but is expected to resume operations in 1984, adding approximately 15 $\mu g/m^3$ to the background nitrous oxide level.

Carbon Monoxide and Ozone

Carbon monoxide and ozone were monitored in Kennewick from June to November, 1979, and north of Richland from December 1979 to September 1980 in a mobile van operated by the State Department of Transportation. In 1979, there were several violations of the ozone standard during the June to September period. No violations were found in 1980 at the new site. Carbon monoxide, which was monitored 3.6 m (12 ft) above ground level, did not violate standards at either site.

Environmental Impacts

Construction--Fugitive Dust

The majority of fugitive dust emissions would be generated during the earth-moving activities in the early construction phases. Emissions would come from windblown dust off the exposed soil areas under moderate to high wind speeds [above 19.3 kmph (12 mph)], and from earth scrapers and earth movers (bulldozers and graders) preparing the contour levels for the plant site. Site preparation would take about 4 months.

Minor fugitive particulate emissions would be produced by the concrete batch plant, which would start about 7 months after the start of site preparation and would continue for about 3 years.

Fugitive dust impacts resulting from construction are expected to be negligible outside the plant site boundaries. Particulate monitors at Richland, Pasco, and Hanford have not shown any clear trends that would indicate adverse effects resulting from construction activities for WNP-1, -2, and -4 (Jenne, 1979).

No offsite complaints about fugitive dust from construction activities for WNP-1, -2 and -4 were received by the TCAPCA during the period from 1976-80. The only complaints the agency had received about construction activities were for improper wood burning. The TCAPCA saw that WPPSS had changed procedures to correct this problem by 1980.

Construction--Carbon Monoxide Emissions

Carbon monoxide would be emitted from internal combustion engines of heavy-duty construction equipment and from light-duty diesel- and gasoline-powered trucks and automobiles belonging to the construction workforce. No measurable changes in carbon monoxide levels off site are anticipated due to operation of construction equipment. Minor increases off site due to traffic at shift changes would occur but 1-hr and 3-hr average levels should remain well below standards.

Onsite heavy-duty construction equipment would reach a maximum of 62 vehicles (26 scrapers, 19 bulldozers, 2 fuel trucks, 5 water trucks, 5 pickups, and 5 graders). Even operated simultaneously, these few vehicles would probably produce less than 70 kg/hr (150 pounds per hour) of carbon monoxide over the entire site area (approximately 36.4 ha encompassing the main power buildings and cooling facilities). Using a simple box model calculation (650 meters average length x 20 meters mixing depth x 2.5 meters per second wind velocity x 3,600 seconds per hour) results in an estimated carbon monoxide concentration on site of about 0.6 mg/m 1-hr average. This is less than 2 percent of the State and Federal carbon monoxide standard of 40 mg/m (35 ppm) 1-hr average.

Off site, construction workforce traffic would add carbon monoxide emissions to major access highways and intersections. Screening level calculations for power projects of similar size have estimated additional carbon monoxide concentrations of less than 2 mg/m 1-hr average and 1 mg/m 8-hr average due to the added traffic (Paulus, 1981). These levels are well below standards, even when added to the highest background levels measured in the Tri-Cities area (Kennewick, WDE, SR-14, December 1, 1979 to September 26, 1980) of 10.3 ppm (9.0 mg/m^3) 1-hr average and 5.7 ppm (5.0 mg/m^3) 8-hr average.

Operation

The facility would have minor impacts on air quality from emissions associated with operating the auxiliary diesel generators for two hours each per month for testing and from minor amounts of ozone produced by transporting high-voltage electricity.

Diesel Generators--The emergency diesel generators are located in the diesel generator building for each unit. The diesel fire pump engine is located in the Unit 1 circulating water pumphouse.

The exhaust stacks for the emergency diesel generators are about 25 m tall, on top of the diesel buildings that are about 15 m high (S/HNP ASC/ER, 1981, Figures 3.1-1 and 3.1-3). However, the turbine buildings are about 50 m (150 ft) high. With a west wind, if both 1 and 2 diesel generators are being tested, the exhaust gases would combine and may get trapped and mixed into the Unit 2 turbine building wake cavity on the east side of the structure. In this situation, the diesel generators could possibly add 985 $\mu g/m^3$ (1-hr average) to the background sulfur dioxide levels. This addition, by itself, is 94 percent of the state 1-hr standard (1,047 $\mu g/m^3$ or 0.40 ppm) never to be exceeded. The background level was 49.0 $\mu g/m^3$. The combined value of 1,034 $\mu g/m^3$ would be 98.8 percent of the State standard.

The diesel generators would be tested for only 2 hr each month. The estimated pollutant emissions for each single engine are listed in the following table in pounds per hour except for estimated total discharges annually.

Pollutant	Fire Pump Diesel	Standby Diesel	HPCS Diesel	Estimated Total Annual Discharge (Total Pounds Annually)
Particulate (TSP)	0.66	21.37	10.15	2,555
Sulfur oxides (SO_2)	0.61	19.89	9.45	2,378
Carbon monoxide (CO)	2.00	64.74	30.77	7,740
Hydrocarbons	0.74	23.93	11.37	2,861
Nitrogen oxides (NO_x)	9.25	299.12	142.16	35,761

Source: S/HNP ASC/ER, 1981; Table 3.7-3

Estimated annual total discharges are from the diesel fire pump, four diesel standby generators and two HPCS (high-pressure core spray) diesel generators, assuming 2 hr of operation per month per unit. Except for the 1-hr sulfur dioxide standards, all other State and Federal standards are for 3-hr averages or longer. The concentrations of all other pollutants for all averaging times would be well below standards. No adverse impacts are expected to occur due to operation of the diesel generators.

The potential short-term (1-hr) impacts for sulfur dioxide pollutants from the diesel generators can be kept well below standards by simply testing the generators for Unit 1 at different times than for Unit 2. If operated in this manner, sulfur dioxide concentrations would likely remain less than half of the State and Federal standards for all averaging times.

Transmission Line Ozone Generation--High-voltage transmission lines generate corona discharges that result in ozone formation. The natural formation of ozone is high compared with ozone formation from transmission lines. Measurements of ozone concentrations near transmission lines have not shown increases that can be differentiated from natural ozone levels. Therefore, the National Primary Air Quality Standards for photochemical oxidants is not exceeded by transmission line ozone generation.

The possibility of air quality impacts is most likely during the construction phase, when the fugitive particulate concentrations may increase, and during testing operations of the emergency diesel generators.

Off site, fugitive dust from vehicular activity will be negligible. On site, the dust will be controlled as much as possible by paving and watering roads and parking areas.

The 1-hr sulfur dioxide levels would be impacted only if the six emergency diesel generators, housed in two units, are tested simultaneously when a west wind is predominating. By testing the two main units at different times, the staff believes that impacts will be minimal.

All other potential air quality impacts such as solid deposition, vehicular carbon monoxide emissions, fugitive emissions from the bath plant, and transmission line ozone generation are expected to be insignificant.

Mitigating Measures

Construction

The applicant committed to the following mitigating measures:

(1) Watering would be used to control fugitive dust generated by construction activities.

(2) Construction roads would be watered, gravelled or paved as necessary to decrease the impact of windblown soil and construction dust.

(3) An appropriately sized collecting system would be provided to prevent emissions of cement, pozzolan, or dust from any part of the plant to the atmosphere.

It is the staff's conclusion that these mitigating measures will be adequate to control dust generated by construction activities.

Operation

The applicant has proposed round mechanical-draft cooling towers equipped with state-of-the-art mist eliminators to minimize the impact of fogging, icing, and salt deposition. Although the cooling tower effluents may impact the environment, the staff believes that the magnitude of the impacts will be small; no further mitigating measures have been recommended at this time.

The following mitigating measure for sulfur dioxide emission control is suggested: Routine testing of emergency diesel generators for Unit 1 should be scheduled at times different from those for testing diesel generators for Unit 2 to reduce the potential combined effluent concentrations, especially in aerodynamic downwash building wakes on site.

Compliance With Applicable Laws and Regulations

The applicant is committed to constructing and operating the facility in full compliance with all applicable air quality laws and regulations.

Construction activities would comply through normal practices to control fugitive dust and proper waste-burning procedures. Secondary construction impacts would be in the form of minor increases in carbon monoxide levels that are expected to remain below the 70 percent of State and Federal standards when added to maximum measured ambient concentrations.

Operational impacts are expected to remain well below applicable standards for all pollutants, except for short-term sulfur oxide State standards. Operating all (6) emergency diesel generators at the same time could produce sulfur oxide concentrations approaching 99 percent of the State 1-hr standard of 0.40 ppm, which is never to be exceeded. Since the diesel generators are only routinely tested for 2 hr of operation per month per unit, scheduling the testing of Unit 1 diesel generators at different times than Unit 2 tests could ensure that short-term sulfur dioxide concentrations would remain well below all applicable State and Federal regulations.

Federal PSD regulations apply only to suspended particulates and sulfur oxides for operation of the facility after construction. Emission levels for both pollutants would be below the minimum levels where PSD evaluation would be required. Hence, it is expected that the plant will meet all applicable PSD increments for added TSP and sulfur dioxide concentrations.

The facility is about 130 km from the nearest "Class I" area and in the staff's judgment it will have negligible impacts on "Class I" areas. Also the sulfur dioxide, TSP, and nitrous oxide emissions are so low that the facility is not expected to adversely impact visibility. The staff has not identified any unavoidable adverse impacts.

4.2.11 Noise

4.2.11.1 Existing Conditions

This noise analysis is based in part on PSP&L's Application for Site Certification (S/HNP ASC/ER, 1981) (NESCO, 1982) plus additional information provided by Northwest Energy Services Company (letter, February 12, 1982), a consultant to the applicant.

Noise is measured as A-weighted sound level in decibels (dB). Equivalent sound level, L_{eq}, is a single-number measure of the energy average of fluctuating noise over a specified time interval. Day-night sound level, L_{dn}, is the L_{eq} over 24 hours with a 10-dB penalty for nighttime noise between 10 p.m. and 7 a.m., when there is greater sensitivity to noise. Apparent loudness doubles for each 10 dB increase in sound level. A 1- to 2-dB change in level is barely perceptible, and a 3- to 5-dB change is clearly perceptible.

The proposed plant site is located on the Hanford Reservation, which is unpopulated except for other nuclear plant sites, and is surrounded by a sparsely populated area. Existing noise levels on and near the Hanford Reservation are relatively low, and vary with distance from noise sources, such as Highway 240, the Bypass Highway, the Columbia and Yakima Rivers, and WPPSS construction sites.

Existing noise levels were measured by a consultant to the applicant on June 25, and 26, 1981, at 15 locations shown in Figure 4.40 (S/HNP ASC/ER, 1981). Brief daytime measurements (2- to 10-minutes) were made using a sound level meter. Figure 4.40 shows the measured equivalent sound levels, L_{eq}, and the consultant's estimate of day-night sound level, L_{dn}.

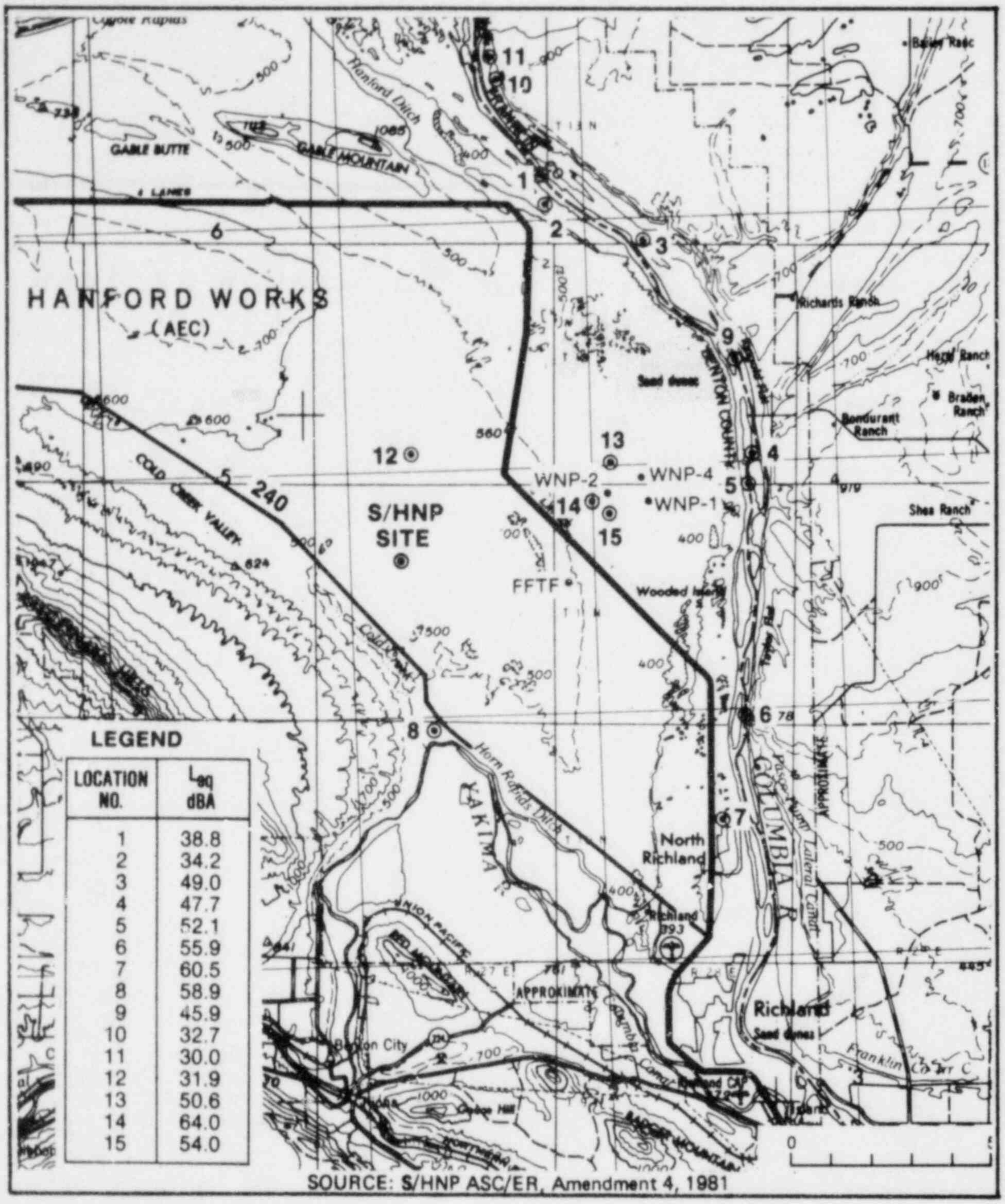
The L_{eq} values for locations east of the site on or near the Columbia River ranged from 30 dB at ranch houses east of the river to 56 dB for locations on the river with boat and river noise. Higher noise levels were measured for river noise near residences along the Yakima River south of the site (59 dB), and for commuter peak traffic southeast of the site (61 dB). Within the Hanford Reservation, measured levels ranged from 32 dB at a relatively quiet location, to 64 dB 350 m (1,150 ft) from the WNP-2 construction site.

The measurements (see Figure 4.40 for measurement locations) indicate that existing noise levels at residences closest to the site are about 30 to 50 dB during daytime, with some noisier locations that are affected by river-related or traffic noise. At night, existing noise levels at the residences would typically be 10 dB lower, or about 20 to 40 dB. L_{dn} is mostly in the range below 55 dB. In this range, noise usually causes no impacts.

4.2.11.2 Environmental Impacts

Construction Noise

Construction is scheduled to begin in 1983 and last for approximately 9 years, with the first unit to be completed by 1991 and the second unit by 1993. In addition to construction at the S/HNP site, there would also be construction of 6.4 km (4 mi) of access railroad, a North Access road, a South Access road to



LOCATION NO.	L_{eq} dBA
1	38.8
2	34.2
3	49.0
4	47.7
5	52.1
6	55.9
7	60.5
8	58.9
9	45.9
10	32.7
11	30.0
12	31.9
13	50.6
14	64.0
15	54.0

Figure 4.40 Existing noise levels, dB (daytime L_{eq}/estimated L_{dn})

Highway 240, distribution lines, water discharge and supply lines, and a pumping plant, all within the Hanford Reservation.

Construction noise from the S/HNP site is expected to affect only construction workers and wildlife, since the nearest residences are about 11.3 km (7 mi) away.

Based on data provided by a consultant to the applicant, noise levels associated with various construction activities 15.2 km (50 ft) from the noise source are as follows:

Area	Activity	Sound level at 50 ft (dB)
Batch plant	Aggregate dropping into hoppers	105
	Hoppers	99
	Pneumatic transfer of powdered cement	97
	Mixing concrete in trucks	98
Laydown areas	Engine-powered equipment	82-88, 100 max.
	Air gouging	95
	Hammering	100
	Chipping	103
	Backup alarms	91
Concrete placement	Sand blasting	87-96
	Concrete vibrator	93
	Premix truck, chute rattles	98
Craft shops	Sawing	88
	Grinding	86
	Hammering	88
	Torch cutting	83
	Pneumatic tools	86
Power block	Excavation	82-88

Although noise levels such as these have been found to cause hearing loss with prolonged or repeated exposure, Federal and State occupational noise exposure standards exist that can protect workers from significant hearing loss.

Construction noise impacts on wildlife are expected to be relatively minor. Such impacts are usually not quantifiable, since there has been little research of their effects. However, construction noise in the old Hanford townsite could contribute to displacement of nesting raptors during the breeding season.

Construction of the pumping plant near the Columbia River would probably occur closest to settled areas. It is estimated that noise levels from the noisier activities would be reduced by distance and atmospheric absorption to about 45 dB 1.6 km (1 mi) away at these areas, and are therefore highly unlikely to cause adverse impacts, although construction might be audible above the low background ambient levels.

There would be a slight noise impact along Highway 240 west of the Bypass Highway due to increased traffic noise from construction traffic. Based on traffic information provided by Northwest Energy Services Company (letter, February 12, 1982), a consultant to the applicant, the L_{dn} noise increase would be about 2 dB, which is in the range 0 to 5 dB considered a slight impact according to EPA noise guidelines. This increase would affect some existing residences in the Horn Rapids area and locations along Highway 240 in the Horn Rapids Triangle planned for residential use in the Richland Comprehensive Plan. At a distance of 61 m (200 ft) from the highway, estimated 1990 day-night sound levels would increase from about 56 dB without construction traffic to 58 dB with construction traffic. The noise level both with and without construction traffic would be in the range of 55 to 65 dB, which is considered to cause some noise impacts on residences according to EPA noise guidelines.

On all routes except Highway 240, vehicular traffic during construction is expected to be lower than during construction of WNP-1, -2, and -4. Construction rail traffic is also expected to be lower. Therefore, adverse noise impacts are not expected to result from the new construction traffic on these routes. No construction is planned during nighttime hours.

Operational Noise

Normal operation of the plant is not expected to be audible above the existing ambient noise at the closest residences, which are about 11.2 km (7 mi) from the site. Based on operational noise contours for Units 1 and 2, the calculated operational noise received at residences would be well below the existing ambient noise, even taking into account the possibility of a 20-dB buildup of operational noise caused by sound focusing during temperature inversions. Noise from the pumping plant near the Columbia River is not expected to be audible above the ambient noise at the closest residences, based on data submitted by a consultant to the applicant.

Transmission Line Noise

Because of the remote location of the new transmission lines, no residences are expected to experience increases in audible transmission line noise.

Operational Traffic Noise

Operational traffic is expected to be less than 200 cars per day, divided between Route 4 and Highway 240. Since 1981 traffic volumes on these roads were between 4,100 and 6,100 vehicles per day, the operational traffic would not cause a noticeable noise increase.

4.2.11.3 Mitigating Measures

The applicant has proposed no mitigating measures for noise. The staff believes that the following mitigating measure should be implemented by the applicant:

(1) The construction contract specifications require that a hearing protection program for workers, including regular audiometric tests and required use of hearing protectors in noisy areas be provided.

4.2.11.4 Unavoidable Adverse Impacts

(1) There would be slight noise impacts at existing and planned residences along Highway 240 west of the Bypass Highway, due to construction traffic.

(2) Construction workers at the site would be exposed to noise levels in a range that could cause some hearing loss.

4.2.12 Radiological Impacts

4.2.12.1 Regulatory Requirements

Nuclear power reactors in the United States must comply with certain regulatory requirements in order to operate. The permissible levels of radiation in unrestricted areas and radioactivity in effluents to unrestricted areas are recorded in 10 CFR 20, "Standards for Protection Against Radiation." These regulations specify limits on levels of radiation and limits on concentrations of radionuclides in the facility's effluent releases to the air and water (above natural background) under which the reactor must operate. These regulations state that no member of the general public in unrestricted areas shall receive a radiation dose, as a result of facility operation, of more than 0.5 rem in 1 calendar year, or, if an individual were continously present in an area, 2 mrems in any 1 hr or 100 mrems in any 7 consecutive days to the total body. These radiation-dose limits are established to be consistent with considerations of the health and safety of the public.

In addition to the Radiation Protection Standards of 10 CFR 20, license require-ments are recorded in 10 CFR 50.36a that are to be imposed on licensees in the form of Technical Specifications on Effluents from Nuclear Power Reactors to keep releases of radioactive materials to unrestricted areas during normal operations, including expected operational occurrences, as low as is reasonably achievable (ALARA). Appendix I of 10 CFR 50 provides numerical guidance on dose-design objectives for LWRs to meet this ALARA requirement. Applicants for permits to construct and for licenses to operate an LWR shall provide reasonable assurance that the following calculated dose-design objectives will be met for all unrestricted areas: 3 mrems/yr to the total body or 10 mrems/yr to any organ from all pathways of exposure from liquid effluents; 10 mrads/yr gamma radiation or 20 mrads/yr beta radiation air dose from gaseous effluents near ground level--and/or 5 mrems/yr to the total body or 15 mrems/yr to the skin from gaseous effluents; and 15 mrems/yr to any organ from all pathways of exposure from airborne effluents that include the radioiodines, carbon-14, tritium, and the particulates.

Experience with the design, construction, and operation of nuclear power reactors indicates that compliance with these design objectives will keep average annual releases of radioactive material in effluents at small percentages of the limits specified in 10 CFR Part 20 and, in fact, will result in doses generally below the dose-design objective values of Appendix I. At the same time, the licensee is permitted the flexibility of operation, compatible with considerations of health and safety, to ensure that the public is provided a dependable source of power, even under unusual operating conditions that may temporarily result in releases higher than such small percentages but still well within the limits specified in 10 CFR Part 20.

In addition to the impact created by facility radioactive effluents as discussed above, there are generic treatments of environmental effects of all aspects of the uranium fuel cycle within the NRC policy and procedures for environmental protection described in 10 CFR 51. These environmental data have been summarized in Table 4.34 (Table S-3) and are discussed later in this report in Section 4.2.13. In the same manner, the environmental impact of transportation of fuel and waste to and from an LWR is summarized in Table 4.35 (Table S-4) and presented in Section 4.2.12.3 of this report.

An additional operational requirement for uranium-fuel-cycle facilities, including nuclear power plants, was recently established by the Environmental Protection Agency in 40 CFR 190. This regulation limits annual doses (excluding radon and daughters) for members of the public to 25 mrems total body, 75 mrems thyroid, and 25 mrems other organs from <u>all</u> fuel-cycle facility contributions that may impact a specific individual in <u>the</u> public.

4.2.12.2 Operational Overview

During normal operations of the Skagit/Hanford Nuclear Project, small quantities of radioactivity (fission and activation products) will be released to the environment. As required by NEPA, the staff has determined the dose estimated to members of the public outside of the plant boundaries as a result of the radiation from these radioisotope releases and relative to natural-background-radiation dose levels.

These facility-generated environmental dose levels are estimated to be very small because of both the plant design and the development of a program that will be implemented at the facility to contain and control all radioactive emissions and effluents. As mentioned in Section 4.1.5, highly efficient radioactive-waste management systems are incorporated into the plant design. These systems are designed to remove most of the fission-product radioactivity that is assumed to leak, in small amounts, from the fuel, as well as most of the activation-product radioactivity produced by neutrons in the reactor-core vicinity. The effectiveness of these systems will be measured by process and effluent radiological monitoring systems that permanently record the amounts of radioactive constituents remaining in the various airborne and waterborne process and effluent streams. The amounts of radioactivity released through vents and discharge points to be further dispersed and diluted to points outside the plant boundaries are to be recorded and published semiannually in the Radioactive-Effluent-Release Reports for the facility.

Table 4.34 (Summary Table S-3) Uranium-fuel cycle environmental data

[Normalized to model LWR annual fuel requirement [WASH-1248] or reference reactor year [NUREG-0116]]

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
NATURAL RESOURCES USE		
Land (acres):		
Temporarily committed [2]	100	
Undisturbed area	79	
Disturbed area	22	Equivalent to a 110 MWe coal-fired power plant.
Permanently committed	13	
Overburden moved (millions of MT)	2.8	Equivalent to 95 MWe coal-fired power plant.
Water (millions of gallons):		
Discharged to air	160	=2 percent of model 1,000 MWe LWR with cooling tower.
Discharged to water bodies	11,090	
Discharged to ground	127	
Total	11,377	<4 percent of model 1,000 MWe LWR with once-through cooling.
Fossil fuel:		
Electrical energy (thousands of MW-hour)	323	<5 percent of model 1,000 MWe LWR output.
Equivalent coal (thousands of MT)	118	Equivalent to the consumption of a 45 MWe coal-fired power plant.
Natural gas (millions of scf)	135	<0.4 percent of model 1,000 MWe energy output.
EFFLUENTS—CHEMICAL (MT)		
Gases (including entrainment): [3]		
SO_x	4,400	
NO_x [4]	1,190	Equivalent to emissions from 45 MWe coal-fired plant for a year.
Hydrocarbons	14	
CO	29.6	
Particulates	1,154	
Other gases:		
F	.67	Principally from UF_6 production, enrichment, and reprocessing. Concentration within range of state standards—below level that has effects on human health.
HCl	.014	
Liquids:		
SO_4^{-}	9.9	From enrichment, fuel fabrication, and reprocessing steps. Components that constitute a potential for adverse environmental effect are present in dilute concentrations and receive additional dilution by receiving bodies of water to levels below permissible standards. The constituents that require dilution and the flow of dilution water are:
NO_3^{-}	25.8	NH_3—600 cfs.
Fluoride	12.9	NO_3—20 cfs.
Ca^{++}	5.4	Fluoride—70 cfs.
Cl^{-}	8.5	
Na^{+}	12.1	
NH_3	10.0	
Fe	.4	
Tailings solutions (thousands of MT)	240	From mills only—no significant effluents to environment.
Solids	91,000	Principally from mills—no significant effluents to environment.
EFFLUENTS—RADIOLOGICAL (CURIES)		
Gases (including entrainment):		
Rn-222		Presently under reconsideration by the Commission.
Ra-226	.02	
Th-230	.02	
Uranium	.034	
Tritium (thousands)	18.1	
C-14	24	
Kr-85 (thousands)	400	
Ru-106	.14	Principally from fuel reprocessing plants.
I-129	1.3	

Table 4.34 (Summary Table S-3, continued)

Environmental considerations	Total	Maximum effect per annual fuel requirement or reference reactor year of model 1,000 MWe LWR
I-131	.83	
Tc-99		Presently under consideration by the Commission.
Fission products and transuranics	.203	
Liquids:		
Uranium and daughters	2.1	Principally from milling—included tailings liquor and returned to ground—no effluents; therefore, no effect on environment.
Ra-226	.0034	From UF_6 production.
Th-230	.0015	
Th-234	.01	From fuel fabrication plants—concentration 10 percent of 10 CFR 20 for total processing 26 annual fuel requirements for model LWR.
Fission and activation products	5.9×10^{-6}	
Solids (buried on site):		
Other than high level (shallow)	11,300	9,100 Ci comes from low level reactor wastes and 1,500 Ci comes from reactor decontamination and decommissioning—buried at land burial facilities. 600 Ci comes from mills—included in tailings returned to ground. Approximately 60 Ci comes from conversion and spent fuel storage. No significant effluent to the environment.
TRU and HLW (deep)	1.1×10^{7}	Buried at Federal Repository.
Effluents—thermal (billions of British thermal units)	4,063	<5 percent of model 1,000 MWe LWR.
Transportation (person-rem):		
Exposure of workers and general public	2.5	
Occupational exposure (person-rem)	22.6	From reprocessing and waste management.

[1] In some cases where no entry appears it is clear from the background documents that the matter was addressed and that, in effect, the Table should be read as if a specific zero entry had been made. However, there are other areas that are not addressed at all in the Table. Table S-3 does not include health effects from the effluents described in the Table, or estimates of releases of Radon-222 from the uranium fuel cycle or estimates of Technetium-99 released from waste management or reprocessing activities. These issues may be the subject of litigation in the individual licensing proceedings.

Data supporting this table are given in the "Environmental Survey of the Uranium Fuel Cycle," WASH-1248, April 1974; the "Environmental Survey of the Reprocessing and Waste Management Portion of the LWR Fuel Cycle," NUREG-0116 (Supp. 1 to WASH-1248); the "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0216 (Supp. 2 to WASH-1248); and in the record of the final rulemaking pertaining to Uranium Fuel Cycle Impacts from Spent Fuel Reprocessing and Radioactive Waste Management, Docket RM-50-3. The contributions from reprocessing, waste management and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle). The contribution from transportation excludes transportation of cold fuel to a reactor and of irradiated fuel and radioactive wastes from a reactor which are considered in Table S-4 of § 51.20(g). The contributions from the other steps of the fuel cycle are given in columns A-E of Table S-3A of WASH-1248.

[2] The contributions to temporarily committed land from reprocessing are not prorated over 30 years, since the complete temporary impact accrues regardless of whether the plant services one reactor for one year or 57 reactors for 30 years.

[3] Estimated effluents based upon combustion of equivalent coal for power generation.

[4] 1.2 percent from natural gas use and process.

Table 4.35 (Summary Table S-4) Environmental impact of transportation of fuel and waste to and from one light-water-cooled nuclear power reactor

NORMAL CONDITIONS OF TRANSPORT

	Environmental impact
Heat (per irradiated fuel cask in transit)	250,000 Btu/hr.
Weight (governed by Federal or State restrictions)	73,000 lbs. per truck; 100 tons per cask per rail car.
Traffic density:	
Truck	Less than 1 per day.
Rail	Less than 3 per month.

Exposed population	Estimated number of persons exposed	Range of doses to exposed individuals [2] (per reactor year)	Cumulative dose to exposed population (per reactor year) [3]
Transportation workers	200	0.01 to 300 millirem	4 man-rem.
General public:			
Onlookers	1,100	0.003 to 1.3 millirem	3 man-rem.
Along Route	600,000	0.0001 to 0.06 millirem	

ACCIDENTS IN TRANSPORT

	Environmental risk
Radiological effects	Small [4]
Common (nonradiological) causes	1 fatal injury in 100 reactor years; 1 nonfatal injury in 10 reactor years; $475 property damage per reactor year.

[1] Data supporting this table are given in the Commission's "Environmental Survey of Transportation of Radioactive Materials to and from Nuclear Power Plants," WASH-1238, December 1972, and Supp. 1, NUREG-75/038 April 1975. Both documents are available for inspection and copying at the Commission's Public Document Room, 1717 H St. NW., Washington, D.C., and may be obtained from National Technical Information Service, Springfield, Va. 22161. WASH-1238 is available from NTIS at a cost of $7.45 (microfiche, $2.25) and NUREG-75/038 is available at a cost of $3.25 (microfiche, $2.25).

[2] The Federal Radiation Council has recommended that the radiation doses from all sources of radiation other than natural background and medical exposures should be limited to 5,000 millirem per year for individuals as a result of occupational exposure and should be limited to 500 millirem per year for individuals in the general population. The dose to individuals due to average natural background radiation is about 130 millirem per year.

[3] Man-rem is an expression for the summation of whole body doses to individuals in a group. Thus, if each member of a population group of 1,000 people were to receive a dose of 0.001 rem (1 millirem), or if 2 people were to receive a dose of 0.5 rem (500 millirem) each, the total man-rem dose in each case would be 1 man-rem.

[4] Although the environmental risk of radiological effects stemming from transportation accidents is currently incapable of being numerically quantified, the risk remains small regardless of whether it is being applied to a single reactor or a multireactor site.

The small amounts of airborne effluents that are released will diffuse in the atmosphere in a fashion determined by the meteorological conditions existing at the time of release and are generally much dispersed and diluted by the time they reach unrestricted areas that are open to the public. Similarly, the small amounts of waterborne effluents released will be diluted with plant waste water and then further diluted as they mix with the Columbia River beyond the plant boundaries.

Radioisotopes in the facility's effluents that enter unrestricted areas will produce doses through their radiations to members of the general public in a manner similar to the way doses are produced from background radiations (that is, cosmic, terrestrial, and internal radiations), which also include radiation from nuclear-weapons fallout. These radiation doses can be calculated for the many potential radiological-exposure pathways specific to the environment around the facility, such as direct-radiation doses from the gaseous plume or internal-radiation-dose commitments from radioactive contaminants that might have been deposited on vegetation, or in meat and fish products eaten by people, or that might be present in drinking water outside the plant or incorporated into milk from cows at nearby farms.

These doses, calculated for the "maximally exposed" individual (that is, the hypothetical individual potentially subject to maximum exposure), form the basis of the NRC staff's evaluation of impacts. Actually, these estimates are for a fictitious person because assumptions are made that tend to overestimate the dose that would accrue to members of the public outside the plant boundaries. For example, if this "maximally exposed" individual were to receive the total body dose calculated at the plant boundary as a result of external exposure to the gaseous plume, he/she is assumed to be physically exposed to gamma radiation at that boundary for 70 percent of the year, an unlikely occurrence.

Site-specific values for various parameters involved in each dose pathway are used in the calculations. These include calculated or observed values for the amounts of radioisotopes released in the gaseous and liquid effluents, meteorological information (for example, wind speed and direction) specific to the site topography and effluent release points, and hydrological information pertaining to dilution of the liquid effluents as they are discharged.

An annual land census will identify changes in the use of unrestricted areas to permit modifications in the programs for evaluating doses to individuals from principal pathways of exposure. This census specification will be incorporated into the Radiological Technical Specifications and will satisfy the requirements of Section IV.B.3 of Appendix I to 10 CFR 50. As use of the land surrounding the site boundary changes, revised calculations will be made to ensure that the dose estimate for gaseous effluents always represents the highest dose that might possibly occur for any individual member of the public for each applicable foodchain pathway. The estimate considers, for example, where people live, where vegetable gardens are located, and where cows are pastured.

An extensive radiological environmental monitoring program, designed specifically for the environs of S/HNP, provides measurements of radiation and radioactive contamination levels that exist outside of the facility boundaries both before and after operations begin. In this program, offsite radiation levels are continuously monitored with thermoluminescent detectors (TLDs). In addition, measurements are made on a number of types of samples from the surrounding area to determine the possible presence of radioactive contaminants that, for example, might be deposited on vegetation, be present in drinking water outside the plant, or be incorporated into cow milk from nearby farms. The results for all radiological environmental samples measured during a calendar year of operation are recorded and published in the Annual Radiological Environmental Operating Report for the facility. The specifics of the final operational-monitoring program and the requirement for annual publication of the monitoring results will be incorporated into the operating license Radiological Technical Specifications for the S/HNP facility.

4.2.12.3 Radiological Impacts from Routine Operations

Radiation Exposure Pathways: Dose Commitments

The potential environmental pathways through which persons may be exposed to radiation originating in a nuclear power reactor are shown in Figure 4.41. When an individual is exposed through one of these pathways, the dose is determined in part by the amount of time he/she is in the vicinity of the source, or the amount of time the radioactivity inhaled or ingested is retained in his/her body. The actual effect of the radiation or radioactivity is determined by calculating the dose commitment. The annual dose commitment is calculated to be the total dose that would be received over a 50-year period, following the intake of radioactivity for 1 year under the conditions existing 15 years after the station begins operation. (Calculation for the 15th year, or midpoint of station operation, represents an average exposure over the life of the plant.) However, with few exceptions, most of the internal dose commitment for each nuclide is given during the first few years after exposure because of the turnover of the nuclide by physiological processes and radioactive decay.

There are a number of possible exposure pathways to man that are appropriate for study to determine the impact of routine releases from the S/HNP facility site on members of the general public living and working outside of the site boundaries, and whether the releases projected at this point in the licensing process will in fact meet regulatory requirements. A detailed listing of these exposure pathways would include external radiation exposure from the gaseous effluents, inhalation of iodines and particulate contaminants in the air, drinking milk from a cow or eating meat from an animal that feeds on open pasture near the site on which iodines or particulates may have been deposited, eating vegetables from a garden near the site that may be contaminated by similar deposits, and drinking water or eating fish caught near the point of discharge of liquid effluents.

Other less important pathways include: external irradiation from radionuclides deposited on the ground surface; eating animals and food crops raised near the site using irrigation water that may contain liquid effluents; shoreline, boating, and swimming activities near lakes or streams that may be contaminated by effluents; drinking potentially contaminated water; and direct radiation from within the plant itself.

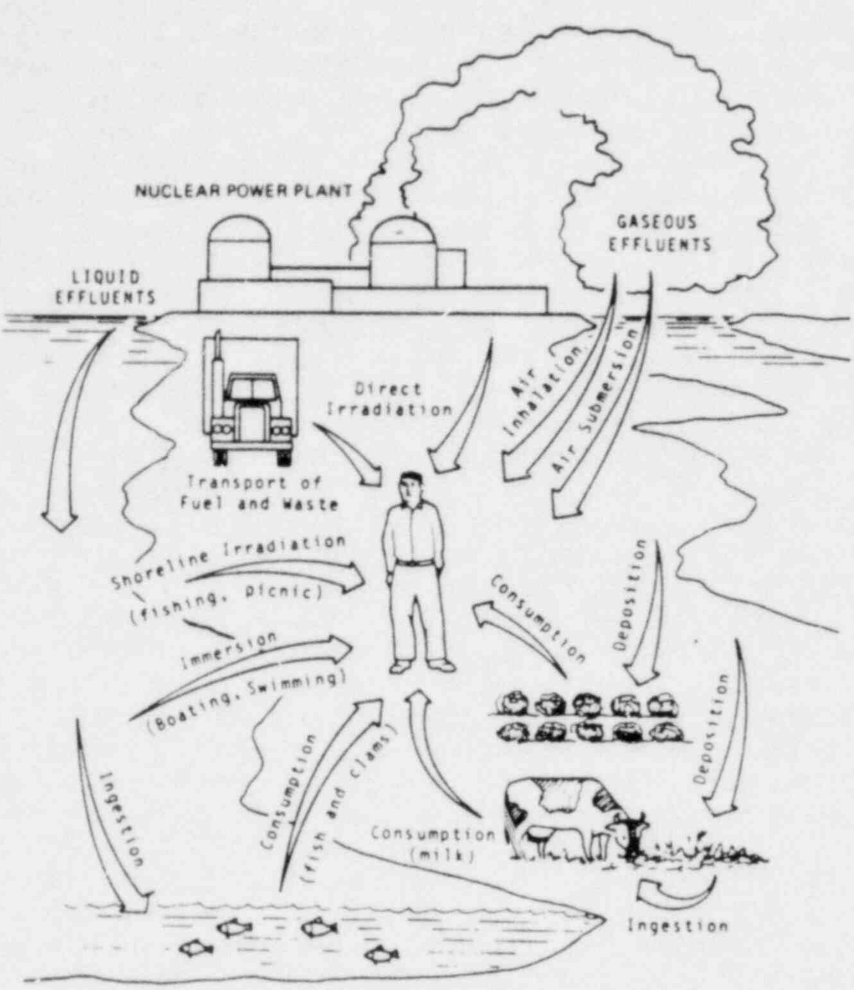


Figure 4.41 Potentially meaningful exposure pathways to individuals

Calculations of the effects for most pathways are limited to a radius of 80 km (50 mi). This limitation is based on several facts. Experience, as demonstrated by calculations, has shown that all individual dose commitments (>0.1 mrem/yr) for radioactive effluents are accounted for within a radius of 80 km from the plant. Beyond 80 km, the doses to individuals are smaller than 0.1 mrem/yr, which is far below natural-background doses, and the doses are subject to substantial uncertainty because of limitations of predictive mathematical models.

The NRC staff has made a detailed study of all of the above important pathways and has evaluated the radiation-dose commitments both to the plant workers and the general public for these pathways resulting from routine operation of the facility. A discussion of these evaluations follows.

Occupational Radiation Exposure for Boiling Water Reactors (BWRs)

Most of the dose to nuclear plant workers results from external exposure to radiation coming from radioactive materials outside of the body rather than internal exposure coming from inhaled or ingested radioactive materials. Experience shows that the dose to nuclear plant workers varies from reactor to reactor and from year to year. For environmental-impact purposes, it can be projected by using the experience to date with modern BWRs. Recently licensed 1000-MWe BWRs are operated in accordance with the post-1975 regulatory requirements and guidance that place increased emphasis on maintaining occupational exposure at nuclear power plants ALARA. These requirements and guidance are outlined primarily in 10 CFR 20, Standard Review Plan Chapter 12 (NUREG-0800), and Regulatory Guide 8.8, "Information Relevant to Ensuring that Occupational Radiation Exposures at Nuclear Power Stations Will Be as Low as Is Reasonably Achievable."

The applicant's proposed implementation of these requirements and guidelines is reviewed by the NRC staff during the licensing process, and the results of that review are reported in the staff's Safety Evaluation Reports. The license is granted only after the review indicates that an ALARA program can be implemented. In addition, regular reviews of operating plants are performed to determine whether the ALARA requirements are being met.

Average collective occupational dose information for 154 BWR reactor years of operation is available for those plants operating between 1974 and 1980. (The year 1974 was chosen as a starting date because the dose data for years prior to 1974 are primarily from reactors with average rated capacities below 500 MWe.) These data indicate that the average reactor annual collective dose at BWRs has been about 740 person-rems, with some plants experiencing an average plant lifetime annual collective dose to date of 1650 person-rems (NUREG-0713, Vol. 2), and with one plant as high as 1853 person-rems. These dose averages are based on widely varying yearly doses at BWRs. For example, for the period mentioned above, annual collective doses for BWRs have ranged from 44 to 3626 person-rems per reactor. However, the average annual dose per nuclear plant worker of about 0.8 rem has not varied significantly during this period. The worker dose limit, established by 10 CFR 20, is 3 rems/quarter (if the average dose over the worker lifetime is being controlled to 5 rems/yr) or 1.25 rems/quarter if it is not.

The wide range of annual collective doses experienced at BWRs in the United States results from a number of factors such as the amount of required maintenance and the amount of reactor operations and inplant surveillance. Because these factors can vary widely and unpredictably, it is impossible to determine in advance a specific year-to-year annual occupational radiation dose for a particular plant over its operating lifetime. There may be an occasional need for relatively high collective occupational doses, even at plants with radiation protection programs designed to ensure that occupational radiation doses will be kept ALARA.

In recognition of the factors mentioned above, staff occupational dose estimates for environmental impact purposes for S/HNP are based on the assumption that the facility will experience the annual average occupational dose for BWRs to date. Thus, the staff has projected that the collective occupational doses for each unit at S/HNP will be 740 person-rems, but doses could average as much as two to three times this value over the life of the plant.

In addition to the occupational radiation exposures discussed above, during the period between the initial power operation of Unit 1 and the similar startup of Unit 2, construction personnel working on Unit 2 will potentially be exposed to sources of radiation from the operation of Unit 1. The applicant has estimated that the integrated dose to construction personnel, over a period of two years, will be about 516 person-rems. This radiation exposure will result predominantly from radiation due to radioactive nitrogen-16 in the steam passing through the the Unit 1 turbine and penetrating the turbine, the building, and the air to where workers may be, and gaseous effluents from Unit 1. Based on experience with other BWRs, the staff finds that the applicant's estimate is reasonable. A detailed breakdown of the integrated dose to the construction workers by the location of their work and its duration is given in Table 12.1-25 of the FSAR.

The average annual dose of about 0.8 rem per nuclear-plant worker at operating BWRs and PWRs has been well within the limits of 10 CFR 20. However, for impact evaluation, the NRC staff has estimated the risk to nuclear-power-plant workers and compared it in Table 4.36 to published risks for other occupations. Based on these comparisons, the staff concludes that the risk to nuclear-plant workers from plant operation is comparable to the risks associated with other occupations.

In estimating the health effects resulting from both offsite (see the section on radiological impact to humans) and occupational radiation exposures as a result of normal operation of this facility, the NRC staff used somatic (cancer) and genetic risk estimators that are based on widely accepted scientific information. Specifically, the staff's estimates are based on information compiled by the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR I). The estimates of the risks to workers and the general public are based on conservative assumptions (that is, the estimates are probably higher than the actual number). The following risk estimators were used to estimate health effects: 135 potential deaths from cancer per million person-rems and 258 potential cases of all forms of genetic disorders per million person-rems. The cancer-mortality risk estimates are based on the "absolute risk" model described in BEIR I. Higher estimates can be developed by use of the "relative risk" model along with the assumption that risk prevails for the duration of life. Use of the "relative risk" model would produce risk values up to about four times greater than those used in this report. The staff regards the use of the "relative risk" model values as a reasonable upper limit of the range of uncertainty. The lower limit of the range would be zero because health effects have not been detected at doses in this dose-rate range. The number of potential nonfatal cancers would be approximately 1.5 to 2 times the number of potential fatal cancers, according to the 1980 report of the National Academy of Sciences' Advisory Committee on the Biological Effects of Ionizing Radiation (BEIR III).

Values for genetic risk estimators range from 60 to 1500 potential cases of all forms of genetic disorders per million person-rems (BEIR I). The value of 258 potential cases of all forms of genetic disorders is equal to the sum of the geometric means of the risk of specific genetic defects and the risk of defects with complex etiology. However, the value of zero cannot be excluded because there is no direct evidence of human effects at doses in this dose-rate range (BEIR III).

Table 4.36 Incidence of job-related mortalities

Occupational group	Mortality rates (premature deaths per 10^5 person-years)
Underground metal miners*	~300
Uranium miners*	420
Smelter workers*	190
Mining**	61
Agriculture, forestry, and fisheries**	35
Contract construction**	33
Transportation and public utilities**	24
Nuclear-plant worker***	23
Manufacturing**	7
Wholesale and retail trade**	6
Finance, insurance, and real estate**	3
Services**	3
Total private sector**	10

*Richardson, 1972.

**U.S. Bureau of Labor Statistics, 1978.

***The nuclear-plant workers' risk is equal to the sum of the radiation-related risk and the nonradiation-related risk. The estimated occupational risk associated with the industry-wide average radiation dose of 0.8 rem is about 11 potential premature deaths per 10^5 person-years due to cancer, based on the risk estimators described in the following text. The average non-radiation-related risk for seven U.S. electrical utilities over the period 1970-1979 is about 12 actual premature deaths per 10^5 person-years as shown in Figure 5 of the paper by Wilson and Koehl, 1980. (Note that the estimate of 11 radiation-related premature cancer deaths describes a potential risk rather than an observed statistic.)

The preceding values for risk estimators are consistent with the recommendations of a number of recognized radiation-protection organizations, such as the International Commission on Radiological Protection (ICRP, 1977), the National Council on Radiation Protection and Measurement (NCRP, 1975), the National Academy of Sciences (BEIR III), and the United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR, 1977).

The risk of potential fatal cancers in the exposed work-force population at the S/HNP facility and the risk of potential genetic disorders in all future generations of this work-force population, is estimated as follows: multiplying the annual plant-worker-population dose (about 1480 person-rems) by the risk estimators, the staff estimates that about 0.2 cancer deaths may occur in the total exposed population and about 0.4 genetic disorders may occur in all future generations of the same exposed population. The value of 0.2 cancer deaths means that the probability of one cancer death over the lifetime of the entire work force as a result of 1 year of facility operation is about one chance in five. The value of 0.4 genetic disorders means that the probability of one genetic disorder in all future generations of the entire work force as a result of 1 year of facility operation is about two chances in five.

Public Radiation Exposure

Transportation of Radioactive Materials--The transportation of "cold" (unirradiated) nuclear fuel to the reactor, spent irradiated fuel from the reactor to a fuel reprocessing plant, and solid radioactive wastes from the reactor to waste burial grounds is considered in 10 CFR 51.20. The contribution of the environmental effects of such transportation to the environmental costs of licensing the nuclear power reactor is set forth in Summary Table S-4 from 10 CFR 51.20, reproduced herein as Table 4.35. The cumulative dose to the exposed population as summarized in Table S-4 is very small when compared to the annual collective dose of about 60,000 person-rems to this same population or 26,000,000 person-rems to the U.S. population from background radiation.

Direct Radiation for BWRs--Radiation fields are produced around nuclear plants as a result of radioactivity within the reactor and its associated components, as well as a result of radioactive-effluent releases. Although the components are shielded, dose rates observed around BWR plants from these plant components have varied from undetectable levels to values of about 100 mrems/yr at onsite locations where members of the general public have been permitted access. For newer BWR plants with a standardized design, dose rates have been estimated using special calculational modeling techniques. The calculated cumulative dose to the exposed population from such a facility would be much less than 1 person-rem/yr per unit, which is insignificant when compared with the natural-background dose.

Low-level radioactivity storage containers outside the plant are estimated to make a dose contribution at the site boundary of less than 0.1 percent of that due to the direct radiation described above.

Radioactive-Effluent Releases: Air and Water--As pointed out in an earlier section, all effluents from this facility will be subject to extensive decontamination, but small controlled quantities of radioactive effluents will be released to the atmosphere and to the hydrosphere during normal operations.

These radioactive effluents will then be diluted by the air and water into which they will be released before they reach areas accessible to the general public.

Estimates of site-specific radioisotope-release values have been developed on the basis of estimates regarding fuel performance and the descriptions of operational and radwaste systems in the applicant's ASC/ER and FSAR and by using the calculational models and parameters developed by the NRC staff in NUREG-0016 and NUREG-0017. These have been supplemented by extensive use of the applicant's site and environmental data in the ASC/ER and in subsequent answers to NRC staff questions, and should be studied to obtain an understanding of airborne and waterborne releases from the facility.

Radioactive effluents can be divided into several groups. Among the airborne effluents, the radioisotopes of the fission product noble gases, krypton and xenon, as well as those of argon, do not deposit on the ground and are not absorbed and accumulated within living organisms. Therefore, the noble gas effluents act primarily as a source of direct external radiation emanating from the effluent plume. Dose calculations are performed for the site boundary where the highest external-radiation doses to a member of the general public as a result of gaseous effluents have been estimated to occur. These include the total body and skin doses as well as the annual beta and gamma air doses from the plume at that boundary location.

Another group of airborne radioactive effluents--the fission product radioiodines, as well as carbon-14 and tritium--are also gaseous, but these effluents tend to be deposited on the ground and/or inhaled into the body during breathing. For this class of effluents, estimates are made of direct external-radiation doses from deposits on the ground, and of internal radiation doses to total body, thyroid, bone, and other organs from inhalation and from vegetable, milk, and meat consumption. Concentrations of iodine in the thyroid and of carbon-14 in bone are of particular significance here.

A third group of airborne effluents, consisting of particulates that remain after filtration of airborne effluents in the plant prior to release, includes fission products, such as cesium and barium, and activated corrosion products, such as cobalt and chromium. The calculational model determines the direct external radiation dose and the internal radiation doses for these contaminants through the same pathways as described above for the radioiodines, carbon-14, and tritium. Doses from the particulates are combined with those of the radioiodines, carbon-14, and tritium for comparison to one of the design objectives of Appendix I to 10 CFR 50.

The waterborne-radioactive-effluent constituents could include fission products, such as nuclides of strontium and iodine; activation products, such as nuclides of sodium and manganese; and tritium, such as tritiated water. Calculations estimate the internal doses (if any) from fish consumption, from water ingestion (as drinking water), and from eating of meat or vegetables raised near the site on irrigation water, as well as any direct external radiation from recreational use of the water near the point of discharge.

The release values for each group of effluents, along with site-specific meteorological and hydrological data, serve as input to computerized radiation-dose models that estimate the maximum radiation dose that would be received outside the facility by a number of pathways for individual members of the public, and for the general public as a whole. These models and the radiation-dose calculations are discussed in the October 1977 Revision 1 of Regulatory Guide 1.109, "Calculation of Annual Doses to Man from Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," and in Appendix B of this statement.

Examples of site-specific dose assessment calculations and discussions of parameters involved are given in Appendix D. Doses from all airborne effluents except the noble gases are calculated for individuals at the location (for example, the site boundary, garden, residence, milk cow, meat animal) where the highest radiation dose to a member of the public has been established from all applicable pathways (such as ground deposition, inhalation, vegetable consumption, cow milk consumption, or meat consumption). Only those pathways associated with airborne effluents that are known to exist at a single location are combined to calculate the total maximum exposure to an exposed individual. Pathway doses associated with liquid effluents are combined without regard to any single location, but they are assumed to be associated with maximum exposure of an individual through other-than-gaseous-effluent pathways.

Radiological Impact on Humans

Although the doses calculated in Appendix D are based primarily on radioactive-waste treatment system capability and are well below the Appendix I (10 CFR 50) design objective values, the actual radiological impact associated with the operation of the facility will depend, in part, on the manner in which the radioactive-waste treatment system is operated. Based on its evaluation of the potential performance of the ventilation and radwaste treatment systems, the NRC staff has concluded that the systems as now proposed are capable of controlling effluent releases to meet the dose-design objectives of Appendix I to 10 CFR 50.

Operation of the S/HNP facility will be governed by operating license Technical Specifications that will be based on the dose-design objectives of Appendix I to 10 CFR 50. Because these design-objective values were chosen to permit flexibility of operation while still ensuring that plant operations are ALARA, the actual radiological impact of plant operation may result in doses close to the dose-design objectives. Even if this situation exists, the individual doses for the member of the public subject to maximum exposure will still be very small when compared with natural background doses (~100 mrems/yr) or the dose limits (500 mrems/yr to total body) specified in 10 CFR 20 as consistent with considerations of the health and safety of the public. As a result, the staff concludes that there will be no measurable radiological impact on any member of the public from routine operation of the S/HNP facility.

Operating standards of 40 CFR 190, the Environmental Protection Agency's Environmental Radiation Protection Standards for Nuclear Power Operations, specify that the annual dose equivalent must not exceed 25 mrems to the whole body, 75 mrems to the thyroid, and 25 mrems to any other organ of any member of the public as the result of exposures to planned discharges of radioactive materials (radon and its daughters excepted) to the general environment from all uranium-fuel-cycle operations and radiation from these operations that can be expected to affect a given individual. The NRC staff concludes that under normal operations, the S/HNP facility is capable of operating within these standards.

The radiological doses and dose commitments resulting from a nuclear power plant are well known and documented. Accurate measurements of radiation and radioactive contaminants can be made with very high sensitivity so that much smaller amounts of radioisotopes can be recorded than can be associated with any possible observable ill effects. Furthermore, the effects of radiation on living systems have been subject for decades to intensive investigation and consideration by individual scientists as well as by select committees that have occasionally been constituted to objectively and independently assess radiation dose effects. Although, as in the case of chemical contaminants, there is debate about the exact extent of the effects of very low levels of radiation that result from nuclear-power-plant effluents, upper-bound limits of deleterious effects are well established and amenable to standard methods of risk analysis. Thus, the risks to the maximally exposed member of the public outside of the site boundaries or to the total population outside of the boundaries can be readily calculated and recorded. These risk estimates for the S/HNP facility are presented below.

The risk to the maximally exposed individual is estimated by multiplying the risk estimators presented in Section 4.2.12.3 by the annual dose-design objectives for total-body radiation in 10 CFR Part 50, Appendix I. This calculation results in a risk of potential premature death from cancer to that individual from exposure to radioactive effluents (gaseous or liquid) from 1 year of reactor operations of less than one chance in one million.* The risk of potential premature death from cancer to the average individual within 80 km (50 mi) of the reactors from exposure to radioactive effluents from the reactors is much less than the risk to the maximally exposed individual. These risks are very small in comparison to natural cancer incidence from causes unrelated to the operation of the S/HNP facility.

Multiplying the annual U.S. general public population dose from exposure to radioactive effluents and transportation of fuel and waste from the operation of this facility (that is, 120 person-rems) by the preceding risk estimators, the staff estimates that about 0.02 cancer deaths may occur in the exposed population and about 0.03 genetic disorders may occur in all future generations of the exposed population. The significance of these risk estimates can be determined by comparing them to the natural incidence of cancer death and genetic abnormalities in the U.S. population. Multiplying the estimated U.S. population for the year 2000 (~260 million persons) by the current incidence of actual cancer fatalities (~20%) and the current incidence of actual genetic diseases (~6%), about 52 million cancer deaths and about 16 million genetic abnormalities are expected (National Academy of Sciences, BEIR I; American Cancer Society, 1978). The risks to the general public from exposure to radioactive effluents and transportation of fuel and wastes from the annual

*The risk of potential premature death from cancer to the maximally exposed individual from exposure to radioiodines and particulates would be in the same range as the risk from exposure to the other types of effluents.

operation of the S/HNP facility are very small fractions (less than one part in a billion) of the estimated normal incidence of cancer fatalities and genetic abnormalities in the year 2000 population.

On the basis of the preceding comparison (that is, comparing the risk from exposure to radioactive effluents and transportation of fuel and waste from the annual operation of this facility with the risk from the estimated incidence of cancer fatalities and genetic abnormalities in the year-2000 population), the staff concludes that the risk to the public health and safety from exposure to radioactive effluents and the transportation of fuel and wastes from normal operation of the S/HNP facility will be very small.

Radiological Impacts on Biota Other Than Humans

Depending on the pathway and the radiation source, terrestrial and aquatic biota will receive doses that are approximately the same or somewhat higher

than humans receive. Although guidelines have not been established for acceptable limits for radiation exposure to species other than humans, it is generally agreed that the limits established for humans are sufficiently protective for other species.

Although the existence of extremely radiosensitive biota is possible and increased radiosensitivity in organisms may result from environmental interactions with other stresses (for example, heat or biocides), no biota have yet been discovered that show a sensitivity (in terms of increased morbidity or mortality) to radiation exposures as low as those expected in the area surrounding the facility. Furthermore, at all nuclear plants for which radiation exposure to biota other than humans has been analyzed (Blaylock and Witherspoon, 1976), there have been no cases of exposure that can be considered significant in terms of harm to the species, or that approach the limits for exposure to members of the public that are permitted by 10 CFR 20. Inasmuch as the 1972 National Academy of Sciences BEIR Report (BEIR I) concluded that evidence to date indicated no other living organisms are very much more radiosensitive than humans, no measurable radiological impact on populations of biota is expected as a result of the routine operation of this facility.

4.2.12.4 Postulated Accidents

The term "accident," as used in this section, refers to any unintentional event not addressed in Section 4.2.12.3 that results in a release of radioactive materials into the environment. The predominant focus, therefore, is on events that can lead to releases substantially in excess of permissable limits for normal operation. Such limits are specified in the Commission's regulations in 10 CFR 20 and 10 CFR 50, Appendix I.

The staff has considered the potential radiological impacts on the environment of possible accidents at S/HNP in accordance with a Statement of Interim Policy published by the Nuclear Regulatory Commission on June 13, 1980 (45 FR 40101-40104). The following discussion reflects these considerations and conclusions.

The first section deals with general characteristics of nuclear power plant accidents, including a brief summary of safety measures to minimize the probability of their occurrence and to mitigate their consequences if they should occur. Also described are the important properties of radioactive materials and the pathways by which they could be transported to become environmental hazards. Potential adverse health effects and impacts on society associated with actions to avoid such health effects are also identified.

Next, actual experience with nuclear power plant accidents and their observed health effects and other societal impacts are described. This is followed by a summary review of safety features of S/HNP and of the site that act to mitigate the consequences of accidents.

The results of calculations of the potential consequences of accidents that have been postulated in the design basis are then given. The results of calculations for the S/HNP site using probabilistic methods to estimate the possible impacts and the risks associated with severe accident sequences of exceedingly low probability of occurrence are also described.

There are several features that combine to reduce the risk associated with accidents at nuclear power plants. Safety features in the design, construction, and operation comprising the first line of defense are, to a very large extent, devoted to the prevention of the release of these radioactive materials from their normal places of confinement within the plant. There are also a number of additional lines of defense that are designed to mitigate the consequences of failures in the first line. Descriptions of these features and additional lines of defense for the station may be found in the Preliminary Safety Analysis Report (S/HNP PSAR, 1978; Amendment 4, 1981), and in the staff's Safety Evaluation Report (NUREG-0309). The most important mitigative features are described later in this EIS.

These safety features are designed taking into consideration the specific locations of radioactive materials within the plant, their amounts, their nuclear, physical, and chemical properties, and their relative tendency to be transported into, and for creating biological hazards in, the environment.

Fission Product Characteristics

By far, the largest inventory of radioactive material in a nuclear power plant is produced by the fission process and is contained in the uranium oxide fuel rods in the reactor core. During periodic refueling shutdowns, the assemblies containing these fuel rods are transferred to a spent fuel storage pool so that the second largest inventory of radioactive material is located in this storage pool. Much smaller inventories of radioactive materials are also normally present in the water that circulates in the reactor coolant system and in the systems used to process gaseous and liquid radioactive wastes in the plant.

These radioactive materials exist in a variety of physical and chemical forms. Their potential for dispersion into the environment is dependent not only on mechanical forces that might physically transport them, but also on their inherent properties, particularly their volatility. The majority of these materials exist as nonvolatile solids over a wide range of temperatures. Some, however, are relatively volatile solids and a few are gaseous in nature. These characteristics have a significant bearing on the assessment of the environmental radiological impact of accidents.

The gaseous materials include radioactive forms of the chemically inert noble gases krypton and xenon. These have the highest potential for release into the atmosphere. If a reactor accident were to occur involving rupture or other failure of the fuel rod cladding, the release of substantial quantities of these radioactive gases from the affected fuel rods is a virtual certainty. Such accidents have a very low frequency but are credible events (see the section on accident experience and observed impacts). It is for this reason that each nuclear power plant is analyzed for a hypothetical design-basis accident that postulates the release of the entire contained inventory of radioactive noble gases from the fuel into the containment structures. If released to the environment beyond the containment structures as a possible result of failure of safety features, the hazard to individuals from these noble gases would arise predominantly through the external gamma radiation from the airborne plume. The reactor containment system is designed to minimize this type of release.

Radioactive forms of iodine are formed in substantial quantities in the fuel by the fission process and in some chemical forms may be quite volatile. For these reasons, they have traditionally been regarded as having a relatively high potential for release from the fuel. If released to the environment, the principal radiological hazard associated with the radioiodines is ingestion into the human body and subsequent concentration in the thyroid gland. Because of this, its potential for release to the atmosphere is reduced by the use of special systems designed to retain the iodine.

The chemical forms in which the fission product radioiodines are found are generally solid materials at room temperatures, however, so that they have a strong tendency to condense (or "plate out") on cooler surfaces. In addition, most of the iodine compounds are quite soluble in, or chemically reactive with, water. Although these properties do not inhibit the release of radioiodines from degraded fuel, they do act to mitigate the release from containment structures that have large internal surface areas and that may contain large quantities of water. The same properties affect the behavior of radioiodines that may "escape" into the atmosphere. Thus, if rainfall occurs during a release, or if there is moisture on exposed surfaces (for example, dew), the radioiodines will show a strong tendency to be absorbed by the moisture.

Other radioactive materials formed during the operation of a nuclear power plant have lower volatilities and, therefore, by comparison with the noble gases and iodine, a much smaller tendency to escape from degraded fuel rods unless the temperature of the fuel becomes very high. Similarly, such materials, if they escape by volatilization from the fuel, tend to condense quite rapidly to solid form again when transported to a lower temperature region and/or dissolve in water when present. The former mechanism can have the result of producing some solid particles of sufficiently small size to be carried some distance by a moving stream of gas or air. If such particulate materials are dispersed into the atmosphere as a result of failure of the containment barrier, they will tend to be carried downwind and deposited on surface features by gravitational settling (fallout) or by precipitation (rainout) where they will become "contamination" hazards in the environment.

All radioactive isotopes exhibit the property of radioactive decay with characteristic half-lives ranging from fractions of a second to many days or years (see Table 4.37). Many of them decay through a sequence or chain of decay processes and all eventually become stable (nonradioactive) isotopes. The radiation emitted during these decay processes is the reason that they are hazardous materials.

Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive material, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways for the transport of radiation and radioactive materials that lead to radiation exposure hazards to humans are generally the same for accidental as for "normal" releases. These are depicted in Figure 4.42. There are two additional possible pathways that could be significant for accident releases that are not shown in Figure 4.42. One of these is the fallout of radioactivity initially carried in the air onto open bodies of water. The second would be unique to an accident that results in temperatures inside the reactor core sufficiently high to cause melting and subsequent penetration of the basemat underlying the reactor by the molten core debris. This creates the potential for the release of radioactive material into the hydrosphere through contact with groundwater. These pathways may lead to external exposure to radiation, and to internal exposures if radioactivity is inhaled or ingested from contaminated food or water.

It is characteristic of these pathways that, during the transport of radioactive material by wind or by water, the material tends to spread and disperse, like a plume of smoke from a smokestack, becoming less concentrated in larger volumes of air or water. The result of these natural processes is to lessen the intensity of exposure to individuals downwind or downstream of the point of release, but they also tend to increase the number who may be exposed. For a release into the atmosphere, the degree to which dispersion reduces the concentration in the plume at any downwind point is governed by the turbulence characteristics of the atmosphere that vary considerably with time and from place to place. This fact, taken in conjunction with the variability of wind direction and the presence or absence of precipitation, means that accident consequences are very much dependent on the weather conditions existing during the accident.

Health Effects

The cause-and-effect relationships between radiation exposure and adverse health effects are quite complex (National Research Council, 1979, pp. 517-534; Land, 1980), but they have been more exhaustively studied than for any other environmental contaminant.

Whole-body radiation exposure resulting in a dose greater than about 10 rem for a few persons and about 25 rem for nearly all people over a short period of time (hours) is necessary before any physiological effects to an individual are clinically detectable. Doses about 10 to 20 times larger than the latter dose, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatalities. At the severe, but extremely low probability, end of the accident spectrum, exposures of these magnitudes are

Table 4.37 Activity of radionuclides in the S/HNP reactor core at 4100 MWt

Group/radionuclide	Radioactive inventory in millons of curies	Half-life (days)
A. NOBLE GASES		
Krypton-85	0.72	3,950
Krypton-85m	31	0.183
Krypton-87	60	0.0528
Krypton-88	87	0.117
Xenon-133	220	5.28
Xenon-135	44	0.384
B. IODINES		
Iodine-131	110	8.05
Iodine-132	150	0.0958
Iodine-133	220	0.875
Iodine-134	240	0.0366
Iodine-135	190	0.280
C. ALKALI METALS		
Rubidium-86	0.033	18.7
Cesium-134	9.6	750
Cesium-136	3.8	13.0
Cesium-137	6.0	11,000
D. TELLURIUM-ANTIMONY		
Tellurium-127	7.6	0.391
Tellurium-127m	1.4	109
Tellurium-129	40	0.048
Tellurium-129m	6.8	34.0
Tellurium-131m	17	1.25
Tellurium-132	150	3.25
Antimony-127	7.8	3.88
Antimony-129	42	0.17
E. ALKALINE EARTHS		
Strontium-89	120	52.1
Strontium-90	4.7	11,030
Strontium-91	140	0.403
Barium-140	210	12.8
F. COBALT AND NOBLE METALS		
Cobalt-58	1.0	71.0
Cobalt-60	0.37	1,920
Molybdenum-99	210	2.8
Technetium-99m	180	0.25
Ruthenium-103	140	39.5
Ruthenium-105	92	0.185
Ruthenium-106	32	366
Rhodium-105	63	1.50

Table 4.37 (continued)

Group/radionuclide	Radioactive inventory in millons of curies	Half-life (days)
G. <u>RARE EARTHS, REFRACTORY OXIDES AND TRANSURANICS</u>		
Yttrium-90	5.0	2.67
Yttrium-91	150	59.0
Zirconium-95	190	65.2
Zirconium-97	190	0.71
Niobium-95	190	35.0
Lanthanum-140	210	1.67
Cerium-141	190	32.3
Cerium-143	170	1.38
Cesium-144	110	284
Praseodymium-143	170	13.7
Neodymium-147	77	11.1
Neptunium-239	2100	2.35
Plutonium-238	0.073	32,500
Plutonium-239	0.027	8.9×10^6
Plutonium-240	0.027	2.4×10^6
Plutonium-241	4.4	5,350
Americium-241	0.0022	1.5×10^5
Curium-242	0.64	163
Curium-244	0.029	6,630

NOTE: The above grouping of radionuclides corresponds to that in Table 4.38.

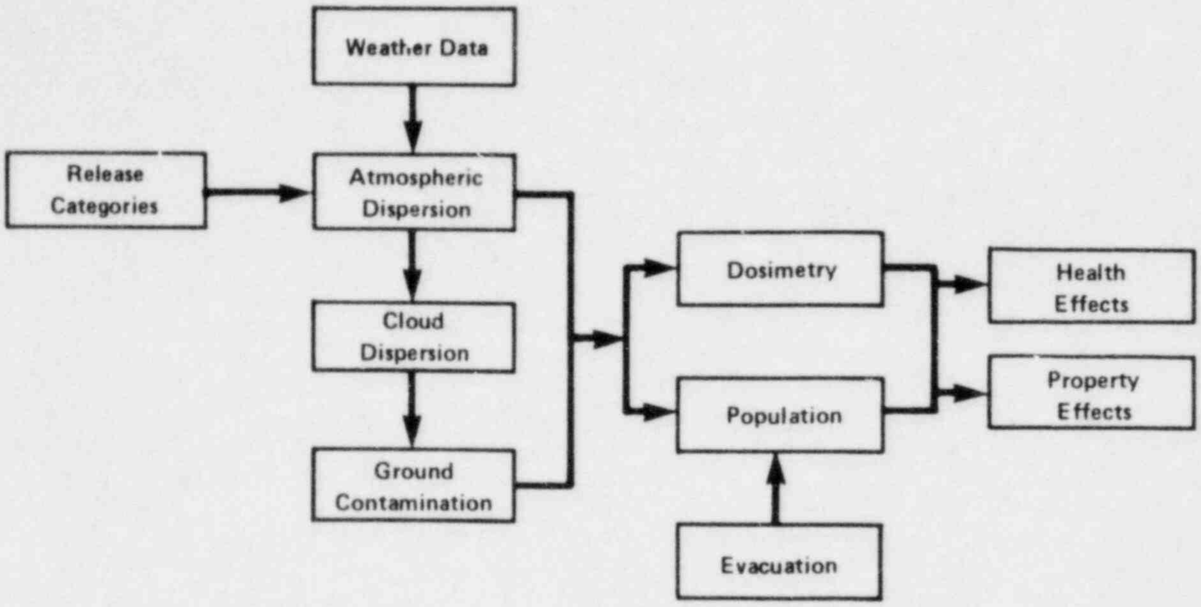


Figure 4.42 Schematic outline of atmospheric pathway consequence model

theoretically possible for persons in the close proximity of such accidents if measures are not or cannot be taken to provide protection, for example, by sheltering, evacuation, or relocation.

Lower levels of exposures may also constitute a health risk, but the ability to define a direct cause-and-effect relationship between a known exposure to radiation and any given health effect is difficult given the backdrop of the many other possible reasons why a particular effect is observed in a specific individual. For this reason, it is necessary to assess such effects on a statistical basis. Such effects include randomly occurring cancer in the exposed population and genetic changes in future generations after exposure of a prospective parent. Occurrences of cancer in the exposed population may begin to develop only after a lapse of 1 to 15 years (latent period) from the time of expsoure and then continue over a period of about 30 years (plateau period). However, in the case of exposure of fetuses (in utero), occurrences of cancer may begin to develop at birth (no latent period) and end at age 10 (i.e., the plateau period is 10 years). The health consequences model currently being used is based on the 1972 BEIR Report of the National Academy of Sciences (NAS) (BEIR I, 1972). The occurrence of cancer itself is not necessarily indicative of fatality from that cause.

Most authorities agree that a reasonable and probably conservative estimate of the randomly occurring health effects of low levels of radiation exposure to a large number of people is within the range of about 10 to 500 potential cancer deaths (although zero is not excluded by the data) per million person-rem. The range comes from the latest NAS BEIR III Report, which also indicates a probable value of about 150. This value is virtually identical to the value of about 140 used in the current NRC health effects models. In addition, approximately 220 genetic changes per million person-rem would be projected by BEIR III over succeeding generations. That also compares well with the value of about 260 per million person-rem currently used by the staff.

Health Effects Avoidance

Radiation hazards in the environment tend to disappear by the natural process of radioactive decay. Where the decay process is a slow one, however, and where the material becomes relatively fixed in its location as an environmental contaminant (for example, in soil), the hazard can continue to exist for a relatively long period of time--months, years, or even decades. Thus, a possible consequential environmental societal impact of severe accidents is the avoidance of the health hazard, rather than the health hazard itself, by restrictions on the use of the contaminated property or contaminated foodstuffs, milk, and drinking water. The potential economic impacts that this can cause are discussed below.

Accident Experience and Observed Impacts

The evidence of accident frequency and impacts in the past is a useful indicator of future probabilities and impacts. As of mid-1981, there were 73 commercial nuclear power reactor units licensed for operation in the United States at 51 sites with power generating capabilities ranging from 50 to 1130 MWe. The combined experience with the 73 operating units represents approximately 500 reactor-years of operation over an elapsed time of about 20 years. Accidents have occurred at several of these facilities (Bertini, 1980; NUREG-0651). Some of these have resulted in releases of radioactive material to the environment, ranging from very small fractions of a curie to a few million curies. None is known to have caused any radiation injury or fatality to any member of the public, or any significant contamination of the environment. This experience base is not large enough to permit a reliable quantitative statistical inference. It does, however, suggest that significant environmental impacts due to accidents are very unlikely to occur over time periods of a few decades.

Melting or severe degradation of reactor fuel has occurred in only one of these 73 operating units, during the accident at Three Mile Island, Unit 2, (TMI-2) on March 28, 1979. In addition to the release of a few million curies of xenon (almost all Xe-133), it has been estimated that approximately 15 curies of radioiodine were also released to the environment at TMI-2 (NUREG/CR-1250, Vol. I). This amount represents an extremely minute fraction of the total radioiodine inventory in the reactor at the time of the accident. No other radioactive fission products were released in measurable quantity.

It has been estimated that the maximum cumulative offsite radiation dose to an individual was less than 100 millirem (NUREG/CR-1250, Vol. I; President's Commission Report, Oct. 1979). The total population exposure has been estimated to be in the range from about 1000 to 5000 person-rem. This exposure could produce between none and one additional fatal cancer over the lifetime of the population. The same population receives each year from natural background radiation about 240,000 person-rem, and approximately a half-million cancers are expected to develop in this group over its lifetime (NUREG/CR-1250, Vol. I; President's Commission Report, Oct. 1979), primarily from causes other than radiation. Trace quantities (barely above the limit of detectability) of radioiodine were found in a few samples of milk produced in the area. No other food or water supplies were affected.

Accidents at commercial nuclear power plants have also caused occupational injuries and a few fatalities, but none have been attributed to radiation exposure. Individual worker exposures have ranged up to about 4 rem as a direct consequence of reactor accidents (although there have been higher exposures to some workers as a result of other unusual occurrences). However, the collective worker exposure levels (person-rem) are a small fraction of the exposures experienced during normal operations that average about 440 to 1300 person-rems in a PWR and 740 to 1650 person-rems in a BWR per reactor-year.

Accidents have also occurred at other nuclear reactor facilities in the United States and in other countries (Bertini, 1980; NUREG-0651). Because of inherent differences in design, construction, operation, and purpose of most of these other facilities, their accident record has only indirect relevance to current nuclear power plants. Melting of reactor fuel occurred in at least seven of these accidents, including the accident in 1966 at the Enrico Fermi Atomic Power Plant Unit 1. This was a sodium-cooled fast breeder demonstration reactor designed to generate 61 MWe. The damages were repaired and the reactor reached full power 4 years following the accident. It operated successfully and completed its mission in 1973. This accident did not release any radioactivity to the environment.

A reactor accident in 1957 at Windscale, England, released a significant quantity of radioiodine, approximately 20,000 curies, to the environment. This reactor, which was not operated to generate electricity, used air rather than water to cool the uranium fuel. During a special operation to heat the large amount of graphite in this reactor, the fuel overheated and radioiodine and noble gases were released directly to the atmosphere from a 123-m (405-ft) stack. Milk produced in a 512-km^2 (200-mi^2) area around the facility was impounded for up to 44 days. This kind of accident cannot occur in a reactor like S/HNP, however, because of its water-cooled design.

Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, the Nuclear Regulatory Commission has conducted a safety evaluation of the application to operate S/HNP. Although this evaluation contains more detailed information on plant design, the principal design features that relate to safety are presented in the following section.

Design Features

Units 1 and 2 at S/HNP include features designed to prevent accidental release of radioactive fission products from the fuel and to lessen the consequences should such a release occur. Many of the design and operating specifications of these features are derived from the analysis of postulated events known as design-basis accidents (DBAs). These accident preventive and mitigative features are collectively referred to as engineered safety features (ESFs). The possibilities or probabilities of failure of these systems are incorporated into the assessments discussed later in the section on probabilistic assessment of severe accidents.

The containment system, one such ESF, will consist of a reinforced concrete drywell, a pressure suppression system, and a steel-lined, reinforced concrete containment. The drywell pressure suppression system is designed to prevent containment failure due to overpressure following an accident. An emergency core cooling system is designed to provide cooling water to the reactor core during an accident to prevent or minimize fuel damage. Included in the containment system will be the free volumes in those buildings that are designated as the secondary containment, and that are designed to dilute and hold up fission products released from the primary containment following a DBA. These buildings are the enclosure building, the fuel building, and the auxiliary building.

The standby gas treatment system (SGTS) will operate and maintain a subatmospheric pressure in the enclosure building, the fuel building, and the auxiliary building following a postulated loss-of-coolant accident (LOCA), and maintain a subatmospheric pressure in the enclosure and fuel handling buildings following a fuel handling accident. The negative pressure, with respect to the outside atmosphere, is designed to prevent out-leakage of radioactivity to the environment except along the release path controlled by the SGTS. Radioactive iodine and particulate fission products would be substantially removed from the flow stream by safety-grade activated charcoal and high-efficiency particulate air filters.

The main steam isolation valve leakage control system is designed to control the release of fission products through the main steam isolation valves. This system directs the leakage through these valves to the area served by the SGTS.

The systems mentioned above are supplied with emergency power from onsite diesel generators in the event that normal offsite station power is interrupted.

Much more extensive discussions of the safety features and characteristics of Units 1 and 2 at S/HNP may be found in the applicant's Preliminary Safety Analysis Report (S/HNP PSAR, 1981, Amendment 4). The staff evaluation of these features is addressed in the Safety Evaluation Report (NUREG-0309). In addition, the implementation of the lessons learned from the Three Mile Island (TMI) accident, in the form of improvements in design, procedures, and operator training, will significantly reduce the likelihood of a degraded core accident, which could result in large releases of fission products to the containment. Specifically, the applicant will be required to meet those TMI-related requirements specified in NUREG-0737.

As noted in the section on uncertainties, no credit has been taken for these actions and improvements in discussing the radiological risks of accidents because the benefits of these actions to risk reduction have not been quantified.

Site Features

The reactor site criteria in 10 CFR 100 require that the site have certain characteristics for every power reactor that tend to reduce the risk of potential impact of accidents. The discussion that follows briefly describes the site for the S/HNP reactors and how it meets certain of these requirements.

First, the site has an exclusion area, as required by 10 CFR 100. The boundary of the exclusion area is very nearly a circle with its center between Units 1 and 2 and a radius of 3 km (1.9 mi). There are no residents or industrial facilities within the exclusion area. The site will consist of 485 ha (1200 acres). All of the land within the exclusion area is, at present, owned by the United States and managed by the Department of Energy as part of the Hanford Reservation. Title will be acquired to 259 ha (640 acres) and easements will be obtained for the remaining 226 ha (560 acres). The applicant's use of the owned land will be restricted to the construction and operation of nuclear electric generating facilities. On completion of the use of the owned land for these purposes, title to the owned land will revert to the U.S. Government. The Government will retain all mineral rights on or in the owned land, but will agree not to exercise those rights as long as title to the owned land remains vested in the applicant. Easements will be acquired by the applicant over the remainder of the site. This will include an easement for an access-control perimeter fence, thus permitting the applicant to fence the site boundary and control access to the entire site. Consequently, the applicant will have the authority to determine all activities within the exclusion area, as required by 10 CFR 100. Route 4 South (a Federally controlled road) traverses the northeast portion of the exclusion area. Arrangements are to be made for traffic control along this road in the event of an emergency. There are no public roads, railroads, or waterways which traverse the exclusion area.

Second, a low population zone (LPZ) beyond and surrounding the exclusion area is also required by 10 CFR 100. The LPZ for the S/HNP reactors is defined as all land within 4 miles of the centroid of the two reactors. Within this zone, the applicant must assure that there is a reasonable probability that appropriate and effective measures could be taken on behalf of the residents and other members of the public in the event of a serious accident. There are no residents presently within the LPZ. The only facility within the LPZ not associated with the proposed operation of the S/HNP is the guard station at the Wye Barricade [about 3.5 km (2.2 mi) east of Unit 1]. A hazardous waste disposal site is proposed approximately 4.0 km (2.5 mi) west-southwest of the plant. Transportation routes in the LPZ are not primary routes. There appears to be no significant problem with regard to developing a radiological emergency plan, including evacuation of personnel in the vicinity of the S/HNP.

Third, 10 CFR 100 also requires that the nearest population center of about 25,000 or more persons be no closer than 1-1/3 times the outer radius of the LPZ. Because accidents of greater potential hazards than those commonly postulated as representing an upper limit are conceivable, although highly improbable, it was considered desirable to add the population center distance requirement in 10 CFR 100 to provide for protection against excessive exposure doses to people in large centers.

The nearest population center is the City of Richland, Washington (1980 estimated population of 33,512), located about 22.5 km (14 mi) southeast of the plant. This distance is at least 1-1/3 times the low population zone distance, as required by 10 CFR 100.

The nearest significant transient populations are located at Washington Nuclear Plant Unit 2 (WNP-2), located approximately 7.2 to 8.0 km (4.5 to 5 mi) east-southeast of the plant, and the Fast Flux Test Facility (FFTF), located 7.2 to 8.0 km (4.5 to 5 mi) southeast of the plant. By the year 1990, it is estimated that WNP-2 will have an operating staff of 294 plus an additional 200 persons during refueling. The FFTF work force is estimated to be 1187.

The safety evaluation of the S/HNP site has also included a review of potential external hazards (i.e., activities off site that might adversely affect the operation of the plant and cause an accident). This review encompasses nearby industrial, transportation, and military facilities that might creat explosive, missile, toxic gas, or similar hazards. The staff has concluded that the hazards from nearby industrial, military, mining, pipelines, and transportation are negligibly small.

Emergency Preparedness

Emergency preparedness plans including protective action measures for the plant and environs are in an advanced, but not yet fully completed stage. In accordance with the provisions of 10 CFR 50.47 (effective November 3, 1980) and Appendix E to 10 CFR 50, no operating license will be issued to a nuclear facility applicant unless a finding is made by the staff that the state of onsite and offsite emergency preparedness provides reasonable assurance that adequate protective measures can and will be taken in the event of a radiological emergency. Among the standards that must be met by these plans are provisions for two emergency planning zones (EPZs). A plume exposure pathway

EPZ of about 16 km (10 mi) in radius and an ingestion exposure pathway EPZ of about 80 km (50 mi) in radius are required. Other standards include appropriate ranges of protective actions for each of these zones, provisions for dissemination to the public of basic emergency planning information, provisions for rapid notification of the public during a serious reactor emergency, and methods, systems, and equipment for assessing and monitoring actual or potential offsite consequences in the EPZs of a radiological emergency condition.

NRC and the Federal Emergency Management Agency (FEMA) have agreed that FEMA will make a finding and determination of the adequacy of State and local government Emergency Response Plans. NRC will determine the adequacy of the applicant's Emergency Response Plans with respect to the standards listed in Section 50.47(b) of 10 CFR 50, the requirements of Appendix E to 10 CFR 50, and the guidance contained in NUREG-0654/FEMA-REP-1, Revision 1, "Criteria for Preparation and Evaluation of Radiological Emergency Response Plans and Preparedness in Support of Nuclear Power Plants," dated November 1980. After the above determinations by NRC and FEMA, NRC will make a finding in the licensing process as to the overall and integrated state of preparedness. NRC staff findings will be reported in the next issuance of the Safety Evaluation Report (NUREG-0309).

The overall objective of emergency response plans is to provide dose saving (and, in some cases, immediate life saving) for a spectrum of accidents that could provide offsite doses in excess of the Environmental Protection Agency and U.S. Department of Health and Human Services Protective Action Guides. However, the presence of an adequate and tested emergency plan cannot ensure that there will be no offsite health effects in the event of an extremely low likelihood accident.

Accident Risk and Impact Assessment

As a means of ensuring that certain features of S/HNP meet acceptable design and performance criteria, the applicant or the staff has analyzed the potential consequences of a number of postulated accidents. Some of these could lead to significant releases of radioactive materials to the environment, and calculations have been performed to estimate the potential radiological consequences to persons off site. For each postulated initiating event, the potential radiological consequences cover a considerable range of values depending on how the accident develops and the relevant conditions, including wind direction and weather prevalent during the accident.

In the safety analysis of S/HNP, three categories of accidents have been considered. These categories are based on their probability of occurrence and include (1) incidents of moderate frequency, i.e., events that can reasonably be expected to occur during any year of operation; (2) infrequent accidents, i.e., events that might occur once during the lifetime of the plant; and (3) limiting faults, i.e., accidents not expected to occur but that have the potential for significant releases of radioactivity. The radiological consequences of incidents in the first category, also called anticipated operational occurrences, are similar to the consequences from normal plant operations that are discussed in Section 4.2.12.3. The latter two categories of accidents are discussed below.

Design-Basis Accidents

Design-basis accidents include infrequent accidents and limiting faults (the last two categories in the preceding discussion). They are called design-basis accidents because specific design and operating features, as described above in the section on design features, are provided to limit their potential radiological consequences. These accidents include radioactive waste system failures, small-break LOCA, fuel-cask drop, main steamline break, large-break LOCA, and control rod drop. The applicant has analyzed the potential radiological consequences of these accidents for this plant, but the staff has not completed its evaluation of these accidents at the S/HNP site. However, the staff will ensure that the maximum dose to an individual from these accidents will not exceed the dose guidelines of 10 CFR 100, by requiring design changes or exclusion area boundary changes if necessary. 10 CFR 100 includes dose guidelines of 25 rems for the whole body and 300 rems to the thyroid for any individual at the exclusion area boundary for 2 hr, and for any individual on the outer boundary of the low population zone for 30 days.

None of the calculations of the impacts of design-basis accidents to be reported in the forthcoming Safety Evaluation Report will take into consideration possible reductions in individual or population exposures as a result of taking any protective actions.

Probabilistic Assessment of Severe Accidents

In this and the following three sections, there is a discussion of the probabilities and consequences of accidents of greater severity than the design-basis accidents identified in the preceding section on design-basis accidents. As a class, they are considered less likely to occur, but their consequences could be more severe both for the plant itself and for the environment. These more severe accidents, frequently called Class 9 accidents, are different from design-basis accidents in two primary respects: (1) they involve substantial physical deterioration of the fuel in the reactor core, including overheating to the point of melting, and (2) they involve deterioration of the capability of the containment structure to perform its intended function of limiting the releases of radioactive materials to the environment.

The assessment methodology used is that described in the Reactor Safety Study (RSS) published in 1975 (NUREG-75/014, formerly WASH-1400).* In 1980, the sets of accident sequences that were found in the RSS to be the dominant contributors to the risk in the prototype BWR (Peach Bottom Unit 2) were updated or rebaselined (NUREG-0715). The method for this effort is similar to that described in RSSMAP (NUREG/CR-1659, Vol. 1). The rebaselining was done largely to incorporate peer group comments (NUREG/CR-0400) and better data and analytical techniques resulting from research and development after the publication of the RSS. Entailed in the rebaselining effort was the evaluation of individual dominant accident sequences as they are understood to evolve. The

*Because this report has been the subject of considerable controversy, a discussion of the uncertainties surrounding it is provided later in this EIS.

earlier technique of grouping a number of accident sequences into the encompassing release categories, as was done in the RSS, was largely eliminated from this rebaselining effort. Further discussion of the rebaselining is included in Appendix E.

Skagit/Hanford Nuclear Project, Units 1 and 2, will use boiling water reactors designed by General Electric having somewhat similar design and operating characteristics to the RSS prototype BWR. Therefore, the present assessment for S/HNP has used as its starting point the rebaselined accident sequences and sequence groups referred to above and more fully described in Appendix E. Characteristics of the sequences (and release categories) used (all of which involve partial to complete melting of the reactor core) are given in Table 4.38. Sequences initiated by natural phenomena, such as tornadoes, floods, or seismic events, and those that could be initiated by deliberate acts of sabotage are not included in these event sequences. The radiological consequences of such events would not be different in kind from those that have been treated. There are design requirements in 10 CFR 50, Appendix A, relating to effects of natural phenomena; and safeguards requirements in 10 CFR 73 assuring that these potential accident initiators are, for the most part, taken into account in the design and operation of the plant. The data base for assessing the probabilities of events more severe than the design bases for natural phenomena or sabotage is small. Therefore, inclusion of accident sequences initiated by natural phenomena or sabotage into probabilistic risk assessment is, at this time, very difficult. However, the staff judges that the additional risk from severe accidents initiated by natural events or sabotage is within the uncertainty of the total risks presented for the sequences considered here.

Calculated probability per reactor-year associated with each accident sequence (or release category) used is given in the second column in Table 4.38. As in the RSS, there are substantial uncertainties in these probabilities. This is due, in part, to difficulties associated with the quantification of human error and to inadequacies in the data base on failure rates of individual plant components that were used to calculate the probabilities (NUREG/CR-0400). (See also the section on uncertainties.) The probabilities of accident sequences from Peach Bottom Unit 2 were used to give a perspective of the societal risk of S/HNP, because, although the probabilities of particular accident sequences may be substantially different for S/HNP, the overall effect of all sequences taken together is likely to be within the uncertainties.

The magnitudes (curies) of radioactivity releases for each accident sequence or release category are obtained by multiplying the release fractions shown in Table 4.38 by the amounts that would be present in the core at the time of the hypothetical accident. These are given in Table 4.37 for S/HNP at a core thermal power level of 4100 MW, the power level used in the safety evaluation.

The potential radiological consequences of these releases have been calculated by the consequence model used in the RSS (NUREG-75/014) and adapted to apply to a specific site. The essential elements are shown in Figure 4.42. Environmental parameters specific to the S/HNP site have been used and include the following:

Table 4.38 Summary of atmospheric release in hypothetical accident sequences in a BWR (rebaselined)

Accident sequence or sequence group**	Probability per reactor-year	Fraction of core inventory released*						
		Xe-Kr	I	Cs-Rb	Te-Sb	Ba-Sr	Ru***	La†
TCγ´	2.0×10^{-6}	1.0	0.45	0.67	0.64	0.73	0.052	0.0083
TWγ´	3.0×10^{-6}	1.0	0.098	0.27	0.41	0.025	0.028	0.005
TQUγ´	3.0×10^{-7}	1.0	0.95	0.3	0.36	0.034	0.027	0.005
AEγ´ $S_1E\gamma'$ $S^2E\gamma'$								
TCγ´	8.0×10^{-6}	1.0	0.07	0.14	0.12	0.015	0.01	0.002
TWγ´	1.0×10^{-5}	1.0	0.003	0.11	0.083	0.011	0.007	0.001
TQUγ´								
AEγ´ $S_1E\gamma'$ $S_2E\gamma'$	1.0×10^{-6}	1.0	0.02	0.055	0.11	0.006	0.007	0.0013

*Background on the isotope groups and release mechanisms is presented in Appendix VII, WASH-1400 (NUREG-75/014).

**See Appendix E for description of the accident sequences and sequence groups.

***Includes, Ru, Rh, Co, Mo, Tc.

†Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.

NOTE: Please refer to section on uncertainties in risk estimates.

(1) Meteorological data for the very similar WNP-2 site representing a full year of consecutive hourly measurements and seasonal variations.

(2) Projected population for the year 2010 extending throughout regions of 80- and 563-km (50- and 350-mi) radius from the site (the latter region includes parts of Canada).

(3) The habitable land fraction within the 563-km (350-mi) radius.

(4) Land use statistics, on a State-wide basis, including farm land values, farm product values (including dairy production), and growing season information, for the State of Washington and each surrounding State within the 563-km (350-mi) region.

(5) Land use statistics including farm land values, farm product values (including dairy production) and growing season information for the adjoining regions of Canada, within 563 km (350 mi), based on comparison with the values for the nearby States of the United States.

To obtain a probability distribution of consequences, the calculations are performed assuming the occurrence of each accident release sequence at each of 91 different "start" times throughout a 1-year period. Each calculation uses the site-specific hourly meteorological data and seasonal information for the time period following each "start" time. The consequence model also contains provisions for incorporating the consequence reduction benefits of evacuation, relocation, and other protective actions. Early evacuation and relocation of people would considerably reduce the exposure from the radioactive cloud and from the contaminated ground in the wake of the cloud passage. The evacuation model used (see Appendix F) has been revised from that used in the RSS for better site-specific application. The quantitative characteristics of the evacuation model used for the site are estimates made by the staff and are partly based on evacuation time estimates prepared by the applicant. There may be some people near a site who will not be notified or who will choose not to evacuate (however, there will be planning for essentially complete notification, even for those with impaired hearing or in remote living situations). Also, there normally would be special facilities near a plant, such as schools or hospitals, where special equipment or personnel may be required to effect evacuation. There are no such facilities within 16 km (10 mi) of S/HNP. There are some at greater distances; for instance, the Kadlec Hospital in Richland is about 25.6 km (16 mi) from the site. For the above reasons, actual evacuation effectiveness could be greater or less than that characterized but is not expected to be much less.

The other protective actions include: (1) either complete denial of use (interdiction), or permitting use only at a sufficiently later time, after appropriate decontamination, of foodstuffs such as crops and milk; (2) decontamination of severely contaminated environment (land and property) when it is considered to be economically feasible to lower the levels of contamination to protective action guide (PAG) levels; (3) denial of use (interdiction) of severely contaminated land and property for varying periods of time until the contamination levels reduce to such values by radioactive decay and weathering so that land and property can be economically decontaminated as in (2) above.

These actions would reduce the radiological exposure to the people from immediate and/or subsequent use of, or living in, the contaminated environment.

Early evacuation within, and early relocation of people from outside the plume exposure pathway EPZ (see Appendix F), and the other protective actions mentioned above, are considered appropriate sequels to serious nuclear reactor accidents at this site involving significant release of radioactivity to the atmosphere. Therefore, the dose consequence results shown for these more severe accidents at S/HNP include the benefits of these protective actions.

There are also uncertainties in each facet of the estimates of consequences, and the error bounds may be as large as they are for the probabilities (see Figure 4.42).

The results of the calculations using this consequence model are radiological doses to individuals and to populations, health effects that might result from these exposures, costs of implementing protective actions, and costs associated with property damage by radioactive contamination.

Dose and Health Impacts of Atmospheric Releases

The results of the calculations of dose and health impacts performed for the facility and site are presented in the form of probability distributions in Figures 4.43 through 4.46 and are included in the impact summary Table 4.39. All of the accident sequences shown in Table 4.38 contribute to the results. The consequences from each sequence of group of sequences is weighted by its associated probability.

Figure 4.43 shows probability distribution curves for the number of persons who might receive whole-body doses equal to or greater than 200 rems and 25 rems, and thyroid doses equal to or greater than 300 rems from early exposure,* all on a per-reactor-year basis. A 200-rem whole-body dose corresponds approximately to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. A 25-rem whole-body dose (which has been identified earlier as the lower limit for clinically observable physiological effects in nearly all people) and 300-rem thyroid dose are guideline values applied to reactor siting in 10 CFR 100.

Figure 4.43 shows that there are less than 2 chances in 100,000 per year (a 2×10^{-5} probability) that one or more persons may receive doses equal to or greater than any of these doses specified.

The fact that the three curves initially run almost parallel in horizontal lines show that, if one person were to receive such doses, the chances are about the same that ten to hundreds would be so exposed. The chances of larger numbers of persons being exposed at those levels are seen to be considerably smaller. For example, the chances are less than 2 in 10,000,000 (a 2×10^{-7} probability) that 10,000 or more people might receive whole-body doses of 200

*Early exposure to an individual includes external doses from the radioactive cloud and the contaminated ground, and the dose from internally deposited radionuclides from inhalation of contaminated air during the cloud passage. Other pathways of exposure are excluded.

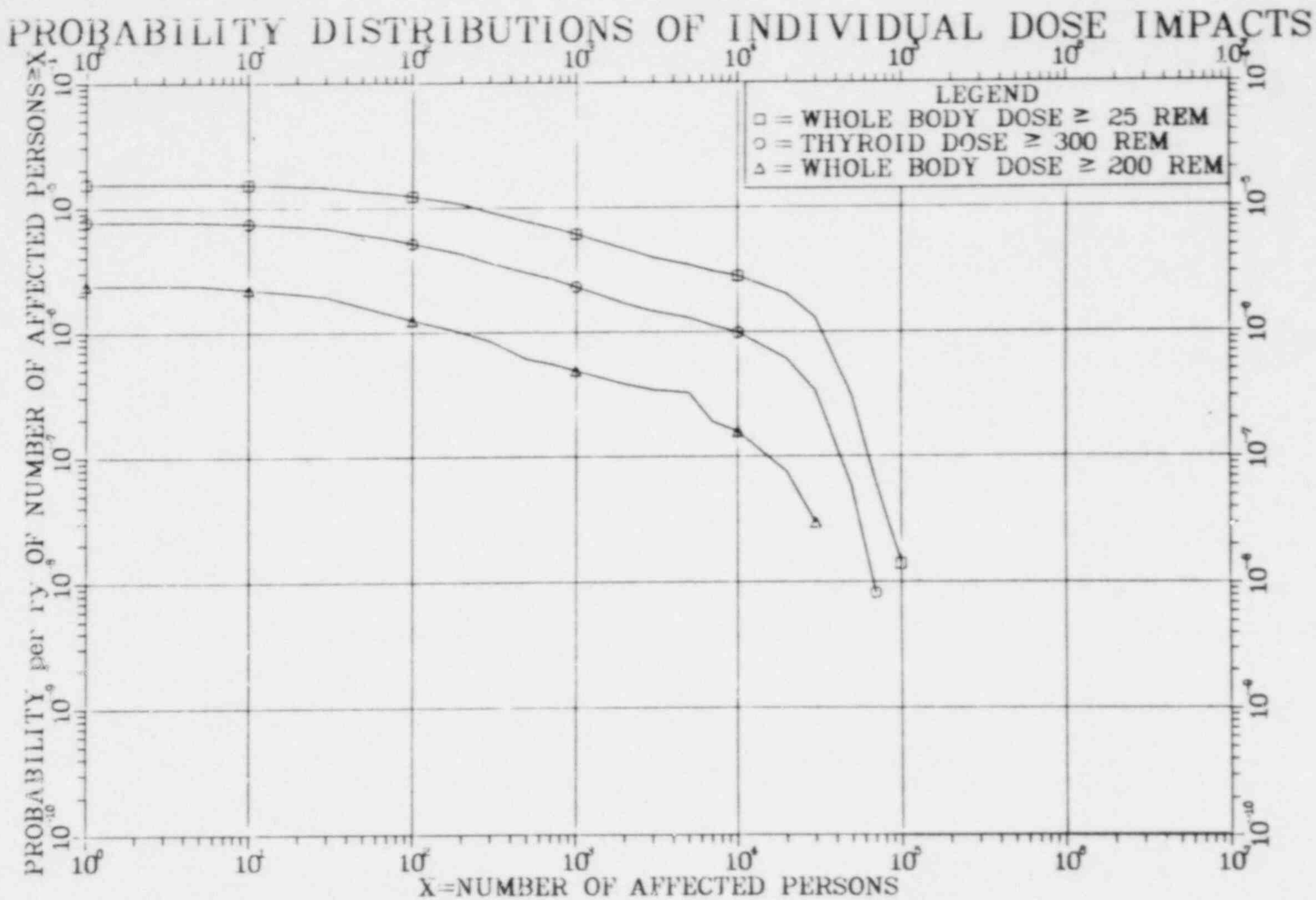


Figure 4.43 Probability distributions of individual dose impacts
(Note: Please see section on uncertainties in risk estimates.)

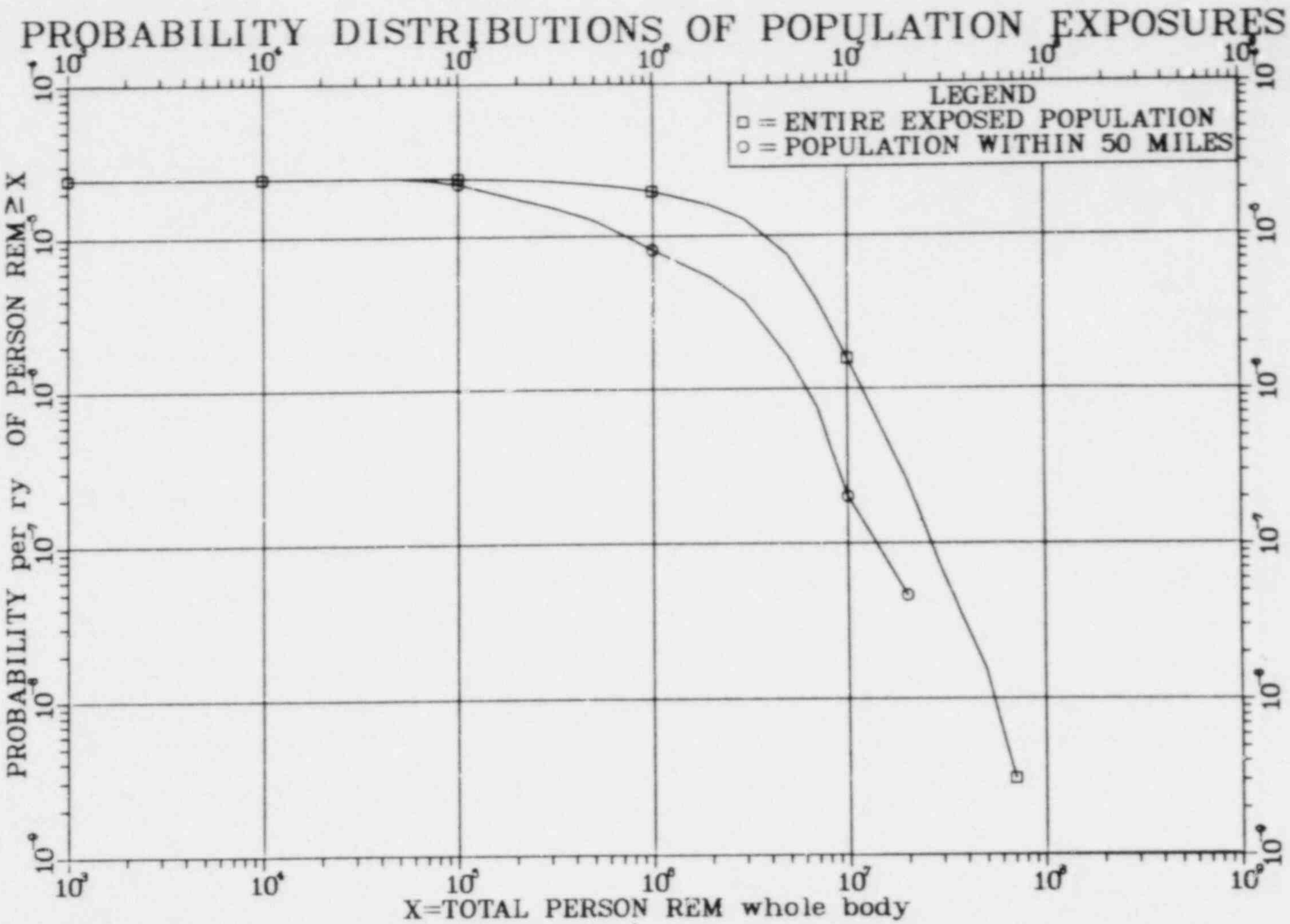


Figure 4.44 Probability distributions of population exposures
(Note: Please see section on uncertainties in risk estimates.)

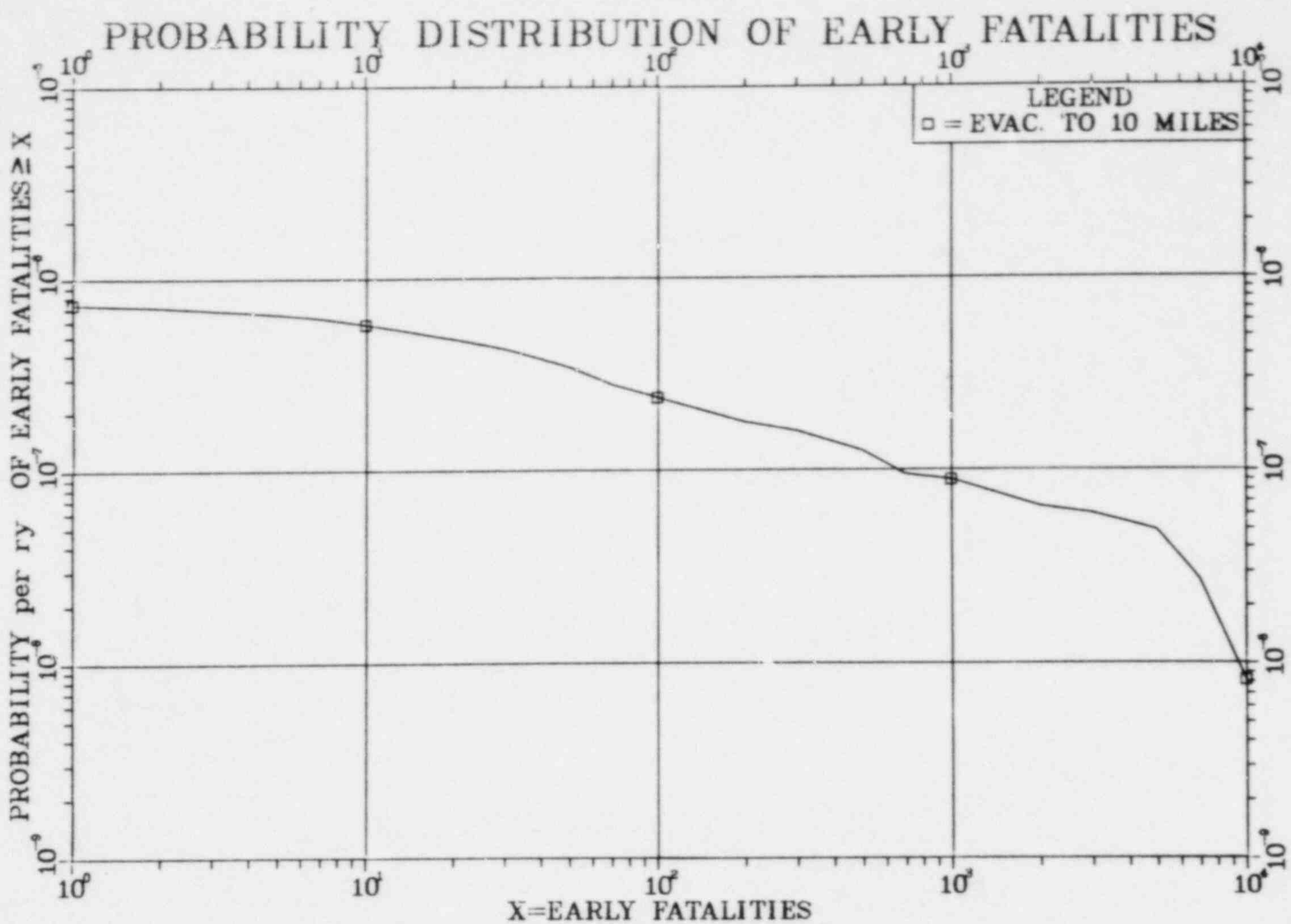


Figure 4.45 Probability distribution of early fatalities
(Note: Please see section on uncertainties in risk estimates.)

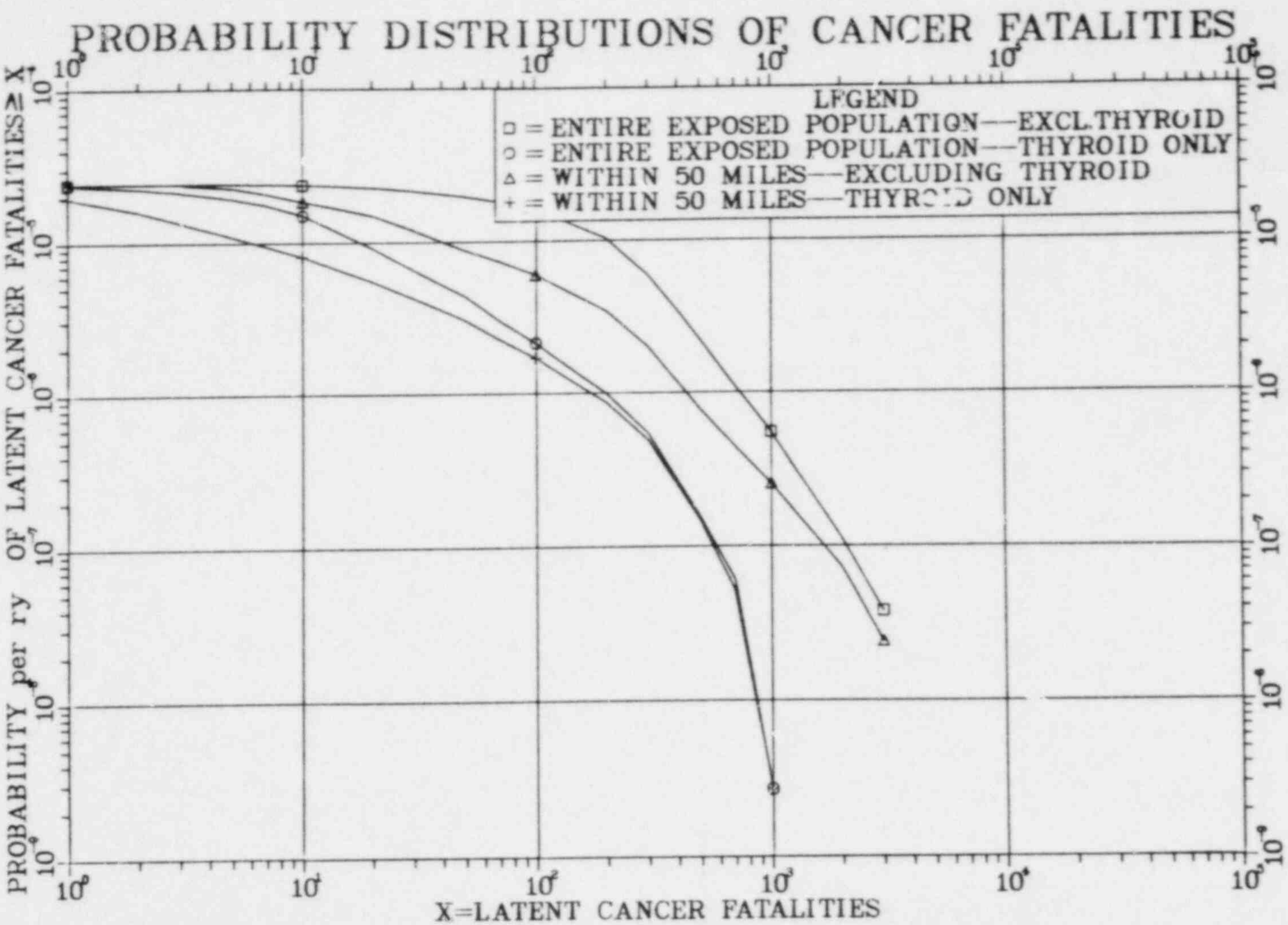


Figure 4.46 Probability distributions of cancer fatalities
(Note: Please see section on uncertainties in risk estimates.)

Table 4.39 Summary of environmental impacts and probabilities

Probability of impact per reactor-year	Persons exposed over 200 rem	Persons exposed over 25 rem	Early fatalities	Population exposure millions of person-rems 50 mi/total	Latent* cancers 50 mi/ total	Cost of offsite mitigating actions ($ millions)
10^{-4}	0	0	0	0/0	0	0
10^{-5}	0	240	0	0.7/3.8	46/220	78
5×10^{-6}	0	1700	0	2.2/6.1	150/370	170
10^{-6}	200	33000	0	6.2/12	610/930	630
10^{-7}	15000	63000	660	14/26	2200/2700	1300
10^{-8}	38000	130000	9400	29/55	4700/5200	2700

*Includes cancers of all organs. Genetic effects might be approximately twice the number of latent cancers.

NOTE: Please refer to section on uncertainties in risk estimates.

rems or greater. It should be noted that a very low probability, such as 2×10^{-7} per reactor year, is associated with a large release of radioactive material at a time when there are weather conditions that tend to maximize total exposure. These types of weather conditions occur very infrequently. A majority of the exposures reflected in this figure would be expected to occur to persons within a 32-km (20-mi) radius of the plant. Virtually all exposures would occur within a 113-km (70-mi) radius.

Figure 4.44 shows the probability distribution for the total population exposure in person-rems; that is, probability per reactor-year that the total population exposure will equal or exceed the values given. Much of the population exposure up to about 100,000 person-rems would occur within 80 km (50 mi) but the more severe releases, as in the first three accident sequences in Table 4.38, would result in exposure to persons beyond the 80-km (50-mi) range as shown.

For perspective, population doses shown in Figure 4.44 may be compared with the annual average dose to the population within 80 km (50 mi) of the S/HNP site due to natural background radiation of 46,000 person-rems, and to the anticipated annual population dose per reactor to the general public (the entire United States) from normal plant operation of 58 person-rems (excluding plant workers).

Figure 4.45 shows the probability distribution for early fatalities, representing radiation injuries that would produce fatalities within about 1 year after exposure. Virtually all of the early fatalities would be expected to occur within a 40-km (25-mi) radius. The results of the calculations shown in Figure 4.45 and in Table 4.39 reflect the effect of evacuation within the 16-km (10-mi) plume exposure pathway EPZ only. For the very low probability accidents having the potential for causing radiation exposure above the threshold for early fatality beyond 16 km (10 mi), it would be realistic to expect that authorities would evacuate persons at all distances at which such exposures might occur. Therefore, the number of persons exposed to doses that might cause early fatalities could reasonably be expected to be lower than calculated. However, for this site, the upper end of the dose consequences versus probability spectrum indicates that, for some very small probabilities, the number of people with doses of such severity as to warrant supportive medical treatment may exceed the nation's capacity for providing the best supportive medical care. The effect of this on the number of early fatalities is discussed in Appendix F.

Figure 4.46 shows the relationship between population exposure and the induction of fatal latent cancers--that is, those fatal cancers that might appear over a period of many years following exposure. The impacts on the total population and the population within 80 km (50 mi) are shown separately. The fatal latent cancers have been subdivided into those attributable to exposures of the thyroid and to those attributable to exposures of all other organs.

Economic and Societal Impacts

As noted in the section on general characteristics of accidents, the various measures for avoidance of adverse health effects, including those due to residual radioactive contamination in the environment, are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for S/HNP and environs have also been made. Unlike the radiation exposure and adverse health effects impacts discussed above, impacts associated with adverse health effects avoidance are more readily transformed into economic impacts.

The results are shown as the probability distribution for costs of offsite mitigating actions in Figure 4.47 and are included in the impact summary (Table 4.39). The factors contributing to these estimated costs include the following:

- Evacuation costs
- Value of crops contaminated and condemned
- Value of milk contaminated and condemned
- Costs of decontamination of property where practical
- Indirect costs due to loss of use of property and incomes derived therefrom.

The last named costs would derive from the necessity for interdiction to prevent the use of property until it is either free of contamination or can be economically decontaminated.

Figure 4.47 shows that, at the extreme end of the accident spectrum, these costs could exceed billions of dollars but that the probability of this occurring is exceedingly small, less than one chance in one million per year.

Additional economic impacts that can be expressed in monetary terms include costs of decontamination of the facility itself and the costs of replacement power. Probability distributions for these impacts have not been calculated, but they are included in the following discussion on risk considerations.

Releases to Groundwater

A pathway for public radiation exposure and environmental contamination that would be unique for severe reactor accidents was identified in the preceding section on exposure pathways. Consideration has been given to the potential environmental impacts of this pathway for the Skagit/Hanford Nuclear Project. The principal contributers to the risk are the core melt accidents associated with the boiling water reactor release categories in WASH-1400 (NUREG-75/014). The penetration of the basemat of the containment building can release molten core debris to the geologic strata beneath the plant. The soluble radionuclides in the debris can be leached and transported with groundwater to downgradient domestic wells used for drinking water, or to surface water bodies used for drinking water, aquatic food, and recreation. The groundwater underlying the site could also receive radioactive liquid from depressurization of the containment atmosphere, radioactive ECCS, or suppression pool water through the failed containment.

An analysis of the potential consequences of a liquid pathway release of radioactivity for several types of generic sites was presented in the Liquid Pathway Generic Study (NUREG-0440). The LPGS compares the risk of accidents involving the liquid pathway (drinking water, irrigation, aquatic food, swimming, and

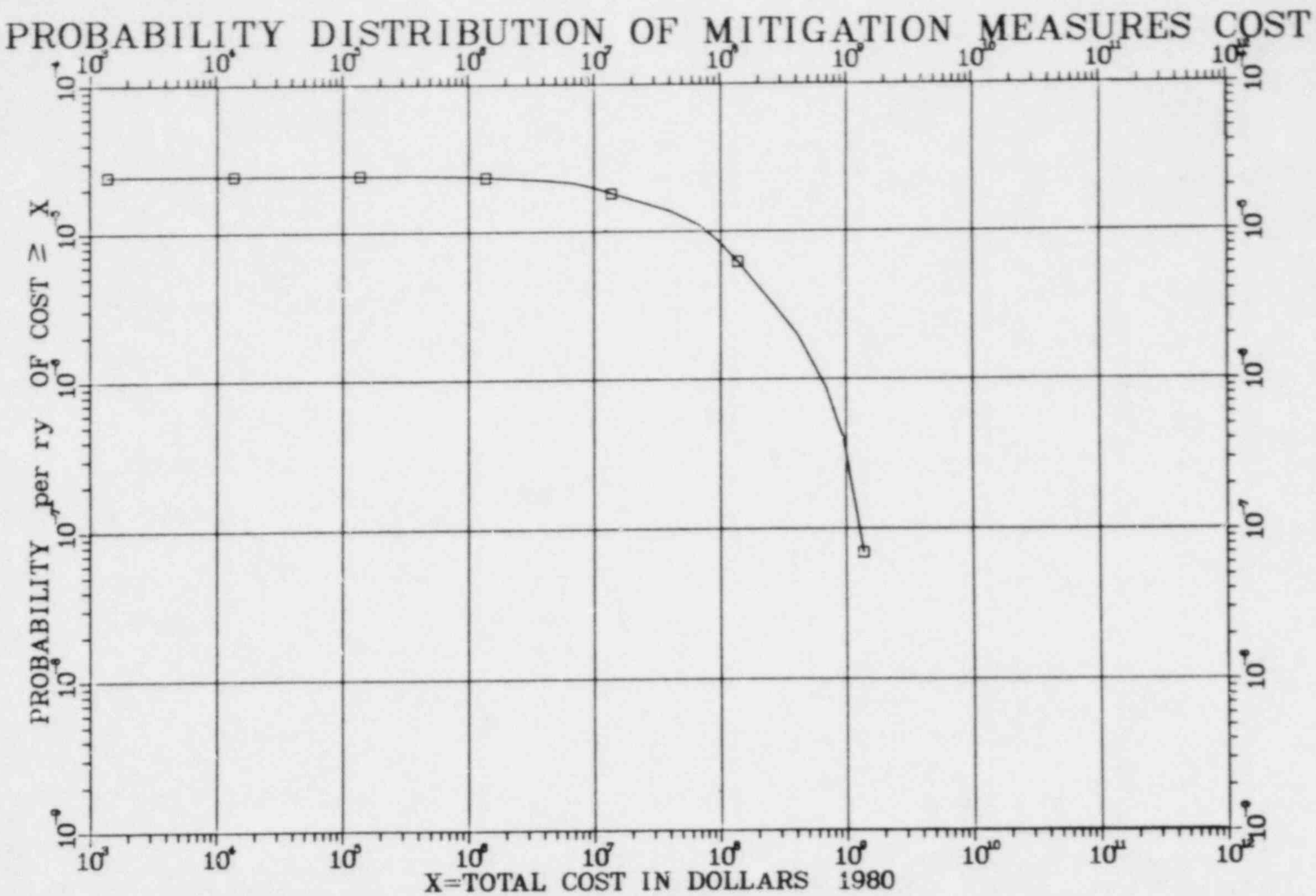


Figure 4.47 Probability distribution of mitigation measures cost
(Note: Please see section on uncertainties in risk estimates.)

shoreline use) for four types of conventional generic land-based nuclear plants and a floating nuclear plant (for which the nuclear reactor would be mounted on a barge and moored in a water body). Parameters for each generic land-based site were chosen to represent averages for a wide range of real sites and were thus "typical" but they represented no real sites in particular. The study concluded that the individual and population doses for the liquid pathway ranged from small fractions to very small fractions of those that arise from the atmospheric pathways. This section summarizes an analysis performed to determine whether or not the liquid pathway consequences of a postulated accident with a release to groundwater beneath the reactor at the S/HNP site would be unique in magnitude when compared with the generic large river, land-based site considered in the LPGS. The method of comparison consists of a direct scaling up or down of the LPGS population doses based on the relative values of key parameters characterizing the LPGS large-river site and the subject site. The parameters that were evaluated in this case include the amounts and rate of release of radioactive materials to the ground, groundwater travel time, and sorption on geological media.

All of the reactors considered in the LPGS were Westinghouse pressurized water reactors (PWRs) with ice condenser containments. There are likely to be significantly different mechanisms and probabilities of releases of radioactivity for the S/HNP boiling water reactors (BWRs). The staff is not aware of any studies that indicate the probabilities or magnitudes of liquid releases for boiling water reactors. It is unlikely, however, that the liquid release for a BWR would be any larger than that conservatively estimated for similarly sized PWRs in the LPGS. The source of radioactivity for S/HNP is, therefore, assumed comparable with that used in the LPGS.

Doses to individuals and populations were calculated in the LPGS without consideration of interdiction methods, such as isolating the contaminated groundwater or denying use of the water. In the event of surface water contamination, alternative sources of water for drinking, irrigation, and industrial uses would be expected to be found, if necessary. Commercial and sports fishing, as well as many other water-related activities, could be restricted. The consequences would, therefore, be largely economic or societal, rather than radiological. In any event, the individual and population doses for the liquid pathway range from fractions to very small fractions of those that can arise from the airborne pathways.

The S/HNP site is located in the Hanford Reservation about 12.8 km (8 mi) west of the Columbia River. Groundwater at the site exists in both a water table aquifer and several confined, artesian aquifers largely in unconsolidated alluvial and glacial sediments. The water table aquifer at the site is about 37.5 km (125 ft) below the surface. Flow in the unconfined aquifer is toward the Columbia River, which is its sink. There is no recharge of the water table at the site.

The plant buildings would be located on highly permeable glaciofluvial outwash sands and gravels. Contaminated water released from the plant would travel vertically until it reached the water table, and would then move down-gradient toward the Columbia River. Although there are many wells on the site, they are closely monitored and are not used for public water consumption. In the event of a core melt accident, use of water from affected wells would presumably be halted. Therefore, the staff analysis focused on potential contamination of the Columbia River by way of contaminated groundwater from the site.

Large releases to the ground of radioactive water resulting from chemical reprocessing of reactor fuel have occurred at the Hanford Reservation. From 1944 to 1972, over 130 billion gallons of waste water and millions of curies of fission products have been discharged from seepage pits to the ground. There have been extensive measurements of the groundwater plumes of several radioactive isotopes and other chemicals released from the seepage pits. Because of this large body of information obtained over the years, the movement of radionuclides in groundwater at the site is relatively well understood. Several constituents of leached waste have migrated up to about 24 km (15 mi) in the direction of the Columbia River in the timespan of 1944 to 1975. On the basis of the observed plume migration, the staff has estimated the groundwater velocity in the unconfined aquifer under the site to be about 7 ft per day toward the Columbia River. Contaminated water released from the plant in the event of a core melt accident could migrate to the river in a minimum of about 12 years. The pathway to the river is at least twice the distance of the previously analyzed WNP-2 (NUREG-0812) located 4.8 km (3 mi) from the river; thus, the minimum migration time and holdup times were doubled for the present analysis. This compares with a minimum groundwater travel time of about 0.6 years used for the LPGS site. For holdup times on the order of years, the LPGS showed that the only significant contributors to population dose to surface water users would be the isotopes cesium-137 (Cs-137) and strontium-90 (Sr-90). Actual observation of the movement of Cs-137 and Sr-90 in site soil columns and in situ measurements at the seepage pits indicate that these two isotopes are strongly bound to the soil (Brown, 1967). Although the plumes of substances not easily sorbed (such as tritium and nitrate) can be seen to extend tens of miles, most of the cesium and strontium has remained within a few tens of feet from the points of release. Based on these data, the staff has estimated retardation factors, which reflect the effects of sorption of the radionuclides within the aquifer, to be about 8400 for cesium and 1400 for strontium. Using these values of the retardation factors, the staff estimates that it would take a minimum of 100,000 years for Cs-137 and 16,800 years for Sr-90 to reach the Columbia River. These travel times compare with about 51 years for Cs-137 and 5.7 years for Sr-90 used in the LPGS. Because their half-lives are approximately 30 years, virtually all the Cs-137 and Sr-90 would decay in the groundwater before they could reach the Columbia River. Because nearly all the population dose calculated in the LPGS resulted from these two isotopes, the staff concludes that the liquid pathway consequences at the S/HNP site, resulting from a postulated Class 9 accident, would be significantly less than that calculated for the LPGS large-river site and would present no uniquely large contribution to risk.

Finally, there are measures that could be taken, if necessary, to isolate liquid contaminants (such as tritium) before they could contaminate the river. The staff's estimate of a 12-year minimum travel time would allow ample time for engineering measures, such as slurry walls and dewatering, to isolate the radioactive contamination near the source.

Risk Considerations

The foregoing discussions have dealt separately with the probabilities and consequences of accidents. These two factors are combined to obtain average measures of environmental risk of accidents. Such averages can be particularly instructive as an aid to the comparison of radiological risks associated with accident releases and with normal operational releases.

A common way in which this combination of factors is used to estimate risk is to multiply the probabilities by the consequences. The estimate is then expressed numerically as consequences expected per unit of time. By use of such a quantification of risk, the staff does not mean to assert that there is universal agreement that people's attitudes about risk, or what constitutes an acceptable risk, should be governed solely by such a measure. Nevertheless, the staff believes that it can be a contributing, but not necessarily decisive, factor in making a risk judgment.

Table 4.40 gives average annual values of risk for the S/HNP reactors associated with population dose; early fatalities; latent fatalities; and costs for evacuation, other protective actions, and decontamination. These average values are obtained by multiplying the probabilities by the consequences and summing these products over the entire range of consequence distribution. Because the probabilities are on a per-reactor-year basis, the average risks shown are also on a per-reactor-year basis.

The population exposure may be compared with those for normal operation releases shown in Appendix D, Table D.7. The population exposure risk with 80 km (50 mi) due to accidents is about 34 person-rems, higher than the average annual dose of 1 person-rem due to normal operations. However, the total population exposure risk of 100 person-rems is comparable to the annual dose to the total population from normal operations of 58 person-rems.

There are no early fatality or economic risks associated with protective actions and decontamination for normal releases; therefore, these risks are unique for accidents. For perspective and understanding of the meaning of the early fatality accident risk estimate of 0.00056 per year, the staff notes that the population at risk is mostly within about 32 km (20 mi) of the plant (about 101,000 persons in the year 2010). The risk of accidental fatalities per year for a population of this size, based on overall averages for the United States, is approximately 22 for motor vehicle accidents, 8 from falls, 3 from drowning, 3 from burns, and 1 from firearms (National Research Council, p. 577). The early fatality risk of 0.00056 per reactor-year is thus an extremely small fraction of the total risk embodied in the above-combined accident modes.

The economic risk associated with protective actions and decontamination could be compared with property damage costs associated with alternative energy-generation technologies. The use of fossil fuels (for example, coal or oil) would emit substantial quantities of sulfur dioxide and nitrogen oxides into the atmosphere, and, among other things, lead to environmental and ecological damage through the phenomenon of acid rain (National Research Council, pp. 559-560). However, this effect has not been sufficiently quantitied to draw a useful comparison at this time.

Table 4.40 Average values of environmental risks due to accidents, per reactor year

Population exposure	
person-rem within 80 km (50 mi)	34
person-rem total	100
Early fatalities	0.00056
Latent cancer fatalities	
all organs excluding thyroid	0.0057
thyroid only	0.00096
Cost of protective actions and decontamination	$3,200

NOTE: See section on uncertainties in risk estimates.

Figure 4.48 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the distance from the plant within the plume exposure pathway EPZ. The values are on a per-reactor-year basis and all accident sequences and sequence groups given in Table 4.38 contributed to the dose, weighted by their associated probabilities.

Evacuation and other protective actions reduce the risks to an individual of early and latent cancer fatalities. Figures 4.49 and 4.50 show curves of constant risk, as a function of distance, per reactor-year, to an individual living in the S/HNP plume exposure pathway EPZ, of early death and death from latent cancer, respectively, due to potential accidents in the reactor. Directional variation of these curves reflect the variation in the average fraction of the year the wind would be blowing into different directions from the plant. For comparison, the following risks of fatality per year to an individual living in the United States may be noted (National Research Council, p. 577); automobile accidents 2.2×10^{-4}, falls 7.7×10^{-5}, drowning 3.1×10^{-5}, burning 2.9×10^{-5}, and firearms 1.2×10^{-5}.

There are other economic impacts and risks not included in the cost calculations discussed in the section on economic and societal impacts that can be monetized. These are accident impacts on the facility itself that result in added costs to the public; i.e., ratepayers, taxpayers, and/or shareholders. These costs would be for decontamination and repair or replacement of the facility, and replacement power. Experience with such costs is currently being accumulated as a result of the accident at Three Mile Island. If an accident occurs during the first full year of operation of S/HNP Unit 1 (1992), the economic penalty associated with the initial year of one unit's operation is estimated between $1800 and $3000 million for decontamination and restoration, including replacement of the damaged nuclear fuel. This is based on an escalation of the $950 to $1600 million cost range estimated for Three Mile

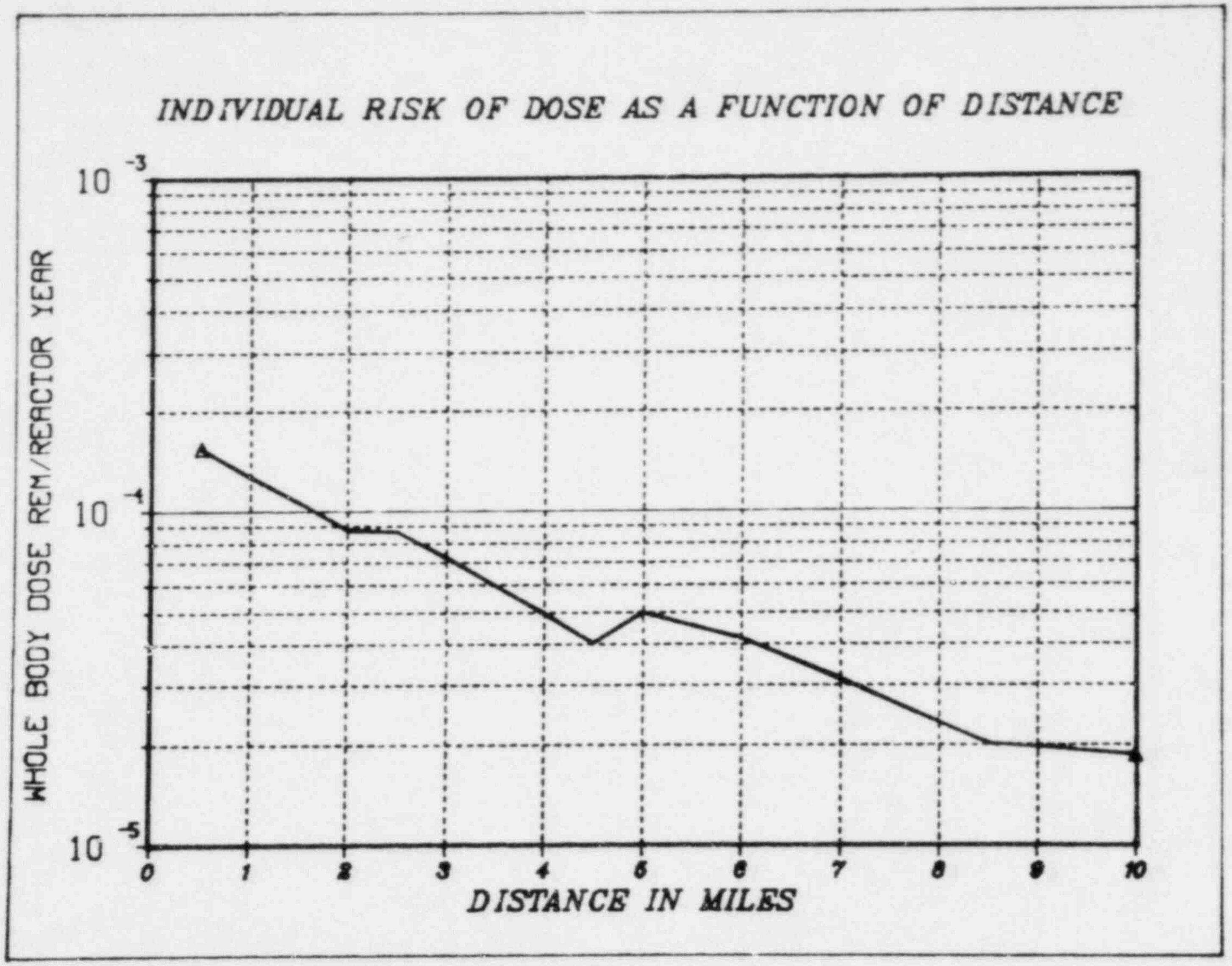


Figure 4.48 Individual risk of dose as a function of distance

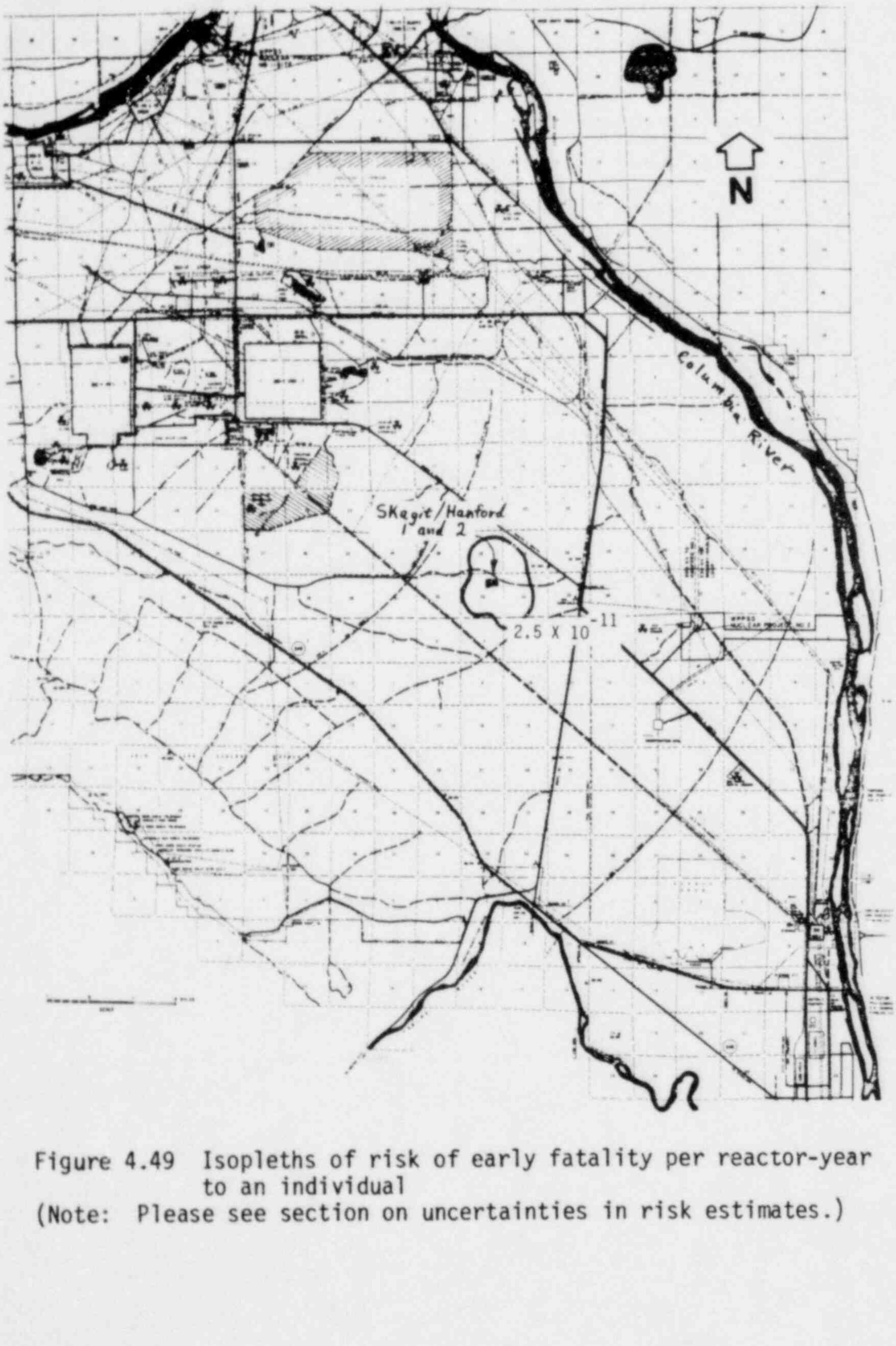


Figure 4.49 Isopleths of risk of early fatality per reactor-year to an individual
(Note: Please see section on uncertainties in risk estimates.)

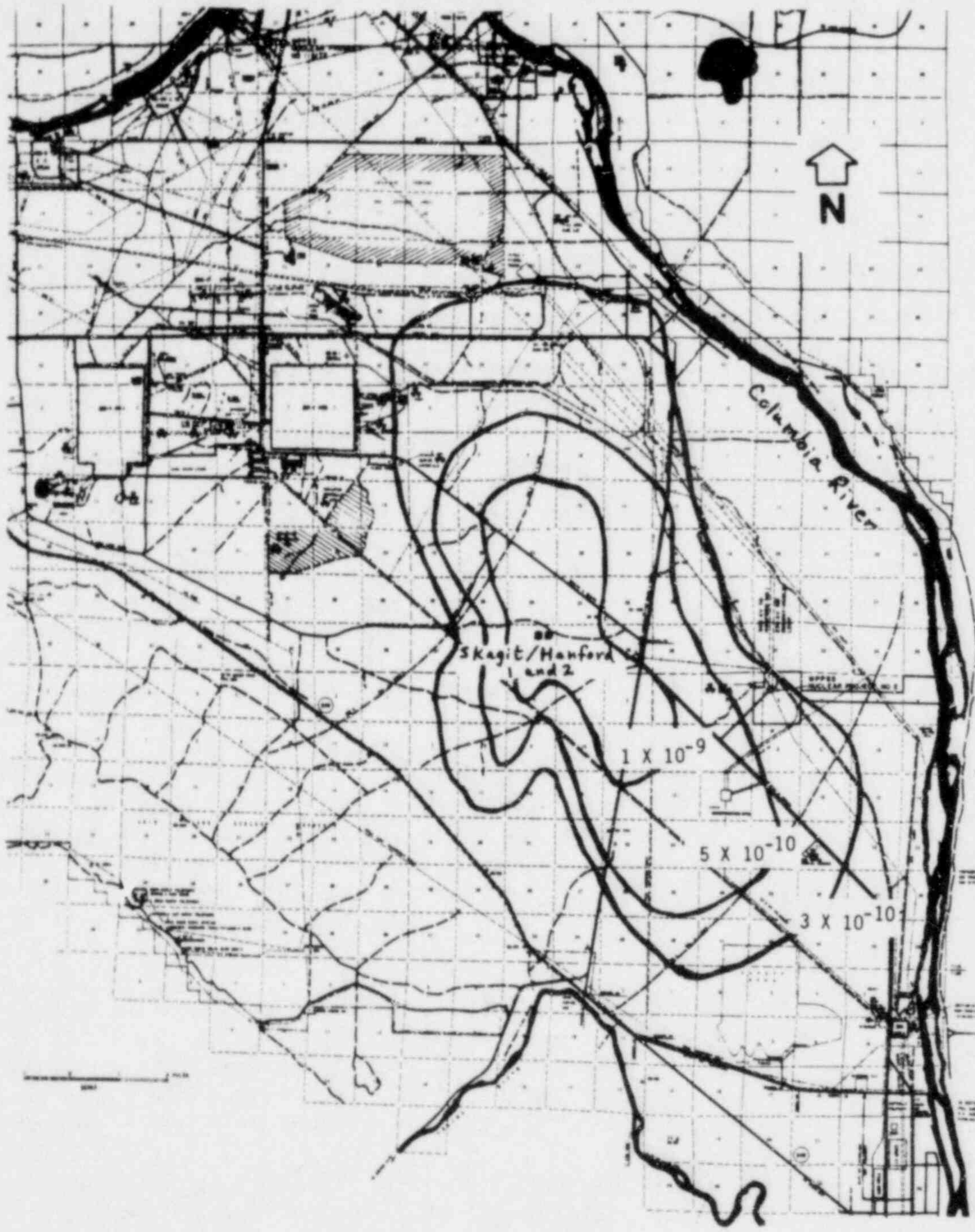


Figure 4.50 Isopleths of risk of latent cancer fatality per reactor-year to an individual
(Note: Please see section on uncertainties in risk estimates.)

Island (EMD-81-106). For purposes of this analysis, the staff used the conservative (high) estimate of $3000 million. Although insurance would cover $300 million or more of the $3000 million, the insurance is not credited against the $3000 million because the insurance payment times the risk probability should theoretically balance the insurance premium. Furthermore, the staff estimates additional fuel costs of $245 million (1992 dollars) for replacement power during each year S/HNP is being restored. This estimate assumes that the energy presumably forthcoming from the unit (assuming 60-percent-capacity factor) will be replaced 75 percent by coal-fired generation and 25 percent by oil-fired generation. Assuming the nuclear unit does not operate for 8 years, the total additional replacement power costs would be approximately $1960 million in 1992 dollars.

If the probability of sustaining a total loss of the original facility is taken as the sum of the occurrences of a core melt accident (the sum of the probabilities for the categories in Table 4.38, then the probability of a disabling accident happening during each year of the unit's service life is 2.43×10^{-5}. Multiplying the previously estimated costs of $4960 million for an accident to S/HNP Unit 1 during the initial year of its operation by the above 2.43×10^{-5} probability results in an economic risk of approximately $120,000 (in 1992 dollars) applicable to S/HNP Unit 1 during its first year of operation. This is also approximately the economic risk (in 1992 dollars) to S/HNP Unit 1 during the second year and each subsequent year of its operation. Although nuclear units depreciate in value and may operate at reduced capacity factors so that the economic consequences resulting from an accident becomes less as the units become older, this is considered to be offset by higher costs of decontamination and restoration of the units in the later years caused by increased inflation. Similarly, inflation is approximately balanced by the present worth discount factor.

The economic risk to S/HNP Unit 2 (in 1992 dollars) is also approximately $120,000 during its first year and each subsequent year of operation resulting from the balancing effect of escalation and the present worth discount factor. The $120,000 annual risk for each unit in 1992 dollars is equivalent to an annual risk of $39,000 in 1980 dollars, assuming a 10 percent discount rate.

Uncertainties

The foregoing probabilistic and risk assessment discussion has been based on the methodology presented in the Reactor Safety Study (RSS) published in 1975 (NUREG-75/014, formerly WASH-1400). There are substantial uncertainties associated with the numerical estimates of the likelihood, as well as the consequences, of nuclear accidents that are evaluated using this methodology.

In the consequence calculations, uncertainties arise from an over-simplified analysis of the magnitude and timing of the fission product release, uncertainties in calculated energy release, radionuclide transport from the core to the reactor, lack of precise dosimetry, and statistical variations of health effects. Recent investigations of accident source terms, for example, have hown that a number of physical phenomena affecting fission product transport through the primary cooling system and the reactor containment have been neglected. Some of these processes have the potential for substantially reducing the quantity of fission products predicted to be released from the containment for some accident sequences. Such a reduction in the source term would result in substantially lower estimates of health effects, particularly the estimate of early fatalities.

One area recently given considerable thought with respect to uncertainty is atmospheric dispersion. Although recent developments in the area of atmospheric dispersion modelling used in CRAC (the computer code developed in RSS) indicate that an improved meteorological sampling scheme would reduce the uncertainties arising from this source (including the effect of washout by precipitation), large uncertainties would still remain in the calculations of radionuclide concentrations in the air and the ground from which radiological exposures to an individual and the population are calculated. These uncertainties arise from lack of precise knowledge about the particle size distribution of the radionuclides released in particulate forms and about their chemical behavior. Therefore, the parameters of particulate deposition that exert considerable influence on the calculated results have uncertain values. Vertical rise of the radioactive plume is dependent on the heat and momentum associated with the release categories, and calculations of both factors have considerable uncertainty. The duration of release that determines cross-wind spread of the plume is another example of considerable uncertainty. Warning time before evacuation has considerable impact on effectiveness of offsite emergency response. This parameter is not precisely calculated because of its dependence on other parameters (e.g., time of release) that are not precisely known.

The state-of-the-art for quantitative evaluation of the uncertainties in the probabilistic risk analysis, such as the type presented here, is not well developed. Therefore, although the staff has made a reasonable analysis of the risks presented here, there are large uncertainties associated with the results shown. It is the qualitative judgment of the staff that the uncertainty bounds could be well over a factor of 10, but not so large as a factor of 100.

Another source of uncertainty for S/HNP accident release evaluations is the fact that its containment design is different from that of the plant for the "rebaselining" study (further discussed in Appendix E). However, this may introduce little additional uncertainty when compared with the uncertainty bounds noted above.

The accident at Three Mile Island occurred in March 1979 at a time when the accumulated experience was about 400 reactor-years. It is of interest to note that this was within the range of frequencies estimated by the RSS for an accident of this severity (National Research Council, p. 553). It should also be noted that the Three Mile Island accident has resulted in a very comprehensive evaluation of reactor accidents like that one by a significant number of investigative groups both within and outside NRC. Actions to improve the safety of nuclear power plants have come out of these investigations, including those from the President's Commission on the Accident at Three Mile Island, (Kemeay, 1979) and staff investigations and task forces. A comprehensive "NRC Action Plan Developed as a Result of the TMI-2 Accident" (NUREG-0660, Vol. I) collects the various recommendations of these groups and describes them under the subject areas of Operational Safety; Siting and Design; Emergency Preparedness and Radiation Effects; Practices and Procedures; and NRC Policy, Organization and Management. The action plan presents a sequence of actions, some already taken, that will result in a gradually increasing improvement in safety as individual actions are completed. S/HNP is now receiving and will continue to receive the benefit of some of these actions. The improvements in safety from these actions has not been quantified, however, and the radiological risk of accidents discussed in this section does not reflect these improvements.

Conclusions

The foregoing sections consider the potential environmental impacts from accidents at S/HNP. These have covered a broad spectrum of possible accidental releases of radioactive materials into the environment by atmospheric and groundwater pathways. Included in the considerations are postulated design-basis accidents and more severe accident sequences that lead to a severely damaged reactor core or core melt.

The environmental impacts that have been considered include potential radiation exposures to individuals and to the population as a whole, the risk of near- and long-term adverse health effects that such exposures could entail, and the potential economic and societal consequences of accidental contamination of the environment. These impacts could be severe, but the likelihood of their occurrence is judged to be small. This conclusion is based on (1) the fact that considerable experience has been gained with the operation of similar facilities without significant degradation of the environment; and (2) a probabilistic assessment of the risk based on the methodology developed in the Reactor Safety Study. The overall assessment of environmental risk of accidents, assuming protective action, shows that it may be somewhat higher than the risk for normal operational releases. Accidents also have a potential for early fatalities and economic costs that are not expected to arise from normal operations. However, the risk of early fatalities from potential accidents at the site are small in comparison with the risk of acute fatalities from other human activities in a comparably sized population.

The staff has concluded that there are no special or unique features about the S/HNP site and environs that would warrant additional mitigation features for S/HNP.

4.2.13 Impacts from the Uranium Fuel Cycle

The Uranium Fuel Cycle rule, 10 CFR Part 51.20 (44 FR 45362), reflects the latest information relative to the reprocessing of spent fuel and to radioactive waste management as discussed in NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," and NUREG-0216, which presents staff responses to comments on NUREG-0116. The rule also considers other environmental factors of the uranium fuel cycle, including aspects of mining and milling, isotopic enrichment, fuel fabrication, and management of low- and high-level wastes. These are described in the AEC report WASH-1248, "Environmental Survey of the Uranium Fuel Cycle." The NRC staff was also directed to develop an explanatory narrative that would convey in understandable termsr the significance of releases in the table. The narrative was also to address such important fuel cycle impacts as environmental dose commitments and health effects, socioeconomic impacts and cumulative impacts, where these are appropriate for generic treatment. This explanatory narrative was published in the Federal Register on March 4, 1981, (46 FR 15154-15175). Appendix C to this report contains a number of sections that address those impacts of the LWR-supporting fuel cycle that reasonably appear to have significance for individual reactor licensing sufficient to warrant attention for NEPA purposes.

Table S-3 of the final rule is reproduced in its entirety as Table 4.34. Specific categories of natural resource use included in the table relate to land use, water consumption and thermal effluents, radioactive releases, burial of transuranic and high- and low-level wastes, and radiation doses from transportation and occupational exposures. The contributions in the table for reprocessing, waste management, and transportation of wastes are maximized for either of the two fuel cycles (uranium only and no recycle); that is, the cycle that results in the greater impact is used.

Appendix C to this report contains a description of the environmental impact assessment of the uranium fuel cycle as related to the operation of the S/HNP facility. The environmental impacts are based on the values give in Table S-3, and on an analysis of the radiological impact from radon-222 and technetium-99 releases. The NRC staff has determined that the environmental impact of this facility on the U.S. population from radioactive gaseous and liquid releases (including radon and technetium) resulting from the uranium fuel cycle is very small when compared with the impact of natural background radiation. In addition, the nonradiological impacts of the uranium fuel cycle have been found to be acceptable.

4.2.14 Decommissioning

A license to operate a nuclear power plant is issued for a term not to exceed 40 years, usually beginning with the issuance of the construction permit (10 CFR 50.51). At the end of the specified period, the operator of a nuclear power plant must renew the license for another time period or must dismantle the facility and dispose of its components. Prior to the expiration of the operating license license, if technical, economic, or other factors are unfavorable to continued operation of the plant, the operator may elect to apply for license termination and dismantling authority at that time (10 CFR 50.82). In addition, at the time of applying for a license to operate a nuclear power plant, the applicant must show that he possesses or has reasonable assurance of obtaining the funds necessary to cover the estimated costs of permanently shutting the facility down and maintaining it in a safe condition" (10 CFR 50.33). These activities, termination of operation and plant dismantling, are generally referred to as "decommissioning."

NRC regulations do not require the applicant to submit decommissioning plans at the construction permit stage; consequently, no definite plan for the decommissioning of S/HNP has been developed. At the end of the plant's useful lifetime, the applicant will prepare a proposed decommissioning plan for review by the Commission. The plan will comply with NRC rules and regulations then in effect. At this time, Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors" (see also Erickson and Lear, 1975), provides guidance on methods and procedures for the termination of operating licenses for nuclear reactors. A recently published report, entitled "Draft General Environmental Impact Statement on Decommmissioning of Nuclear Facilities" (NUREG-0586), provides information for the impact of various decommissioning alternatives on the quality of the human environment. This report, along with other studies commissioned by the NRC staff, will be used in formulating appropriate changes to the Commission's current regulatory policy regarding decommissioning.

Although no large-scale nuclear power plants have been decommissioned, experience in the decommissioning of reactors is available. Since 1960, 5 licensed nuclear power plants, 4 demonstration nuclear power plants, 6 licensed test reactors, 1 licensed ship reactor, and 52 licensed research reactors and critical facilities have been or are in the process of being decommissioned (NUREG-0586). The primary methods of decommissioning are referred to as DECON, SAFSTOR, and ENTOMB. The three primary methods defined below are taken from the definitions provided in NUREG-0586.

DECON

DECON means to immediately remove all radioactive materials down to levels that are considered acceptable to permit the property to be released for unrestricted use. DECON is the only one of the decommissioning alternatives presented here that leads to termination of the facility license and release of the facility and site for unrestricted use shortly after cessation of facility operations. DECON is estimated to last from fairly short time periods for small facilities to approximately 4 years for a large BWR.

The primary advantage of DECON, which is terminating the facility license and making the facility and site available for some other beneficial use, is accomplished at the expense of larger initial commitments of money, personnel radiation exposure, and waste disposal site space than for the other alternatives. However, for some facilities, DECON results in less overall dose and cost. Other advantages of DECON inlcude the availability of work force highly knowledgeable about the facility and the elimination of the need for long-term security, maintenance and surveillance of the facility that would be required for the other decommissioning alternatives.

SAFSTOR

SAFSTOR is defined as those activities required to place (preparation for safe storage) and maintain (safe storage) a radioactive facility in such condition that the risk to safety is within acceptable bounds and that the facility can be safely stored and subsequently decontaminated to levels that permit release of the facility for unrestricted use. SAFSTOR consists of a short period of preparation for safe storage (up to 2 years); a variable safe storage period of continuing care consisting of security, surveillance, and maintenance (up to 100 years depending on the type of facility; 100 years is consistent with recommended EPA policy on institutional control reliance for radioactivity containment); and a short period of final decontamination. Several subcategories of SAFSTOR are possible. These subcategories are custodial, passive, or hardened SAFSTOR, the differences among them being the degree of cleanup and surveillance required.

SAFSTOR is used as a means to satisfy the requirements for protection of the public while minimizing the initial commitments of time, money, occupational radiation exposure, and waste disposal space. Modifications to the facilities are limited to those that ensure that security of the buildings against intruders, and to those required to ensure containment of radioactive or toxic material.

The reduced initial effort (and cost) of the preparation for safe storage is tempered somewhat by the need for continuing surveillance and physical security to ensure the protection of the public. Maintenance of the facility's structures and an ongoing program of environmental surveillance are also necessary. The duration of the storage and surveillance are also necessary. The duration of the storage and surveillance period can vary from a few years to approximately 100 years depending on the type of facility.

ENTOMB

ENTOMB means to encase and maintain property in a strong and structural long-lived material (e.g., concrete) to assure retention until radioactivity decays to a level acceptable for releasing the facility for unrestricted use. ENTOMB is intended for use where the residual radioactivity will decay to levels permitting unrestricted release of the facility within reasonable time periods (i.e., within the time period of continued structural integrity of the entombing structure, approximately 100 years is considered to be consistent with recommended EPA policy on institutional control reliance for radioactivity containment). However, a few radioactive isotopes found in fuel reprocessing plants, nuclear reactors, fuel storage facilities, or mixed-oxide fuel (MOX) facilities have half-lives in excess of 100 years and the radioactivity will not decay to levels permitting release of the facilities for unrestricted use within the foreseeable lifetime of any manmade structure. Thus, the basic requirement of continued structural integrity of the entombment cannot be ensured for these facilities, and ENTOMB is not a viable alternative. On the other hand, if the entombing structure can be expected to last many half-lives of the most objectionable long-lived isotope, then ENTOMB becomes a viable alternative because of the reduced occupational and public exposure to radiation. ENTOMB does, of course, contribute to the problem of increased numbers of sites dedicated for very long periods to the containment of radioactive materials.

The DECON alternative is estimated to require 6 years to complete, including 2 years of planning prior to reactor shutdown, and would cost $43,600,000 in 1978 dollars (NUREG-0586). The costs of SAFSTOR are greater than those of DECON and vary with the number of years of storage. For example, the total cost of 30 years SAFSTOR is estimated to be $58,900,000 in 1978 dollars and the cost of 100 years of SAFSTOR is estimated to total $55,000,000.

ENTOMB for a BWR, with the pressure vessel and internals intact, is estimated to cost $35,000,000 with an annual surveillance and maintenance cost of $40,000 (1978 dollars). ENTOMB, with the pressure vessel and internals removed to a radioactive waste repository, is estimated to cost $40,600,000 with an estimated annual surveillance and maintenance cost of $40,000 (1978 dollars).

Table 4.41 compares the cost of the three decommissioning alternatives in items of each alternative's impact on incremental operating costs. These costs were derived based on a 1200 MWe generating unit beginning operation in 1985 with an

Table 4.41 Comparison of costs of decommissioning alternatives*

Decommissioning alternative	Increased operating costs (mills/kWh)
DECON	.458
SAFSTOR	
10 years	.602
30 years	.618
100 years	.577
ENTOMB	
Internals intact	.379
Internals removed	.437

*Base year is 1978, with 8 percent escalation rate, 12 percent discount rate.

annual capacity factor of 60 precent. Escalation and discount rates are assessed to average 8 percent and 12 percent, respectively, during the study period.

The costs given in Table 4.41 are for single-unit stations. The saving associated with multi-unit stations is small; thus, the unit cost (mill/kWh) is essentially the same for a single-unit station or a multi-unit station.

Studies of social and environmental effects of decommissioning large commercial power generating units have not identified any significant impacts beyond those already known. Each alternative will have radiological impacts associated with the transportation of radioactive material, but those should be no different than those associated with transportation impacts during normal facility operation. Also, studies indicate that occupational doses experienced with operating reactors through the use of appropriate work procedures, shielding, and remotely controlled equipment. To date, experience at decommissioned facilities has shown that the occupational exposures are generally less than those associated with the facility when operational.

The applicant may retain the site for power generation purposes indefinitely after the useful life of the station. The degree of dismantlement would normally be determined by an economic and environmental study comparing land values with the cost of complete demolition and removal of the complex. In any event, the operation will be controlled by rules and regulations in effect at the time to protect the health and safety of he public.

4.2.15 Emergency Planning

In connection with the promulgation of the Commission's upgraded emergency planning requirements, the NRC staff issued NUREG-0685, "Environmental Assessment for Effective Changes to 10 CFR Part 50 and Appendix E to 10 CFR Part 50;

Emergency Planning Requirement for Nuclear Power Plants" (August 1980). At this time, however, the staff does not have sufficient information to determine whether any environmental impacts will result from implementation by the applicant of the upgraded emergency planning requirements in 10 CFR 50, Appendix E, such as construction of a near-site emergency preparedness exercises. Upon receipt of all components of the applicant's emergency plan and implementing procedures, the staff will be in a position to determine whether or not such a plan and implementing procedures will result in any environmental impacts.

4.2.16 Measures and Controls to Limit Adverse Impact

4.2.16.1 Applicant's Commitments

The applicant has committed to, and will be required to implement, the following measures to limit adverse effects during construction of the S/HNP.

Water Quality (S/HNP ASC/ER, 1981, Section 5.1.1)

(1) Percolation tests would be conducted prior to construction and their results incorporated in the final percolation pond design.

(2) Surface runoff would be controlled by grading away from the power plant area and by constructing ditches if necessary.

(3) During construction, contractors would be required to maintain drainage and erosion control around the construction areas, especially in areas of excavation or fill. Controls would be employed to ensure proper embankment slopes. Onsite borrow pits would be prepared by grading to minimize wind and water erosion and to conform, where possible, to the natural topography.

(4) To ensure that no residual chlorine would be discharged to the Columbia River, cooling tower blowdown would be terminated during the addition of sodium hypochlorite if the circulating water had dropped to less than 0.38 mg/l. (This concentration and a minimum dilution ratio 190:1 would meet the Federal water quality criteria.) Chlorination of the two units would not occur simultaneously.

Aquatic Ecology (S/HNP ASC/ER, 1981, Section 4.2.4)

(1) Use of perforated pipe, midstream intake structures with low approach velocities.

(2) Timing of construction activities.

(3) Location of intake and discharge structures away from important spawning and rearing areas.

(4) Delivery of sanitary sewage effluent to a percolation pond instead of the river.

(5) Nondischarge of cooling system blowdown during chlorination and until total residual chlorine (TRC) falls to or below 0.38 mg/l.

Transportation (S/HNP ASC/ER, 1981, Section 4.1)

(1) The applicant has proposed construction of a two-lane reversible access road connecting the S/HNP site with Route 240. This access road would be used for commuting access and egress by construction workers. An additional access road for noncommuter use would the site with Route 10 on the Hanford Reservation. Ridesharing and staggered hours programs are also proposed.

Historical and Archeological Sites and National Landmarks (S/HNP ASC/ER 1981, Section 4.2.6)

(1) A cultural resources overview and preliminary reconnaissance have been completed. An intensive field survey of the areas to be impacted by construction of the plant and associated facilities would follow. The methodology proposed for the intensive survey would be presented to the Office of Archaeology and Historic Preservation staff for comments.

(2) Determinations of project effects on cultural resources and determinations of eligibility of properties to be affected would be made to the National Register of Historic Places.

(3) A detailed mitigation plan would be formulated and implemented through avoidance of significant sites, protection, or data recovery of any prior to construction through monitoring of construction activities.

(4) An archaeologist would be retained to inspect the S/HNP site during the excavation phase and report on the uncovering of any potential archaeological or historical sites and to recommend means to preserve or interpret any historical or archaeological sites or artifacts uncovered.

Air Quality (S/HNP ASC/ER, 1981, Section 4.5.2)

(1) Watering would be used to control fugitive dust generated by construction activities.

(2) Construction roads would be watered, gravelled, or paved as necessary to decrease the impact of windblown soil and construction dust.

(3) An appropriately sized collecting system would be provided to prevent emissions of cement, pozzolan, or dust from any part of the plant to the atmosphere.

4.2.16.2 Staff Evaluations and Recommendations

Based on a review of the anticipated construction activities and the expected environmental effects therefrom, the staff concludes that the measures and controls committed to by the applicant (summarized in Section 4.2.16.1 above) are adequate to ensure that adverse environmental effects will be mitigated at the minimum practicable level, when supplemented by the following identified additional requirements.

Water Quality (Section 4.2.3.2)

(1) The emergency overflows from the percolation pond shall be contained.

(2) Drainage courses downstream from the plant shall be defined and protected from potential erosions.

(3) A plan shall be developed to control the chemical leakages, and accidental or emergency spills.

Aquatic Ecology (Section 4.2.4.1)

(1) Use of neutralized agents for TRC in effluent (sodium thiosulfate) is required.

(2) Use of an alternative to sodium hypochloride for antifouling purposes (ozone or bromine gas) is required.

(3) Since naturally occurring suspended silt concentrations in Columbia River water are apparently high enough to scour the plumbing and keep it clean, antifouling agents shall not be used.

Endangered and Threatened Species (Section 4.2.5.3)

(1) Disturbance of shoreline areas during construction of intake and discharge structures shall be monitored and minimized to reduce the disturbance of Rorippa calycina var. columbiae and the noted aquatic species of concern. Should this species become listed as threatened or endangered prior to construction, formal consultation with the U.S. Fish and Wildlife Service pursuant to the provisions of the Endangered Species Act, as amended (16 USC 1536), would be required. Where possible, construction activities shall be directed to avoid disturbing Astragaulus and Cryptantha habitat areas.

Historical and Archaelogical Sites and Natural Landmarks (4.2.6.15)

(1) Appropriate studies shall be conducted to provide adequate information to the State Historic Preservation Officer (SHPO) in order to determine effect and eligibility. A detailed mitigation plan shall be formulated in consultation with the SHPO (36 CFR 800.4).

(2) Field surveys of additional offsite areas where ground disturbance may occur, such as location of improvements to Route 240, disposal and borrow sites, etc., shall be conducted where appropriate in accordance with 36 CFR 800.4.

(3) If, in the course of construction cultural remains are encountered, measures shall be taken pursuant to 36 CFR 800.7, "Resources Discovered During Construction."

Topography (Section 4.2.7.2)

(1) The greater part of the excavated foundation and trench materials shall be used as backfill around the constructed foundation at a depth of approximately 35 ft, and disposal of the excess shall be implemented by grading and spreading the materials over the site or depositing it in existing borrow areas in the Hanford Reservation to restore the topography of the area surrounding the facility.

(2) Selection of service road and pipeline routes shall be done carefully to minimize removal of vegetation from dune areas. Where removal is unavoidable, the affected dunes shall be revegetated after construction to prevent reactivation of inactive sand dunes.

Noise (Section 4.2.11)

(1) The construction contract specifications shall require that a hearing protection program for workers, including regular audiometric tests and required use of hearing protectors in noisy areas, be provided.

4.2.17 Floodplain Aspects

4.2.17.1 Existing Conditions

Executive Order 11988, Floodplain Management, was issued in May 1977 (42 FR 26921) to ensure that Federal agencies were following procedures "...to avoid to the extent possible the long- and short-term adverse impacts associated with the occupany and modifications of floodplains and to avoid direct or indirect support of floodplain development wherever there is a practicable alternative."

Based on flood frequency and rating curves, the staffs determined the elevation of the Columbia River 100-year regulated flood (1 percent or greater chance of flooding in any given year) to be 115 m (377 ft) mean sea level (msl) at the location of the intake structure. There are no major structures that will be located within the 100-year floodplain. The raw water supply system pumphouse, which will supply makeup water to both units, is located on the west shore of the Columbia River, approximately 23 m (75 ft) downstream of river mile 361.54 at elevation 115.8 m (380 ft) msl and, thus, above the 100-year floodplain. However, the intake system has three inlets located about 229 m (750 ft) offshore and projecting about 1.2 m (4 ft) above the river bottom. Three intake pipes, approximately 335 m (1,000 ft) long, run beneath the river bed to the pumphouse sump. In addition, a single discharge pipe running adjacent and parallel to the intake lines will be buried approximately 33.5 m (100 ft) downstream of the intake pipes. It will continue out beneath the river bottom, terminating in a single discharge nozzle about 168 m (550 ft) from the river low water shoreline.

4.2.17.2 Environmental Impacts

The pumphouse would be inundated by any flood with a water level greater than 115.8 m (380 ft) msl, but it is not essential to the post-shutdown cooling of the reactor. The ultimate heat sink, located on the plant site, provides cooling water to shut down and cool down the reactor. Because the pumphouse and intake system are not essential to post-shutdown cooling of the reactor, it is considered a noncritical structure and is evaluated only with respect to the 100-year floodplain. The discharge line is also noncritical.

The primary short-term floodplain impacts will be associated with construction of the intake and discharge systems. During construction, the river bed will be dredged and there will be construction disturbances of the 100-year floodplain, but no major alterations or structures in the floodplain will be built that would increase flood levels. A clamshell bucket or similar equipment will be used for trenching and placing, as well as bedding and anchoring of the pipelines with riprap. Approximately 49,400 m^3 (65,000 cubic yards) of soil will be excavated below the high waterline. No coffer dams or channel alterations are planned during construction.

The pumphouse construction is at an onshore location and will not adversely affect river conditions. The riverbank at river mile 361.5 is considered stable, and slope protection requirements are not anticipated.

Once construction is complete, the intake and discharge components will not result in long-term floodplain impacts. Only the torpedo-shaped inlet and riser pipes of the intake system extend above the river bottom. They will have a negligible effect on the level of any flood flow. At low flow, the intakes are 3.0 m (10 ft) below the surface and, thus, should cause little interference with navigation or boating on the river in this reach. For the discharge pipe, the physical situation is similar to that of the intake pipes. The discharge pipe is buried beneath the river bottom, projecting just a few feet out into the flow near the middle of the river. It causes no impact on flood levels either by reducing conveyance or adding to the discharge rate.

The staff, therefore, concludes that, from among the alternative intake systems considered, the one with the least impact on floodplain was selected. The staff further concludes that the objectives of Executive Order 11988 have been met.

5. ENVIRONMENTAL MEASUREMENTS AND MONITORING PROGRAMS

5.1 THERMAL

5.1.1 Preapplication Monitoring

The applicant has incorporated all surface water quality and hydrological monitoring discussion, including thermal, into one section. Many historical and ongoing monitoring studies are referenced (S/HNP ASC/ER, 1981, Section 6.1). The applicant feels that adequate surface water data exists for the preapplication phase and staff concurs.

5.1.2 Site Preparation and Construction Monitoring

The applicant has proposed temperature measurement as part of the water quality program during intake and discharge structure construction. The staff does not feel that the thermal effects monitoring is needed here, therefore, no changes are recommended.

5.1.3 Preoperational Monitoring Program

The applicant's proposed program, designed to begin one year prior to fuel load, is included within this hydrological monitoring program. Seven stations (see Section 5.1.4) will be sampled. The staff feels the program, as proposed, is adequate except that the detection limit of temperature is not adequate. Staff recommends temperature probes accurate to 0.5°C and readable to 0.1°C for all three-dimensional thermal plume investigations.

5.1.4 Operational Monitoring Program

The applicant has included thermal monitoring within their chemical and hydrological study of receiving waters. Continuous intake and effluent temperature will be monitored. Biweekly, monthly and seasonal efforts are included. Three-dimensional grid sampling will be conducted within the plume and at control locations. Station locations and sampling schemes will be modified based on results from the first years program and will be incorporated with other ongoing programs. Monthly sampling will occur at Vernita Bridge, at the mixing zone boundary 3.2 km (2 mi) below the discharge, at the WNP-1 and -4 intake, and at the City of Richland municipal intake.

5.2 RADIOLOGICAL

Radiological environmental monitoring programs are established to provide data where there are measurable levels of radiation and radioactive materials in the site environs and to show that, in many cases, no detectable levels exist. Such monitoring programs are conducted to verify the effectiveness of inplant systems used to control the release of radioactive materials and to ensure that unanticipated buildups of radioactivity will not occur in the environment. The environmental monitoring programs could identify the highly unlikely existence of releases of radioactivity from unanticipated release points that are not monitored. An annual surveillance (land census) program will be established to identify changes in the use of unrestricted areas to provide a basis for modifications of the monitoring programs or of the Technical Specifications conditions that relate to the control of doses to individuals.

These programs are discussed in greater detail in NRC Regulatory Guide 4.1, Revision 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and the Radiological Assessment Branch Technical Position, Revision 1, November 1979, "An Acceptable Radiological Environmental Monitoring Program."

5.2.1 Preoperational

The preoperational phase of the monitoring program should provide for the measurement of background levels of radioactivity and radiation and their variations along the anticipated important pathways in the areas surrounding the facility, the training of personnel, and the evaluation of procedures, equipment, and techniques. The applicant proposed a radiological environmental-monitoring program to meet these objectives in the S/HNP ASC/ER. This program is presented in Table 5.1.

The applicant states that the preoperational program will be implemented 2 years before initial criticality of Unit 1 to document background levels of direct radiation and concentrations of radionuclides that exist in the environment. The preoperational program will continue up to initial criticality of Unit 1, at which time the operational radiological monitoring program will commence.

The staff has reviewed the preoperational environmental monitoring plan of the applicant and finds that it is generally acceptable as presented.

5.2.2 Operational

The operational, offsite radiological-monitoring program is conducted to provide data on measurable levels of radiation and radioactive materials in the site environs in accordance with 10 CFR Parts 20 and 50. It assists and provides backup support to the effluent-monitoring program recommended in NRC Regulatory Guide 1.21, "Measuring, Evaluating and Reporting Radioactivity in Solid Wastes and Releases of Radioactive Materials in Liquid and Gaseous Effluents from Light-Water Cooled Nuclear Power Plants."

The applicant states that the operational program will in essence be a continuation of the previously described preoperational program with some periodic adjustment of sampling frequencies in expected critical exposure pathways. The proposed operational program will be reviewed prior to plant operation. Modification will be based on anomalies and/or exposure pathway variations observed during the preoperational program.

The final operational monitoring program proposed by the applicant will be reviewed in detail by the NRC staff, and the specifics of the required monitoring program will be incorporated into the operating license Radiological Technical Specifications.

Table 5.1 S/HNP preoperational radiological environmental monitoring program summary

Sample media	Location	Sampling Frequency[1]	Analysis	
			Type	Frequency
Airborne:				
Radioiodine[2] Particulates[3]	3 locations at site boundary (in different sectors) with highest calculated annual average groundlevel concentrations	Continuous sampling, weekly collection	Radioiodine (I-131)	Weekly
			Particulates gross beta[4]	Weekly
	1 location at site boundary in an upwind direction			
	Supply System Station B (residence having highest χ/Q)		Gamma isotopic[5]	Composite, by location quarterly
	Supply System Station Number 6 (community)			
	Supply System Station Number 9 (control) approximately 48 km from the site boundary			
Direct Radiation[6]	A station will be located in each sector of: (1) an inner ring in the general area of the site boundary (inclusive of airborne locations), and (2) an outter ring in the 6.4- to 8.0-km	Quarterly set (2 TLDs)	Gamma dose	Quarterly
		Annual set (2 TLDs)	Gamma dose	Annually
	Supply system Station Number 6 (Community)			
	Supply System Station Number 9 (control)			

Table 5.1 (continued)

Sample Media	Location	Sampling frequency[1]	Analysis: Type	Analysis: Frequency
Waterborne:				
drinking water[6]	Supply System Station Numbers 29 and 30 (Richland Water Treatment Plant and DOE 300 (area)	Composite[7] for month	H-3 Radioiodine Gamma isotopic Gross beta	Quarterly composite Semi-monthly Monthly Monthly
River water[3]	S/HNP intake S/HNP Discharge	Composite[7] for month	H-3 Gamma isotopic	Quarterly composite Monthly
Aquatic:				
Indicator organisms[6]	Above and below S/HNP discharge Supply System Station Number 35 and above S/HNP discharge	Semi-annually Semi-annually	Gamma isotopic Gamma isotopic	Semi-annually Semi-annually
Ingestion:				
Milk[3,8]	Closest milk animal	Semi-monthly during grazing season; monthly at other times	Gamma isotopic	Semi-annually monthly
	Supply System Station 8		I-131	
	Supply System Station Number 9 (Control)			Semi-monthly when animals are in pasture
	Supply System Station Number 37			
	Supply System Station Number 38 S/HNP discharge			
Fish[6]	Supply System Station Number 27 (in vicinity of WNP-2 discharge)	Semi-annually	Gamma isotopic (edible portion)	Semi-annually

Table 5.1 (continued)

Sample media	Location	Sampling frequency[1]	Analysis: Type	Analysis: Frequency
Fruit and vegetables[9]	Supply System Station Number 8 Supply System Station Number 9 (control)	Monthly during growing season	Gamma isotopic	Monthly

(1) Deviation may be required if samples are unobtainable due to hazardous conditions, seasonal availability, malfunctions of automatic sampling equipment, or other legitimate reasons. All deviations will be documented in the annual report.

(2) Minimum 6-month preoperational sampling.

(3) Minimum 1-year preoperational sampling.

(4) Particulate sample filters will be analyzed for gross Beta after at least 24 hours decay. If gross Beta activity is greater than 10 times the mean of the control sample, gamma isotopic analysis should be performed on the individual sample.

(5) Gamma isotopic means identification and quantification of gamma-emitting radionuclides that may be attributable to the effluents of the facility.

(6) Minimum 2-years preoperational monitoring.

(7) Composite samples will be collected with equipment that is capable of collecting an aliquot at time intervals that are short relative to the compositing period.

(8) Milk samples will be obtained from farms or individual milk animals located in sectors with the higher calculated annual average ground-level X/Q's. If cesium-134 or cesium-137 is measured in an individual milk sample in excess of 30 pCi/l, then strontium-90 analysis should be performed.

(9) Fruit and vegetables will be obtained from farms or gardens that use Columbia River water, if possible, for irrigation, and different varieties will be obtained as they are in season. One sample each of root food, leafy vegetables, and fruit should be collected each period.

Source: S/HNP ASC/ER (Table 6.1-15)

5.3 HYDROLOGICAL

5.3.1 Surface Water

5.3.1.1 Preapplication Monitoring

According to the applicant's Environmental Report, no preapplication water quality monitoring program was necessary since a comprehensive history of surface water quality data exists and since two ongoing water quality monitoring programs exist: (1) U.S. Geological Survey collects water quality data upstream of the S/HNP at Venital Bridge (river mile 388.1); and (2) WWPSS conducts 1-year water chemistry study downstream of the S/HNP at river mile 352.1, that bracket the area in the vicinity of the intake and discharge structures.

As part of preapplication monitoring program, an Instream Data Collection Program for bathymetric survey and current velocity measurements was conducted from May 8 through May 11, 1981. The field work was conducted along a 4.0-km (2.5-mi) portion (66 cross-sections) of the Columbia where the S/HNP intake and discharge structures would be located. The stage-discharge relationships for the Columbia River at river mile 361.5 was developed using the U.S. Army Corps of Engineers HEC-2 Water Surface profiles computer program (U.S. Army Corps of Engineers, 1973) with input data obtained from the Instream Data Collection Program.

The applicant has simulated the condition of the resulting thermal plume from the S/HNP discharges. The input data to the computer model include, discharge designs, discharge flow parameters, and receiving water characteristics. The model generates an output of excess temperature as well as concentration profiles in the ambient receiving water. A complete description of the thermal plume modeling is presented in Appendix C of the applicant's Environmental Report (S/HNP ASC/ER, 1981).

5.3.1.2 Site Preparation and Construction Monitoring

A runoff and erosion monitoring program would be established to detect direct or indirect effects of site preparation and S/HNP construction on surface waters, and to evaluate potential impacts on the Columbia River ecology. This program would serve as part of the construction impact control program proposed by the applicant (S/HNP ASC/ER, 1981) to ensure that construction activities would be performed in a manner to minimize scouring, erosion, runoff, turbidity, and toxicity. The design and scope of the proposed program are not completely known. When developed, it should be submitted to the staff and EFSEC for approval prior to implementation.

A water quality monitoring program would be initiated during excavation and backfilling activities for the intake and discharge structures. The basic monitoring program would include measurements of total suspended solids (TSS), turbidity, light penetration, pH, oil and grease, temperature, and dissolved oxygen at five stations located both upstream and downstream from the excavation site (S/HNP ASC/ER, 1981).

In addition, samples of material to be dredged shall be collected and standard tests would be performed. Such tests delineate the type and amount of trace substances and the organic content of the material in question. The applicant indicates that, should results indicate high levels of contaminating substances, the basic monitoring program can be expected to incorporate these parameters.

5.3.1.3 Preoperational Monitoring

The preoperational water quality monitoring program proposed by the applicant consists of a 2-year effort, initiated a year prior to fuel loading, which is designed to be compatible with the operational monitoring program.

Results of preoperational monitoring would be used to establish an environmental baseline to which data from operational studies would be compared.

The applicant stated in the application (S/HNP ASC/ER, 1981) that the proposed program would include all of the physical and chemical parameters considered essential to characterize the water quality in the vicinity of the intake and discharge structures.

The water quality parameters to be monitored were chosen to detect any possible direct effects of S/HNP operation on the thermal regime or water quality characteristics of the Columbia River, and to detect possible synergistic effects that may affect the ecology of the Columbia River. Table 5.2 gives the water quality parameters that would be sampled in the preoperational monitoring program.

Seven sampling locations have been established. Three stations unique to the S/HNP will be sampled on a weekly or monthly basis, depending on the parameter. The stations include the S/HNP intake, the downstream boundary of a legally defined mixing zone, and a station approximately 3.2 km (2 mi) downstream of the S/HNP discharge in the major axis of the discharge plume. The remaining four stations correspond to sampling locations for related monitoring programs (Table 5.3). These stations would be sampled quarterly to ensure that preoperational results can be correlated with other studies in progress. This objective would be accomplished by performing side-by-side sample collection and sample splitting with the various agencies or laboratories involved.

5.3.1.4 Groundwater Monitoring

The applicant has stated in the application (S/HNP ASC/ER, 1981) that extensive environmental monitoring programs concerning the physical, chemical, and radiological characteristics of groundwater on the Hanford Reservation have been conducted for the Department of Energy (DOE) and felt that no additional monitoring program was necessary other than recently installed eight monitoring wells in the vicinity of the S/HNP site to provide data on the geohydrologic condition of the project site.

The existing programs and investigations would continue to accumulate comprehensive information on groundwater characteristics and are expected to be continued routinely as part of the DOE program. There are over 2,000 wells on the Hanford Reservation, more than 45 of which are located within 8.0 km (5 mi) of the S/HNP site.

Table 5.2 Water quality parameters to be sampled in the preoperational monitoring program

Weekly Samples	Monthly Samples
Temperature	Total suspended solids (non-filterable residue)
Dissolved oxygen	Total dissolved solids (filterable residue)
pH	Ammonia-nitrogen
Specific conductivity	Nitrate-nitrogen
Turbidity	Organic-nitrogen
Total alkalinity	Ortho-phosphorus
Total hardress	Total phosphorus
Cadmium (total + dissolved)	Calcium
Chromium (total + dissolved)	Magnesium
Copper (total + dissolved)	Sodium
Iron (total + dissolved)	Potassium
Mercury (total + dissolved)	Bicarbonate
Zinc (total + dissolved)	Sulfate
	Chloride
Quarterly Samples	Fluoride
PCBx	Silica
Chlorinated hydrocarbons	Arsenic (total + dissolved)
Hydrogen sulphide	Barium (total + dissolved)
	Boron (total + dissolved)
	Cobalt (total + dissolved)
	Manganese (total + dissolved)
	Selenium (total + dissolved)
	Total residual chlorine
	Oil and grease
	Color, apparent
	Fecal coliform

Source: S/HNP ASCER, 1981

Table 5.3 Related monitoring programs

Agency	Program
U.S. Geological Survey, Tacoma District Office	Continuous water temperature measurements of the Columbia River at the City of Richland water supply treatment plant (river mile 338) and at Vernita Bridge (river mile 388.1)
U.S. Geological Survey, Tacoma District Office	Monthly to quarterly monitoring of National Stream Quality Accounting Network Stations at Vernita Bridge and City of Richland pumping plant intake. Parameters measured are: conductance, pH, turbidity, dissolved oxygen, fecal coliform, hardness, major cations and anions, alkalinity, dissolved and suspended solids, dissolved silica, total and dissolved nutrients, metals (total recoverable, suspended recoverable, and dissolved). In addition, at the Vernita Bridge Station, periphyton biomass, chlorophyll a and b and phytoplankton cell counts are conducted.
U.S. Department of Energy, Richland Operations Office	Weekly pH, turbidity, dissolved oxygen, biochemical oxygen demand, and coliform sampling of the Columbia River at the City of Richland water supply treatment plant (river mile 338), 300 area (river mile 345), and Vernita Bridge, (river mile 388.1) by Battelle Pacific Northwest Laboratory.
U.S. Department of Energy, Richland Operations Office	Weekly coliform, fluoride, and nitrate sampling of Columbia River at the City of Richland water supply treatment plant (river mile 338), 300 area (river mile 345), and 100 areas (to river mile 384), by Hanford Environmental Health Foundation.
Washington State Department of Ecology	Water temperature, dissolved oxygen, conductivity, color, pH, turbidity, total coliform bacteria and fecal coliform bacteria sampling in the Columbia River at Highway 24 Bridge near Vernita (river mile 388.1) (semimonthly during water year 1972, quarterly during water year 1975, semimonthly since October 1975), and at the Port of Pasco public dock (river mile 328.4, semimonthly December 1971-September 1972), and occasional biochemical oxygen demand and streamflow determinations at both sites. Sampling of additional 21 parameters at Vernita Bridge during water year 1972. Data also available through STORET.

Table 5.3 (continued)

Agency	Program
U.S. Environmental Protection Agency	Miscellaneous water quality measurements in STORET data system for period 1957 to present at following Columbia River locations between McNary and Priest Rapids Dams: river miles 292.0 (McNary Dam), 292.4, 292,5, 293.0, 324.9 (above mouth of Snake River), 326.3, 328.0 (Kennewick-Pasco railroad bridge), 328.3, 329.0, 330.0 (Kennewick-Pasco State Highway 12 bridge), 334.7 (below mouth of Yakima River), 388.1 (Vernita Bridge, State Highway 24), 388.5, 388.5, 395.6, 397.1 (Priest Rapids Dam).

Source: S/HNP ASC/ER, 1981

The applicant has no plan to monitor nonradiological groundwater quality parameters during the preoperation phase.

5.4 METEOROLOGICAL

Meteorological measurements on the Hanford Reservation for the WNP-2 project, located approximately 8 km (5 mi) east of the proposed S/HNP site, should provide representative data to evaluate the plant effects on the environment. The WNP-2 data are taken in an area with topography and ground cover similar to the S/HNP site.

The meteorological measurements include wind speed and direction at the 0- to 63.5-m (33- and 245-ft) levels with temperature difference between these two levels. Dewpoint is measured at 10 m (33 ft) and precipitation at ground level.

The evaluation of short-term accidental releases and routine operational releases used WNP-2 meteorological data and acceptable analyses described in Regulatory Guide 1.111 and 1.145. In addition to these analyses, a probabilistic risk analysis (CRAC 2) was used to evaluate the severe accident consequence at the sit? and area surrounding the plant. These evaluations are provided in other portions of this statement.

5.5 BIOLOGICAL

5.5.1 Terrestrial Ecology

5.5.1.1 Preapplication Monitoring

The applicant has designed a monitoring program to describe the terrestrial biota from a regional and site-specific perspective and identify important species or areas of special concern that may be affected by this project. Because the Hanford Reservation has been extensively studied, the preoperational monitoring consisted of a review of the existing information and evaluating it with respect to the S/HNP and its associated areas. This review of information was followed by a qualitative field investigation to assure applicability to the site. The field investigation conducted by a plant taxonomist/ecologist consisted of two phases: (1) from April to October 1981, searching on foot for any threatened, endangered or other sensitive plant species or habitats, documenting their presence, and determining local and regional abundance, sensitivity and relationship to the S/HNP; (2) from May to July 1981, a qualitative investigation of wildlife occurring on S/HNP site and associated areas, to locate specific areas inhabited by important species and to search for unique wildlife features within those areas that might be directly impacted by site preparation and station construction activities.

5.5.1.2 Construction Monitoring

The applicant has proposed a monitoring program for this phase of the project (S/HNP ASC/ER, Section 6.1.4.3.2). After reviewing and evaluating the proposal, the staff believes that, because the only unique areas to be impacted by the S/HNP are the old Hanford townsite and that portion of the riparian community that will be crossed by the pipeline, only the following aspects of the proposed monitoring program need be implemented: (1) bald eagle surveys during the winter months to determine the number present, habitat usage, prey selection, preferred roosting sites and sensitivity to disturbance; (2) review of persistantsepal yellow cress (*Rorippa calycina* var. *columbiae*) to determine the status (this species is presently being studied by the U.S. Fish and Wildlife Service for possible designation as a threatened or endangered species); and (3) raptors, landbirds, and deer during the fall, winter, and spring (but not summer). However, the staff believes that because construction in the river for intake and discharge will take place during the period of July 15 through October 15 each year, with potential disturbance to raptors and deer, monitoring of these species should be extended to cover that period as well.

Washington State's Heritage Program has listed the long-billed curlew (*Numenius americanus*) as a species of concern. The applicant proposed to do monthly surveys from March to June.

To ensure high quality, the applicant is in the process of preparing a "Construction Impact Control Program." Upon submittal and approval of this document by EFSEC, the applicant will submit it for approval by NRC.

5.5.1.3 Preoperational Monitoring

In S/HNP ASC/ER Section 6.1.4.3.3, the applicant states that drift effects on vegetation and wildlife associated with the S/HNP will require monitoring since the quantity of drift will be negligible. In Section 6.3.2.2, the applicant describes the studies being conducted in conjunction with WNP-1, -2, and -4 on the potential impact of drift on vegetation and wildlife. The staff agrees with the applicant that the results of these studies be used to determine whether operational monitoring of drift effects will be required.

5.5.2 Aquatic Ecology

The applicant has proposed that no preapplication or site preparation and construction monitoring programs be conducted. A modest preoperational monitoring program has been proposed (S/HNP ASC/ER, 1981) and is discussed.

5.5.2.1 Preapplication Monitoring

According to the applicant's Environmental Report (S/HNP ASC/ER, 1981), no preapplication monitoring program was needed to fulfill the NRC staff and EFSEC needs to assess site suitability and identify and evaluate potential adverse impacts that might occur from construction and operation. The applicant felt that work conducted elsewhere in the Hanford Reach and literature surveys conducted by the Washington Public Power Supply System (WPPSS) relating to WNP-2 were sufficient to characterize the aquatic environment and associated biota at river mile 361.5. Some site-specific studies are presently being completed on behalf of the applicant as confirmatory investigations relating to site suitability, but the scope and design of these studies are not completely known as they are not finished and have not been presented.

5.5.2.2 Site Preparation and Construction Monitoring

No site preparation and construction monitoring was proposed by the applicant. According to the applicant's Environmental Report (S/HNP ASC/ER, 1981), based on studies conducted in conjunction with other (smaller scale) construction activities located elsewhere in the Hanford Reach (river mile 380), effects on aquatic habitats and associated biota were sufficiently predictable; therefore, monitoring of effects would be unnecessary. Staff does not agree with this conclusion and has recommended additional work.

5.5.2.3 Preoperational Monitoring

The preoperational monitoring program proposed by the applicant consists of a 2-year effort that would occur between placement of the intake and discharge structures in the river and plant startup. Results of preoperational monitoring would be used to establish an environmental baseline to which data from operational studies would be compared. The proposed program would not include any plankton studies since the applicant believes existing baseline information from studies conducted elsewhere in the river is sufficient to serve as a baseline for the proposed site. However, programs to monitor benthic organisms and fish are proposed.

Benthic Organisms

Studies to characterize benthic flora and fauna would be carried out after instream construction activities have been completed and after a sufficient waiting period for the benthic habitats and associated biota to have "settled down" to a reasonably steady-state condition. Sampling sites are shown on Figure 5.1. The proposed program consists of the following elements:

(1) Benthic Invertebrates--Three stations, four samples per year. Rock-filled baskets would be allowed to colonize for 3 months prior to retrieval in March, June, September, and December. Stations would consist of one upstream control station, one station at the downstream end of the discharge mixing zone [91 m (300 ft downstream of the outfall)], and one station 3.2 km (2.0 mi) downstream of the outfall. Replicate sampling is proposed, but the number of replicates has not been specified.

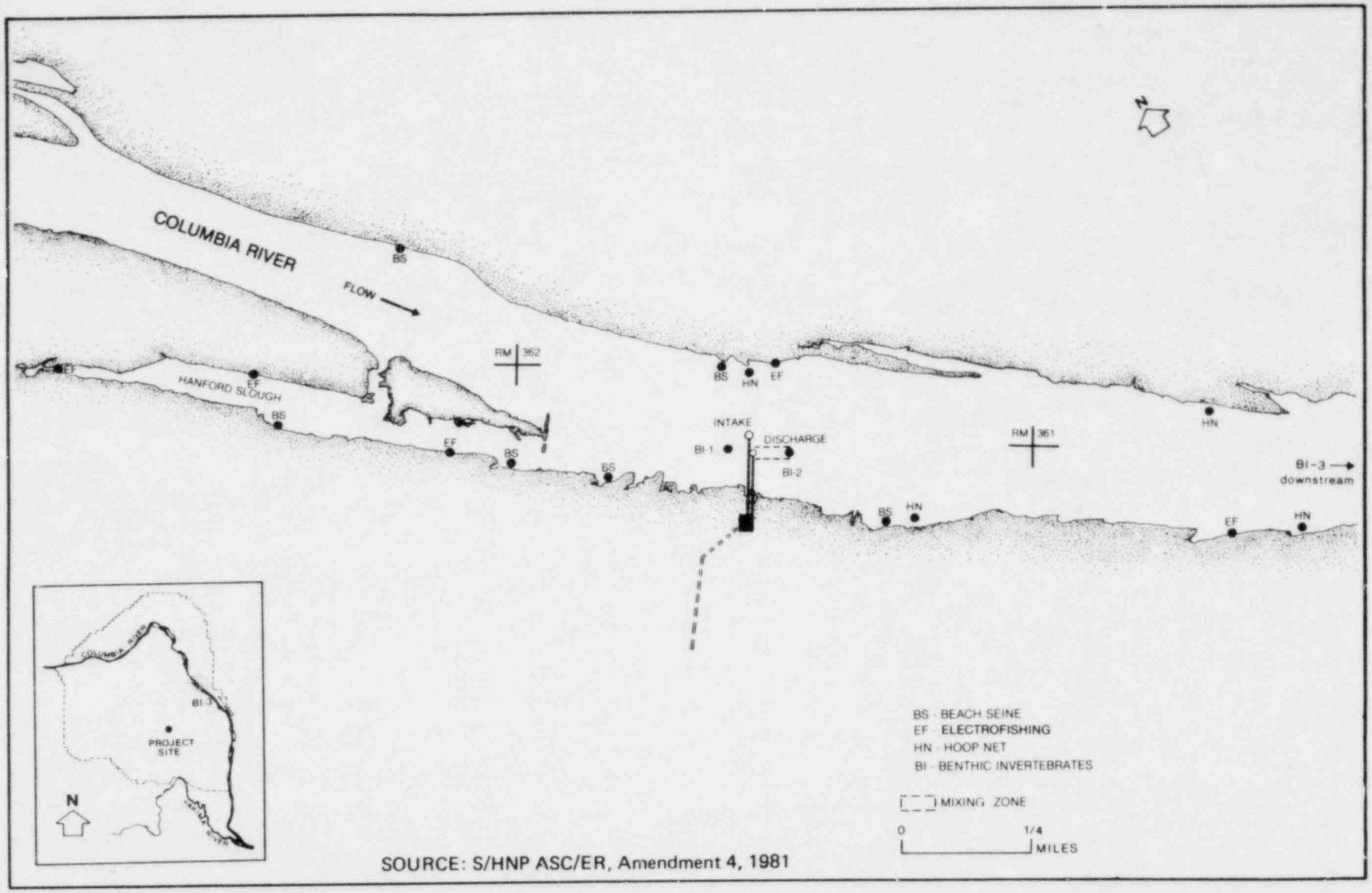
(2) Periphyton--Three stations, four samples per year. Artificial substrates (glass slides) would be allowed to colonize and then be analyzed qualitatively for species composition, chlorophyll-a and biomass. Sampling stations, incubation periods, and times of collection would correspond directly with benthic invertebrate sampling. Replicate samples are proposed, but the number of replicates has not been specified.

(3) Other Organisms--Some additional studies might be carried out relating to fouling organisms (i.e., the asiatic clam corbicula sp.) if the need arises.

Fish

A sampling program to identify seasonal abundance of fish species in various areas near the proposed intake/discharge location has been proposed by the applicant (S/HNP ASC/ER, 1981). As presented, the sampling program would be restricted to shoreline areas, including Hanford Slough. No mid-river or ichthyoplankton sampling is proposed. Sampling sites are shown in Figure 5.1. Although three potential sampling techniques are presented, no commitment beyond using one or more techniques is made. This implies that neither all the sites shown on Figure 5.1 nor all the sampling events given in Table 5. 4 might be used, since both sample locations and sample frequencies are tied to the techniques that might or might not be employed. Potentially, the proposed program could consist of the following elements:

(1) Hoop Net Sampling--Four locations, including one across from and three along shorelines downstream of, the proposed intake/outfall structures and pumphouse. Sample frequencies are given in Table 5.4. No sampling would be conducted from October through February. Emphasis would be on juvenile salmonids and smallmouth bass moving downstream along shorelines. Statistical treatment of data would include standard error calculations.



SOURCE: S/HNP ASC/ER, Amendment 4, 1981

Figure 5.1 Aquatic biological sampling stations for preoperational monitoring program

Table 5.4 Proposed fish sampling frequency, listed by station and method, for the preoperational monitoring program

Month	Beach Seine (6 stations)	Hoop Net (4 stations)	Electro-Fishing (5 stations)
January	1	0	0
February	1	0	0
March	2	1	2
April	4	2	4
May	4	2	4
June	4	2	4
July	2	1	2
August	2	1	2
September	2	1	2
October	1	0	0
November	1	0	0
December	1	0	0

Note: See Figure 1 for station locations.

Source: S/HNP ASC/ER, 1981.

(2) Beach Seine Sampling--Six shoreline locations, including one across from, one downstream of, and four upstream of the proposed intake/discharge and pumphouse locations, including two in Hanford Slough. Sample frequencies are given in Table 5.4. Sampling would occur during all seasons. Emphasis would be on juvenile salmonids and smallmouth bass. Statistical treatment of data would include standard error calculations.

(3) Electrofishing--Five shoreline locations, including one across from, one downstream of the proposed intake/outfall and pumphouse locations, and three in Hanford Slough. Sample frequency is given in Table 5.5. No sampling would occur from October through February. Statistical treatment of data would include standard error calculations.

(4) Tag-Recapture Program--No sample areas or seasons are given. Presumably, this element would be conducted during spring and/or summer months. The collection method was not specified, but presumably this element would be conducted in conjunction with electrofishing and/or beach seining efforts. Emphasis would be placed on population size and residence time of spiny-rayed game fishes and possibly juvenile salmonids in Hanford Slough.

(5) Incorporation of Data From Other Studies--The incorporation of data from release-recapture studies to be conducted by others is proposed. Emphasis would be on information relating to distribution and residence time of juvenile anadromous species.

5.6 SOCIOECONOMIC MONITORING

5.6.1 Applicant's Monitoring Program

To identify any adverse socioeconomic impacts resulting from S/HNP development, that should be mitigated, the applicant has proposed a socioeconomic monitoring program. The monitoring program would focus on identifying changes in socioeconomic conditions that result from S/HNP development, and also on identifying the actual location of impacts and impact areas. Where adverse changes in socioeconomic conditions occur, the applicant proposes to develop mitigation measures on a case-by-case basis, depending on the nature of the specific adverse conditions (S/HNP ASC/ER, 1981).

5.6.2 Fiscal Impact Monitoring

The applicant does not specifically identify or discuss components of their socioeconomic monitoring program. However, as discussed in Section 4.2.6.14, jurisdictional fiscal imbalances could arise as a result of the disparity among local taxing districts between the geographic incidence of increased local expenditures resulting from S/HNP development. As a result of this, the monitoring program implemented by the applicant should emphasize identifying any fiscal imbalances arising from geographic revenue/expenditure disparities and identify potential mitigating measures.

5.7 STAFF RECOMMENDATIONS

5.7.1 Site Preparation and Construction Monitoring

Aquatic Ecology

No site preparation and construction monitoring program is proposed by the applicant. Although data relating to environmental effects of similar (small scale) activities elsewhere in the river are available, it is recommended that a minimal program to monitor habitat alteration and recovery time be instituted. Sufficient data to correlate the extent and duration of habitat alteration with expected biological effects appear to exist, but site-specific differences in habitat character, especially any substrate differences, and hydraulic conditions may significantly alter the extent and duration of physical changes that are expected to accrue from construction activities. Of particular interest should be the extent and duration of the deposition and subsequent scouring of fine materials downstream of proposed excavations.

No quality assurance program has been proposed relating to potential influences of construction on aquatic biota. It is recommended that the applicant prepare a program containing the following elements:

(1) Written procedures and instructions to control construction activities.

(2) Procedures that provide for the detection and reporting of unexpected harmful effects or evidence of serious damage to the aquatic environment.

(3) Provisions for periodic management audits relative to environemtnal license conditions.

(4) Procedures for records retention.

5.7.2 Preoperational Monitoring

5.7.2.1 Thermal Monitoring Program

EFSEC would require, as part of their operational monitoring program, temperature measurements of thermal discharge. Temperature of the river makeup water, blowdown and discharge plume would be required. In the Site Certification Agreement for WNP-1 and -4, and Hanford No. 2, continuous temperature was required at two intake locations, monthly temperature was required at points 1.6 km (1 mi) upstream of the discharge, 91.4 m (300 ft) downstream and at a location a few kilometers farther downstream, which was out of the obvious influence of the discharge.

The specifics of this program would depend on results of the applicant's preoperational monitoring program and evidence and testimony given before the Council's order and would be included in the Site Certification Agreement, if the project were approved. This operational phase of the program will be included in the operating license stage of this project.

5.7.2.2 Aquatic Ecology

Although a preoperational monitoring program has been proposed by the applicant, certain potential changes have been identified which may increase the appropriateness of the program. It is recommended that consideration be given to the following changes:

Plankton

Ichthyoplankton tows (vertical and horizontal) should be made in the immediate vicinity of the proposed intake and discharge structures during those periods when abundance is likely to be greatest. A low but statistically valid level of effort should be employed.

Benthic Organisms

Establish a total of three sampling stations beneath the centerline of the plume, instead of one at the downstream end of the mixing zone, in order to monitor the effects of any plume attachment that may occur. Some influence of plume attachment would be expected, especially if sodium hypochlorite is used as a biocide, but is not neutralized with sodium thiosulfate. If plume attachment does occur, the phenomenon would probably not persist to the end of the 91.4-m (300-ft) long mixing zone, where the proposed sampling site is located. Without intermediate sample locations, effects would go undetected. The question of plume attachment could be resolved through a study of water quality characteristics, e.g., residual chlorine, temperature, etc. The monitoring sites should be reduced to one or eliminated altogether if it is shown after startup that no plume attachment occurs during river and operational conditions under which plume attachment would be most likely.

Fish

(1) Some midstream sampling locations should be established. The "diminishingly small effect" hypothesis relies to a significant degree on a single study conducted by Maims and Smith (1964), which suggested that juvenile salmonids moved primarily along shoreline areas, away from the proposed intake/discharge site. Although these notions of fish behavior are probably true, some confirmatory work, preferably on a site-specific basis, is called for. This requires sampling methods which would compare the temporal and spatial frequency of fish occurrence among midstream and shoreline stations. The feasibility of using a periodically recording, inverted, multiple transducer echosonics tagline approach instead of the traditional labor-intensive inclined plane trap or dyke net array should be explored.

(2) Entrainment studies during pump testing should be conducted to confirm findings of the studies performed at WNP-2. Although a modest level of effort should be employed, some of the water entering the system should be filtered through a mesh size smaller than the 2.0 mm mesh used during the WNP-2 tests in an effort to detect organisms, especially fish eggs and larvae, which would pass through a 2 mm square opening (2.8 mm diagonal). Sampling should be restricted to those periods when entrainable organisms are expected to be most abundant.

(3) The sites and frequency of tag-release studies should be specified, along with the collection method to be used.

(4) Some documentation of the extent and duration of habitat alteration should be undertaken. A qualitative or semiquantitative description of the changes in composition of bottom materials, sizes of affected areas, and habitat alterations produced by the presence of structures should be prepared.

(5) Consideration should be given to changing the number and/or locations of certain shoreline sampling sites. The following changes are recommended:

(a) Move the beach seine and hoop net sites proposed for the southwest bank about 0.4 km (0.25 mi) downstream of river mile 361.5 to a point close to the proposed pumphouse location. Add an electrofishing station in this location, if appropriate.

(b) Eliminate the two-hoop net and one of electrofishing sites proposed for about river mile 360.5 [about 1.6 km (1 mi) downstream of the proposed intake/discharge location].

(c) Add a beach seine (or hoop net) site at about river mile 362.3, just upstream of the small connecting channel between the main Columbia River channel and Hanford Slough.

(d) Add a hoop net station, if feasible, in the small connecting channel between the main Columbia River channel and Hanford Slough, or report on existing information relating to the use of the connection by outmigrating juvenile salmonids.

(e) Reduce the level of effort of electrofishing in Hanford Slough, either through reductions in the number of stations, frequency of sampling, or both.

(6) The exchange of information with other investigating entities working near the proposed intake/discharge location and elsewhere along the Hanford Reach is admirable, but the means of cooperative exchange and the use to which data would be put is vague. Some formal program should be developed and presented for the incorporation of specific information into the environmental baseline and monitoring products. For example, monitoring of sport fishing intensity and success rate in the vicinity of the proposed intake/outfall location could be undertaken to augment Washington State, Department of Game efforts that are presently occurring in that area (see Section 4.2.4.2).

6 EVALUATION OF THE PROPOSED ACTION

6.1 UNAVOIDABLE ADVERSE IMPACTS

6.1.1 Water Quality (Section 4.2.3.2)

(1) Temporary increases in erosion and sediment transport due to construction activities would temporarily degrade the local receiving water quality.

(2) Alteration of drainage, percolation, and runoff patterns would result from project construction.

(3) 1.58 to 2.12 m^3/s (56 to 75 cfs) of water would be taken from the Columbia River at river mile 361.5 and would not be returned to the river.

6.1.2 Transportation (Section 4.2.6.4)

(1) High volumes of commuter traffic on the site access road, Route 240, Bypass Highway, and other facilities would cause increased noise and air pollution of the types commonly associated with traffic movement.

(2) The construction of the site commuter access road, the widening of Route 240, and intersection improvements would commit construction materials and other resources that would not be retrievable after completion of project construction.

6.1.3 Historical and Archeological Sites and National Landmarks (Section 4.2.6.15)

(1) Inadvertent loss of, or damage to, undiscovered cultural resources would be a possible unavoidable impact concomitant with any construction project.

6.1.4 Climate (Section 4.2.10.1)

(1) There would be a slight increase in the potential for fog and surface icing off site.

(2) There would be slight deposition of dissolved solids (salts) to acreage off site.

6.1.5 Noise (Section 4.2.11)

(1) There would be slight noise impacts at existing and planned residences along Route 240 west of the Bypass Highway, due to construction traffic.

(2) Construction workers at the site would be exposed to noise levels in a range that could cause some hearing loss.

6.2 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES

6.2.1 Introduction

Irreversible commitments generally concern changes set in motion by the proposed action that, at some later time, could not be altered to restore the present order of environmental resources. Irretrievable commitments are generally the use or consumption of resources that are neither renewable nor recoverable for subsequent use.

Commitments inherent in environmental impacts are identified in this section, whereas the main discussions of the impacts are included in Section 4. Also, commitments that involve local, long-term effects on productivity are discussed in Section 6.3.

6.2.2 Commitments Considered

The types of resources of concern in this case can be identified as (1) material resources, including materials of construction, renewable resource materials consumed in operation, and nonrenewable resources consumed; and (2) nonmaterial resources, including a range of beneficial uses of the environment.

Resources considered that may be irreversibly or irretrievably committed by the operation are: (1) biological resources destroyed in the vicinity, (2) construction materials that cannot be recovered and recycled with present technology, (3) materials that are rendered radioactive but cannot be decontaminated, (4) materials consumed or reduced to unrecoverable forms of waste, including uranium-235 and -238 consumed, (5) the atmosphere and water bodies used for disposal of heat and certain waste effluents, to the extent that other beneficial uses are curtailed, and (6) land areas rendered unfit for other uses. Those of importance to this project are discussed in the following sections.

6.2.3 Biotic Resources

The construction of the station will result in effects on the onsite biota, and disturbance of some of the biota adjacent to the site. The lands occupied by the station buildings, cooling towers, and ponds will be permanently altered. Although restoration of some of the acreage not directly associated with the generation of electricity might be possible, the staff believes that the considerable difficulties that would be encountered makes this unlikely. Therefore, the above uses can be considered an irreversible and/or irretrievable commitment.

The reproduction potential of most species in the S/HNP area or along the transmission corridors is sufficiently high that losses of individuals as a result of station construction and operation will not have a long-term effect on population stability and structure of the local ecosystems.

6.2.4 Material Resources

6.2.4.1 Materials of Construction

Materials of construction are almost entirely of the depletable category of resources. Concrete and steel constitute the bulk of these materials, but numerous other mineral resources are incorporated in the physical plant (see Table 6.1). No commitments have been made on whether these materials will be recycled when their present use terminates.

There will be a long period of time before terminal disposition of construction materials must be decided. At that time, quantities of materials in the categories of precious metals, strategic and critical materials, or resources having small natural reserves must be considered individually. Plans to recover and recycle as much of these valuable depletable resources as is practicable will depend on need.

6.2.4.2 Replaceable Components and Consumable Materials

Uranium is the principal natural resource irretrievably consumed in plant operation. Other materials consumed, for practical purposes, are fuel-cladding materials, reactor-control elements, other replaceable reactor core components, chemicals used in processes (such as water treatment and ion-exchanger regeneration), ion-exchanger resins, and minor quantities of materials used in maintenance and operation (see Table 6.2).

The two reactors in the plant will be fueled with uranium enriched in the isotope U-235. After use in the plant, the fuel elements will still contain U-235 at slightly above the natural fraction. This enriched uranium, upon separation from plutonium and other radioactive materials (separation takes place in a chemical reprocessing plant), is available for recycling through the gaseous diffusion plant. Scrap material containing valuable quantities of uranium is also recycled through appropriate steps in the fuel production process. Fissionable plutonium, if recovered in the chemical reprocessing of spent fuel, is valuable for fuel in power reactors.

If the two units of the plant operate at 75 percent of capacity for 40 years, about 14,200 metric tons of natural uranium contained in about 16,750 metric tons of U_3O_8 would be used to fabricate the required fuel. These values assume an irradiation level of 27,500 MWD_{th}/MTU when the plant is operating in its steady state. They further assume uranium recycle and an enrichment tails assay of 0.3 percent.

6.2.5 Uranium Fuel and Its Availability

Department of Energy resource estimates indicate that sufficient uranium resources exist in the United States to fuel all operating reactors, reactors under construction, and reactors being planned for their full 30-year lifetimes at a U_3O cost (1978 dollars) of $30/lb or less. These quantities of uranium can be supplied from the resource categories designated as "reserves" and "probable potential," the two most certain resource categories (Hetland, 1978).

Table 6.1 Material requirements for construction of the proposed Skagit/Hanford Nuclear Project, Units 1 and 2

Material	Approximate quantity used in plant* (metric tons)	World production* (metric tons)	U. S. consumption* (metric tons)	U. S. reserves* (metric tons)
Aluminum	000**	9,089,000	4,227,000	8,165,000
Asbestos	90	2,985,000	712,000	1,800,000
Beryllium	0.6	288	308	72,700
Cadmium	0.0050	17,000	6,800	86,000
Chromium	300	1,590,000	398,000	2,000,000
Concrete	700,000	--	--	--
Copper	4,000	6,616,000	1,905,000	77,564,000
Gold	0.0010	1,444	221	9,238
Lead	15	3,329,000	1,261,000	32,024,000
Manganese	800	7,711,000	1,043,000	907,000
Mercury	0.030	9,837	2,727	703
Molybdenum	5	64,770	23,420	2,585,000
Nickel	200	480,000	129,000	181,000
Platinum	0.002	46.5	16.0	93.3
Silver	2	8,989	5,005	41,057
Steel	33,000	574,000,000	128,000,000	2,000,000,000
Tin	0.10	454,000	82,100	47
Tungsten	0.010	35,000	7,300	79,000
Zinc	200	5,001,000	1,630,000	30,600,000

*Quantities used are modified from Table 10.1 of the Final Environmental Statement for Hope Creek Generating Station, Units 1 & 2, Docket Nos. 50-354 and 50-355.

**Data concerning proposed aluminum usage for the S/HNP transmission system are not available; thus, total use cannot be calculated.

Table 6.2 Estimated quantities of materials used in reactor core replaceable components of water-cooled nuclear power plants

Material	Quantity used in plant[a] (metric tons)	World production[b] (metric tons)	U.S. consumption (metric tons)	U.S. reserves[b] (metric tons)	Strategic & critical material[c]
Antimony	0.0016	65,400	37,800	100,000[d]	Yes
Beryllium	0.0024	288	308	72,700	Yes
Boron	2.92	217,000[e]	79,000[e]	33×10^6	No
Cadmium	0.18	17,000	6,800	86,000	Yes
Chromium	94.7	1,590,000	398,000	2×10^6[d]	Yes
Cobalt	0.054	20,200	6,980	25,000[d]	Yes
Gadolinium	2.3	8[f]		14,920[d]	No
Iron	384	574×10^6[h]	128×10^6[i]	2×10^9[d]	No
Nickel	47.9 272.0	480,000[i]	129,000[i]	181,000[d]	Yes
Tin	20.8	248,000	89,000	57,000[d]	Yes
Tungsten	0.008	35,000	7,300	79,000	Yes
Zirconium	959	224,000[e]	71,000	51×10^6	No

[a]Quantities used are modified from the final ER for Hope Creek Generating Station, Table 10.1, Docket Nos. 50-354 and 50-355.

[b]Production, consumption, and reserves were compiled, except as noted, from the U.S. Bureau of Mines publications "Mineral Facts and Problems" (1970 ed. Bur. Mines Bull. 650) and the "1969 Minerals Yearbook."

[c]Designated by G. A. Lincoln, "List of Strategic and Critical Materials," Office of Emergency Preparedness; Fed. Regist. 37(39):4123 (Feb. 26, 1972).

[d]World reserves are much larger than U. S. reserves.

[e]Information for 1968.

[f]Production of gadolinium is estimated for 1971 from data for total separated rare earths given by J. G. Cannon, Eng. Mining J. 173(3):187-200 (March 1972). Production and reserves of gadolinium are assumed to be proportional to the ratio of gadolinium to total rare earth content of minerals given in "Comprehensive Inorganic Chemistry," Vol. 4, ed. M. C. Sneed and R. C. Brasted, D. Van Nostrand Co., Princeton, N. J., 1955, p. 153.

[g]Reserves include only those at Mountain Pass, Calif., according to the "1969 Minerals Yearbook."

[h]Excludes quantities obtained from scrap.

[i]Production of raw steel.

[j]Metallic zirconium accounted for 8% of total U.S. consumption in 1968.

Source: Table 5.7-1, S/HNP ASC/ER, 1981.

6.3 RELATIONSHIP BETWEEN SHORT-TERM USES AND LONG-TERM PRODUCTIVITY

The purpose of this section is to set forth the relationship between the proposed use of man's environment implicit in the proposed construction and operation of the nuclear generating station and the actions that could be taken to maintain and enhance the long-term productivity. The staff attempts to foresee the uses of the environment by succeeding generations and considers the extent to which this present use might limit or, on the contrary, enhance the range of beneficial uses in the long term.

6.3.1 Enhancement of Productivity

Operation of the S/HNP will result primarily in supplying the electrical energy needed to meet projected demand. The availability of the additional electricity will have a beneficial effect on the economy and should enhance continued growth and improvement in the service areas.

The site is presently covered by a naturally growing sagebrush/cheatgrass vegetative community within an area generally denoted to energy-related activities. Thus, commitment of this land to the specific use of energy generation will provide a more productive use.

6.3.2 Uses Adverse to Productivity

6.3.2.1 Land Use

At the present time, the land to be occupied and used by the proposed S/HNP facility is not being used for any productive purpose. In the staff's judgment, its diversion to industrial use will not be adverse to productivity.

6.3.2.2 Water Use

No groundwater will be required for plant consumption. Cooling water for the plant will be Columbia River water, withdrawn at river mile 361.5 at a rate of 1.58 to 2.12 m^2/s (56 to 75 cfs). This consumptive use will preclude use of this water downstream.

6.4 BENEFIT-COST SUMMARY

The primary benefit from the operation and construction of the proposed station will be the production of about 15.6 billion kWh per year over the life of the station. The construction and operation of the S/HNP will also create a substantial amount of economic activity with associated increased employment and commerce. Other benefits and costs are summarized in Table 6.3.

6.5 CONCLUSION

The staff concludes that the overall environmental impact resulting from the construction and operation of the S/HNP as proposed will be the mimimum practicable for a 2550-MWe nuclear electrical generating facility.

Furthermore, the overall benefit-cost balance would not be significantly improved by an alternative choice of site or by the use of an alternative generation system.

Table 6.3 Benefit-cost summary for S/HNP

Benefit or cost (reference)	Magnitude or reference[a]	Staff assessment of benefit or cost[b]
BENEFITS		
Direct		
Electrical energy (S/HNP ASC/ER, Table 11.4-1)	15.6 billion kWh/yr (70% capacity factor)	Large
Additional capacity (Sec. 4.1.2)	2550 MWe	Large
Indirect		
Local property taxes (Sec. 4.2.6.14)	$8.7 million/year[c]	Large
Operation employment (Sec. 4.2.6.1)	345 employees	Moderate
Operation payroll (Sec. 4.2.6.1)	$9.1 million/year[c]	Moderate
Local purchases by utility during operations (Sec. 4.2.6.14)	$640,000/year[c]	Small
COSTS		
Economic		
Capital cost (S/HNP ASC/ER, Table 11.4-1)	$7.8 billion	Moderate
Fuel (S/HNP ASC/ER, Table 11.4-1)	37.9 mills/kWh[d]	Small
Operation and maintenance (S/HNP ASC/ER, Table 11.4-1)	31.6 mills/kWh[d]	Small
Decommissioning (Sec. 4.2.14)	0.4-0.6 mills/kWh[d]	Small

Table 6.3 (continued)

Benefit or cost (reference)	Magnitude or reference[a]	Staff assessment of benefit or cost[b]
COSTS (continued)		
Environmental and Socioeconomic		
Resources committed:		
Land (Sec. 4.2.2)	485 hectares	Small
Water (Sec. 4.2.3)	250.9×10^6 m^3/yr	Moderate
Uranium (U_3O_8)(NUREG-0480)	About 5000 tons	Small
Other materials and supplies	Sect. 6.2	Small
Aquatic resources:		
Consumption:		
Surface water	149.9×10^6 m^3/yr	Moderate
Groundwater	None	None
Contamination:		
Surface water	(Sec. 4.2.3.2)	Small
Groundwater	(Sec. 4.2.3.2)	Small
Ecological:		
Impingement and entrainment	(Sec. 4.2.4.2)	Small
Thermal effects	(Sec. 4.2.4.2)	Small
Chemical discharges	(Sec. 4.2.[illegible].2)	Small
Terrestrial resources	(Sec. 4.2.4.1)	Small
Fog and ice	(Sec. 4.2.10)	Small

Table 6.3 (continued)

Benefit or cost (reference)	Magnitude or reference[a]	Staff assessment of benefit or cost[b]
COSTS (continued)		
Environmental and Socioeconomic (continued)		
Adverse socioeconomic effects due to:		
Loss of historic or prehistoric resources	(Sec. 4.2.6.15)	Moderate
Increased traffic	(Sec. 4.2.6.4)	Moderate
Increased demands on public facilities and services	(Sec. 4.2.6.5-12)	Small
Increased demands on private facilities and services	(Sec. 4.2.6.1)	Small
Adverse nonradiological health effects due to:		
Air quality changes	(Sec. 4.2.10)	Small
Water quality changes	(Sec. 4.2.3.2)	Small
Noise quality changes	(Sec. 4.2.11)	Small
Adverse radiological health effects due to:		
Reactor operation on:		
General population	(Sec. 4.2.12.3)	Small
Workers on site	(Sec. 4.2.12.3)	Small
Balance of fuel cycle	(Sec. 4.2.13)	Small
Accident risks	(Sec. 4.2.12.4)	Small[e]

[a]Where a particular unit of measure for a benefit-cost category has not been specified in the EIS, or where an estimate of the magnitude of the benefit/cost under consideration has not been made, the reader is directed to the appropriate EIS section or other sources for further information.

[b]Subjective measure of costs and benefits are assigned by reviewers, where quantification is not possible: "Small" - impacts that, in the reviewers' judgments, are of such minor nature, based on currently available information, that they do not warrant detailed investigations or considerations of mitigative actions; "Moderate" - impacts that, in the reviewers' judgments, are likely to be clearly evident (mitigation alternatives are usually considered for moderate impacts); "Large" - impacts that, in the reviewers' judgments, represent either a severe penalty or a major benefit. Acceptance requires that large negative impacts should be more than offset by other overriding project considerations.

[c]1981 dollars.

[d]Levelized over 30 years of operation.

[e]The impact of an accident, thus its cost, could possibly be large, but the risk of an accident is small.

7. LIST OF CONTRIBUTORS

The following individuals were responsible for preparing the Environmental Impact Statement.

<u>EFSEC/URS</u>

Walter Berschauer	Officer-in-Charge
Grant Bailey	Project Director, Biology
Steve Fusco	EIS Project Manager, Land Use Planning
Karl Leaverton	Socioeconomics, Infrastructure Management
Bruce Petersen	Socioeconomics, Alternative Site Analysis, Need for Facility Analysis
Andrew Cunningham	Geology
Mike King	Geology
Charles Tang	Hydrology
E. A. Wells	Limnology, Microbiology, Water Quality
Paul Korsmo	Biology
Jennifer Campbell	Word Processing
Mike Bertman	Graphic Design
Dean Volheim	Editing
Jim Buell, Consulting Biologist	Fisheries Biology
Joan Robinson, Office of Public Archaeology	Archaeology
Hal Kennedy, Office of Public Archaeology	Archaeology
Carol Kielusiak, Office of Public Archaeology	Archaeology

Keith Gilbert, TRANSPO Group	Transportation Planning
Roger Willsie, Economic Consulting	Economics
Gerald Erickson, Infometrix, Inc.	Air Quality
Jan Hauge, Towne, Richards, Chaudiere, Inc.	Noise

<u>NRC</u>

S. Acharya	Accident Evaluation
S. Baker	Accident Evaluation
D. L. Chery, Jr.	Accident Evaluation
Patrick G. Easley	Accident Evaluation
Sidney Feld	Cost-Benefit
Nick E. Fields	Decommissioning
R. W. Houston	Accident Evaluation
Abou-Bakr Ibrahim	Seismology
H. Krug	Accident Evaluation
Germain E. LaRoche	Terrestrial Ecology
Harold E. Lefevre	Geology
Joseph Levine	Meteorology
Jan A. Norris	Project Manager
J. Sears	Accident Evaluation
Marthe H. Singh	Editor
Anton A. Sinisgalli	Demography, Offsite Hazards
Gary B. Staley	Hydrology
Richard K. Struckmeyer	Radiological Assessment
M. Taylor	Accident Evaluation

A. Toalston	Accident Evaluation
D. West	Accident Evaluation

8. AGENCIES, ORGANIZATION AND INDIVIDUALS TO WHICH COPIES OF THIS DRAFT ENVIRONMENTAL IMPACT STATEMENT WERE SENT

8.1 NRC DISTRIBUTION LIST

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Department of Commerce
Department of Energy
Department of Health and Human Services
Department of Housing and Human Development
Department of Interior
Department of Transportation
Environmental Protection Agency

8.2 EFSEC DISTRIBUTION LIST

Applicant

Mr. Ted Van Decar
Senior Environmental Engineer
Puget Sound Power & Light Co.
Puget Power Building
Bellevue, WA 98009

Mr. Gordon Jacobsen
Vice Pres., Nuclear Projects
Northwest Energy Services Co.
P.O. Box 1090
Kirkland, WA 98003

Mr. F. Theodore Thomsen
Perkins, Coie, Stone, Olsen & Williams
1900 Washington Bldg.
Seattle, WA 98101

Executive Secretary

Mr. William L. Fitch, Executive Secretary
Energy Facility Site Evaluation Council
4224 Sixth Ave., S.E., PY-11
Olympia, WA 98504

Council

Mr. Nicholas D. Lewis, Chairman
Energy Facility Site Evaluation Council
4224 Sixth Ave., S.E., PY-11
Olympia, WA 98504

Council (cont.)

Mr. Arthur Scheunemann
Department of Agriculture
General Administration Bldg., AX-41
Olympia, WA 98504

Mr. Merlin Smith
Comm. & Economic Development
General Administration Bldg., AX-13
Olympia, WA 98504

Mr. Fred D. Hahn
Department of Ecology, PV-12
Olympia, WA 98504

Mr. David H. Guier
Dept. of Emergency Services
4220 East Martin Way, PT-11
Olympia, WA 98504

Mr. John C. Douglass
State Energy Office
400 East Union, ER-11
Olympia, WA 98504

Dr. Charles Woelke
Department of Fisheries
General Administration Bldg., AX-11
Olympia, WA 98504

Council (cont.)

Mr. John Ward
Department of Game
600 North Capitol Way, OW-21
Olympia, WA 98504

Mr. John L. Chambers
Dept. of Natural Resources
Public Lands Bldg., OW-21
Olympia, WA 98504

Mr. Claude E. Lakewold
Office of Financial Mgmt.
House Office Building, AL-01
Olympia, WA 98504

Mr. John A. Clark
Parks & Recreation Comm.
7150 Cleanwater Lane, KY-11
Olympia, WA 98504

Mr. Bert Baron
Planning & Comm. Affairs
400 Capitol Center Bldg., GH-51
Olympia, WA 98504

Mr. Sam I. Reed
Social & Health Serv., LD-11
Olympia, WA 98504

Mr. Thomas C. Stacer
Utilities & Transp. Comm.
Highways-Licenses Building, PB-02
Olympia, WA 98504

Mr. Joe Bell
Dept. of Transportation
Highway Administration Bldg., KF-01
Olympia, WA 98504

Counsel for the Council

Mr. Kevin M. Ryan
Assistant Attorney General
Temple of Justice, AV-21
Olympia, WA 98504

Counsel for the Environment

Mr. Thomas R. Bjorgen
Assistant Attorney General
Temple of Justice, AQ-01
Olympia, WA 98504

Counsel Legal Officer

Mr. Patrick Biggs
Legal Officer
Energy Facility Site
Evaluation Council, PY-11
Olympia, WA 98504

Agency Parties

Mr. Spencer W. Daniels
Assistant Attorney General
Department of Transportation, KF-01
Olympia, WA 98504

Mr. R. C. Schuster
District Administrator
Department of Transportation
P.O. Box 52
Yakima, WA 98907

Mr. Charles Lean
Department of Ecology
Mail Stop PV-11
Olympia, WA 98504

County Member

Commissioner William H. Sebero
Board of Benton County Comms.
Benton County Courthouse
Pasco, WA 99301

State

Department of Commerce &
Ecomomic Development
General Administration Bldg., AX-13
Olympia, WA 98504

Department of Emergency Services
4220 East Martin Way, PT-11
Olympia, WA 98504

State Energy Office
400 East Union, ER-11
Olympia, WA 98504

Department of Fisheries
General Administration Bldg., AX-11
Olympia, WA 98504

Department of Natural Resources
Public Lands Bldg., QW-21
Olympia, WA 98504

State (cont.)

Office of Financial Management
House Office Building, ER-13
Olympia, WA 98504

State Parks & Recreation Commission
7150 Cleanwater Lane, KY-11
Olympia, WA 98504

Utilities & Transportation Commission
Highways-Licenses Bldg., PB-02
Olympia, WA 98504

Office of Archaeology &
Historic Preservation
111 West 21st St., KL-11
Olympia, WA 98504

Office of Planning &
Community Affairs
400 Capital Center Bldg., GH-51
Olympia, WA 98504

Counties

Franklin County
County Courthouse
Pasco, WA 99301
(1) County Commission
(2) County Engineer
(3) County Planner

Benton County
County Courthouse
Dudley Avenue
Prosser, WA 99350
(1) County Commission
(2) County Engineer
(3) County Planner

Yakima County
County Courthouse
North 2nd and East B Street
Yakima, WA 98901
ATTN: County Commission

Cities

City of Richland
P.O. Box 190
Richland, WA 99351
(1) City Manager
(2) City Engineer
(3) Planning Director

Cities (cont.)

City of Kennewick
P. O. Box 6108
Kennewick, WA 99336
(1) City Manager
(2) City Engineer
(3) Planning Director

City of Pasco
P.O. Box 293
Pasco, WA 99301
(1) City Manager
(2) City Manager
(3) Planning Director

City of Sunnyside
719 Edison Avenue
Sunnyside, WA 98944
ATTN: City Manager

City of West Richland
3805 Van Giesen
West Richland, WA 99352
(1) Mayor
(2) City Engineer
(3) Planning Director

City of Prosser
601 7th Street
Prosser, WA 99350
ATTN: City Superintendent

City of Grandview
207 W. 2nd Street
Grandview, WA 98930
ATTN: Mayor

City of Benton City
P.O. Box 218
Benton City, WA 99320
ATTN: Mayor

Town of Mabton
P.O. Box 655
Mabton, WA 98939

Libraries

Mid-Columbia Library System
405 S. Dayton
Kennewick, WA 99336

Libraries (cont.)

City of Seattle
Public Library
600 4th Avenue
Seattle, WA 98121

Spokane Public Library
W. 906 Main
Spokane, WA 99210

Columbia Basin Community
College Library
2600 N. 20th
Pasco, WA 99301

Richland Public Library
P.O. Box 190
Richland, WA 99352

University of Washington
Odegard Library
Seattle, WA 98122

Washington State University
Holland Library
Pullman, WA 99164

News Organizations

Tri-Cities *Herald*
P.O. Box 2608
Tri-Cities, WA 99302

The Spokane Daily Chronicle
W. 926 Sprague
Spokane, WA 99210

The Spokesman Review
W. 927 Riverside
Spokane, WA 99210

The Seattle Times
P.O. Box 70
Seattle, WA 98111

Seattle Post Intelligencer
6th and Wall
Seattle, WA 98121

Yakima Herald
114 N. 4th St.
Yakima, WA 98906

Indian Nations

Mr. Russell Jim
Tribal Councilman
Consolidated Tribes and Bands
Yakima Indian Nation
P.O. Box 151
Toppenish, WA 98948

Mr. Bob Tuck, Director
Fisheries Resources Management
T-0787 Yakima Indian Nation
Toppenish, WA 98948

Atomic Safety & Licensing Board

Judge Gustave Lindenberger
Atomic Safety & Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Judge Robert Lazo
Atomic Safety & Licensing Board
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Judge Frank Hooper
Ecology, Fisheries & Wildlife
School of Natural Resources
University of Michigan
128 S.T. Dana Building
Ann Arbor, MI 48109

Mr. John F. Wolf
3409 Shephard Street
Chevy Chase, MD 20015

NRC Staff

Richard L. Black, Esq.
Office of Executive Legal Director
U.S. Nuclear Regulatory Commission
Washington, D.C. 20005

Mr. Jan A. Norris
Senior Siting Engineer
Siting Analysis Branch
U.S. Nuclear Regulatory Commission
M/S AR-5200
Washington, D.C. 20555

Additional Distribution (cont.)

Benton-Franklin Government
  Conference
P.O. Box 217
Richland, WA 99352

Washington Public Power
  Supply System
3000 George Washington Way
Richland, WA 99352

Pacific NW Electric Power
  Planning & Conservtion
  Council
700 SW Taylor
Portland, OR 97205

Williams, Kuebelbeck &
  Assoc. Inc.
2001 Western Ave.
Market Place One
Suite 225
Seattle, WA 98121

Mr. Earnest McNeely
Prosser Hospital
723 Memorial
Prosser, WA 99350

Mr. Frank Hall
Benton County Fire Dist. #4
1545 SE 38th
West Richland, WA 99352

Mr. Grant Bailey
URS Engineers
4th and Vine Building
Seattle, WA 98121

Frank J. Owens
926 24th Way, SW.
Olympia, WA 98502

9. BIBLIOGRAPHY

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*A version published by W. H. Freeman and Company, San Francisco, CA, is also available. Page numbers will differ.

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APPENDIX A

RESERVED FOR COMMENTS ON THE

DRAFT ENVIRONMENTAL IMPACT STATEMENT

APPENDIX B

NEPA POPULATION-DOSE ASSESSMENT

APPENDIX B

NEPA POPULATION-DOSE ASSESSMENT

Population-dose commitments are calculated for all individuals living within 80 km (50 miles) of the S/HNP facility, employing the same dose calculation models used for individual doses (see Regulatory Guide 1.109, Revision 1) for the purpose of meeting the "as low as reasonably achievable" (ALARA) requirements of 10 CFR 50, Appendix I. In addition, dose commitments to the population residing beyond the 80-km region, associated with the export of food crops produced within the 80-km region and with the atmospheric and hydrospheric transport of the more mobile effluent species (such as noble gases, tritium, and carbon-14), are taken into consideration for the purpose of meeting the requirements of the National Environmental Policy Act, 1969 (NEPA). This appendix describes the methods used to make these NEPA population-dose estimates.

1. Iodines and Particulates Released to the Atmosphere

Effluent nuclides in this category deposit onto the ground as the effluent moves downwind; thus, the concentration of these nuclides remaining in the plume is continuously being reduced. Within 80 km of the facility, the deposition model in Regulatory Guide 1.111, Revision 1, is used in conjunction with the dose models in Regulatory Guide 1.109, Revision 1. Site-specific data concerning production and consumption of foods within 80 km of the reactor are used. For estimates of population doses beyond 80 km, it is assumed that excess food not consumed within the 80-km area would be consumed by the population beyond 80 km. It is further assumed that none, or very few, of the particulates released from the facility will be transported beyond the 80-km distance; thus, they will make no significant contribution to the population dose outside the 80-km region, except by export of food crops. This assumption was tested and found to be reasonable for the S/HNP facility.

2. Noble Gases, Carbon-14, and Tritium Released to the Atmosphere

For locations within 80 km of the reactor facility, exposures to these effluents are calculated with a constant mean wind-direction model according to the guidance provided in Regulatory Guide 1.111, Revision 1, and the dose models described in Regulatory Guide 1.109, Revision 1. For estimating the dose commitment from these radionuclides to the U.S. population residing beyond the 80-km region, two dispersion regimes are considered. These are referred to as the first-pass-dispersion regime and the world-wide-dispersion regime. The model for the first-pass-dispersion regime estimates the dose commitment to the population from the radioactive plume as it leaves the facility and drifts across the continental United States toward the northeastern corner of the United States. The model for the world-wide-dispersion regime estimates the dose commitment to the U.S. population after the released radionuclides mix uniformly in the world's atmosphere or oceans.

First-Pass Dispersion--For estimating the dose commitment to the U.S. population residing beyond the 80-km region as a result of the first pass of radioactive pollutants, it is assumed that the pollutants disperse in the lateral and vertical directions along the plume path. The direction of movement of the plume is assumed to be from the facility toward the northeast corner of the United States. The extent of vertical dispersion is assumed to be limited by the ground plane and the stable atmospheric layer aloft, the height of which determines the mixing depth. The shape of such a plume geometry can be visualized as a right cylindrical wedge whose height is equal to the mixing depth. Under the assumption of constant population density, the population dose associated with such a plume geometry is independent of the extent of lateral dispersion, and is only dependent upon the mixing depth and other nongeometrical related factors (NUREG-0597). The mixing depth is estimated to be 1000 m, and a uniform population density of 62 persons/km^2 is assumed along the plume path, with an average plume-transport velocity of 2 meters per second (m/s).

The total-body population-dose commitment from the first pass of radioactive effluents is due principally to external exposure from gamma-emitting noble gases, and to internal exposure from inhalation of air containing tritium and from ingestion of food containing carbon-14 and tritium.

World-Wide Dispersion--For estimating the dose commitment to the U.S. population after the first-pass dispersion, world-wide dispersion is assumed. Nondepositing radionuclides with half-lives greater than 1 year are considered. Noble gases and carbon-14 are assumed to mix uniformly in the world's atmosphere (3.8×10^{18} m^3), and radioactive decay is taken into consideration. The world-wide-dispersion model estimates the activity of each nuclide at the end of a 15-year release period (midpoint of reactor life) and estimates the annual population-dose commitment at that time, taking into consideration radioactive decay and physical removal mechanisms (for example, C-14 is gradually removed to the world's oceans). The total-body population-dose commitment from the noble gases results mainly from external exposure from gamma-emitting nuclides, whereas from carbon-14 it is due mainly to internal exposure from ingestion of food containing carbon-14.

The population-dose commitment as a result of tritium releases is estimated in a manner similar to that for carbon-14, except that, after the first pass, all the tritium is assumed to be immediately distributed in the world's circulating water volume (2.7×10^{16} m^3), including the top 75 m of the seas and oceans as well as the rivers and atmospheric moisture. The concentration of tritium in the world's circulating water is estimated at the time after 15 years of releases have occurred, taking into consideration radioactive decay; the population-dose commitment estimates are based on the incremental concentration at that time. The total-body population-dose commitment from tritium results mainly from internal exposure from the consumption of food.

3. Liquid Effluents

Population-dose commitments due to effluents in the receiving water within 80 km of the facility are calculated as described in Regulatory Guide 1.109, Revision 1. It is assumed that no depletion by sedimentation of the nuclides present in the receiving water occurs within 80 km. It also is assumed that aquatic biota concentrate radioactivity in the same manner as was assumed for the ALARA evaluation for the maximally exposed individual. However, food-consumption values appropriate for the average, rather than the maximum, individual are used. It is further assumed that all the sport and commercial fish and shellfish caught within the 80-km area are eaten by the U.S. population.

Beyond 80 km, it is assumed that all the liquid-effluent nuclides except tritium have deposited on the sediments so that they make no further contribution to population exposures. The tritium is assumed to mix uniformly in the world's circulating water volume and to result in an exposure to the U.S. population in the same manner as discussed for tritium in gaseous effluents.

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APPENDIX C

IMPACTS OF THE URANIUM FUEL CYCLE

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IMPACTS OF THE URANIUM FUEL CYCLE

The following assessment of the environmental impacts of the LWR-supporting fuel cycle as related to the operation of the proposed project is based on the values given in Table S-3 (see Section 4.2.13 of this EIS) and the NRC staff's analysis of the radiological impact from radon and technetium releases. For the sake of consistency, the analysis of fuel-cycle impacts has been cast in terms of a model 1000-MWe light-water-cooled reactor (LWR) operating at an annual capacity factor of 80 percent. In the following review and evaluation of the environmental impacts of the fuel cycle, the staff's analysis and conclusions would not be altered if the analysis were to be based on the net electrical power output of the S/HNP facility.

1. Land Use

The total annual land requirement for the fuel cycle supporting a model 1000-MWe LWR is about 460,000 m^2 (113 acres). Approximately 53,000 m^2 (13 acres) per year are permanently committed land, and 405,000 m^2 (100 acres) per year are temporarily committed. (A "temporary" land commitment is a commitment for the life of the specific fuel-cycle plant, such as a mill, enrichment plant, or succeeding plants. On abandonment or decommissioning, such land can be used for any purpose. "Permanent" commitments represent land that may not be released for use after plant shutdown and/or decommissioning.) Of the 405,000 m^2 per year of temporarily committed land, 320,000 m^2 are undisturbed and 90,000 m^2 are disturbed. Considering common classes of land use in the United States,* fuel-cycle land-use requirements to support the model 1000-MWe LWR do not represent a significant impact.

2. Water Use

The principal water-use requirement for the fuel cycle supporting a model 1000-MWe LWR is that required to remove waste heat from the power stations supplying electrical energy to the enrichment step of this cycle. Of the total annual requirement of 43×10^6 m^3 (11.4×10^9 gal), about 42×10^6 m^3 are required for this purpose, assuming that these plants use once-through cooling. Other water uses involve the discharge to air (for example, evaporation losses in process cooling) of about 0.6×10^6 m^3 (16×10^7 gal) per year and water discharged to the ground (for example, mine drainage) of about 0.5×10^6 m^3 per year.

On a thermal effluent basis, annual discharges from the nuclear fuel cycle are about 4 percent of those from the model 1000-MWe LWR using once-through cooling. The consumptive water use of 0.6×10^6 m^3 per year is about 2 percent of that from the model 1000-MWe LWR using cooling towers. The maximum consumptive water use (assuming that all plants supplying electrical energy to the nuclear fuel

*A coal-fired plant of 1000-MWe capacity using strip-mined coal requires the disturbance of about 810,000 m^2 (200 acres) per year for fuel alone.

cycle used cooling towers) would be about 6 percent of the model 1000-MWe LWR using cooling towers. Under this condition, thermal effluents would be negligible. The staff finds that these combinations of thermal loadings and water consumption are acceptable relative to the water use and thermal discharges of the proposed project.

3. Fossil Fuel Consumption

Electrical energy and process heat are required during various phases of the fuel cycle process. The electrical energy is usually produced by the combustion of fossil fuel at conventional power plants. Electrical energy associated with the fuel cycle represents about 5 percent of the annual electrical power production of the model 1000-MWe LWR. Process heat is primarily generated by the combustion of natural gas. This gas consumption, if used to generate electricity, would be less than 0.3 percent of the electrical output from the model plant. The staff finds that the direct and indirect consumptions of electrical energy for fuel-cycle operations are small and acceptable relative to the net power production of the proposed project.

4. Chemical Effluents

The quantities of chemical, gaseous, and particulate effluents associated with fuel-cycle processes are given in Table S-3 (See Table 4.34 in Section 4.2.12 of this EIS). The principal species are sulfur oxides, nitrogen oxides, and particulates. On the basis of data in a Council on Environmental Quality report (CEQ, 1976), the staff finds that these emissions constitute an extremely small additional atmospheric loading in comparison with the same emissions from the stationary fuel-combustion and transportation sectors in the United States; that is, about 0.02 percent of the annual national releases for each of these species. The staff believes that such small increases in releases of these pollutants are acceptable.

Liquid chemical effluents produced in fuel cycle processes are related to fuel-enrichment, -fabrication, and -reprocessing operations and may be released to receiving waters. These effluents are usually present in dilute concentrations such that only small amounts of dilution water are required to reach levels of concentration that are within established standards. The flow of dilution water required for specific constituents is specified in Table S-3. In addition, all liquid discharges into the navigable waters of the United States from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in the national pollution discharge elimination system (NPDES) permit.

Tailings solutions and solids are generated during the milling process. These solutions and solids are not released in quantities sufficient to have a significant impact on the environment.

5. Radioactive Effluents

Radioactive effluents estimated to be released to the environment from reprocessing and waste-management activities and certain other phases of the fuel-cycle process are set forth in Table S-3. Using these data, the staff has calculated, for 1 year of operation of the model 1000-MWe LWR, the 100-year involuntary environmental dose commitment* to the U.S. population from the LWR-supporting fuel cycle.

It is estimated from these calculations that the overall involuntary total-body gaseous dose commitment to the U.S. population from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222 and technetium-99) would be approximately 400 person-rems for each year of operation of the model 1000-MWe LWR (reference reactor year, or RRY). Based on Table S-3 values, the additional involuntary total-body dose commitments to the U.S. population from radioactive liquid effluents (excluding technetium-99) as a result of all fuel-cycle operations other than reactor operation would be about 100 person-rems per year of operation. Thus, the estimated involuntary 100-year environmental dose commitment to the U.S. population from radioactive gaseous and liquid releases due to these portions of the fuel cycle is about 500 person-rems (whole-body) per RRY.

At this time, the radiological impacts associated with radon-222 and technetium-99 releases are not addressed in Table S-3. Principal radon releases occur during mining and milling operations and as emissions from mill tailings, whereas principal technetium-99 releases occur from gaseous diffusion enrichment facilities. The staff has determined that radon-222 releases per RRY from these operations are as given in Table C.1. The staff has calculated population-dose commitments for these sources of radon-222 using the RABGAD computer code described in Volume 3 of NUREG-0002 (Appendix A, Chapter IV, Section J). The results of these calculations for mining and milling activities prior to tailings stabilization are listed in Table C.2.

When added to the 500 person-rems total-body dose commitment for the balance of the fuel cycle, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is approximately 640 person-rems. Over this period of time, this dose is equivalent to 0.00002 percent of the natural-background total-body dose of about 3 billion person-rems to the U.S. population.**

The staff has considered the health effects associated with the releases of radon-222, including both the short-term effects of mining and milling, and active tailings, and the potential long-term effects from unreclaimed open-pit mines and stabilized tailings. The staff has assumed that, after completion of active mining, underground mines will be sealed, thereby returning releases of radon-222 to background levels. For purposes of providing an upper-bound impact assessment, the staff has assumed that open-pit mines will be unreclaimed and has calculated that, if all ore were produced from open-pit mines, releases from them would be 110 Ci per RRY. However, because the distribution of uranium-ore reserves available by conventional mining methods is 66 percent underground and 34 percent open pit (Department of Energy, 1978), the staff has further

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*The 100-year environmental dose commitment is the integrated population dose for 100 years; that is, it represents the sum of the annual population doses for a total of 100 years.

**Based on an annual average natural-background individual dose commitment of 100 millirems and a stabilized U.S. population of 300 million.

Table C.1 Radon releases from mining and milling operations and mill tailings for each year of operation of the model 1000-MWe LWR*

Radon source	Quantity released
Mining**	4060 Ci
Milling and tailings*** (during active mining)	780 Ci
Inactive tailings*** (before stabilization)	350 Ci
Stabilized tailings*** (several hundred years)	1 to 10 Ci/year
Stabilized tailings*** (after several hundred years)	110 Ci/year

*After three days of hearings before the Atomic Safety and Licensing Appeal Board (ASLAB) using the Perkins record in a "lead case" approach, the ASLAB issued a decision on May 13, 1981 (ALAB-640) on the radon-222 release source term for the uranium fuel cycle. The decision, among other matters, produced new source-term numbers based on the record developed at the hearings. These new numbers did not differ significantly from those in the Perkins record, which are the values set forth in this table. Any health effects relative to radon-222 are still under consideration before the ASLAB. Because the source term numbers in ALAB-640 do not differ significantly from those in the Perkins record, the staff continues to conclude that both the dose commitments and health effects of the uranium fuel cycle are insignificant when compared to dose commitments and potential health effects to the U.S. population resulting from all natural background sources. Subsequent to ALAB-640, a second ASLAB decision (ALAB-654, issued September 11, 1981) permits intervenors a 60-day period to challenge the Perkins record on the potential health effects of radon-222 emissions.

**R. Wilde, NRC transcript of direct testimony given "In the Matter of Duke Power Company (Perkins Nuclear Station)," Docket No. 50-488, April 17, 1978.

***P. Magno, NRC transcript of direct testimony given "In the Matter of Duke Power Company (Perkins Nuclear Station)" Docket No. 50-488, April 17, 1978.

Table C.2 Estimated 100-year environmental dose commitment per year of operation of the model 1000-MWe LWR

Radon source	Radon-222 releases (Ci)	Dosage (person-rems)		
		Total body	Bone	Lung (bronchial epithelium)
Mining	4100	110	2800	2300
Milling and active tailings	1100	29	750	620
Total	5200	140	3600	2900

assumed that uranium to fuel LWRs will be produced by conventional mining method in these proportions. This means that long-term releases from unreclaimed open-pit mines will be 0.34 x 110 or 37 Ci per year per RRY.

Based on the above, the radon released from unreclaimed open-pit mines over 100- and 1000-year periods would be about 3700 Ci and 37,000 Ci per RRY, respectively. The total dose commitments for a 100- to 1000-year period would be as given in Table C.3.

Table C.3 Population-dose commitments from unreclaimed open-pit mines for each year of operation of the model 1000-MWe LWR

Time span (years)	Radon-222 releases (Ci)	Population dose commitments (person-rems)		
		Total body	Bone	Lung (bronchial epithelium)
100	3,700	96	2,500	2,000
500	19,000	480	13,000	11,000
1,000	37,000	960	25,000	20,000

These commitments represent a worst-case situation in that no mitigating circumstances are assumed. However, State and Federal laws currently require reclamation of strip and open-pit coal mines, and it is very probable that similar reclamation will be required for open-pit uranium mines. If so, long-term releases from such mines should approach background levels.

For long-term radon releases from stabilized tailings piles, the staff has assumed that these tailings would emit (per RRY) 1 Ci per year for 100 years, 10 Ci per year for the next 400 years, and 100 Ci per year for periods beyond 500 years. With these assumptions, the cumulative radon-222 release from stabilized-tailings piles per RRY would be 100 Ci in 100 years, 4090 Ci in 500 years, and 53,800 Ci in 1000 years (Gotchy, 1978). The total-body, bone, and bronchial epithelium dose commitments for these periods are as shown in Table C.4.

Table C.4 Population-dose commitments from stabilized-tailings piles for each year of operation of the model 1000-MWe LWR

Time span (years)	Randon-222 releases (Ci)	Population dose commitments (person-rems)		
		Total body	Bone	Lung (bronchial epithelium)
100	100	2.6	68	56
500	4,090	110	2,800	2,300
1,000	53,800	1,400	37,000	30,000

Using risk estimators of 135, 6.9, and 22 cancer deaths per million person-rems for total-body, bone, and lung exposures, respectively, the estimated risk of cancer mortality resulting from mining, milling, and active-tailings emissions of radon-222 is about 0.11 cancer fatality per RRY. When the risk from radon-222 emissions from stabilized tailings over a 100-year release period is added, the estimated risk of cancer mortality over a 100-year period is unchanged. Similarly, a risk of about 1.2 cancer fatalities per RRY is estimated over a 1000-year release period. When potential radon releases from reclaimed and unreclaimed open-pit mines are included, the overall risks of radon-induced cancer fatalities per RRY range as follows:

0.11 to 0.19 fatality for a 100-year period
0.19 to 0.57 fatality for a 500-year period
1.2 to 2.0 fatalities for a 1000-year period

To illustrate, a single model 1000-MWe LWR operating at an 80 percent capacity factor for 30 years would be predicted to induce between 3.3 and 5.7 cancer fatalities in 100 years, 5.7 and 17 in 500 years, and 36 and 60 in 1000 years as a result of releases of radon-222.

These doses and predicted health effects have been compared with those that can be expected from natural-background emissions of radon-222. Using data from the National Council on Radiation Protection (NCRP 1975), the staff calculates the average radon-222 concentration in air in the contiguous United States to be about 150 pCi/m^3, which the NCRP estimates will result in an annual dose to the bronchial epithelium of 450 millirems. For a stabilized future U.S. population of 300 million, this represents a total lung-dose commitment of 135 million person-rems per year. Using the same risk estimator of

22 lung-cancer fatalities per million person-lung-rems used to predict cancer fatalities for the model 1000 MWe LWR, the staff estimates that lung-cancer fatalities alone from background radon-222 in the air can be calculated to be about 3000 per year, or 300,000 to 3,000,000 lung-cancer deaths over periods of 100 to 1000 years, respectively.

The staff is currently formulating a specific model for analyzing the potential impact and health effects from the release of technetium-99 during the fuel cycle. However, for the interim period until the model is completed, the staff has calculated that the potential 100-year environmental dose commitment to the U.S. population from the release of technetium-99 should not exceed 100 person-rems per RRY. These calculations are based on the gaseous and the hydrological pathway model systems described in Volume 3 of NUREG-0002 (Chapter IV, Section J, Appendix A.) When these figures are added to the 640 person-rem total-body dose commitment for the balance of the fuel cycle, including radon-222, the overall estimated total-body involuntary 100-year environmental dose commitment to the U.S. population from the fuel cycle for the model 1000-MWe LWR is about 740 person-rems. Over this period of time, this dose is equivalent to 0.00002 percent of the natural-background total-body dose of about three billion person-rems to the U.S. population.*

The staff also considered the potential health effects associated with this release of technetium-99. Using the modeling systems described in NUREG-0002, (Vol. 3), the major risks from technetium-99 are from exposure of the gastro-intestinal tract and kidney, although there is a small risk from total-body exposure. Using organ-specific risk estimators, these individual organ risks can be converted to total-body risk equivalent doses. Then, by using the total-body risk estimator of 135 cancer deaths per million person-rems, the estimated risk of cancer mortality due to technetium-99 releases from the nuclear fuel cycle is about 0.01 cancer fatality per RRY over the subsequent 100 to 1000 years.

In addition to the radon- and technetium-related potential health effects from the fuel cycle, other nuclides produced in the cycle, such as carbon-14, will contribute to population exposures. It is estimated that an additional 0.08 to 0.12 cancer death may occur per RRY (assuming that no cure for or prevention of cancer is ever developed) over the next 100 to 1000 years, respectively, from exposures to these other nuclides.

The latter exposures can also be compared with those from naturally occurring terrestrial and cosmic-ray sources. These average about 100 millirems. Therefore, for a stable future population of 300 million persons, the whole-body dose commitment would be about 30 million person-rems per year, or 3 billion person-rems and 30 billion person-rems for periods of 100 and 1000 years, respectively. These natural-background dose commitments could produce about 400,000 and 4,000,000 cancer deaths during the same time periods. From the above analysis, the staff concludes that both the dose commitments and health

*Based on an annual average natural-background individual dose commitment of 100 mrems and a stablilized U.S. population of 300 million.

effects of the LWR-supporting uranium fuel cycle are very small when compared with dose commitments and potential health effects to the U.S. population resulting from all natural-background sources.

6. Radioactive Wastes

The quantities of buried radioactive waste material (low-level, high-level, and transuranic wastes) associated with the uranium fuel cycle are specified in Table S-3. For low-level waste disposal at land-burial facilities, the Commission notes in Table S-3 that there will be no significant radioactive releases to the environment. The Commission notes that high-level and transuranic wastes are to be buried at a Federal repository and that no release to the environment is associated with such disposal. NUREG-0116, which provides background and context for the high-level and transuranic Table S-3 values established by the Commission, indicates that these high-level and transuranic wastes will be buried and will not be released to the biosphere. No radiological environmental impact is anticipated from such disposal.

7. Occupational Dose

The annual occupational dose attributable to all phases of the fuel cycle for the model 1000-MWe LWR is about 200 person-rems. The staff concludes that this occupational dose will have a small environmental impact.

8. Transportation

The transportation dose to workers and the public is specified in Table S-3. This dose is small in comparison with the natural-background dose.

9. Fuel Cycle

The staff's analysis of the uranium fuel cycle did not depend on the selected fuel cycle (no recycle or uranium-only recycle), because the data provided in Table S-3 include maximum recycle-option impact for each element of the fuel cycle. Thus, the staff's conclusions as to acceptability of the environmental impacts of the fuel cycle are not affected by the specific fuel cycle selected.

10. References

Council on Environmental Quality, "The Seventh Annual Report of the Council on Environmental Quality," Figs. 11-27 and 11-28, pp. 238-239, September 1976.

Gotchy, R., NRC transcript of direct testimony given "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

National Council on Radiation Protection and Measurements (NCRP), "Natural Background Radiation in the United States," NCRP Report No. 45, November 1975.

U.S. Department of Energy, "Statistical Data of the Uranium Industry," GJO-100(8-78), January 1978.

U.S. Nuclear Regulatory Commission, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle," NUREG-0116 (Supplement 1 to WASH-1248), October 1976.

U.S. Nuclear Regulatory Commission, "Final Generic Environmental Statement on the Use of Recycle Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors," NUREG-0002, Vol. 3, August 1976.

APPENDIX D

EXAMPLES OF SITE-SPECIFIC DOSE ASSESSMENT CALCULATIONS

APPENDIX D

EXAMPLES OF SITE-SPECIFIC DOSE ASSESSMENT CALCULATIONS

1. Calculational Approach

As mentioned in the main body of this report the quantities of radioactive material that may be released annually from the S/HNP facility are estimated on the basis of the description of the radwaste systems in the applicant's S/HNP ASC/ER and FSAR and by using the calculational models and parameters developed by the NRC staff in NUREG-0016. These estimated effluent release values for normal operation, including anticipated operational occurrences, along with the applicant's site and environmental data in the S/HNP ASC/ER and in subsequent answers to NRC staff questions, are used in the calculation of radiation doses and dose commitments.

The models and considerations for environmental pathways that lead to estimates of radiation doses and dose commitments to individual members of the public near the plant and of cumulative doses and dose commitments to the entire population within an 80-km (50-mile) radius of the plant as a result of plant operations are discussed in detail in Regulatory Guide 1.109, Revision 1. Use of these models with additional assumptions for environmental pathways that lead to exposure to the general population outside the 80-km radius are described in Appendix B of this EIS.

The calculations performed by the staff for the releases to the atmosphere and hydrosphere provide total integrated dose commitments to the entire population within 80 km of this facility based on the projected population distribution in the year 2000. The dose commitments represent the total dose that would be received over a 50-year period, following the intake of radioactivity for 1 year under the conditions existing 15 years after the station begins operation (that is, the mid-point of station operation). For younger persons, changes in organ mass and metabolic parameters with age after the initial intake of radioactivity are accounted for.

2. Dose Commitments from Radioactive Effluent Releases

The NRC staff's estimates of the expected gaseous and particulate releases (listed in Table D.1) along with the site meteorological considerations (summarized in Table D.2) were used to estimate radiation doses and dose commitments for airborne effluents. Individual receptor locations and pathway locations considered for the maximally exposed individual in these calculations are listed in Table D.3.

Two years of meteorological data were used in the calculation of concentrations of effluents. The data were collected onsite at the WPPSS-2 meteorological tower from April 1974 to March 1976. The long-term atmospheric dispersion estimates were made using the procedure described in Regulatory Guide 1.111, Revision 1. Open terrain recirculation factors were used by the staff in the computer model and modified Pasquill-Gifford dispersion factors were used to account for poorer effluent dispersion in the desert.

The NRC staff estimates of the expected liquid releases (listed in Table D.4), along with the site hydrological considerations (summarized in Table D.5), were used to estimate radiation doses and dose commitments from liquid releases.

Radiation Dose Commitments to Individual Members of the Public--As explained in the text, calculations are made for a hypothetical individual member of the public (that is, the maximally exposed individual) who would be expected to receive the highest radiation dose from all pathways that contribute. This method tends to overestimate the doses because assumptions are made that would be difficult for a real individual to fulfill.

The estimated dose commitments to the individual who is subject to maximum exposure at selected offsite locations from airborne releases of radioiodine and particulates, and waterborne releases are listed in Tables D.6, D.7, and D.8. The maximum annual total body and skin dose to a hypothetical individual and the maximum beta and gamma air dose at the site boundary are presented in Tables D.6, D.7, and D.8.

The maximally exposed individual is assumed to consume considerably above-average quantities of the potentially affected foods and to spend more time at potentially affected locations than the average person, as indicated in Tables E-4 and E-5 of Revision 1 of Regulatory Guide 1.109.

Cumulative Dose Commitments to the General Population--Annual radiation dose commitments from airborne and waterborne radioactive releases from the S/HNP facility are estimated for two populations in the year 2000: (1) all members of the general public within 80 km (50 miles) of the station (Table D.7), and (2) the entire U.S. population (Table D.9). Dose commitments beyond 80 km are based on the assumptions discussed in Appendix B. For perspective, annual background radiation doses are given in the tables for both populations.

3. References

U.S. Nuclear Regulatory Commission, "Calculation of Annual Doses to Man From Routine Releases of Reactor Effluents for the Purpose of Evaluating Compliance with 10 CFR Part 50, Appendix I," Regulatory Guide 1.109, Revision 1, October 1977.

U.S. Nuclear Regulatory Commission, F. P. Cardile and R. R. Bellamy (editors), "Calculation of Radioactive Materials in Gaseous and Liquid Effluents from Boiling Water Reactors," NUREG-0016, Revision 1, January 1979.

U.S. Nuclear Regulatory Commission, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Reactors," Regulatory Guide 1.111, Revision 1, 1977.

Table D.1 Calculated releases of radioactive materials in gaseous effluents from the S/HNP (Ci/yr per reactor)

Nuclides	Reactor building vent (continuous)	Reactor building vent (intermittent)	Turbine building vent (continuous)	Auxiliary building vent (continuous)	Radwaste building vent (continuous)	Total
Ar-41	a	25*	a	a	a	a
Kr-83m	a	a	a	a	a	a
Kr-85m	37	a	34	3	78	152
Kr-85	a	a	a	a	310	310
Kr-87	68	a	65	3	a	136
Kr-88	118	a	115	3	4	240
Kr-89	a	a	a	a	a	a
Xe-131m	a	a	a	a	19	19
Xe-133	190	2300**	125	66	460	3140
Xe-135m	370	a	325	45	a	740
Xe-135	350	350**	320	35	45	1100
Xe-138	700	a	700	7	a	1400
			Total noble gases			7237
Cr-51	3.0E-03	b	6.0E-03	3.0E-04	4.5E-03	1.4E-02
Mn-54	3.0E-03	b	3.0E-04	3.0E-03	1.5E-02	2.1E-02
Fe-59	4.0E-04	b	2.5E-04	4.0E-04	7.5E-03	8.6E-03
Co-58	6.0E-04	b	3.0E-04	6.0E-04	2.3E-03	3.8E-03
Co-60	1.0E-02	b	1.0E-03	1-0E-02	4.5E-02	6.6E-02
Zn-65	2.0E-03	b	1.0E-04	2.0E-03	7.5E-04	4.8E-03
Sr-89	1.2E-04	b	3.0E-03	9.0E-05	2.3E-04	3.4E-03
Sr-90	5.1E-06	b	1.0E-05	5.0E-06	1.5E-04	1.7E-04
Zr-95	4.0E-04	b	5.0E-05	4.0E-04	2.5E-05	8.7E-04
Sb-124	2.0E-04	b	1.5E-04	2.0E-04	2.5E-05	5.7E-04
Cs-134	4.0E-03	b	1.5E-04	4.0E-03	2.3E-03	1.0E-02
Cs-136	3.0E-04	b	2.5E-05	3.0E-01	2.3E-04	8.5E-04
Cs-137	5.5E-03	b	3.0E-04	5.5E-03	4.5E-03	1.6E-02
Ba-140	4.5E-04	b	5.0E-03	4.0E-04	5.0E-05	5.9E-03
Ce-141	1.0E-04	b	3.0E-04	1.0E-04	1.3E-03	1.8E-03
			Total particulates			0.158
I-131	0.18	a	0.095	0.17	0.05	0.5
I-133	0.72	a	0.38	0.68	0.18	2.0
H-3	95	-	-	-	-	95
C-14	-	-	-	-	9.5	9.5

*Intermittent release, 24 2-hr releases per year from reactor building ventilation.

**Intermittent release, 4 24-hr releases per year from reactor building ventilation.

[a]Less than 1.0 Ci/yr for noble gases and C-14, less than 10^{-4} Ci/yr for iodine.

[b]Less than 1 percent of total for this nuclide.

Table D.2. Summary of atmospheric dispersion factors (χ/Q) and relative deposition values for maximum site boundary and receptor locations near S/HNP*

Location**	Source***	χ/Q (sec/m^3)	Relative deposition (m^{-2})
Nearest site boundary (0.50 km SE)	A	4.0×10^{-7}	8.3×10^{-9}
	B	8.7×10^{-7}	1.8×10^{-8}
	C	7.8×10^{-7}	1.6×10^{-8}
	D	2.2×10^{-5}	5.3×10^{-8}
	E	1.3×10^{-5}	4.5×10^{-8}
	F	4.8×10^{-6}	2.6×10^{-8}
Nearest residence garden, milk cow, and meat animal (12.1 km S)	A	5.6×10^{-9}	4.6×10^{-11}
	B	5.2×10^{-7}	4.3×10^{-9}
	C	2.8×10^{-7}	2.3×10^{-9}
	D	3.2×10^{-7}	1.1×10^{-10}
	E	1.2×10^{-7}	1.1×10^{-10}
	F	3.8×10^{-8}	6.0×10^{-11}

*The values presented in this table are corrected for radioactive decay and cloud depletion from deposition, where appropriate, in accordance with Regulatory Guide 1.111, Rev. 1, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light Water Reactors," July 1977.

**"Nearest" refers to that type of location where the highest radiation dose is expected to occur from all appropriate pathways.

***Sources:
- A - Reactor building vent, Unit 1 or 2, continuous release.
- B - Reactor building vent, Unit 1 or 2, intermittent release, 24 releases per year, 2 hours each release
- C - Reactor building vent, Unit 1 or 2, intermittent release, 4 releases per year, 24 hours each release.
- D - Turbine building vent, Unit 1 or 2, continuous release.
- E - Auxiliary building vent, Unit 1 or 2, continuous release.
- F - Radwaste building vent, both units, continous release.

Table D.3 Nearest pathway locations used for maximally exposed individual dose commitments for S/HNP

Location	Sector	Distance (km)
Nearest site boundary*	SE	1.1
Residence, garden, milk cow, and meat animal**	S	12.1

*Beta and gamma air doses, total body doses, and skin doses from noble gases are determined at the effluent-control boundaries in the sector where the maximum potential value is likely to occur.

**Dose pathways including inhalation of atmospheric radioactivity, exposure to deposited radionuclides, and submersion in gaseous radioactivity are evaluated at residences. This particular location includes doses from vegetable, milk, and meat consumption as well.

Table D.4 Calculated release of radioactive materials in liquid effluents from S/HNP Units 1 and 2

Nuclide	Ci/yr per reactor*	Nuclide	Ci/yr per reactor
Corrosion and activation products		Fission products (cont'd)	
Na-24	0.00519	Ru-103	0.00003
P-32	0.00033	Rh-103m	0.00003
Cr-51	0.01022	Ru-105	0.00027
Mn-54	0.00012	Ru-105m	0.00027
Mn-56	0.00318	Rh-105	0.00025
Fe-55	0.00176	Te-129m	0.00007
Fe-59	0.00005	Te-129	0.00004
Co-58	0.00035	Te-131m	0.00009
Co-60	0.00071	Te-131	0.00002
Cu-64	0.01341	I-131	0.00704
Ni-65	0.00002	Te-132	0.00001
Zn-65	0.00035	I-132	0.00355
Zn-69m	0.00096	I-133	0.04118
Zn-69	0.00102	I-134	0.00078
W-187	0.00023	Cs-134	0.00053
Np-239	0.00834	I-135	0.01291
		Cs-136	0.00033
		Cs-137	0.00141
Fission products		Ba-137m	0.00132
Br-83	0.00038	Cs-138	0.00015
Br-84	0.00001	Ba-139	0.00021
Sr-89	0.00018	Ba-140	0.00065
Sr-90	0.00001	La-140	0.00028
Sr-91	0.00134	La-141	0.00012
Y-91m	0.00085	Ce-141	0.00006
Y-91	0.00011	La-142	0.00016
Sr-92	0.00069	Ce-143	0.00003
Y-92	0.00171	Pr-143	0.00007
Y-93	0.00142		
Zr-95	0.00001	All others	0.00005
Nb-95	0.00001		
Nb-98	0.00003	Total (except H-3)	0.13361
Mo-99	0.00253	H-3	14.
Tc-99m	0.00616		

*Nuclides whose release rates are less than 10^{-5} Ci/yr per reactor are not listed individually but are included in "all others."

Table D.5 Summary of hydrologic transport and dispersion for liquid releases from the S/HNP facility*

Location	Transit time (hours)	Dilution factor
Individual Dose Calculations:		
Nearest drinking water intake (WPPSS, 15.3 km downstream)	2.5	8,000
Nearest sport-fishing location (0.15 km downstream)**	0	700
Nearest shoreline access (0.15 km downstream)**	0	700
Irrigated foods (1.6 km downstream)**	0.35	2,500
Population Dose Calculations:		
Nearest drinking water intake (WPPSS, 15.3 km downstream)***	2.5	8,000
Nearest sport-fishing location (0.8 km downstream)	0.17	1,900
Nearest shoreline access (Groves Park, 35 km downstream)†	8.0	11,000
Irrigated foods (9.6 km downstream)	2.0	6,000

*See Regulatory Guide 1.113, "Estimating Aquatic Dispersion of Effluents from Accidental and Routine Reactor Releases for the Purpose of Implementing Appendix I," April 1977.

**Assumed for purposes of an upper-limit estimate; detailed information not available.

***Assumed for purposes of an upper-limit estimate using estimated year 2000 composite population of Richland, Kennewick, and Pasco. Actual water intakes are further downstream.

†Includes swimming and boating.

Table D.6. Annual dose commitments to a maximally exposed individual near the S/HNP facility

Location	Pathway	Doses (mrems/yr per unit, except as noted)			
		Noble gases in gaseous effluents			
		Total body	Skin	Gamma air dose (mrads/yr per unit)	Beta air dose (mrads/yr per unit)
Nearest site boundary* (1.1 km SE)	Direct radiation from plume	3.1	6.0	4.7	3.0
		Iodine and particulates in gaseous effluents**			
		Total body	Organ		
Nearest*** site boundary (1.1 km SE)	Ground deposition	1.5 (T)	1.5 (C) (thyroid)		
	Inhalation	0.03 (T)	4.3 (C) (thyroid)		
Nearest residence, garden, milk cow, and meat animal (12.1 km S)	Ground deposition	0.004 (C)	0.004 (I) (thyroid)		
	Inhalation	<0.001 (C)	0.041(I) (thyroid)		
	Vegetable consumption	0.009 (C)	-		
	Cow milk consumption	0.005 (C)	0.38 (I) (thyroid)		
	Meat consumption	0.001 (C)	-		
		Liquid effluents			
		Total body	Organ		
Nearest drinking water at WNP-2	Water ingestion	<0.0001 (I)	0.0027 (I) (thyroid)		
Nearest fish near plant site boundary	Fish consumption	0.0062 (A)	0.095 (C) (bone)		
Nearest shore access near plant site boundary	Shoreline recreation	<0.0001 (T)	<0.0001 (T) (skin)		
Irrigated foods	Vegetable, milk, and meat ingestion	0.0004(C)	0.007 (C) (thyroid)		

*"Nearest" refers to that site boundary location where the highest radiation doses as a result of gaseous effluents have been estimated to occur.

**Doses are for the age group and organ that results in the highest cumulative dose for the location: A=adult, T=teen, C=child, I=infant. Calculations were made for these age groups and for the following organs: gastrointestinal tract, bone, liver, kidney, thyroid, lung, and skin.

***"Nearest" refers to the location where the highest radiation dose to an individual from all applicable pathways has been estimated.

Table D.7 Calculated Appendix I (10 CFR 50) dose commitments to a maximally exposed individual and to the population from operation of the S/HNP facility

Pathway	Annual dose per reactor unit	
	Individual	
	Appendix I design objectives*	Calculated doses**
Liquid effluents:		
Dose to total body from all pathways	3 mrems	0.006 mrems
Dose to any organ from all pathways	10 mrems	0.10 mrems (bone)
Noble-gas effluents (at site boundary):		
Gamma dose in air	10 mrads	4.7 mrads
Beta dose in air	20 mrads	3.0 mrads
Dose to total body of an individual	5 mrems	3.1 mrems
Dose to skin of an individual	15 mrems	6.0 mrems
Radioiodines and particulates:***		
Dose to any organ from all pathways	15 mrems	0.42 mrems (thyroid)
	Population within 80 km	
	Total body (person-rems)	Thyroid (person-rems)
Natural-background radiation†	42,600.	
Liquid effluents	0.06	0.30
Noble-gas effluents	0.35	0.35
Radioiodine and particulates	0.52	5.8

*Design objectives from Sections II.A, II.B, II.C, and II.D of Appendix I, 10 CFR Part 50 consider doses to maximally exposed individual and to population per reactor unit.

**Numerical values in this column were obtained by summing appropriate values in Table D.6. Locations resulting in maximum doses are represented here.

***Carbon-14 and tritium have been added to this category.

†"Natural Radiation Exposure in the United States," U.S. Environmental Protection Agency, ORP-SID-72-1, June 1972; using the average background dose for Washington of 108 mrems/yr, and year 2000 projected population of 394,000.

Table D.8 Annual total-body population dose commitments, year 2000 (both units of S/HNP)

Category	U.S. population dose commitment, (person-rems/yr)
Natural background radiation*	26,000,000*
Skagit/Hanford Nuclear Project Units 1 and 2 (combined) operation:	
Plant workers	1,480.
General public:	
Liquid effluents	1.8
Gaseous effluents	112.
Transportation of fuel and waste	6.

*Using the average U.S. background dose (100 mrem/yr) and year 2000 projected U.S. population from "Population Estimates and Projections," Series II, U.S. Department of Commerce, Bureau of the Census, Series P-25, No. 704, July 1977.

APPENDIX E

REBASELINING OF THE RSS RESULTS FOR BOILING-WATER REACTORS

APPENDIX E

REBASELINING OF THE RSS RESULTS FOR BOILING-WATER REACTORS

The results of the Reactor Safety Study (RSS) have been updated. The update was done largely to incorporate results of research and development conducted after the October 1975 publication of the RSS and to provide a baseline against which the risk associated with various LWRs could be consistently compared.

Primarily, the rebaselined RSS results reflect use of advanced modeling of the processes involved in meltdown accidents; i.e., the MARCH computer code modeling for transient and LOCA-initiated sequences and the CORRAL code used for calculating magnitudes of release accompanying various accident sequences. These codes* have led to a capability to predict the transient and small LOCA-initiated sequences that is considerably advanced beyond what existed at the time the Reactor Safety Study was completed. The advanced accident process models (MARCH and CORRAL) produced some changes in our estimates of the release magnitudes from various accident sequences in WASH-1400 (NUREG-75/0140). These changes primarily involved release magnitudes for the iodine, cesium and tellurium families of isotopes. In general, a decrease in the iodines was predicted for many of the dominant accident sequences while some increases in the release magnitudes for the cesium and tellurium isotopes were predicted.

Entailed in this rebaselining effort was the evaluation of individual dominant accident sequences as we understand them to evolve rather than the technique of grouping large numbers of accident sequences into encompassing, but synthetic, release categories as was done in WASH-1400. The rebaselining of the RSS also eliminated the "smoothing technique" that was criticized in the report by the Risk Assessment Review Group (sometimes known as the Lewis Report, NUREG/CR-0400).

In both of the RSS designs (PWR and BWR), the likelihood of an accident sequence leading to the occurrence of a steam explosion (α) in the reactor vessel was decreased. This was done to reflect both experimental and calculational indications that such explosions are unlikely to occur in those sequences involving small-sized LOCAs and transients because of the high pressures and temperatures expected to exist within the reactor coolant system during these scenarios. Furthermore, if such an explosion were to occur, there are indications that it would be unlikely to produce as much energy and the massive missile-caused breach of containment as was postulated in WASH-1400.

*It should be noted that the MARCH code was used on a number of scenarios in connection with the TMI-2 recovery efforts and for post-TMI-2 investigations to explore possible alternative scenarios that TMI-2 could have experienced.

For rebaselining of the RSS BWR design, the sequence TCγ' (described later) was explicitly included into the rebaselining results. The accident processes associated with the TC sequence had been erroneously calculated in WASH-1400.

In general, the rebaselined results led to slightly increased health impacts being predicted for the RSS BWR design. This is believed to be largely attributable to the inclusion of TCγ'.

In summary, the rebaselining of the RSS results led to small overall differences from the predictions in WASH-1400. It should be recognized that these small differences resulting from the rebaselining efforts are likely to be far outweighed by the uncertainties associated with such analyses.

The accident sequences identified in the rebaselining effort that are expected to dominate risk of the RSS-BWR design are briefly described below. These sequences are assumed to represent the approximate accident risks from the S/HNP design, although there are some design differences, particularly in the containment systems, between S/HNP and the plant for which the BWR rebaselining was done (Peach Bottom Unit 2). These design differences could affect the probabilities of accident sequences and the course that the sequences could take. The staff has initiated studies similar to the rebaselining study, and one of them was for a plant more similar to S/HNP. The report on this study, however, has not received final review by the staff (NUREG/CR-1659). After this review, and if the determination is made that the new results would be more valid than those resulting from the Peach Bottom study, the new results will be incorporated in the EIS for S/HNP at the operating license stage. However, the staff judges that the overall effect of all sequences used here is likely to be within the uncertainties discussed in Section 4.2.12.4.

Each of the accident sequences is designated by a string of identification characters in the same manner as in the RSS. Each character represents a failure in one or more of the important plant systems or features (see Table E-1). For example, in sequences having a γ' at the end of the string, it means a particular failure mode (overpressure) of the containment structure (and a rupture location) where a release of radioactivity takes place directly to the atmosphere from the primary containment. In the sequence having a γ at the end of the string, the containment failure mode is again by overpressure, but this time the rupture location is such that the release takes place into the reactor building (secondary containment) before discharging to the environment. In this latter (γ) case, the overall magnitude of radioactivity release is somewhat diminished by the deposition and plateout processes that take place within the reactor building.

TCγ' and TCγ

These sequences involve a transient event requiring shutdown of the reactor while at full power, followed by a failure to make the reactor subcritical (i.e., terminate power generation by the core). The containment is assumed to be isolated by these events; then, one or the other of the following chain of events is assumed to happen:

(1) High-pressure coolant injection system would succeed for some time in providing makeup water to the core in sufficient quantity to cope with the

rate of coolant loss through relief and safety valves to the suppression pool of the containment. During this time, the core power level varies, but causes substantial energy to be directed into the suppression pool; this energy is in excess of what the containment and containment heat removal systems are designed to cope with. Ultimately, in about 1-1/3 hours, the containment is estimated to fail by overpressure and it is assumed that this rather severe structural failure of the containment would disable the high-pressure coolant makeup system. It is assumed that, over a period of roughly 1-1/2 hours after breach of containment, the core would melt. This has been estimated to be one of the more dominant sequences in terms of accident risks to the public.

(2) A variant to the above sequence is one in which the high-pressure coolant injection system fails somewhat earlier and prior to containment overpressure failure. In this case, the earlier melt could result in a reduced magnitude of release because some of the fission products discharged to the suppression pool, via the safety and relief valves, could be more effectively retained if the pool remained subcooled. The overall accident consequences would be somewhat reduced in this earlier melt sequence, but ultimately the processes accompanying melt (e.g., noncondensibles, steam, and steam pressure pulses during reactor vessel melt-through) could cause overpressure failure (γ or γ') of the containment.

<u>$TW\gamma'$ and $TW\gamma$</u>

The TW sequence involves a transient in which the reactor has been shut down and it and the containment have been isolated from their normal heat sinks. In this sequence, the failure to transfer decay heat from the core and containment to an ultimate sink could ultimately cause overpressure failure of containment. Overpressure failure of containment would take many, many hours, allowing for repair or other emergency actions to be accomplished, but it is assumed that, should this sequence occur, the rather severe structural failure of containment would disable the systems (e.g., HPI, RCIC) providing coolant makeup to the reactor core. (In the RSS design, the service water system that conveys heat from the containment via RHR system to the ultimate sink was found to be the dominant failure contribution in the TW sequence.) After breach of containment, the core is assumed to melt.

<u>[$TQUV\gamma'$, $AE\gamma'$, $S_1E\gamma'$, $S_2E\gamma'$] and [$TQUV\gamma$, $AE\gamma$, $S_1E\gamma$, $S_2E\gamma$]</u>

Each of the accident sequences grouped into the two bracketed categories above are estimated to have quite similar consequence outcomes and these would be somewhat smaller than the $TC\gamma'$, $TC\gamma$, and $TW\gamma'$ sequences previously described. In essence, these sequences, which are characterized as in the RSS, involve failure to deliver makeup coolant to the core after a LOCA or a shutdown transient event requiring such coolant makeup. The core is assumed to melt down and the melt processes ultimately cause overpressure failure of containment (either γ' or γ). The overall risk from these sequences is expected to be dominated by the higher frequency initiating events [i.e., the small LOCA (S_2) and shutdown transients (T)].

References

NUREG/CR-0400, H. W. Lewis, et al., "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," September 1978.

NUREG/CR-1659, Vol. 4, S. W. Hatch, P. Cybulskis, and R. O. Wooton, "Reactor Safety Study Methodology Applications Program: Grand Gulf #1 BWR Power Plant," prepared by Sandia National Laboratories, October 1981.

Table E.1 Key to BWR accident sequence symbols

A	-	Rupture of reactor coolant boundary with an equivalent diameter of greater than 6 in.
C	-	Failure of the reactor protection system.
E	-	Failure of emergency core cooling injection.
Q	-	Failure of normal feedwater system to provide core makeup water.
S_1	-	Small pipe break with an equivalent diameter of about 2 to 6 in.
S_2	-	Small pipe break with an equivalent diameter of about 1/2 to 2 in.
T	-	Transient event.
U	-	Failure of HPCI or RCIC to provide core makeup water.
V	-	Failure of low-pressure ECCS to provide core makeup water.
W	-	Failure to remove residual core heat.
α	-	Containment failure due to steam explosion in vessel.
γ	-	Containment failure due to overpressure--release through reactor building.
γ'	-	Containment failure due to overpressure--release direct to atmosphere.

APPENDIX F

CONSEQUENCE MODELING CONSIDERATIONS

APPENDIX F

CONSEQUENCE MODELING CONSIDERATIONS

1. Evacuation Model

"Evacuation," used in the context of offsite emergency response in the event of substantial amounts of radioactivity release to the atmosphere in a reactor accident, denotes an early and expeditious movement of people to avoid exposure to the passing radioactive cloud and/or to acute ground contamination in the wake of the cloud passage. It should be distinguished from "relocation," which denotes a postaccident response to reduce exposure from long-term ground contamination. The Reactor Safety Study (RSS) (NUREG-75/014, formerly WASH-1400), consequence model contains provision for incorporating radiological consequence reduction benefits of public evacuation. The benefits of a properly planned and expeditiously carried out public evacuation would be well manifested in a reduction of early health effects associated with early exposure; namely, in the number of cases of early fatality (see Section 2) and acute radiation sickness that would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400 (NUREG-75/0141) as well as in NUREG-0340. However, the evacuation model that has been used herein is a version of the RSS model (modified by Sandia Laboratories in SAND78-0092) and is, to a certain extent, site-emergency-planning oriented. The modified version is briefly outlined below:

The model uses a circular area with a specified radius [the 10-mile plume exposure pathway emergency planning zone (EPZ)], with the reactor at the center. It is assumed that people living within portions of this area would evacuate if an accident should occur involving imminent or actual release of significant quantities of radioactivity to the atmosphere.

Significant atmospheric releases of radioactivity would in general be preceded by 1 or more hours of warning time (postulated as the time interval between the awareness of impending core melt and the beginning of the release of radioactivity from the containment building). For the purpose of calculation of radiological exposure, the model assumes that all people who live in a fan-shaped area (fanning out from the reactor), within the circular zone with the down-wind direction as its centerline--i.e., those people who would potentially be under the radioactive cloud that would develop following the release--would leave their residences after a lapse of a specified amount of delay time* and then evacuate. The delay time is reckoned from the beginning of the warning time and is recognized as the sum of the time required by the reactor operators to notify the responsible authorities; time required by the authorities to

*Assumed to be a time-constant value that would be the same for all evacuees.

interpret the data, decide to evacuate, and direct the people to evacuate; and time required for the people to mobilize and get under way.

The model assumes that each evacuee would move radially out in the downwind direction** with an average effective speed* (obtained by dividing the largest distance between the evacuees and the 10-mile ring by the average time taken to clear the zone after the delay time) over a fixed distance* from the evacuee's starting point.

The distance travelled by each evacuee is selected to be 15 miles (which is 5 miles more than the 10-mile plume exposure pathway EPZ radius). After reaching the end of the travel distance, the evacuee is assumed to receive no further radiation exposure.

The model incorporates a finite length of the radioactive cloud in the downwind direction that would be determined by the product of the duration over which the atmospheric release would take place and the average windspeed during the release. It is assumed that the front and the back of the cloud formed would move with an equal speed that would be the same as the prevailing windspeed; therefore, its length would remain constant at its initial value. At any time after the release, the concentration of radioactivity is assumed to be uniform over the length of the cloud. If the delay time were less than the warning time, then all evacuees would have a head start, i.e., the cloud would be trailing behind the evacuees initially. On the other hand, if the delay time were more than the warning time, then, depending on initial locations of the evacuees, there are possibilities that (1) an evacuee will still have a head-start, or (2) the cloud would be already overhead when an evacuee starts to leave, or (3) an evacuee would be initially trailing behind the cloud. However, this initial picture of cloud-people disposition would change as the evacuees travel depending on the relative speed and positions between the cloud and people. The cloud and an evacuee might overtake one another one or more times before the evacuee would reach his or her destination. In the model, the radial position of an evacuating person, either stationary or in transit, is compared to the front and the back of the cloud as a function of time to determine a realistic period of exposure to airborne radionuclides. The model calculates the time periods during which people are exposed to radionuclides on the ground while they are stationary and while they are evacuating. Because radionuclides would be deposited continually from the cloud as it passed a given location, a person who is under the cloud would be exposed to ground contamination less concentrated than if the cloud had completely passed. To account for this, at least in part, the revised model assumes that persons are (1) exposed to the total ground contamination concentration that is calculated to exist after complete passage of the cloud, after they are completely passed by the cloud; (2) exposed to half the calculated concentration when anywhere under the cloud; and (3) not exposed when they are in front of the cloud. Different values of the shielding protection factors for exposure from airborne radioactivity and contaminated ground have been used.

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*Assumed to be a time-constant value that would be the same for all evacuees.
**In the RSS consequence model, the radioactive cloud is assumed to travel radially outward only.

Results shown in Section 4.2.12.4 for accidents involving significant release of radioactivity to the atmosphere were based on the assumption that all people within the 10-mile plume exposure pathway EPZ would evacuate as indicated in the evacuation scenario described above. Because sheltering can be a mitigative feature, it is not expected that detailed inclusion of any facility (see Section 4.2.12.4) near a specific plant site, where not all persons would be quickly evacuated, would significantly alter the conclusions. For the delay time before evacuation, a value of 1 hour was used. The staff believes that this is achievable by appropriate planning. The staff estimated the effective speed of evacuation to be 1.85 meters per second (4.14 miles per hour) based upon the applicant's estimate of the time necessary to clear the 10-mile zone. As an additional emergency measure for the site, it was also assumed that all people beyond the evacuation distance who would be exposed to the contaminated ground would be relocated after passage of the plume. The period of ground exposure was taken to be the usual assumption of the RSS consequence model--if the calculated ground dose to the total marrow over a 7-day period would exceed 200 rems, then this high dose rate would be detected by actual field measurements following the plume passage, and people from those regions would then be relocated immediately. For this situation, the staff limits the period of ground dose calculation to 24 hours; otherwise, the period of ground exposure is limited to 7 days for calculation of early doses. However, it is reasonable that relocation could occur after a shorter time interval under some circumstances. The staff has made calculations for comparative purposes, assuming a reasonable relocation time delay of 8 hours, during which each person is assumed to receive additional exposure to the ground contamination, for those people beyond the evacuation distance and within 25 miles of the site. With a shorter relocation delay assumption, there is a great decrease in the total calculated risk of early fatality--from 5.6×10^{-4} (relocation after 1 or 7 days) to 7.3×10^{-6} early fatality per reactor-year (relocation after 8 hours in the 10-to 25-mile ring).

Figure F.1 shows, for comparison to Figure 4.45, a pessimistic case for which no early evacuation is assumed and all persons are assumed to be exposed for the first 24 hours following an accident and are then relocated. However, it is more realistic to expect that authorities would evacuate persons at distances from the site where exposures above the threshold for causing early fatalities could occur, regardless of the plume exposure pathway EPZ distance. Figure F.1 also illustrates the reduction in early fatalities that can occur by extending the area of evacuation to larger radii, such as 15 and 20 miles from the site. If it is assumed that all people within a distance of 25 miles are evacuated, the model predicts that there would be no early fatalities at any probability level for this site. However, complete evacuation in a timely manner may be difficult for the reasons noted in Section 4.2.12.4.

The model has the same provision for calculation of the economic cost associated with implementation of evacuation as in the orginal RSS model. For this purpose, the model assumes that for atmospheric releases of durations 3 hours or less, all people living within a circular area of 5-mile radius centered at the reactor plus all people within a 45° angular sector within the plume exposure pathway EPZ and centered on the downwind direction would evacuate and temporarily relocate. However, if the duration of release would exceed 3 hours, the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would evacuate and temporarily relocate. For either of these situations, the cost of evacuation and relocation is assumed to be $125 (1980 dollars) per person, which includes cost of food and temporary sheltering for a period of one week.

2. Early Health Effects Model

The medical advisors to the Reactor Safety Study proposed three alternative dose-mortality relationships that can be used to estimate the number of early fatalities that might result in an exposed population. These alternatives characterize different degrees of post-exposure medical treatment from "minimal," to "supportive," to "heroic," and are more fully described in NUREG-0340.

The calculational estimates of the early fatality risks presented in the texts of Section 4.2.12.4 and Section 1 of this appendix used the dose-mortality relationship that is based on the supportive treatment alternative. This implies the availability of medical care facilities and services for those exposed in excess of about 200 rems. At the extreme low probability end of the spectrum, i.e., at the one chance in ten million per reactor-year level, the number of persons involved might exceed the capacity of facilities for such services, in which case the number of early fatalities might have been somewhat underestimated. To gain perspective on this element of uncertainty, the staff has also performed calculations using the most pessimistic dose-mortality relationship based on minimal medical treatment and using identical assumptions regarding early evacuation and early relocation as made in Section 4.2.12.4. This shows 40 early fatalities at the one chance in one-million-per-reactor-year probability level, an increase from 660 to 3500 early fatalities at the one chance in ten-million-per-reactor-year level (see Table 4.39), and an overall three-fold increase in annual risk of early fatalities (see Table 4.40). The major fraction of the increased risk of early fatality in the absence of supportive medical treatment would occur within 15 miles and virtually all would be contained within 35 miles of the S/HNP site.

References

NUREG-75/014 (WASH-1400), "Reactor Safety Study," October 1975.

NUREG-0340, "Overview of the Reactor Safety Study Consequences Model," October 1977.

SAND78-0092, "A Model of Public Evacuation for Atmospheric Radiological Releases," Sandia National Laboratories, June 1978.

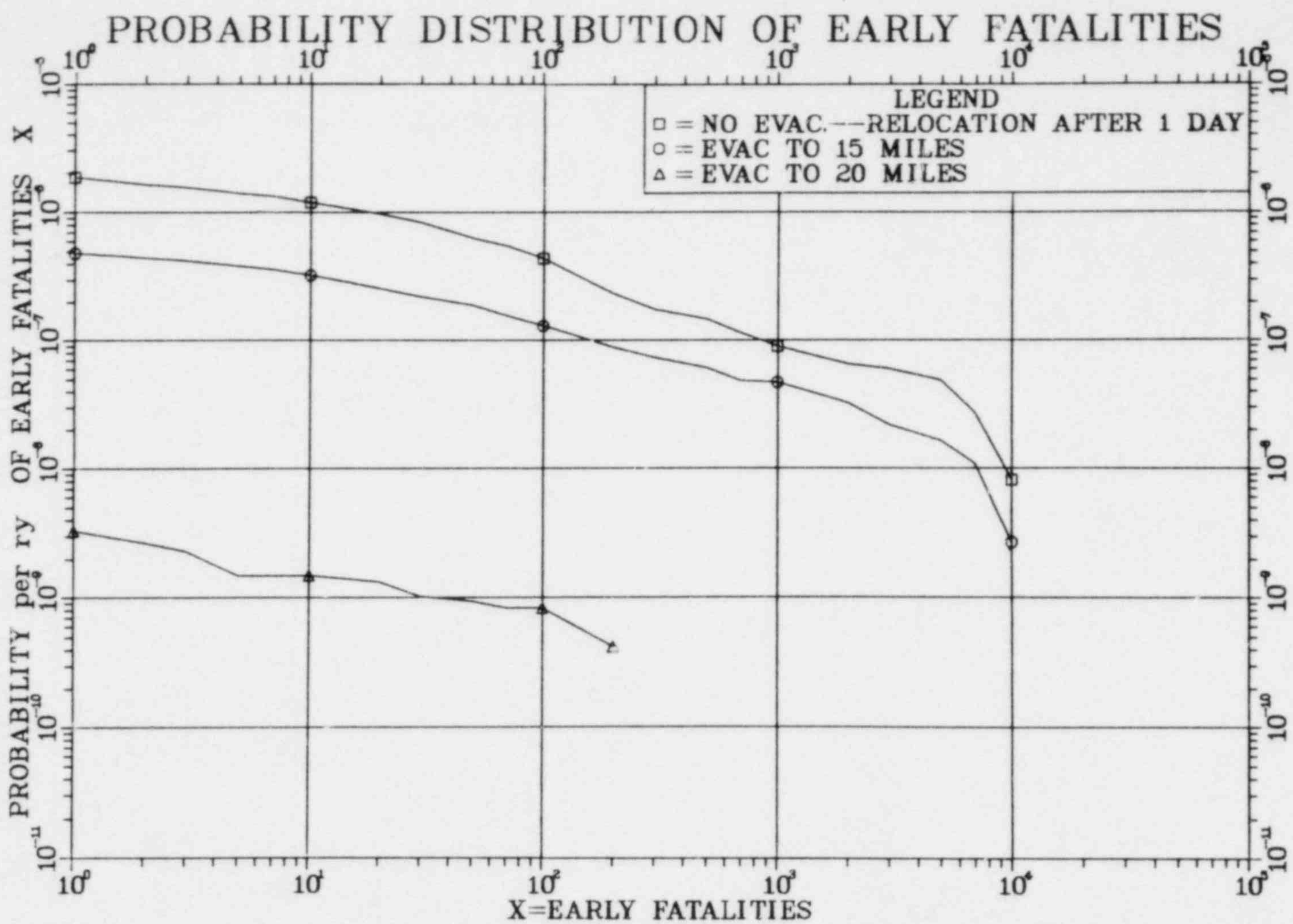


Figure F.1 Probability distribution of early fatalities
(Note: Please section on uncertainties in Section 4.2.12.4.)

APPENDIX G

PERMITS

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION X
1200 SIXTH AVENUE
SEATTLE, WASHINGTON 98101

REPLY TO ATTN OF: Mail Stop 524

JAN 25 1982

Mr. John Thielke
Puget Sound Power and Light Company
Puget Power Building
Bellevue, Washington 98009

Dear Mr. Thielke:

Our technical staff has reviewed the information regarding applicability of the Prevention of Significant Deterioration (PSD) requirements to the proposed standby diesel generators on the Hanford Reservation. Based on a review of that information, we have concluded that potential emissions from the project with control equipment indicated in your applicability determination request of January 28, 1982, will be less than 250 tons per year, the PSD threshold value for sources of this type. For this reason, we have determined that the construction of this facility is not subject to PSD review if a federally enforceable permit condition limiting emissions to less than the PSD threshold level is secured.

The easiest way to secure such a condition would be through the permit you must obtain from the Energy Facility Site Evaluation Council (EFSEC). While that permit generally does not limit emissions to less than SIP limits or those quantities necessary to prevent a violation of National Ambient Air Quality Standards (NAAQS), local and state agencies are generally very cooperative in assisting EPA and industry to limit emissions to below the PSD threshold levels. Assuming that the source obtains a federally enforceable permit through EFSEC with appropriate conditions, the project will not be subject to PSD and the attendant increment analysis.

If you have any questions, please contact Raymond Nye of my staff at (206) 442-7176.

Sincerely,

Michael M. Johnston, Chief
Permits Section

cc: Mike Landon, DOE
Al Ewing, WOO
William Fitch, EFSEC
Phil Cook, BFWWCAPCA

Draft 3/10/82-mg

NOTICE OF HEARING

Before the Washington State Energy
Facility Site Evaluation Council
on the
Proposed National Pollutant Discharge Elimination System
Permit Issuance
for the
Puget Sound Power & Light Company Skagit/Hanford
Nuclear Steam Electric Generating Plant No. I & II

In accordance with the provisions of Chapters 80.50 and 90.48 of the Revised Code of Washington and Chapter 463 of the Washington Administrative Code, a hearing will be held regarding the Proposed Permit issuance to the Puget Sound Power & Light Co. Skagit/HNP Project, Puget Power Building, Bellevue, Washington 98009, ("Applicant") on May 6 and 7, 1982 under the provisions of the National Pollutant Discharge Elimination System ("NPDES").

This notice serves also for the purpose of WAC 463-38-041, application received notice for the issuance of a permit for the wastewater discharge to the Columbia River approximately 12-miles north of Richland, Washington from the construction and operation of an electric power generating facility located approximately 3½ miles west of the point of discharge.

During the regular meeting of March 22, 1982 the Council adopted a Proposed Permit, and made the Tentative Determination to issue same, subject to appropriate modification of adjustment as the hearing record and/or the Federal Environmental Protection Agency review may require.

The purpose of the Tentative Determination and Proposed Permit is to serve as a notice to the Applicant and the general public of the Council's proposed decision. Copies of the Tentative Determination and accompanying Fact Sheet explaining the proposed decisions and effluent limitations (limit on the amount and concentration of individual pollutants) following therefrom, as well as the Proposed Permit, will be placed on file in the regular Council offices for inspection and copying by any interested member of the public. Copies will be also mailed to persons upon request. Any person is invited to submit written comments on the Council's Tentative Determination within thirty days immediately following publication of this notice. Comments should be mailed to:

William L. Fitch, Executive Secretary
Energy Facility Site Evaluation Council
Mail Stop PY-11
Olympia, WA 98504
Telephone: (206) 459-6490

NOTICE Is hereby given that a public hearing shall be conducted as a contested case in accordance with provisions of Chapters 80.50 and 34.04 of the Revised Code of Washington and Chapter 463 of the Washington Administrative Code before the Council on the Tentative Determination and the Proposed Permit, such hearing commencing at 1:30 p.m., May 6, 1982, in the Pasco Public Library, 1320 West Hopkins, Pasco, Washington. The hearing shall continue as the Council may deem necessary at the Hearing Room of the Energy Facility Site Evaluation Council at 4224 6th Avenue S.E., Lacey, Washington. Persons who wish to become parties by intervention in the contested case as to this matter may do so by timely application in writing to the Council as is set out in the Washington Administrative Code Sections 463-30-400 and 463-30-410. Other persons who only wish to testify will be presented that opportunity to at the above time and place and if sufficient numbers of persons appear to make accommodations at that time unattainable, additional time will be scheduled.

On conclusion of the hearing, the Council will consider the information before it and reach a decision to either deny the permit or to issue the permit in such form as it considers appropriate.

Washington State Energy Facility
Site Evaluation Council

By________________________________

William L. Fitch
Executive Secretary

Dated at Olympia, Washington and effective this 22nd day of March, 1982.

SKAGIT/HANFORD NUCLEAR PROJECT
EFSEC Application No. 81-1

<u>NPDES PERMIT PROCEEDING - SCHEDULE</u>

<u>March</u>

8 (Mon)	EFSEC Staff - review draft permit and schedule
11 (Thur)	CCC review permit draft
12 (Fri)	EPA (& EFSEC) Staff - review draft permit
17 (Wed)	EFSEC Staff - mail agenda with draft permit & proposed order
22 (Mon)	EFSEC Meeting - consider order: A. approving draft permit (tentative decision) B. setting dates for: 1) pre-filling testimony 2) prehearing conference 3) contested case hearing
31 (Wed)	Last date for intervention petitions

<u>April</u>

7 (Wed)	Puget answers to intervention petitions
12 (Mon)	EFSEC Meeting - decision on intervention petitions
19 (Mon)	EFSEC Special Meeting (?) - complete above All parties prefile testimony
23 (Fri)	Prehearing conference

<u>May</u>

6-7	Hearing begins at 1:30 p.m. in the Pasco Public Library, 1320 West Hopkins, Pasco, WA
10 (Mon)	EFSEC Meeting

Draft 3/10/82-mg

FACT SHEET

Proposed Issuance of NPDES Permit

PUGET SOUND POWER & LIGHT CO. SKAGIT/HNP

A. Discharge Location

Figures F-1 and F-3 depict, respectively, the project and discharge locations.

B. Quantitative Description of the Discharge

1. Average Daily Discharge = 24,500 GPD
2. Discharge Temperatures

	Maximum Effluent	Minimum Effluent	Average Effluent
Summer°F	80	66	73
Winter°F	70	57	62

3. Discharge Parameters

a. Low Volume Waste Sources Portion of Discharge

Parameter	Effluent Limitations
Total suspended solids (lb/day)	6.1
pH	Between 6.5 and 8.5 at all times
Oil and Grease (lb/day)	3.1
Flow (GPD)	24,500

b. Recirculated Cooling Water Blowdown Portion of Discharge

Parameter	Effluent Limitations Daily Average
Temperature	The temperature of the recirculated cooling water blowdown shall not exceed, at any time, the lowest temperature of the recirculated cooling water prior to the addition of the makeup water.
Total Residual Chlorine (mg/l)	.11
(#/day)	4.62
pH	Between 6.5 an 8.5 at all times
Flow (GPD)	2.0×10^6

C. Tentative Determination (WAC 463-38-033)

The Council by their action during the March 22, 1982 regular meeting intends to issue the proposed permit, Attachment 1 hereto, subject to such modification or adjustment as the hearing record and/or the EPA review may require.

D. Water Quality Classification of Receiving WAter:

Columbia River - River mile 361.5 Class A

1. Characteristic Uses of Columbia River at River Mile 361.5 (Washington State Water Quality Standards)

   a. Water supply
   b. Wildlife habitat, stock watering

c. General recreation and aesthetic enjoyment

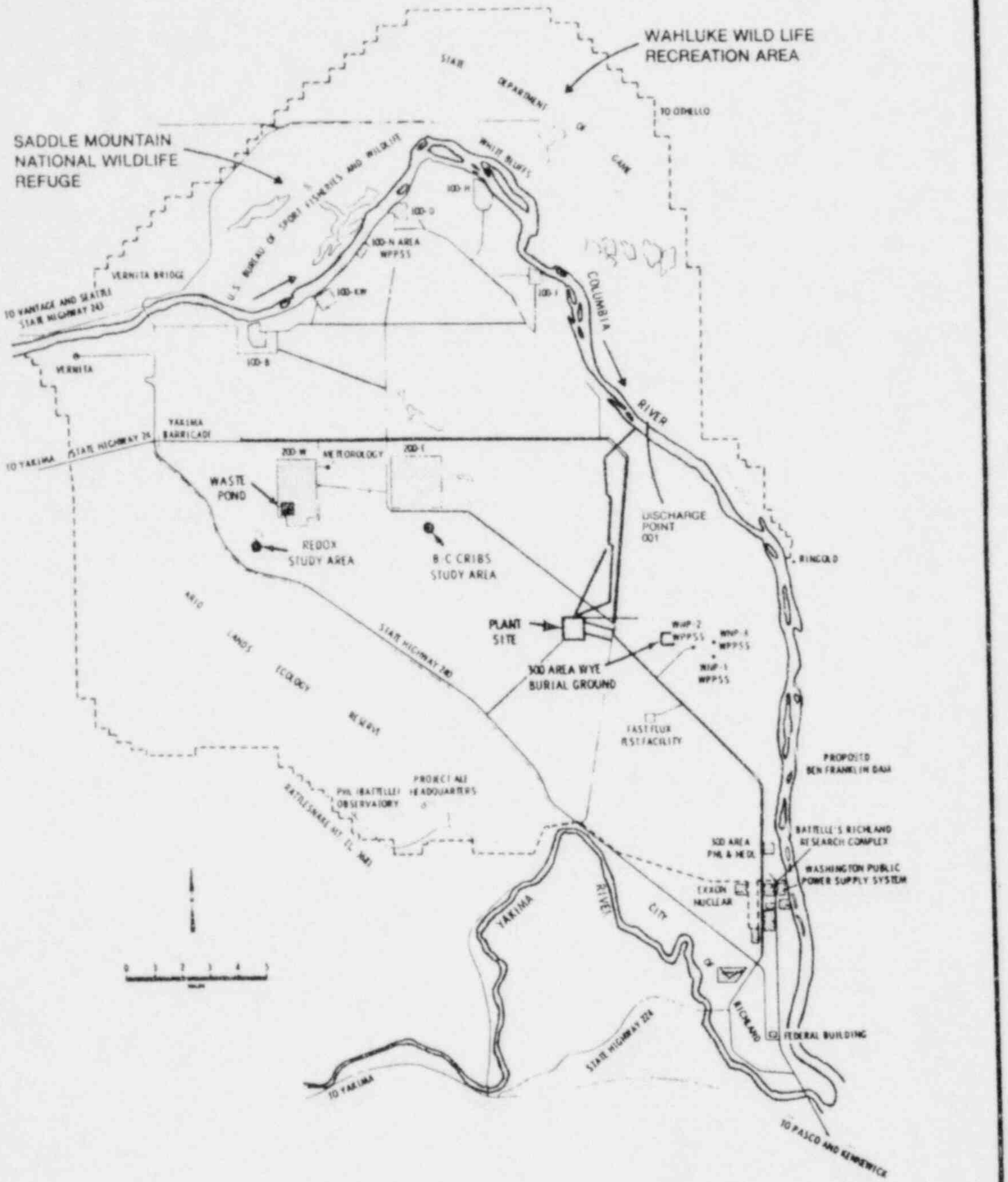
d. Commerce and navigation

e. Fish and shellfish reproduction, rearing and harvesting

2. Effluent Standards and Limitations

"Development Document for Effluent Limitations Guidelines and New Source Performance Standards for Steam Electric Power Generating Point Source Category" U.S. EPA January 1980. EPA Effluent Guidelines and Standards for Steam Electric Power Generating, 40 CFR 423. (Attachment 5)

E. Notice was given on March 22, 1982 pursuant to WAC 463-38-041 and 042 providing a 30-day comment period in addition to the opportunity for any person to be heard, pursuant to WAC 463-30, during a contested case hearing which is to commence at 1:30 p.m. on May 6, 1982 at the Pasco Public Library, 1320 West Hopkins, Pasco, Washington..



PUGET SOUND POWER & LIGHT COMPANY
SKAGIT / HANFORD NUCLEAR PROJECT
NATIONAL POLLUTANT DISCHARGE
ELIMINATION SYSTEM PERMIT

LOCATION MAP

FIGURE F-1

Issuance Date:
Expiration Date:

PROPOSED

NATIONAL POLLUTANT DISCHARGE ELIMINATION SYSTEM WASTE DISCHARGE PERMIT

State of Washington
Energy Facility Site Evaluation Council
Olympia, Washington 98504

In Compliance With the Provisions of
Chapter 155, Laws of 1973, (RCW 90.48) as amended

and

The Clean Water Act, as amended
Public Law 95-217

PUGET SOUND POWER & LIGHT COMPANY SKAGIT/HNP
Puget Power Building
Bellevue, Washington 98009

Plant Location

Section 33, T.12N, R27E W.M.
North of Richland
Benton County, Washington

Industry Type: Nuclear Steam

Electric Generating Plant
(Skagit/Hanford I and II)

Receiving Water:

Columbia River

Discharge Location:

S/HNP 1 & 2 001
Latitude: 46°34'59" N
Longitude: 119°22'01" W

Water Segment No.: 26-03-00

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is authorized to discharge in accordance with the special and general conditions which follow.

Approved: March 22, 1982

Nicholas D. Lewis, Chairman
Energy Facility Site
Evaluation Council

SPECIAL CONDITIONS

S.1 EFFLUENT LIMITATIONS AND MONITORING REQUIREMENTS

During the period beginning with the issuance of this permit and lasting until the expiration date of this permit, the permittee is authorized to discharge effluents from Outfall Discharge Serial Number 001 subject to the following limitations and monitoring requirements:

A. LOW VOLUME WASTE SOURCES PORTION OF S/HNP 1 & 2 DISCHARGE SERIAL NUMBER 001

PARAMETER	EFFLUENT LIMITATIONS(1)		MONITORING REQUIREMENTS (2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Total Suspended Solids (lb/day)	72.1[3]	6.1	Weekly	Grab
pH	Between 6.5 and 8.5 at all times		Continuous	N/A
Oil and Grease (lb/day)	14.4[4]	3.1	Weekly	Grab
Flow (GPD)[5]	86,400	24,500	Continuous while discharging	N/A

Compliance with these limitations shall be determined by monitoring all low volume waste sources including liquid radwaste prior to their confluence with the recirculated cooling water.

Note (1): These limitations apply regardless of whether one, two or no units are in operation.

Note (2): Permittee shall monitor the effluent prior to confluence with other inplant streams.

Note (3): The maximum concentration of total suspended solids shall not exceed 100 mg/l at any time

Note (4): The maximum concentration of oil and grease shall not exceed 20 mg/l at any time

Note (5): Permittee is allowed on an intermittent basis to discharge subject to the provisions of G.5 herein to a maximum of 504,000 GPD additional flow originating from the liquid radwaste treatment system.

B. RECIRCULATED COOLING WATER BLOWDOWN PORTION OF S/HNP 1 & 2 DISCHARGE SERIAL NUMBER 001

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS(1)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Temperature	Note (2)		Continuous	N/A
Total Residual Chlorine (mg/l)	0.14(3)		Continuous(4)	N/A
(lb/day)	4.62			
pH	Between 6.5 and 8.5 at all times		Continuous(5)	N/A
Flow (GPD)	7.9×10^6	4.00×10^6	Continuous	N/A

Note (1): Permittee shall monitor the effluent prior to confluence with other inplant streams.

Note (2) The temperature of the recirculated cooling water blowdown shall not exceed, at any time, the lowest temperature of the recirculated cooling water prior to the addition of the makeup water.

Note (3): Upon initiating chlorination of a unit, permittee shall terminate all discharges from the recirculating cooling water system for that unit to the receiving water until the total residual chlorine concentration has been at or below 0.14 mg/l for 15 minutes. For compliance chlorine will be measured at and will be characteristic of the unit being chlorinated.

Note (4) Continuous recording of total residual chlorine is required during periods of active chlorination and thereafter until chlorine residual reaches an undetectable level. If continuous chlorine monitor malfunctions, grab samples will be analyzed by amperometric titration every 15 minutes until Total Residual Chlorine reaches 0.14 mg/l maximum prior to discharge.

Note (5) Permittee shall include an alarm system for the pH control to provide

C. HYDROSTATIC TESTING AND FLUSHING WASTES PORTION OF S/HNP 1 & 2 DISCHARGE SERIAL NUMBER 001 PER UNIT

PARAMETER	EFFLUENT LIMITATIONS (1)		MONITORING REQUIREMENTS (2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Total Suspended Solids (lbs/day)	83.5	25	3 times per day when discharging	Grab
pH	Between 6.5 and 8.5 at all times		Continuous	N/A
Flow (GPD)	0.1×10^6	0.1×10^6	Each discharge	N/A

Note (1): No water contaminated with oil and grease or chemical cleaning agents shall be discharged

Note (2): Permittee shall monitor the effluent prior to confluence with other inplant streams.

GENERAL CONDITIONS

G1. No discharge of polychlorinated biphenyl, such as transformer fluid, is permitted. There shall be nodischarge of water treatment chemicals which contain any of the 129 priority pollutants listed in Appendix B to proposed 40 CFR Part 423 (45 Fed. Reg. 68355-56, October 14, 1980). The discharge of water treatment additives which are not identified in the permit application shall be subject to Council approval.

G2. All discharges and activities authorized herein shall be consistent with the terms and conditions of this permit. Permittee is authorized to discharge those pollutants which are: (1) contained in the raw water supply, (2) entrained from the atmosphere, or (3) quantitatively and qualitatively identified in the permit application; except as modified or limited by the special or general conditions of this permit. However, the effluent concentrations in permittee's waste water shall be determined on a gross basis and the effluent limitations in this permit mean gross concentrations and not net addition of pollutants. The discharge of any pollutant more frequently than or at a level in excess of that authorized by this permit shall constitute a violation of the terms and conditions of this permit.

G3. The effluent limitation for the total combined flow discharged from Discharge No. 001 for any particular pollutant, excluding pH, shall be the sum of the amounts for each contributing inplant stream as authorized by the special or general conditions of this permit.

G4. Permittee shall not discharge any effluent which shall cause a violation of any applicable State of Washington Water Quality Criteria or standards contained in WAC 173-201, as they exist now or hereafter are amended, outside the mixing zone whose boundaries shall be:

a. The boundaries in the vertical plane shall extend from the receiving water surface to the riverbed;

b. The upstream and downstream boundaries shall be 50 feet and 300 feet, respectively, from the center line of the discharge point; and

c. The lateral boundaries shall be separated by 100 feet.

G5. Excess process water shall not be discharged to the river unless sampling and analysis has demonstrated that the water complies with the applicable regulations on liquid radioactive discharges. Excess process water not meeting these conditions shall be processed in the liquid radwaste treatment system prior to discharge to the river. The liquid radwaste treatment system shall provide facilities with 24-hour retention capabilities and liquids may be discharged only after sampling and analysis demonstrate that all applicable regulations are complied with. No other liquid radwaste shall be discharged at the holding facilities.

G6. Permittee shall notify the Council no later than 120 days before the date of anticipated first discharge from Discharge 001 under this permit.

G7. As used in this permit, the following terms are as defined herein:

a. The "daily maximum" discharge means the total discharge by weight during any calendar day, or in the case of concentration limitation, "daily maximum" means the maximum concentration of samples collected during any calendar day.

b. The "daily average" discharge means the total discharge by weight during a calendar month divided by the number of days in the month that the respective discharges occur. Where less than daily sampling is required by the permit, the daily average discharge shall be determined by the summation of the measured daily discharges by weight divided by the number of days during the calendar month when the measurements were made.

c. "Composite sample" is a sample consisting of a minimum of six grab samples collected at regular intervals over a normal operating day and combined proportional to flow, or a sample continuously collected proportional to flow over a normal operating day.

d. "Grab sample" is an individual sample collected in a period of less than 15 minutes.

G8. Permittee shall study the use of chlorine for biofouling prevention in cooling tower operation for one year. The purpose of the study shall be to determine the minimum daily discharge of free available and total residual chlorine which will allow efficient plant operation. The results of this study will be evaluated by the Council for use in the potential modification of this permit.

G9. Permittee shall install an alternative electric power source capable of operating any electrically powered pollution control facilities; or, alternatively, permittee shall certify to the Council that the terms and conditions of this permit will be met in case of a loss of primary power to the pollution control equipment by controlling production.

G10. The Additional Federal General Conditions set forth on pages (9) through (21) of this permit are hereby incorporated in this permit.

ADDITIONAL FEDERAL GENERAL CONDITIONS

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II. MONITORING, RECORDING AND REPORTING REQUIREMENTS

A. Representative Sampling. Samples taken in compliance with the monitoring requirements established under this permit shall be collected from the effluent streams prior to discharge into the receiving waters. Samples and measurements shall be representative of the volume and nature of the monitored discharge.

B. Monitoring Procedures. Monitoring must be conducted according to test procedures approved under 40 CFR Part 136, unless other test procedures have been specified in this permit.

C. Penalties for Tampering. The Clean Water Act (33 USC Article 1251 et sec) provides that any person who falsifies, tampers with, or knowingly renders inaccurate, any monitoring device or method required to be maintained under this permit shall, upon conviction, be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

D. Reporting of Monitoring Results. Monitoring results shall be summarized each month on a Discharge Monitoring Report (DMR) form (EPA No. 3320-1). The reports shall be submitted quarterly and are to be postmarked by the 28th day of the month following the end of the quarter. The first report is due by the 28th day of the month following the end of the quarter in which the first discharge under this permit occurs. Legible copies of these, and all other reports, shall be signed and certified in accordance with the requirements of Part IV.G Signatory Requirements, and be submitted in duplicate to EPA and the Council at the following addresses:

U.S. EPA Region #10
Attn: Water Compliance Section
M/S 521
1200 6th Avenue
Seattle, WA 98101

EFSEC
Attn: Executive Secretary
Mail Stop PY-11
Olympia, WA 98504

E. Compliance Schedules. Reports of compliance or non-compliance with, or any progress reports on interim, and final requirements contained in any Compliance Schedule of this permit shall be submitted no later than 14 days following each schedule date.

F. Additional Monitoring by the Permittee. If the permittee monitors any pollutant more frequently than required by this permit, using test procedures approved under 40 CFR 136 or as specified in this permit, the results of this monitoring shall be included in the calculation and reporting of the data submitted in the DMR. Such increased frequency shall also be indicated.

G. Records Contents. Records of monitoring information shall include:

1. The date, exact place, and time of sampling or measurements;

2. The individual(s) who performed the sampling or measurements;

3. The date(s) analyses were performed;

4. The individual(s) who performed the analyses;

5. The analytical techniques or methods used; and

6. The results of such analyses.

H. Retention of Records. The permittee shall retain records of all monitoring information, including all calibration and maintenance records and all original strip chart recordings for continuous monitoring instrumentation, copies of all reports required by this permit, and records of all data used to complete the application for this permit, for a period of at least 3 years from the date of the sample, measurement, report or application. This period may be extended by request of the Council at any time.

I. Twenty-four Hour Notice of Noncompliance Reporting.

1. The following occurrences of noncompliance shall be reported orally within 24 hours from the time the permittee becomes aware of the circumstances:

   a. Any noncompliance which may endanger health or the environment.

   b. Any unanticipated bypass which exceeds any effluent limitation in the permit. (See Part III.G. Bypass of Treatment Facilities.)

   c. Any upset which exceeds any effluent limitation in the permit. (See Part III.H. Upset Conditions.)

   d. Violation of a maximum daily discharge limitation for any of the pollutants listed in the permit to be reported within 24 hours.

2. A written submission shall also be provided within 5 days of the time that the permittee becomes aware of the circumstances. The written description shall contain:

   a. A description of the noncompliace and its cause;

   b. The period of noncompliance, including exact dates and times;

   c. The estimated time noncompliance is expected to continue if it has not been corrected; and

   d. Steps taken or planned to reduce, eliminate, and prevent reoccurrence of the noncompliance.

3. The Council may waive the written report on a case-by-case basis if the oral report has been received within 24-hours.

4. Reports shall be submitted to the addresses in Part II.D. Reporting of Monitoring Results.

J. Other Noncompliance Reporting. Instances of noncompliance not required to be reported within 24 hours shall be reported at the time that monitoring reports for Part II.D. are submitted. The reports shall contain the information listed in Part II.I.2.

K. Inspection and Entry. The permittee shall allow the Council, or an authorized representative, upon the presentation of credentials and other documents as may be required by law, to:

1. Enter upon the permittee's premises where a regulated facility or activity is located or conducted, or where records must be kept under the conditions of this permit;

2. Have access to and copy, at reasonable times, any records that must be kept under the conditions of this permit;

3. Inspect at reasonable times any facilities, equipment (including monitoring and control equipment), practices, or operations regulated or required under this permit; and

4. Sample or monitor at reasonable times, for the purpose of assuring permit compliance or as otherwise authorized by the Clean Water Act, any substances or parameters at any location.

III. COMPLIANCE RESPONSIBILITIES

A. Duty to Comply. The permittee must comply with all conditions of this permit. Any permit noncompliance constitutes a violation of the Clean Water Act and is grounds for enforcement action; for permit termination, revocation and reissuance, or modification; or for denial of a permit renewal application. The permittee shall give advance notice to the Council of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

B. Penalties for Violations of Permit Conditions. The Clean Water Act provides that any person who violates a permit condition implementing sections 301, 302, 306, 307, 308, 318, or 405 of the Clean Water Act is subject to a civil penalty not to exceed $10,000 per day of such violation. Any person who willfully or negligently violates permit conditions implementing sections 301, 302, 306, 307, or 308 of the Clean Water Act is subject to a fine of not less than $2,500, nor more than $25,000 per day of violation, or by imprisonment for not more than 1-year, or both. Except as provided in permit conditions on Part III.G. Bypass of Treatment Facilities and Part

III.F. Upset Conditions. nothing in this permit shall be construed to relieve the permittee of the civil or criminal penalties for noncompliance.

C. Duty to Halt or Reduce Activity. Upon reduction, loss, or failure of the treatment facility, the permittee shall, to the extent necessary to maintain compliance with its permit, control production or all discharges or both until the facility is restored or an alternative method of treatment is provided. This requirement applies, for example, when the primary source of power of the treatment facility fails or is reduced or lost. It shall not be a defense for a permittee in an enforcement action that it would have been necessary to halt or reduce the permitted activity in order to maintain compliance with the conditions of this permit.

D. Duty to Mitigate. The permittee shall take all reasonable steps to minimize or correct any adverse impact on the environment resulting from noncompliance with this permit.

E. Proper Operation and Maintenance. The permittee shall at all times properly operate and maintain all facilities and systems of treatment and control (and related appurtenances) which are installed or used by the permittee to achieve compliance with the conditions of this permit. Proper operation and maintenance includes effective performance, adequate funding, adequate operator staffing and training, and adequate laboratory and process controls, including appropriate quality assurance procedures. This provision requires the operation of backup or auxiliary facilities or similar systems only when necessary to achieve compliance with the conditions of the permit.

F. Removed Substances. Solids, sludges, filter backwash, or other pollutants removed in the course of treatment or control of wastewaters shall be disposed of in a manner such as to prevent any pollutant from such materials from entering navigable waters.

G. Bypass of Treatment Facilities:

1. Bypass not exceeding limitations. The permittee may allow any bypass to occur which does not cause effluent limitations to be exceeded, but only if it

also is for essential maintenance to assure efficient operation. These bypasses are not subject to the provisions of paragraphs 2 and 3 of this section.

2. Notice

a. Anticipated bypass. If the permittee knows in advance of the need for a bypass, it shall submit prior notice, if possible at least 10 days before the date of the bypass.

b. Unanticipated bypass. The permittee shall submit notice of an unanticipated bypass as required under Part II.I. Twenty-Four Hour Notice of Noncompliance Reporting.

3. Prohibition of bypass

a. Bypass is prohibited and the Council may take enforcement action against a permittee for a bypass, unless:

(1) The bypass was unavoidable to prevent loss of life, personal injury, or severe property damage;

(2) There were no feasible alternatives to the bypass, such as the use of auxiliary treatment facilities, retention of untreated wastes, or maintenance during normal periods of equipment downtime. This condition is not satisfied if the permittee could have installed adequate backup equipment to prevent a bypass which occurred during normal periods of equipment downtime or preventive maintenance; and

(3) The permittee submitted notices as required under paragraph 2 of this section.

b. The Council may approve an anticipated bypass, after considering its adverse effects, if the Council determines that it will meet the three conditions listed above in paragraph 3a of this section.

H. Upset Conditions

1. Effect of an upset. An upset constitutes an affirmative defense to an action brought for noncompliance with technology based permit effluent limitations if the requirements of paragraph 2 of this section are met. No determination made during administrative review of claims that noncompliance was caused by upset, and before an action for noncompliance, is final administrative action subject to judicial review.

2. Conditions necessary for a demonstration of upset. A permittee who wishes to establish the affirmative defense of upset shall demonstrate, through properly signed, contemporaneous operating logs, or other relevant evidence that:

   a. An upset occurred and that the permittee can identify the specific cause(s) of the upset;

   b. The permitted facility was at the time being properly operated; and

   c. The permittee submitted notice of the upset as required under Part II.I. Twenty-Four Hour Notice of Noncompliance Reporting.

   d. The permittee complied with any remedial measures required under Part III.D. Duty to Mitigate.

3. Burden of proof. In any enforcement proceeding, the permittee seeking to establish the occurrence of an upset has the burden of proof.

I. Toxic Pollutants. The permittee shall comply with effluent standards or prohibitions established under Section 307(a) of the Clean Water Act for toxic pollutants within the time provided in the regualtions that establish those standards or prohibitions, even if the permit has not yet been modified to incorporate the requirement.

IV. GENERAL REQUIREMENTS

A. Changes in Discharge of Toxic Substances (Not Applicable-Prohibited by Condition G2)

B. Planned Changes. The permittee shall give notice to the Council, as soon as possible, of any planned physical alterations or additions to the permitted facility. The permittee shall also give advance notice of any planned changes in the permitted facility or activity which may result in noncompliance with permit requirements.

C. Permit Actions. This permit may be modified, revoked and reissued, or terminated for cause. The filing of a request by the permittee for a permit modification, revocation and reissuance, or termiantion, or a notification of planned changes or anticipated noncompliance, does not stay any permit condition.

D. Duty to Reapply. If the permittee wishes to continue an activity regulated by this permit after the expiration date of this permit, the permittee must apply for and obtain a new permit. The application should be submitted at least 180 days before the expiration date of this permit.

E. Duty to Provide Information. The permittee shall furnish to the Council, within a reasonable time, any information which the Council may request to determine whether cause exists for modifying, revoking and reissuing, or terminating this permit, or to determine compliance with this permit. The permittee shall also furnish to the Council, upon request, copies of records required to be kept by this permit.

F. Other Information. When the permittee becomes aware that it failed to submit any relevant facts in a permit application, or submitted incorrect information in a permit application or any report to the Council, it shall promptly submit such facts or information.

G. Signatory Requirements. All applications, reports or information submitted to the Council shall be signed and certified.

1. All permit applications shall be signed as follows:

   a. For a corporation: by a principal executive officer of at least the level of vice president;

b. For a partnership or sole proprietorship: by a general partner or the proprietor, respectively;

c. For a municipality, State, Federal, or other public agency: by either a principal executive officer or ranking elected official.

2. All reports required by the permit and other information requested by the Council shall be signed by a person described above or by a duly authorized representative of that person. A person is a duly authorized representative only if:

a. The authorization is made in writing by a person described above and submitted to the Council.

b. The authorization specified either an individual or a position having responsibility for the overall operation of the regulated facility or activity, such as the position of plant manager, operator of a well or a well field, superintendent, or position of equivalent responsibility. (A duly authorized representative may thus be either a named individual or any individual occupying a named position.)

3. Changes to authorization. If an authorization under paragraph IV.G.2. is no longer accurate because a different individual or position has responsibility for the overall operation of the facility, a new authorization satisfying the requirements of paragraph IV.G.2. must be submitted to the Council prior to or together with any reports, information, or applications to be signed by an authorized representative.

4. Certification. Any person signing a document under this section shall make the following certification:

"I certify under penalty of law that I have personally examined and am familiar with the information submitted in this document and all attachments and that, based on my inquiry of those individuals immediately responsible for obtaining the information, I believe that the information is true, accurate, and complete. I am aware that there are significant penalties for submitting false information, including the possibility of fine and imprisonment."

H. Penalties for Falsification of Reports. The Clean Water Act provides that any person who knowingly makes any false statement, representation, or certification in any record or other document submitted or required to be maintained under this permit, including monitoring reports or reports of compliance or noncompliance shall, upon conviction be punished by a fine of not more than $10,000 per violation, or by imprisonment for not more than 6 months per violation, or by both.

I. Availability of Reports. Except for data determined to be confidential under 40 CFR Part 2, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the offices of the Energy Facility Site Evaluation Council and the Regional Administrator. As required by the Act, permit applications, permits and effluent data shall not be considered confidential.

J. Oil and Hazardous Substance Liability. Nothing in this permit shall be construed to preclude the institution of any legal action or relieve the permittee from any responsibilities, liabilities or penalties to which the permittee is or may be subject under Section 311 of the Act.

K. Property Rights. The issuance of this permit does not convey any property rights of any sort, or any exclusive privileges, nor does it authorize any injury to private property or any invasion of personal rights, nor any infringement of Federal, State or local laws or regulations.

L. Severability. The provisions of this permit are severable, and if any provision of this permit, or the application of any provision of this permit to any circumstance, is held invalid, the application of such provision to other circumstances, and the remainder of this permit, shall not be effected thereby.

M. Transfers. This permit may be automatically transferred to a new permittee if:

1. The current permittee notifies the Council at least 30 days in advance of the proposed transfer date;

2. The notice includes a written agreement between the existing and new permittees containing a specific date for transfer of permit resonsibility, coverage, and liability between them; and

3. The Council does not notify the existing permittee and the proposed new permittee of his or her intent to modify, or revoke and reissue the permit. If this notice is not received, the transfer is effective on the date specified in the agreement mentioned in paragraph 2. above.

------------------------------E N D------------------------------

BEFORE THE STATE OF WASHINGTON

ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of the Application of the Puget Sound Power and Light Company A Washington Corporation	))))))))	APPLICATION NO. 81-1 COUNCIL ADOPTION OF ORDER 639

PLEASE BE ADVISED That the Washington State Energy Facility Site Evaluation Council did adopt at its regular meeting of April 12, 1982 Findings of Fact, Conclusions of Law and Order of Consistency and Compliance with Benton County Comprehensive Plan and Zoning Ordinance pursuant to RCW 80.50.090(2).

Dated this 13th day of April, 1982 in Olympia, Washington.

William L. Fitch
Executive Secretary

ORDER NO: 639
DATE: April 12, 1982

BEFORE THE STATE OF WASHINGTON

ENERGY FACILITY SITE EVALUATION COUNCIL

In the Matter of the Application No. 81-1 (Skagit/Hanford Nuclear Project) Puget Sound Power & Light Company A Washington Corporation	FINDINGS OF FACT, CONCLUSIONS OF LAW AND ORDER OF CONSISTENCY AND COMPLIANCE WITH BENTON COUNTY COMPREHENSIVE PLAN AND ZONING ORDINANCE PURSUANT TO RCW 80.50.090(2)

THIS MATTER Came on regularly for hearing, in Richland, Washington, pursuant to a Notice duly given on January 27, 1982. The hearing was held before the Energy Facility Site Evaluation Council (hereinafter Council) for determination pursuant to RCW 80.50.090 and WAC 463-26 of the consistency and compliance of the proposed Skagit/Hanford Nuclear Project Site as described in Application No. 81-1 with the Benton County Comprehensive Plan and Benton County Zoning Ordinance.

The parties were represented as follows: Puget Sound Power and Light Company by F. Theodore Thomsen, Attorney at Law, 1900 Washington Building, Seattle, Washington, 98101; and Counsel for the Environment, Thomas Bjorgen, Assistant Attorney General, Temple of Justice, Olympia, Washington, 98504.

FINDINGS OF FACT

I.

On December 30, 1981, Puget Sound Power and Light Company filed its Application No. 81-1 with the Council. The Application was for the siting of two nuclear reactors, two electrical generating units (each with a net electrical output of approximately 1,275 megawatts) and various associated facilities located on the United States Department of Energy, Hanford Reservation, Benton County, Washington.

II.

The applicable land use plans consisted of the Benton County Comprehensive Plan and the Benton County Zoning Ordinance.

III.

The proposed project is proposed to be located in an "Unclassified District" under the zoning ordinance and the applicable use district map. Under the applicable provisions of the Zoning Ordinance (Section 11-48-010(c), Benton County Code), the project is permitted outright on the site and associated areas.

IV.

The use of the site and associated areas for the project are not inconsistent with the Comprehensive Plan of Benton County.

V.

The site and associated areas proposed by Puget Sound Power and Light Company pursuant to Application No. 81-1 and the use of the site and associated areas are consistent and in compliance with the Benton County Comprehensive Plan and the Benton County Zoning Ordinance.

CONCLUSIONS OF LAW

I.

The Washington State Energy Facility Site Evaluation Council has jurisdiction over the subject matter of this proceeding.

II.

The site and associated areas and the use of the site and associated areas for the project proposed by Puget Sound Power and Light Company pursuant to Application No. 81-1 are consistent and in compliance with the Benton County Comprehensive Plan and the Benton County Zoning Ordinance.

ORDER

IT IS HEREBY ORDERED That the Site and associated areas as proposed by Puget Sound Power and Light Company pursuant to Application No. 81-1 are consistent and in compliance with the Benton County Comprehensive Plan and the Benton County Zoning Ordinance.

Dated at Olympia, Washington and effective this 12th day of April, 1982.

WASHINGTON STATE ENERGY FACILITY
SITE EVALUATION COUNCIL

By Nicholas D. Lewis
Nicholas D. Lewis
Chairman

ATTEST:

By William L. Fitch
William L. Fitch
Executive Secretary

APPENDIX H

PROPOSED RULE ON ALTERNATIVE SITES

NUCLEAR REGULATORY COMMISSION

10 CFR Part 51

Licensing and Regulatory Policy and Procedures for Environmental Protection; Alternative Site Reviews

AGENCY: U.S. Nuclear Regulatory Commission.

ACTION: Proposed rule.

SUMMARY: The Nuclear Regulatory Commission is proposing to amend its regulation in 10 CFR Part 51 to provide procedures and performance criteria for the review of alternative sites for nuclear power plants under the National Environmental Policy Act of 1969 (NEPA). The proposed rule provides for (a) information requirements for applying for an alternative site review by the Commission, (b) timing of Commission review, (c) region of interest to be considered in selecting sites, (d) criteria for the selection of sites, (e) criteria for comparing a proposed site with alternative sites, and (f) requirements for reopening an alternative site decision. It is also proposed that minor amendments be made to 10 CFR Part 2 and 10 CFR Part 50 to reflect the provisions of the proposed rule. Public comment is requested on the proposed rule, on whether safety matters including emergency response capability should be admitted as issues in alternative site reviews, and on the value/impact statement supporting the proposed rule.

DATES: Comments are due on or before June 9, 1980.

ADDRESSES: Interested persons are invited to submit written comments and suggestions to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, Attention: Docketing and Service Branch. Single copies of the value/impact statement may be obtained on request from the Director, Division of Technical Information and Document Control. Copies of the value/impact statement may be examined in the Commission's Public Document Room at 1717 H Street NW., Washington, D.C.

FOR FURTHER INFORMATION CONTACT: Dr. Jerry R. Kline, Environmental Engineering Branch, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555, telephone (301) 492-8251.

SUPPLEMENTARY INFORMATION:

I. Foreword

NEPA and NRC's environmental regulations in 10 CFR Part 51 have many provisions that shape the NRC's environmental reviews for nuclear power plants, but the basic underlying aspect is the consideration of alternatives. There are four distinct and different areas of NRC decisionmaking that involve alternatives, as described below:

1. One decision that must be made is whether additional baseload generating capacity need be provided. In other words, NRC considered the "no action" alternative, which includes consideration of conservation of energy.

2. A second decision that must be made by the NRC is whether nuclear fueled generation is an acceptable choice or whether other types of energy sources, e.g., coal, are superior.

3. A third NRC decision is whether the proposed site is acceptable. This particular decision involves the consideration of alternative sites; consideration of reasonable major mitigation measures that might be employed to make environmental impact acceptable at the candidate sites, such as the type of cooling system that should be employed at a particular site; and consideration of the costs of such major mitigation measures, as well as any major costs that might be required to make the site acceptable from a safety standpoint.

4. A fourth type of decision that is made involves whether other types of mitigation measures are warranted that normally would be of little importance to site selection, but may still be important from the standpoint of minimizing, to the extent reasonable, any residual adverse environmental impact that likely might be incurred during the construction or operation of the plant.

The proposed rulemaking focuses on the third type of NRC's environmental decisions—i.e., the question of alternative sites.

The NRC has considered the question of alternative sites in all of its NEPA reviews of applications to construct and operate nuclear power plants. As in most situations, however, the type and nature of the review has evolved over the years. Until recently, the NRC's review of the alternative site question has focused primarily on the qualities of the proposed site; i.e., a review that focuses on the "products" of an applicant's site selection process. The NRC typically did not initiate an extensive review of the applicant's site selection process and alternative site unless substantial inferior qualities were identified at the applicant's proposed site. However, the NRC has recently and dramatically expanded its review of the applicant's site selection process and procedures, as well as its review of the scope and depth of the detailed investigation of alternative sites.

The NRC believes that the experience gained in past and recent reviews of nuclear power plant sites should permit codification of the lessons learned into an intelligible, intelligent, and environmentally sensitive rule that governs the NRC review of alternative sites. While it is true that many of the issues that would be addressed by a rule on alternative site reviews could also be addressed more informally by issuance of regulatory guides and standard review plans and litigated in individual cases, some issues, particularly issues relating to notice and timing of public participation, can only be adequately addressed by rule. In addition, a comprehensive rule addressing review of alternative sites will promote public understanding of and participation in the NRC review of alternative sites. The proposed rule would:

1. Provide for more effective public participation by implementing procedural changes that: (a) require early notification of the public of an applicant's choice of a proposed site and its alternatives; (b) permit an early review of the alternative site question apart from other early site review issues; and (c) provide explicitly for consideration of candidate sites proposed by other parties that meet certain criteria and are proposed in a timely fashion.

2. Provide for greater predictability in the licensing process by (a) prescribing criteria for determining when a region of interest of sufficient size has been considered; (b) prescribing criteria for judging whether candidate sites are among the best that could reasonably be found; (c) prescribing the basic standards for comparing the proposed site to the alternative cites; and (d)

providing criteria for reopening the alternative site question after a previous NRC decision has been rendered on this subject.

The basic forces motivating the development of the proposed rulemaking are:

1. The necessity to protect the environment from unduly adverse environmental impacts, recognizing that the siting of a large, nuclear generating facility will result in some adverse impact regardless of where it is sited. Unduly adverse environmental impacts are an undersirable cost to society.

2. The realization that (a) reasonable bounds may be placed on the search for alternative sites without compromising environmental protection, and (b) the NRC's informational needs require the applicant to make a significant commitment of resources at the proposed site. As a general matter these costs are ultimately borne by the ratepayer and the taxpayer.

3. The fact that it is in the public interest to attempt to develop written, understandable NRC review and decisional criteria that provide for the necessary protection of important environmental qualities; i.e., criteria that are sensitive to the factors that would significantly and adversely impact the environment, yet still reasonably bound the consideration of alternatives to permit a rational and timely decision about the sufficiency of analysis.

Considering the above points, it should be noted that the proposed rule is environmentally based, but it does provide for other considerations (such as cost) to bound in a reasonable manner the search for candidate sites. The NRC fully realizes that an applicant does consider other factors in its site selection process. These factors are important to the applicant because they affect the economics and technical merits of the project and because many of these parameters affect reactor safety and thus must be reviewed and found acceptable by the NRC during the safety review process. The NRC sees no basic incompatibility between the environmentally-based rule proposed here and the fact that the applicant must realistically consider other, equally important, parameters in its formulation of a reasonable and effective site selection process. Also, it should be noted that the proposed rule (Section VI.2.b.(7)) includes threshold population criteria that are the same as the numerical values for population density contained in Regulatory Guide 4.7, "General Site Suitability Criteria for Nuclear Power Stations." This is reflective of past staff practice. However, these criteria may be changed in accordance with an ongoing Commission review of siting policy which will be the subject of an advance notice of rulemaking in the immediate future.

To assist in the Commission's consideration of this question on population and related questions and as part of this proposed rulemaking on alternative sites, public comment is requested at this time on whether safety issues, including emergency response capability, should be admitted in the review and decisionmaking on alternative sites; and if so, how. At least two alternatives exist with regard to this question:

1. Establish, in a public rulemaking, exclusionary safety standards that must be met in order to have an acceptable site. Safety issues would not be considered in subsequent review of alternative sites, since such standards would be set sufficiently conservative that the residual radiological risk to the environment would be small and would be sufficiently similar to the residual risk at other reasonable sites in the region that an obviously superior alternative would likely not exist; i.e., these differences in residual radiological impacts would not weigh heavily in a NEPA-type cost-benefit balance. Such acceptance standards might include, for example, reasonable limits on population density, distances to towns and cities, distances to airports and other manmade hazards, and distances to capable faults.

2. Establish, in a public rulemaking, exclusionary safety standards that must be met, but also provide for inclusion of these safety issues in the consideration of alternative sites even when the sites meet these criteria. Such criteria may or may not be the same numerically as those addressed in 1 above. The rationale of this alternative rests on the view that even when a safety-related characteristic (e.g., population density) does not render a site unacceptable in any absolute sense, it may nevertheless involve sufficient residual risk to justify attempts to do better. The alternative sites evaluation process is suited to a determination of how well one can reasonably do in the particular area under consideration, since the process would illuminate specific alternatives. As an option, a second set of more conservative criteria might also be established which, if met, would not require that safety issue to be included in the consideration of alternative sites.

With respect to population density, alternative 1 above would seek to obtain a similar result as alternative 2, i.e., acceptance thresholds, set in light of population density and distribution.

The NRC realizes that implementation will not, and should not, remove the controversy over the question of alternative sites. The question rightfully is a controversial one that elicits high public interest. The purpose of the rule is not to eliminate this controversy, but to focus it on factors of critical importance to the protection of the environment.

II. Background

NEPA requires the study and development of alternatives to any major Federal action that would significantly affect the quality of the human environment. The procedure for doing this must be an integral part of the planning and decisionmaking processes of Federal agencies. 10 CFR Part 51 establishes the NRC's licensing and regulatory policy and procedures under NEPA and requires that each applicant for a permit to construct a nuclear power plant discuss in an Environmental Report "Appropriate Alternatives" to the proposed facility. Among the primary alternatives to be considered, once the need for a nuclear facility has been established, are alternative sites for the facility.

The assessment of alternative sites for proposed nuclear power plants is a complex and difficult task, for the applicant, the NRC staff, and all parties in the process. Issues related to alternative siting have been a major source of controversy in a number of cases involving construction permits for nuclear power plants. The NRC has observed that there are some recurring issues at the heart of the controversy. The Commission believes that these recurring issues can and should be resolved on a generic basis.

An NRC study group seeking to identify ways to improve the effectiveness of NRC nuclear power plant licensing procedures recommended in June 1977 (see NUREG-0292, "Nuclear Power Plant Licensing: Opportunities for Improvement") that, among other measures, rulemaking should be considered for the generic resolution of certain issues presently litigated in individual licensing proceedings. An interim policy statement on generic rulemaking was published in the **Federal Register** on December 14, 1978, with a 90-day period for public comment ending on March 12, 1979. Additional technical detail on the ten issues identified by the staff for possible rulemaking was provided in NUREG-0499, "Preliminary Statement on General Policy for Rulemaking to Improve Nuclear Power Plant Licensing."

One of the ten issues proposed by the staff for consideration in generic rulemaking was alternative siting methodology and information requirements. Recognizing the need for further clarification of this issue, the staff issued Supplement No. 1 to NUREG–0499, a staff report entitled "General Considerations and Issues of Significance on the Evaluation of Alternative Sites for Nuclear Generating Stations Under NEPA." The major purpose of the report was to provide additional information to members of the public, industry, and other governmental agencies who intended to comment by March 12, 1979, on issues of alternative siting.

In addition, the NRC conducted a workshop to actively seek out comments on the alternative sites issue. This workshop provided invited representatives from industry, State and Federal government, public interest groups, and others the opportunity to scrutinize and comment on the NRC staff's most recent thinking on the issue of alternative sites.

Comments and feedback received from the workshop participants and observers, and those received from the public review of Supplement 1 to NUREG–0499, have been considered in the development of the proposed rule on alternative sites.

This proposed rule sets forth the resultant NRC policy regarding the evaluation of alternative sites for nuclear power plants under NEPA. The proposed rule is intended to (1) fulfill the NEPA objectives of ensuring that environmental factors have been fully considered in NRC decisionmaking; (2) reduce uncertainty and delay in the decisionmaking process; (3) reduce Federal paperwork in NEPA statements; and (4) limit alternative site review to relevant and material issues. The basic objective of this rule is to provide for a meaningful, rationale, understandable, and stable NRC review and decisionmaking process that will both reasonably protect environmental values and yield a timely decision.

The intent of this proposed rule is to establish procedural and performance criteria for the identification and evaluation of alternative sites for nuclear power plants. Controversy with regard to the issue of alternative sites will not and should not be eliminated. This proposed rule will, however, focus the controversy on whether criteria important to environmental protection have indeed been met.

The NRC has considered the values and impacts of rulemaking and of alternative actions. These considerations have been put forth by the Commission's staff in a value/impact statement.

III. The Role of NRC and Others in the Considerations of Alternative Sites

The NRC has the statutory responsibility to review applications for the construction and operation of nuclear power plants. It must assure the accuracy and relevance of environmental information, perform the environmental analyses, and make the decision to accept or reject a site. In carrying out its responsibilities, the NRC does not select sites or participate with the applicant in selecting a proposed site. However, the NRC is the lead Federal agency under NEPA for carrying out the NEPA mandate that alternative sites be considered in connection with nuclear power plant licensing.

The NRC may give appropriate deference to other Federal agency expertise in the assessment of certain impact, e.g., U.S. Environmental Protection Agency expertise in evaluating aquatic impacts. The Commission has also stated that "the fact that competent and responsible State authority has approved the environmental acceptability of a site or project after extensive and thorough environmentally sensitive hearings is properly entitled to 'substantial weight' in the conduct of our own NEPA analysis." Public Service Company of New Hampshire, et al. (Seabrook Station, Units 1 & 2), 5 NRC 503 at 527 (1977). Additionally, consideration is given to other information developed by State, regional, and local agencies (such as land or water use plans).

The proposed rulemaking represents no change in the above stated present practice.

IV. The Proposed Rule

A rule must address those elements of the alternative siting process that are generic in nature and likely to recur in all or many of the cases likely to be encountered. In formulating the proposed rule, the staff identified six major issues associated with alternative site consideration. These are (1) information requirements, (2) timing, (3) region of interest, (4) selection of candidate sites, (5) comparison of the proposed site with the alternative sites, and (6) reopening of the alternative sites decision.

The following sections provide a statement of each element of the proposed rule, describe its relation to present practice, and discuss the need for the rule and rationale for each element of the rule. The elements of the rule are organized to reflect the logic and chronology of a normal NRC review of alternative sites in response to an actual submittal for such a review.

A. Information Requirements

A–1. Notice of Intent

1. *Statement of Rule.* An applicant is to provide the NRC staff with a notice of intent to tender an application for a construction permit (CP) for a nuclear power plant either at least three months before tendering of a CP application requesting an early review of the alternative sites issue (pursuant to § 2.101 and subpart F of 10 CFR Part 2) or 3 months prior to beginning the detailed studies on the proposed site, whichever comes first. The notice of intent will identify the location, cooling water sources, and physiographic unit of the proposed and alternative sites, as well as describe the anticipated generating capacity, the number of generating units, and the types of condenser cooling systems that would be used.

2. *Relationship to Present Practice.* Present NRC rules do not require submittal of such a notice, and present practice does not yield the information on cooling systems or alternative sites at the times specified.

3. *Need for Action.* Early public notification is needed to allow the public to become aware of the project, to identify their concerns and to express those concerns in advance of significant financial commitments by the applicant and at a time when due consideration of their concerns would not result in unacceptable schedule delays.

4. *Rationale and Discussion.* After receiving a notice of intent as required by the rule, NRC would publish the information received in the **Federal Register** and in newspapers local to the sites identified. This would assure that potential public participants have sufficient time prior to the NRC review to prepare meaningful information to be considered early in the licensing process. This provision is in direct response to a recommendation from several workshop participants.

For situations where, on the effective date of this rule, a future applicant has already begun or is about to begin detailed, long-term investigations on a site likely to be proposed subsequently to the NRC as a site for a nuclear power plant, such a future applicant must provide a notice of intent within three months following the effective date of this rule.

A.2. Reconnaissance Level Information

1. *Statement of Rule.* Reconnaissance level information, i.e., information or analyses that can be retrieved or

generated without the performance of new, comprehensive site-specific investigations, is normally adequate as a basis for identifying candidate sites and for selecting a proposed site.

Analysis of the slate of candidate sites may address other aspects of siting that are important to the applicant's decision, but must address the following subjects that are important to the NEPA reviews: hydrology, water quality and availability, aquatic and terrestrial biological resources, land use, transmission requirements, socioeconomics, population distribution and density, facility costs, institutional constraints, and public concerns where such have been provided to the applicant or NRC in writing.

2. *Relationship to Present Practice.* Present practice is that the analysis of alternative sites is normally based upon readily available, reconnaissance level information such as provided by scientific literature, reports of government and private research agencies, consultation with experts, and brief field investigations. The scope of depth of the data and analysis required are matched to the importance of possible impacts and the degree of certainty regarding their magnitude. In some cases, detailed investigations related to specific issues may be required.

While detailed site-specific baseline studies on the proposed site are required to support the remainder of the NRC's environmental review, these data normally add little to NRC's determinations regarding alternative sites. These detailed studies principally serve as a basis for decision-making regarding mitigative measures to reduce (on a practicable basis) any residual adverse environmental impacts. However, they also serve a secondary purpose in that they confirm judgments on likely adverse environmental impacts that are made using reconnaissance level data. On occasion these studies may not confirm such judgments, but may lead to a finding that the proposed site is unacceptable.

The proposed rule on reconnaissance level information represents no change in the above stated practice.

3. *Need for Action.* Present practice is sufficiently well established through licensing experience to permit rulemaking on information requirements for alternative site analysis.

4. *Rationale and Discussion.* The rationale for the rule on reconnaissance level information proceeds from the premise that major adverse environmental impacts can normally be identified using this type of information. Therefore, the added costs of requiring detailed site-specific investigations and analyses on all candidate sites normally would not be justified with respect to any marginal improvement in environmental protection. There was substantial discussion during the workshop on the applicability of reconnaissance level information to alternative site analyses. Many workshop participants emphasized that the term "reconnaissance level information" should not be interpreted to mean the reliance on limited data and subsequent superficial analyses. Such an interpretation is not intended, thus the proposed rule has been drafted to ensure that this misinterpretation will not occur.

B. Timing

1. *Statement of Rule.* Under the proposed rule an applicant may submit the proposed and alternative sites for NRC evaluation as part of a full construction permit review either early and separate from the review of plant design (an early site review) or in conjunction with the review of plant design. An early site review (ESR) of alternative sites may be in conjunction with or separate from consideration of other ESR issues. The applicant may later submit other siting issues for an early site review during the effective period of the early alternative sites partial decision.

2. *Relationship to Present Practice.* In the past, the NRC's review of alternative sites has generally occurred concurrently with the review of all other environmental issues and at the same time as the CP safety review of facility design. However, NRC regulations do provide for a single optional early site review, which may include any issues involving environmental impact or site safety that the applicant desires to address at a proposed site. While the applicant must describe the site selection process in an early site review, the review of specific alternative sites need not be addressed unless it is believed by the NRC that the consideration of other issues could prejudice the full consideration of alternative sites at a later time.

The proposed rule on timing represents a change in the above stated practice in that early review of the full question of alternative sites would be permitted in advance of the other early site review issues, and a subsequent early review would be allowed to consider the detailed baseline studies at the proposed site.

3. *Need for Action.* The option for early review of alternative sites is needed to permit a full consideration before the applicant commits substantial resources to the proposed site. If a favorable decision is made on the alternative site question, the applicant could then commit the funds necessary to perform early site-specific studies of environmental and safety matters with a greater degree of confidence that the proposed site will not subsequently be rejected in favor of an alternative.

4. *Rationale and Discussion.* A two-stage early site review process is permitted to provide incentive for an early review of the alternative site question. In this way an early decision could be arrived at on alternative sites, after which the applicant could expend the necessary resources for detailed site-specific studies and apply at a later date for the remainder of a full early site review. Thus, less of the applicant's resources would be placed at risk prior to an NRC decision on alternative sites, and yet the applicant and the public would ultimately be able to achieve all of the ultimate benefits of an early site review.

All reviews and decisions would still be performed within the effective period for the early site review decision. All that would be added would be the opportunity to receive a regulatory decision on the question of alternative sites shortly after the applicant has decided upon the proposed site, but prior to the commitment of substantial funds at that proposed site.

C. Region of Interest

1. *Statement of Rule.* The initial geographic area for determining the region of interest for NRC regulatory review purposes may be either the State in which the proposed site is located or the service areas of the applicant. The actual region of interest must be larger in accordance with Section V.3 of the rule, or may be smaller in accordance with Section V.2 of the rule, depending on the environmental diversity, institutional factors, and cost considerations set forth in those sections.

For the purpose of determining the region of interest, environmental diversity refers to the types of water bodies available within the region (upper or lower reaches of large rivers, small rivers, lakes, bays, and oceans) and the associated physiographic units.

2. *Relationship to Present Practice.* Past practice has normally been to accept the applicant's proposed region of interest which commonly is the applicant's service areas. However, the region of interest has been smaller in some situations, and in other situations an expansion of the proposed region of interest has been required. This rule preserves that practice, but it adds

specific criteria for expansion or contraction of the initial geographic area in determining the region of interest.

3. *Need for Action.* The basic forces motivating the development of this rule are:

a. The necessity to protect the environment from unduly adverse environmental impacts by providing an adequate choice of candidate sites representing reasonable environmental alternatives, and

b. The realization that reasonable bounds may be placed on the search for alternative sites without compromising environmental protection.

4. *Rationale and Discussion.* The use of service areas coupled with performance criteria for expansion or contraction is judged to be sufficient to provide a substantial range of environmental alternatives from which to choose in making the final siting decision. Unlimited expansion of the areas to be searched likely would not yield significant additional new alternatives for limiting of environmental impacts that would already be present in a reasonably bounded area. As a practical matter, utilities may initiate their searches within their service areas. In many cases this will lead to the identification of the required diversity of resources. Where service areas are small, the requirement could cause an expansion that would extend the region of interest beyond the service area boundaries. However, in very large service areas, the required diversity might be found without exploring the entire service area.

The requirements may impose a need for large regions of interest in water limited areas, particularly in the western regions of the nation. The rule is intended to ensure in all cases that all reasonable alternatives have been considered. The analysis of remote alternatives need be carried only as far as necessary to demonstrate the reasons (which include costs) for not considering them further.

The rule is intended to apply to utilities having well defined service areas as well as those that do not. In situations where the State is asking the review of the alternative sites issue or where the service areas of the applicant are not defined, the State in which the proposed site is located would be the starting point for determining the region of interest.

When considering water sources that would provide adequate water availability, the staff intends that the characteristics of the terrestrial watershed (i.e., the physiographic characteristics) also be included and considered. Under this concept, a river having adequate water for a nuclear power plant but that flows through a dedicated terrestrial area such as a national park or national forest might not qualify as an acceptable resource. It is permissible, however, to designate portions of a watershed for possible siting while excluding other portions of the same watershed.

Different portions of a watershed or coastal zone may be considered to be different physiographic units, if the environmental impacts of siting in these areas would be clearly different from one another. For example, the "head waters" region of a river watershed would be designated as a physiographic unit separate from the estuarine region of the same watershed, since the impacts on fisheries and other aspects of the environment would be clearly different in the two areas. The rule is not intended to compel the consideration of water bodies that are in similar physiographic settings, since that would not add significantly to the range of environmental choice.

In emphasizing the terrestrial components the staff intends that the search for sites should not be confined to land areas immediately adjacent to water bodies but should be expanded to include a reasonable corridor of search around the water body. Siting up to several miles from a suitable water body may be desirable to avoid land use conflicts that are often found adjacent to water bodies.

The workshop participants unanimously supported the concepts of (1) environmental diversity as a determinant in bounding the region of interest, and (2) water being the principal regional determinant of environmental diversity.

D. Selection of Candidate Sites

1. *Statement of Rule.* An applicant may submit a slate of candidate sites based on either (1) a demonstration (according to criteria for site selection procedures set forth in the rule) that the site selection methodology is a reasonable, environmentally sensitive site screening process that provides a diligent search for sites that are among the best that could reasonably be found, or (2) a demonstration that the slate of candidate sites meets the prescribed environmentally sensitive threshold criteria (set forth in the rule) and are therefore among the best that could reasonably be found. The rule states that a slate of candidate sites should contain at least four sites. The rule also provides criteria for acceptance of candidate sites proposed by any party to the proceeding.

2. *Relationship to Present Practice.* Present practice is to make a determination that candidate sites identified by the applicant are "among the best that reasonably could have been found." Until recently, the NRC's review has focused primarily on the qualities of the proposed site (a product-oriented review). However, recently the NRC has expanded its review and the staff presently reviews the demonstration of this "among the best" standard by focusing on the adequacy of the applicant's site selection procedure (a process-oriented review). The rule preserves the advantages of both the process-oriented and product-oriented approaches. The rule adds criteria for implementing an adequate site selection process demonstration and evaluation, and provides the option for a product-oriented review by specifying threshold criteria for evaluating the slate of candidate sites. Most of the workshop participants believed that the applicants should be given the option to seek either a process-oriented or a product-oriented review of the slate of candidate sites.

3. *Need for Action.* The process-oriented approach codifies the elements that govern NRC reviews of the site selection process and provides guidance for the applicant's management of that site selection process. The product-oriented approach emphasizes the environmental merits of the candidate sites rather than the process that yielded these sites, and will likely be a more environmentally sensitive approach.

4. *Rationale and discussion.* The rationale for codifying the process-oriented approach is to provide guidance to all parties regarding the elements that govern NRC reviews of that process. The general rationale for the product-oriented approach is that candidate sites that pass all of the proposed threshold standards would be unlikely to have substantial, unidentified, adverse environmental impacts. Therefore, the resulting slate of candidate sites likely would be of comparable environmental quality and should be environmentally acceptable to the NRC. While there could be a situation where the proposed site could be marginal with respect to several of the thresholds and thus might be inferior on a cumlative impact basis, it would be unlikely that all the candidate sites would be similarly inferior. Thus the proposed site's inferiority would be clearly displayed in the subsequent detailed comparison with the other candidate sites.

The rule provides that the slate of candidates sites should contain at least four sites. The reason for this is to ensure that even in regions of little diversity, there is some choice among the sites in the slate. For more diverse regions the criteria controlling how many sites would be necessary are oriented towards the diversity of environmental qualities presented, so as to give a meaningful environmental comparison of alternatives. The candidate sites would be required to be reasonably representative of all of the major diverse environmental qualities present in the region of interest, as follows:

a. Major types of water sources.

b. Major physiographic units.

c. Consideration of sites of existing electric generating facilities as well as new sites.

As an example of acceptable diversity, if a new site on a lake in a woodland area was already identified as a candidate site, a woodland site on another lake within the region of interest would not be required, unless that site also hosts an existing electric generating facility.

One of the positions adopted by the public workshop on alternative sites is that public participation in the siting process would be enhanced if parties other than the applicant were permitted to propose additional candidate sites for consideration, but that the criteria proposed for acceptance of such sites should be no more stringent than those which the applicant's sites must meet. Criteria are proposed for the acceptance of such a site that are essentially the same criteria that the applicant's sites must meet in establishing the original slate of candiates.

In addition, the proposed rule imposes time limits for proposing additional candidate sites. The time limits are a key element in achieving a timely evaluation of the alternative sites issue and, except upon a substantial showing of good cause, will not be extended.

E. Comparison of the Proposed Site With Alternative Sites

1. *Statement of Rule.* A proposed site that comes from a slate of candidate sites that are among the best that could reasonably be found will not be rejected by the NRC on the basis of the alternative site review unless a comparison with the alternative sites results in a determination that an obviously superior alternative exists. There will be a two-part, sequential test for obvious superiority. The first stage of the test will be to determine whether there is an environmentally preferred site. The second stage of the test will consider economics, technology, and institutional factors to determine whether any environmentally preferred site is obviously superior to the proposed site.

2. *Relationship to Present Practice.* Present staff practice does consider the range of factors that would be addressed by the proposed rule.

3. *Need for Action.* This proposed element of the rule will provide a more stable structure for the procedural aspects of how environmental factors should receive consideration and how these factors should be balanced with non-environmental factors to determine obvious superiority.

4. *Rationale and Discussion.* The criteria for testing the proposed site against the alternative sites comes from past practice, as reflected in individual nuclear power plant licensing reviews.

F. Reopening of the Alternative Site Decision

1. *Statement of Rule.* a. A reopening and reconsideration of the alternative site decision after a final limited work authorization or construction permit decision will be permitted only upon a reasonable showing that there exists significant new information that could substantially affect the earlier decision. Any decision to reconsider the alternative sites decision or not in these instances will consider the reasonable costs of delay and of moving to another site compared with the adverse environmental impacts that might be avoided by moving to another site.

b. For cases where the portion of the construction permit application containing facility design is filed three years or more after the effective date of this rule and where an application for an early review of alternative sites was tendered at least two and a half years prior to filing the portion of the CP application containing detailed facility design information, any reconsideration of the alternative site decision will be permitted only upon a reasonable showing that there exists significant new information that could substantially affect the earlier decision, even when allowance is made for reasonable costs of delay and of moving to another site. If such an application was not made at least two and a half years prior to filing such portion of the CP application, costs of delay and of moving to another site will not be considered in any decision to reconsider the alternative site decision or not, or in any resulting decision that there is or is not an obviously superior site.

c. If two sites are reasonably within a region of interest for a nuclear power plant site and both sites have received an affirmative NRC partial decision in an early review of alternative sites, an applicant may choose either site for an application to construct a specific nuclear power plant without reviewing the alternative site question, except on the basis of new information, as provided above.

2. *Relationship to Present Practice.* The proposed rule is generally consistent with present criteria regarding treatment of new information under the early-site-review rule, and would result in consistent criteria for the treatment of new information regarding alternative sites at the construction permit and operating license stages.

The treatment of forward costs associated with moving to another site (including costs of delay) prescribed in this element of the proposed rule would generally codify a practice that has evolved, except that it would preclude the consideration of costs of moving to another site if the applicant did not seek an early resolution of the alternative site question.

3. *Need for Action.* This proposed element of the rule will provide for consistent treatment of new information regarding alternative sites througout the licensing process.

4. *Rationale and Discussion.* The rationale for this element of the proposed rule is that after a decision has been reached regarding the alternative site question, during either an early site review or a CP review, the applicant (or licensee) will logically begin committing greater resources to that site. While such commitments are clearly at the applicant's risk, it is logical to allow the inclusion of such costs in any subsequent cost-benefit analyses, since such investments would have been made by the applicant in good faith.

Therefore, while it is possible that a reversal of the previous decision could be made based on new information (which is a risk the applicant or licensee must run), any reconsideration of the question of alternative sites and the cost-benefit analysis supporting any reversed decision should normally permit the full accounting of all reasonable forward costs to develop the new site (including costs of delay) compared to the reasonable forward costs of completing the project at the previously approved site.

At some point after issuance of the CP, the alternative of siting the nuclear power plant elsewhere likely will no longer be a reasonable alternative for the purposes of NEPA. That is, there is a point where comparative forward costs and the temporal proximity to the provision of needed (or desirably substitutable) power so favor the partially constructed site that, there likely is no real possibility that the nonsafety-related considerations at an alternative site would be obviously superior to the proposed site. At that point, the reconsideration of alternative sites likely would not be required, unless the proposed site has been judged unsuitable for some safety or environmental reason.

Forward costs also could become substantial after an early site review decision, particularly as the time for a CP decision approaches. This means that a reevaluation of alternative sites after an early site review decision likely would not be justified on the basis of a full cost-benefit analysis unless there is, for example, a determination that the actual use of the site (rating and number of units) would be greater than had been evaluated earlier, or that firm and major changes in land or water use or changes in legal requirements involving the protection of species or resources have occurred since the previous evaluation. It is unlikely that changes in the prediction of environmental impacts would be so great as to warrant a re-review of the alternative sites decision on that basis alone.

The rationale for the third criterion of this portion of the proposed rule is that if two sites in the same general region of interest had been evaluated in separate reviews and neither had been found to have an obviously superior alternative, than it is likely that neither would be obviously superior to the other.

Pursuant to the Atomic Energy Act of 1954, as amended, the Energy Reorganization Act of 1974, and section 553 of title 5 of the United States Code, notice is hereby given that adoption of the following amendments to 10 CFR Part 2, 10 CFR Part 50, and 10 CFR Part 51 is comtemplated. All interested persons who desire to submit written comments should send them to the Secretary of the Commission, U.S. Nuclear Regulatory Commission, Attention: Docketing and Service Branch, Washington, D.C. 20555 by June 9, 1980. Copies of comments received will be available for public inspection at the Commission's Public Document Room at 1717 H Street, NW., Washington, D.C.

§ 2.603 [Amended]

1. It is proposed that § 2.603(a) be amended by adding at the end thereof the following:

(a) * * * Where an applicant has failed to file the notice of intent required by Appendix A of 10 CFR Part 51, the application shall be docketed in accordance with the provisions of that appendix.

§ 2.605 [Amended]

2. It is proposed that § 2.605(a) be amended by adding at the end thereof the following:

(a) * * * Where an application has been filed pursuant to Appendix A of 10 CFR Part 51 for an early alternative site evaluation separate from other early site review issues, the alternative site evaluation shall not be considered a review for purposes of this one review limitation.

Appendix Q [Amended]

3. It is proposed that the numbered paragraph 1. of Appendix Q of 10 CFR Part 50 be amended by inserting between the first and second sentence thereof the following:

"As a part of an early site review, either in conjunction with or separate from the consideration of other early site review issues, a person may submit a request for a review of the alternative site issue and for issuance of a Staff Site Report concluding that there is no obviously superior alternative to the proposed site. If the person requests an early alternative site review separate from the consideration of other early site review issues, the person may later submit other siting issues for an early site review during the effective period of the Staff Site Report on the alternative site issue, provided that any later early site review of other issues shall remain in effect only so long as the initial Staff Site Report on alternative sites remains effective."

4. It is proposed that the numbered paragraph 3. of Appendix Q of 10 CFR Part 50 be amended by adding at the end thereof the following:

"Where a person has failed to file the notice of intent required by Appendix A of 10 CFR Part 51, the request for review shall be acted upon in accordance with the provisions of that appendix."

5. It is proposed that the numbered paragraph 5 of Appendix Q of 10 CFR Part 50 be amended by deleting the last sentence thereof and substituting the following:

"The conclusions of the Staff Site Report will be reexamined by the staff where five years or more have elapsed between the issuance of the first Staff Site Report and its incorporation by reference in a construction permit application."

6. It is proposed that the first sentence of the numbered paragraph 7. of Appendix Q of 10 CFR Part 50 be amended by adding at the end thereof the following:

"However, if a person, pursuant to Appendix A of 10 CFR Part 51, has submitted a request for an early alternative site review separate from other early site review issues, the alternative site review shall not be considered a review for purposes of this one review limitation."

7. It is proposed that a new Appendix A be added to 10 CFR Part 51 to read as follows:

Appendix A.—Evaluation of Alternative Sites for Nuclear Power Plants

I. Introduction and Scope

This appendix sets forth procedures and performance criteria for the review of alternative sites for nuclear power plants under NEPA. Specifically, this appendix provides for (a) information requirements for applying for an alternative site review by the Commission, (b) timing of Commission review, (c) region of interest to be considered in selecting sites, (d) criteria for the selection of sites, (e) criteria for comparing a proposed site with alternative sites, and (f) requirements for reopening an alternative site decision.

The basic objectives of this appendix are:

1. To provide for more effective public participation by implementing procedural changes that (a) require early notification of the public as to an applicant's choice of a proposed site and its alternatives, (b) permit an early review of the alternative site question apart from other early site review issues, and (c) provide explicitly for consideration of candidate sites proposed by other parties that meet certain criteria and are proposed in a timely fashion; and

2. To provide for greater predictability in the licensing process by codification of present practice that (a) prescribes criteria for determining when a region of interest of sufficient size has been considered, (b) prescribes criteria for judging whether candidate sites are among the best that could reasonably be found, (c) prescribes the basic standards for comparing the proposed site to the alternatives sites, and (d) provides criteria for reopening the alternative site question after a previous NRC decision has been rendered on this subject.

The nuclear power plants referred to in this appendix are those facilities which are subject to § 51.5(a) of this chapter and are of the type specified in § 50.21(b)(2) or (3) or § 50.22 or are testing facilities. The submittal for review and evaluation of alternative sites shall be made in the same manner and in the same number of copies as provided in § 50.30(a), (c)(1), and (c)(3) for license applications.

II. Definitions

As used in this appendix,

1. "Region of interest" means the geographic areas considered in searching for candidate sites.

2. "Candidate sites" means those sites that are within the region of interest and are considered in the comparative evaluation of sites for a nuclear power plant and are judged to be among the best that can reasonably be found for the siting of a nuclear power plant.

3. "Proposed site" means the candidate site submitted to the NRC by the applicant, or a person requesting an early review pursuant to Appendix Q of 10 CFR Part 50, as the proposed location for a nuclear power plant.

4. "Alternative sites" means those candidate sites which are specifically compared to the proposed site to determine

whether there is an obviously superior alternative site.

5. "Slate of candidate sites" means the group of candidate sites comprised of the proposed site and all alternative sites.

6. "Environmentally preferred alternative site" means an alternative site for which the environmental impacts are sufficiently less adverse than for the proposed site that environmental preference for the alternative site can be established.

7. "Site" means the geographic area needed for the construction and operation of a nuclear power plant, including the associated transmission corridors to the first intertie.

8. "Reconnaissance level information" means any information or analyses that can be retrieved or generated without the performance of new, comprehensive site-specific investigations. Reconnaissance level information includes relevant scientific literature, reports of government or private research agencies, consultation with experts, short-term field investigations, and analyses performed using such information. The amount of reconnaissance level information and the extent of analyses conducted depend on (1) the importance and magnitude of the potential impact under evaluation and (2) whether the decision is one of identifying a region of interest, identifying candidate sites, or selecting a proposed site.

9. "Partial decision on alternative sites" means a partial decision pursuant to § 2.101 and Subpart F of 10 CFR part 2 that includes a finding that there is or is not an obviously superior alternative to the proposed site.

10. "Applicant" means a person who intends to apply, or who has applied, for a permit to construct a nuclear power plant.

11. "Notice of intent" means a notice that an application will be tendered for a construction permit for a nuclear power plant.

12. "NRC" means the Nuclear Regulatory Commission, the agency established by Title II of the Energy Reorganization Act of 1974, as amended.

13. "NRC staff" means any NRC officer or employee or his/her authorized representative, except a Commissioner, a member of a Commissioner's immediate staff, an Atomic Safety and Licensing Board, an Atomic Safety and Licensing Appeal Board, a presiding officer, or an administrative law judge.

III. Information Requirements

1.a. An applicant shall provide the NRC staff with a notice of intent to tender an application for a construction permit (CP) for a nuclear power plant either at least 3 months before tendering of a CP application requesting an early review (pursuant to § 2.101 and Subpart F of 10 CFR Part 2) of the alternative sites issue or at least 3 months before beginning detailed studies on environmental impact and site safety at the proposed site, whichever occurs earlier. The notice of intent shall identify the location, cooling water sources, and physiographic unit of the proposed and alternative sites, and shall describe the anticipated generating capacity and number and type of generating units for which a CP application will be tendered, and types of condenser cooling systems that would be used.[1]

Upon receipt of the notice of intent, the NRC will publish the information received in the Federal Register and in the newspapers local to the sites identified.

If an applicant fails to provide a notice of intent within the time specified, the NRC will not docket the tendered application for 3 months where no detailed studies of the proposed site have been performed or for 12 months where such studies have been performed. As soon as practicable after tendering, the NRC will publish the above specified information in the Federal Register and in the newspapers local to the sites identified.

b. A person requesting an early review of the alternative sites issue pursuant to Appendix Q of 10 CFR Part 50 shall provide the NRC staff with a notice of intent to submit such request at least 3 months before submitting the request for review or at least 3 months before beginning detailed studies of the proposed site, whichever occurs earlier. The notice of intent shall identify the location, cooling water sources, and physiographic unit of the proposed and alternative sites, and shall describe the generating capacity, number and type of generating units, and types of condenser cooling systems anticipated or assumed to be used.

Upon receipt of the notice of intent, the NRC will publish the information received in the Federal Register and in the newspapers local to the sites identified.

If the person requesting the review pursuant to Appendix Q to 10 CFR Part 50 fails to provide a notice of intent within the time specified, the NRC will not initiate the review for 3 months where no detailed studies of the proposed site have been performed or for 12 months where such studies have been performed. As soon as practicable after receiving the request for review, the NRC will publish the above specified information in the Federal Register and in newspapers local to the sites identified.

2. Reconnaissance level information shall normally be adequate to identify candidate sites and to select a proposed site in an alternative site analysis. In the identification of candidate sites or selection of the proposed site, the amount of data required and the extent of analyses conducted shall be appropriate to support a reasoned decision.

In some cases, reconnaissance level information may not be sufficient to support the analyses necessary to reach a reasoned decision. In these situations, new comprehensive site-specific investigations must be considered. For example, if substantial questions exist regarding the likely acceptability of a site from a geologic standpoint, substantial geotechnical investigations might be required. Also, if substantial questions exist regarding whether a large adverse impact will occur to an important aquatic species, long-term baseline studies will be considered. The NRC staff will advise the applicant of any additional information requirements as early as practicable.

3. Where a party to a proceeding proposes for consideration (according to Section VI.4.a of this appendix) a candidate site not included in the applicant's slate of candidate sites, it is the responsibility of that party to provide adequate information to support a decision to accept the site or not. If the site is accepted as a candidate site, it is the responsibility of the applicant in the proceeding to provide the information necessary to make the final comparison of that site with the proposed site.

4. Alternative site analyses of both the identification of the slate of candidate sites and the selection of the proposed site shall, at a minimum, address the following subjects:

a. hydrology, water quality, and water availability

b. aquatic biological resources, including endangered species

c. terrestrial resources and land uses, including endangered species

d. transmission corridors (approximate length and general location) and resources affected

e. socioeconomics, including aesthetics, and archeological and historic preservation

f. population distribution and density[2]

g. facility costs

h. institutional constraints, as they affect site availability

i. public concerns in the above subject areas, where such have been provided to the applicant or NRC in writing.

IV. Timing of NRC Review

1. An applicant may submit the proposed and alternative sites for NRC evaluation as part of a full CP review either prior to and separate from the review of plant design (an early site review) or in conjunction with the review of plant design.

2. As part of an early site review, an applicant that tenders an application for an alternative site review and requests a finding that there is not obviously superior alternative to the proposed site may do so either in conjunction with or separate from the consideration of other early site review issues. If the applicant applies for an early alternative site evaluation separate from the consideration of other early site review issues, the applicant may later submit other siting issues for an early site review during the effective period of the early alternative site partial decision, provided that any later early site review of other issues shall remain in effect only so long as the initial early site review of alternative sites remains effective.

V. Region of Interest

1. The initial geographic area for determining the region of interest for NRC regulatory review purposes shall be (a) the State in which the proposed site is located or (b) the service areas of the applicant. The

[1] For situations where, on the effective date of this rule, a future applicant has already begun or is about to begin detailed, long-term investigations on a site likely to be proposed subsequently to the NRC as a site for a nuclear power plant, such a future applicant must provide a notice of intent within three months following the effective date of this rule.

[2] This requirement will be modified as appropriate to conform to revisions to 10 CFR Part 100.

actual region of interest must be larger than the initial geographic area according to 3. below, or may be smaller than the initial geographic area according to 2. below.

2. The region of interest may be smaller than the initial geographic area, if (a) environmental diversity is not substantially reduced and candidate sites within the region of interest meet threshold criteria described in Section VI.2.b. of this appendix, or (b) costs of generating electricity would be exorbitant for sites located in those areas not included, or (c) siting in those areas not included would be in violation of State laws governing nonradiological health and safety aspects of utility siting, or (d) the costs would be exorbitant of developing information to demonstrate whether sites within those areas not included would likely be acceptable from the standpoint of safety.

3. The region of interest must be greater than the initial geographic area if environmental diversity would likely be substantially increased and if (a) candidate sites within the initial geographic area meet the threshold criteria in Section VI.2.b. of this appendix, and the development of sites in the added geographic areas would likely not substantially increase costs, or (b) candidate sites within the initial geographic areas do not meet threshold criteria in Section VI.2.b., and the development of sites in the added geographic areas would not require exorbitant costs.

4. For the purpose of determining the region of interest, environmental diversity refers to the types of water bodies available within the region (upper or lower reaches of large rivers, small rivers, lakes, bays, and oceans) and the associated physiographic units. A substantial increase or decrease in diversity would occur whether the region of interest includes or excludes such a water body. In areas of critical water supply, ground water and waste water are also appropriate water sources for diversity considerations.

VI. Selection of Candidate Sites

1. The candidate sites used in the subsequent site-specific comparison of alternatives must be one of the following:

a. Be identified through the use of a site selection methodology that (1) includes an environmentally sensitive site screening process (i.e., considers the same environmental parameters that are addressed by the criteria in VI.2.b., although not necessarily in the same way) resulting in a slate of candidate sites that are among the best that could reasonably be found and (2) meets the criteria presented in VI.3. below; or

b. Meet the criteria presented in VI.2. below, in which case there shall be no further review of the site selection process.

2. a. A sufficient number of candidate sites, which should include at least four sites, shall be selected from the region of interest to provide reasonable representation of the diversity of land and water resources within the region of interest. One or more of these sites should be associated with each type of water source and physiographic unit reasonably available within the defined region of interest, and one alternative site must have the same water source as the proposed site.

b. Except as noted in 2.c.(1), a site must meet the following criteria to be accepted as a candidate site without further review of the site selection process. (Technically appropriate and economically reasonable cooling system mitigative measures may be assumed for each candidate site.)

(1) Consumptive use of water would not cause significant adverse effects on other water users.

(2) There would not likely be any further endangerment of a State or Federally listed threatened or endangered plant or animal species.

(3) There would not likely be any significant impacts to spawning grounds or nursery areas of significance in the maintenance of populations of important aquatic species.

(4) Discharges of effluents into waterways would likely be in accordance with State or Federal regulations (e.g., avoidance of discharges to waters of the highest State quality designation) and would not likely adversely affect efforts of State or Federal agencies to implement water quality objectives (e.g., additional discharges to waters of currently unacceptable quality as determined by a State).

(5) There would be no preemption or likely adverse impacts on land uses specially designated for environmental or recreational purposes such as parks, wildlife preserves, State and National forests, wilderness areas, flood plains, Wild and Scenic rivers, or areas on the National Register of Historic Places.

(6) There would not likely be any significant impact on terrestrial and aquatic ecosystems, including wetlands, which are unique to the resource area.

(7) The population density, including weighted transient population, projected at the time of initial operation of a nuclear power plant, would not exceed 500 persons per square mile averaged over any radial distance out to 30 miles from the site (cumulative population at a distance divided by the area at that distance), and the projected population density over the lifetime of the nuclear power plant would not exceed 1,000 persons per square mile (simularly weighted and measured).[3]

(8) The site is not in an area where additional safety considerations (geology; seismology; hydrology; meteorology; and industrial, military, and transportation facilities) or environmental considerations for one site compared to other reasonable sites within the region of interest would result in the reasonable likelihood of having to expend substantial additional sums of money (cumulative expenditures in excess of about 5% of total project capital costs) to make the project licensable from a safety standpoint or to mitigate unduly adverse environmental impacts.

c. (1) If a site does not meet one or more of the threshold criteria provided in VI.2.b., the site may be acceptable as a candidate if it can be reasonably shown that further examination of that particular type of water source and physiographic unit would not likely identify a site that would meet those same threshold criteria.

(2) If any candidate site does not meet one or more of the threshold criteria provided in VI.2.b. to such an extent that serious adverse environmental impacts would result from its use, that site should be rejected as a candidate site.

3. If the approach of VI.1.a. above is relied upon, demonstration must be made that the site selection process incorporated the following criteria:

a. The overall objectives of the siting study and all initial constraints and limitations (including the geographic area, i.e., region of interest, which is the subject of the study) shall be explicitly stated giving the basis and rationale for all choices.

b. The proposed ways of meeting the stated objectives shall be described, including the general approach to the site selection process.

c. The study shall explicitly state factors (e.g., aquatic biology) under consideration, parameters (e.g., spawning grounds and nursery areas) by which these factors were measured, and criteria (e.g., no significant impact) that define levels of achievement.

d. The site selection study shall be interdisciplinary and shall include natural, social, and environmental sciences. The range of the responsibilities of the study team shall be clearly defined and the methods employed in resolving differences within the group or of arriving at the consensus shall be explicitly stated.

e. The process that led to the identification of candidate sites including all specific methodologies shall be explicitly stated in detail.

(1) Where preemptive screening is used, all limiting or exclusionary criteria employed shall be explicitly stated, the bases for each criterion given, and the ways in which they are applied explained.

(2) Where comparative analysis is used, all methodologies used involving importance factors, preference functions, utility functions, weighting factors, ranking scales, scoring schemes, and rating systems shall be explictly described; the basis for the selection of each methodology given; and the ways in which each is applied explained.

f. The study shall contain detailed description of administrative means used to support the site selection study, including any quality assurance program commensurate with the objectives of the study and a data management system for handling technical files, maps, and other information.

g. Definitions of terms used in the study shall be included.

4. Any intervening party and the NRC staff may propose one or more additional sites for consideration as candidate sites provided that the following conditions are met:

a. The additional sites are proposed for review within 30 days after the first special prehearing conference (i.e., the conference held pursuant to § 2.751a of 10 CFR Part 2.).

b. The proposal contains a reasonable showing that the additional sites are comparable to the applicant's slate of candidate sites in their ability to meet the criteria specified in VI.2.b. and VI.2.c. and would add to the diversity which is exhibited

[3] This requirement will be modified as appropriate to conform to revisions to 10 CFR Part 100.

by the applicant's slate of candidate sites; or where the applicant's candidate sites do not meet all the criteria specified in VI.2.b. and VI.2.c., the proposal contains a reasonable showing that the additional sites will meet these criteria.

c. Where a party identifies more than one additional site, each additional site must meet one of the tests specified in VI.4.b. above.

d. The additional sites have no physical features that would likely create substantial increases in the cost of constructing and operating nuclear power plants at the additional sites compared with the applicant's proposed site, unless there is a reasonable showing that the additional sites meet a criterion specified in VI.2.b. that is not met by the applicant's proposed site.

e. Multiple parties to NRC proceedings should consult with one another prior to proposing additional sites for consideration as candidate sites in order to reasonably limit the total number submitted.

5. A presiding Atomic Safety and Licensing Board (ASLB) may on its own initiative proposed one or more additional sites for consideration as candidate sites up to 30 days after the issuance of the Draft Environmental Statement (DES). On or after the issuance of the DES, additional sites may be introduced by the ASLB, only after a balancing of the cost of delaying the proceeding against the likelihood that utilization of the additional site would avoid significant environmental harm.

6. The 30-day time limits in VI.4.a. and VI.5. above shall not be extended except upon a substantial showing of good cause.

VII. Comparison of Proposed Site With Alternative Sites

1. After it is determined by either of the above approaches that the proposed site comes from a slate of candidate sites that are among the best that could reasonably be found, the NRC will not reject the proposed site solely based on its review of the alternative sites unless a comparision with the remaining candidate sites results in a determination that an abviously superior alternative exists. The NRC will determine obvicus superiority among the candidate sites by a sequential two-part analytical test. The first part gives primary consideration to hydrology, water quality, aquatic biological resources, terrestrial resouces, water and land use, socioeconomics, and population [4] to determine whether any alternative sites are environmentally preferred to the proposed site. The second part overlays consideration of project economics, technology, and institutional factors to determine whether, if such a environmentally preferred site exists, such a site is, in fact, an obvioulsy superior site.[5] The following factors are considered in this second part of the test:

a. The environmental and safety [6] considerations in terms of technology and costs of construction and operation of nuclear power plants at the sites.

b. The forward costs [7] at the proposed site compared to the alternative sites.

c. Other considerations, such as possible institutional barriers. The applicant's proposed site will be rejected solely based on NRC review of alternative sites only when the NRC determines that, considering both parts of the test, there is an environmentally preferable alternative which also is obviously superior, i.e., the NRC is confident that the applicant's proposed site should be rejected.

2.a. If an obviously superior alternative site is identified and the proposed site is rejected by the NRC, and if the applicant submits a new application naming the identified obviously superior site as the newly proposed site, the NRC will not require review of the alternative site question for the newly proposed site, provided that the previous slate of candidate sites had been determined to be acceptable by the criteria established in this rule.

b. If more than one obviously superior alternative site is identified and the proposed site is rejected by the NRC, the applicant may request that a further finding be made in that proceeding to determine whether one of those sites is obviously superior to the others. If that finding is made and one of those sites is obviously superior to the others and the applicant submits the obviously superior site as the new proposed site, the NRC will not require review of the alternative sites question for the newly proposed site, provided that the previous slate of candidate sites had been determined to be acceptable by the criteria established in this rule. If that finding is made and none of those sites is obviously superior to the others, the applicant may propose any of the obviously superior alternative sites for review as permitted according to 2.a. above.

c. If one or more obviously superior sites are identified and the proposed site is rejected by the NRC, the applicant may submit a new proposed site that is comparable to the obviously superior sites in its ability to meet the criteria specified in Section VI.2.b. Where a new site is proposed, appropriate public notice of intent is provided, and a showing of comparability in meeting the criteria is made, the NRC will only require that the sequential two-part analytical test for obvious superiority be performed on the new proposed site and on the sites found obviously superior in the earlier proceeding.

VIII. Reopening of the Alternative Site Decision

1. A reopening and reconsideration of the alternative site decision after a final limited work authorization or construction permit decision will be permitted only upon a reasonable showing that there exists significant new information that could substantially affect the earlier decision. Any decision to reconsider the alternative site decision or not in these instances will take into account preliminary estimates of the reasonable costs of delay and of moving to another site compared with the adverse environmental impacts that might be avoided by moving to another site.

2. For cases where the portion of the construction permit containing facility design is filed three years or more after the effective date of this rule and where an applicant submits the proposed and alternative sites for NRC evaluation as part of a full construction permit review at least 2½ years prior to filing the portion of the construction permit application containing detailed plant design, any reconsideration of the alternative site decision will be permitted only upon a reasonable showing that there exists significant new information that could substantially affect the earlier decision, as described in VIII.1. above. If the proposed and alternative sites were not submitted for NRC evaluation as part of a full construction permit review at leat 2½ years prior to filing the portion of the construction permit application containing the plant design, costs of delay and of moving to another site will not be considered in any decision to reconsider the alternative site decision or not or in any resulting decision that there is or is not an obviously superior site.

3. If two sites are reasonably within a region of interest for a nuclear power plant site and both sites have received an affirmative NRC partial decision on an early review of alternative sites, an applicant may choose either site for an application to construct a specific nuclear power plant without reviewing the alternative site question, except on the basis of new information as provided in VIII.2. above.

(Sec. 161 h., i., o., Pub. L. 83-703, 68 Stat. 948 (42 U.S.C. 2201 (h), (i), and (o)); Sec. 102, Pub. L. 91-190, 83 Stat. 853 (42 U.S.C. 4332); Sec. 201, as amended, Pub. L. 93-438, 88 Stat. 1242; Pub. L. 94-79, 89 Stat. 413 (42 U.S.C. 5841))

Dated at Washington, D.C., this 4th day of April 1980.

For the Nuclear Regulatory Commission.

Samuel J. Chilk,

Secretary of the Commission.

[FR Doc. 80-10897 Filed 4-8-80; 8:45 am]

BILLING CODE 7590-01-M

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[4] This requirement will be modified as appropriate to conform to revisions to 10 CFR Part 100.

[5] In applying both parts of the test, the NRC will give consideration to the inherent uncertainties of cost-benefit analysis techniques and, where applicable, to the disparity in the data base between the proposed and alternative sites.

[6] There are some site safety issues for which a cost-effective means for successful mitigation is not state-of-the-art engineering. For the purposes of alternative site analysis, these site safety issues are considered in terms of site acceptability, i.e., where successful mitigation is considered outside the state of the art, the site would be considered unacceptable. However, where the mitigation of the safety issues are considered to be within the state of the art, the site would be considered acceptable but still must undergo the comparative test, which includes the impact of the mitigation on overall project cost, to determine whether there is an obviously superior alternative. Even though the proposed site successfully passes the early evaluation of alternative sites, it could still be found unacceptable in the later detailed safety review of that site.

[7] For cases where the portion of the construction permit application containing facility design is filed 3 years or more after the effective date of this rule, and an early site review application for the review of alternative sites had not been filed at least 2½ years earlier, the costs of moving to another site, including costs of delay, will be given no weight in any consideration of alternative sites or in any decision whether to reopen a previous decision on this subject.

APPENDIX I

ENVIRONMENTAL ANALYSIS OF THE
CONDITIONAL LAND SALE AND EASEMENT CONTRACT
WITH PUGET SOUND POWER AND LIGHT COMPANY

PREPARED BY

U.S. DEPARTMENT OF ENERGY

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CONDITIONAL LAND SALE AND EASEMENT CONTRACT
WITH PUGET SOUND POWER AND LIGHT COMPANY

1.0 DESCRIPTION OF THE PROPOSED ACTION

The Department of Energy (DOE) proposes to enter into a conditional land sales contract with Puget Sound Power and Light Company (PSP&L), representing itself, Portland General Electric Company, The Washington Water Power Company, and Pacific Power and Light Company. The purpose of this contract will be to provide for the conveyance of 640 acres (259 ha) by sale of the land which is owned by the United States and under the jurisdiction of the Department of Energy at its Hanford Site at Richland, Washington, for use in construction and operation of one or more commercial nuclear generating plants. In addition, easements totaling about 500 acres (202 ha) will be granted to PSP&L or comparable rights will be given to the Bonneville Power Administration for transmission corridors and switching stations, and to PSP&L for access roads, railroad and water lines and related facilities. DOE will meet PSP&L's need for an exclusion area of about 6000 acres (2430 ha) around the generating plants to comply with the Nuclear Regulatory Commission's (NRC) requirements; however, there will be no conveyance of land for that purpose. For the purpose of this environmental analysis, it will be assumed that a maximum of four 1200 MWe plants will be constructed and operated. The conditional sales contract will provide that the land shall not be conveyed until: 1) all licenses required by law, such as State Site Certification, Limited Work Authorization, or NRC Federal Construction Permit, to allow the company to proceed with construction have been received including the preparation of appropriate environmental reports for both the Washington State Energy Facility Site Evaluation Council and the NRC; 2) DOE has determined that the proposed facilities are compatible with existing and future DOE programs and projects at Hanford; and 3) as a result of necessary environmental reviews, DOE has determined that conveyance of the land is the appropriate action to be taken. DOE will be a cooperating agency in the NRC Environmental Impact Statement (EIS) process. As such, DOE will consider the contents of the EIS before making a final decision on sale of the land. Upon review of the EIS, DOE will issue a Record of Decision. The transfer of title to the land will not occur until after the Record of Decision by DOE is issued.

To maintain the integrity of the Hanford Site, the agreement will include a provision requiring PSP&L to comply with whatever decontamination and decommissioning regulations are in force when the plant(s) reaches the end of its useful life, and that the land revert to the Government at no cost to the Government.

This environmental analysis will address the alternative sites potentially available for purchase at Hanford and consider, in general terms, the environmental impacts of the proposed construction and operation at these various sites along with the compatibilities and/or conflicts with Hanford land-use plans. Included in the environmental analysis will be consideration of a no-action alternative.

2.0 DESCRIPTION OF THE EXISTING ENVIRONMENT AND DOE PLANS AND PROGRAMS .OR THE HANFORD SITE

This section of the Environmental Analysis includes a description of Hanford Site environs, a description of present activities at Hanford, a description of the proposed (or reference) site under consideration by PSP&L, and a description of postulated future DOE programs to help evaluate potential impacts of the proposed action.

2.1. HANFORD SITE ENVIRONS

The Hanford Site occupies about 570 square miles or 365,000 acres (147,716 ha) of the southeastern part of the State of Washington (Figure 1). The population living within a 50-mile (80 km) radius of the Hanford Site varies from about 275,000 for a radius center midway between the two chemical processing and waste storage areas in the 200 Area to about 180,000 for a radius center at the 300 Area (Figure 2). Land uses in the surrounding area include urban and industrial uses, and irrigated and dry land farming. Of the

FIGURE 1. Location of Hanford Site in Washington State

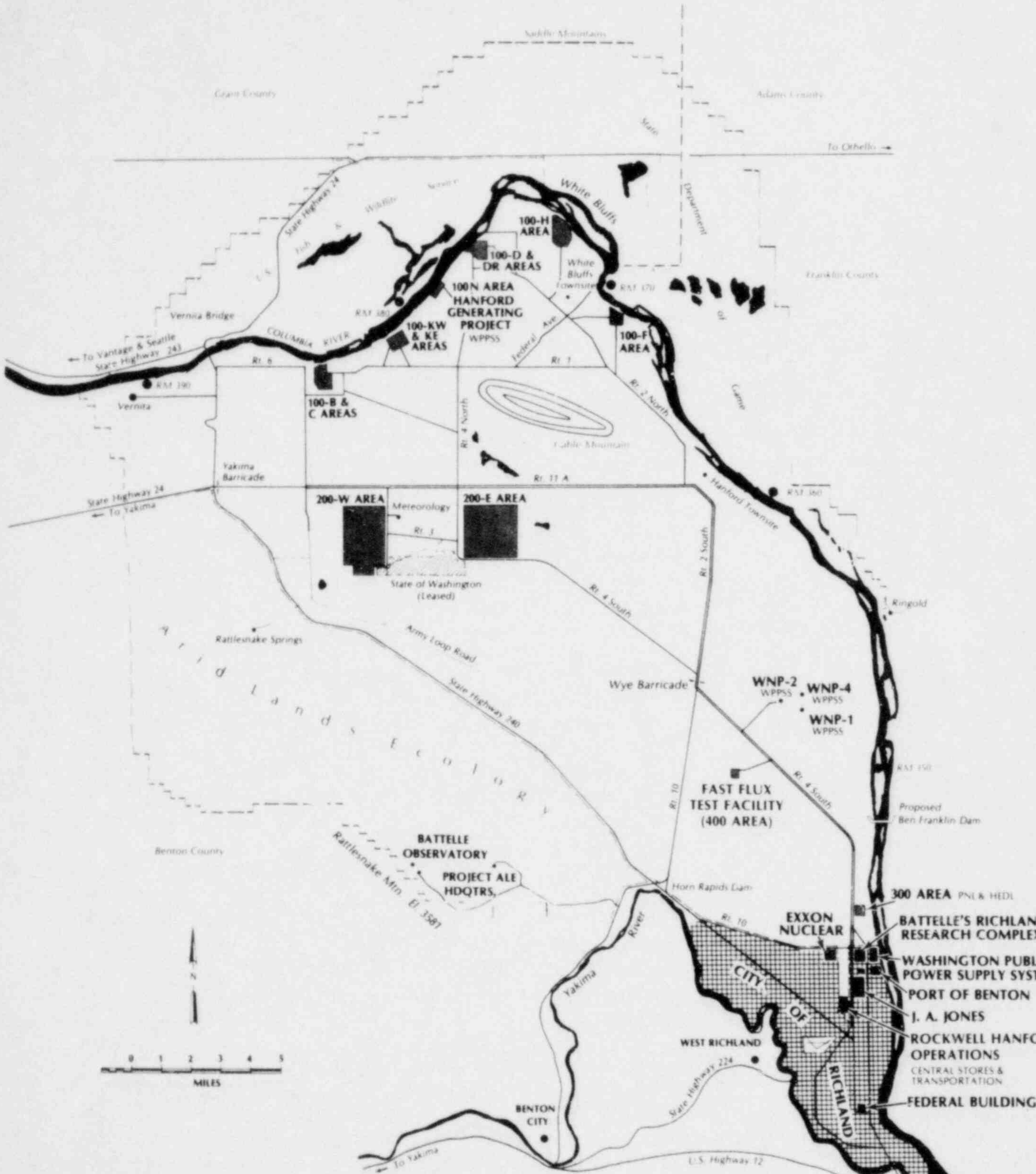


FIGURE 2. Map of Hanford Site

irrigated crops, alfalfa hay occupies 30 percent of the total area, wheat 15 percent, and potatoes and other crops about 8 percent. Water removal rights, other than Hanford's, amount to about 250 cfs (7.1 m^3/s) within 50 miles (80 km) of the N Reactor, from an annual average river flow of about 120,000 cfs (3398 m^3/s).

The National Register of Historic Places lists the following sites on the Hanford Reservation: Locke Island Archaeological District, Paris Archaeological Site, Ryegrass Archaeological District, Wooded Island Archaeological District, Savage Island Archaeological District, North Archaeological District, Hanford Island Archaeological Sites, Rattlesnake Springs Archaeological District, and Snively Canyon Archaeological district. The following have been nominated but not listed on the Register: Wahluke Archaeological District and Coyote Rapids Archaeological District. None of the land proposed for sale or easement to PSP&L contains any land that has been named or nominated to the National Register of Historic Places. The closest historic site to the land proposed for transfer is the Hanford Island Archaeological Site, located about one mile up river (northwest) of the proposed easement point for cooling water intake structures and pipes on the Columbia River. Hanford Island was named to the National Register of Historic Places in 1976. The remains of many Indian campsites and fishing grounds are to be found along the Columbia River within the Hanford Site boundary. However, none of the land proposed for sale or easement contains any known past or present native American religious sites. Applications for three sites within 50 miles are currently being processed: 1) Marmes Rockshelter, 2) Olmstead Place State Park, and 3) Whitman Mission National Historic Site. The Hanford Dunes area has been recommended as a potential National Natural Landmark under a program administered by the National Park Service (Scott 1978; Daubenmire 1975).

Eastern Washington is dominated by the Columbia River geologic province encompassing about 50,000 square miles (12,950,000 ha). It is underlain by the vast field of flood lavas of the Columbia River Basalt Group. Late in the Pleistocene epoch, about 18,000 to 12,000 years ago, large floods scoured and carved the Ringold formation surface beneath the Hanford Site, depositing the sediments now found on the Site.

The Hanford Site is in a region of low to moderate seismicity. On the basis of the damage that has been experienced since 1840, the U.S. Coast and Geodetic Survey designated the area a Zone 2 seismic probability, implying the potential for moderate damage from earthquakes. The underlying sands and gravels on the Hanford Site provide excellent protection against damage. Earthquake intensities greater than four on the Modified Mercalli Scale (MM-IV) have not occurred in the immediate Hanford area (the Pasco Basin) (ERDA 1975).

Over 1,500 wells have been drilled at Hanford to provide data for evaluating the chemical and physical properties of the underlying materials and to study movement of radioactive materials in soils.

The climate of the Hanford area is generally mild, although there are well-developed seasonal variations in most climatological elements. During the late fall and winter low wind speeds frequently combine with high atmospheric stability to produce poor dispersion conditions (stagnation). Periods of stagnation of 10 days can be expected to occur each year or two.

Severe weather events are infrequent. Thunderstorms occur on an average of 11 days per year, but they are not the violent storms found in many other parts of the country, and tornadoes are rare. There has only been one confirmed tornado siting at Hanford and 14 within a radius of 100 miles (1600 m) since 1912.

The vegetation mosaic of the Hanford Site consists of eight major kinds of shrub-steppe communities.

Mule deer and a small number of elk are the only big game mammals, while the cottontail rabbit and the black-tailed hares are the most abundant small game mammals on the Hanford Site. Small mammals are abundant, particularly the Great Basin pocket mouse. The chukar partridge is the most abundant upland gamebird. Hunting is not permitted on the south or west sides of the Columbia River, the major portion of the Hanford Site.

The Hanford Site provides refuge for one animal and four plant species either listed or under consideration for listing by the U.S. Fish and Wildlife Service under provisions of the Endangered Species Act of 1973, as amended. These species and their status are shown in Table 1. The bald eagles, the only Hanford species that could potentially be impacted by the proposed action are discussed in Section 3.3.2. Several species under consideration by the State of Washington for possible protection under a State Endangered Species program are known or suspected to occur on the Hanford Site. These species are listed in Section 3.3.2.

TABLE 1. Federal Listed or Candidate Endangered Species Occurring on the Hanford Site

Scientific Name	Common Name	Status[a]
Plants		
Allium Robinsonii	Robinson's Onion	Candidate
Astragalus columbianus	Columbia Milk Vetch	Candidate
Balsmorhiza rosea	Rosy Balsamroot	Candidate
Rorippa calycina var. columbiae	Persistent Sepal Yellow Cress	Candidate
Animals		
Haliaeetus leucocephalus	Bald Eagle	Threatened

(a) Federal Register, 45(99):33768-33781, May 20, 1980;
Federal Register, 45(242):82480-82569, December 14, 1980.

The anadromous salmon and the steelhead trout are the fish of greatest economic importance in the Columbia River. About 21,000 fall chinook salmon and 10,000 steelhead trout spawn in the Hanford Reach of the river. Over 30 percent of the adult fall chinook ascending McNary Dam spawn in the Hanford section of the river. There are also approximately 40 species of resident fishes in this part of the Columbia and about half contribute to recreational fishing.

The local reach of the river also serves as a route for passage of the anadromous fishes to and from upstream spawning and rearing areas. Species that migrate to upriver areas include chinook, coho, and sockeye salmon; steelhead trout; and shad.

2.2. DESCRIPTION OF HANFORD SITE ACTIVITIES

The Hanford Site operating areas are identified by area numbers. The production reactor facilities are located in what are known as the 100 Areas. The reactor fuel processing and waste management facilities are in the 200 Areas. The 300 Area contains the reactor fuel manufacturing f cilities and the research and development laboratories. The 400 Area contains the Fast Flux Test Facility. The 600 Area comprises most of those portions of the Hanford Site not contained in the 100, 200, 300, and 400 Areas.

The six 100 Areas (B, K, N, D, H, and F) bordering on the Columbia River in the northernmost portion of the Hanford Site are the sites of the plutonium production reactors. At the present only N Reactor is operating.

B-Reactor Area, about 650 acres (263 ha), is the furthest upstream of the six 100 acres. It contains the reactors designated as B and C reactor.

The 100-K Area, about 135 acres (54.6 ha) is 2.5 miles (4.0 km) downriver of the 100-B Area. It contains the KE Reactor and KW Reactor.

The 100-N Area, about 90 acres (36 ha) at river mile 380, is 2.3 miles (3.7 km) downriver of the 100-K Area. It contains the N Reactor, a dual-purpose unit that provides plutonium for military purposes and low-pressure steam for the 860,000 kW Washington Public Power Supply System (WPPSS) generating plant nearby.

The 100-D Area, about 960 acres (389 ha), is located 1.7 miles (2.7 km) downriver of the 100-N Area. It contains the D Reactor and DR Reactors.

The 100-H Area, about 320 acres (130 ha), is located about 3.2 miles (5.1 km) downriver of the 100-D Area. It contains H Reactor. Several major buildings in 100-H Area, including the power house and stacks and some of the water treatment buildings, have been removed in recent years.

The 100-F Area, about 540 acres (219 ha), is located 3.2 miles (5.1 km) downriver of the 100-H Area. It contains F Reactor. A number of buildings have been removed from 100-F Area.

In the middle of the Site, on a plateau about 7 miles (11.3 km) from the Columbia River, are the two 200 Areas where the fuel and waste processing and waste storage activities are located. The location of the 200 Areas was chosen because it provides the most isolation from the Site boundaries and is the most removed from both surface and subsurface water. The 200 Area activities include or have included fuel reprocessing, plutonium fabrication and processing, waste fractionization, laboratory work and management of the high-level radioactive liquid waste resulting from fuel reprocessing. Radioactive waste from 100 and 300 Areas is also sent to the 200 Areas for disposal.

The 300 Area is located about 1 mile (1.6 km) north of the Richland city limits on the bank of the Columbia River. It includes about 375 acres (152 ha). Most facilities in the 300 Area, completed in 1943 and the years immediately following, were related to the fabrication of production reactor fuel. More recently research and development activities in support of a wide range of DOE programs have constituted a major part of the work in the

300 Area. The newer facilities house mostly laboratories and large test facilities in support of peaceful utilization of plutonium, reactor fuels development, liquid metal technology, Fast Flux Test Facility support, gas-cooled reactor programs and life sciences programs.

The 400 Area is about 7 miles (11.3 km) northwest of the 300 Area and is the site of the Fast Flux Test Reactor.

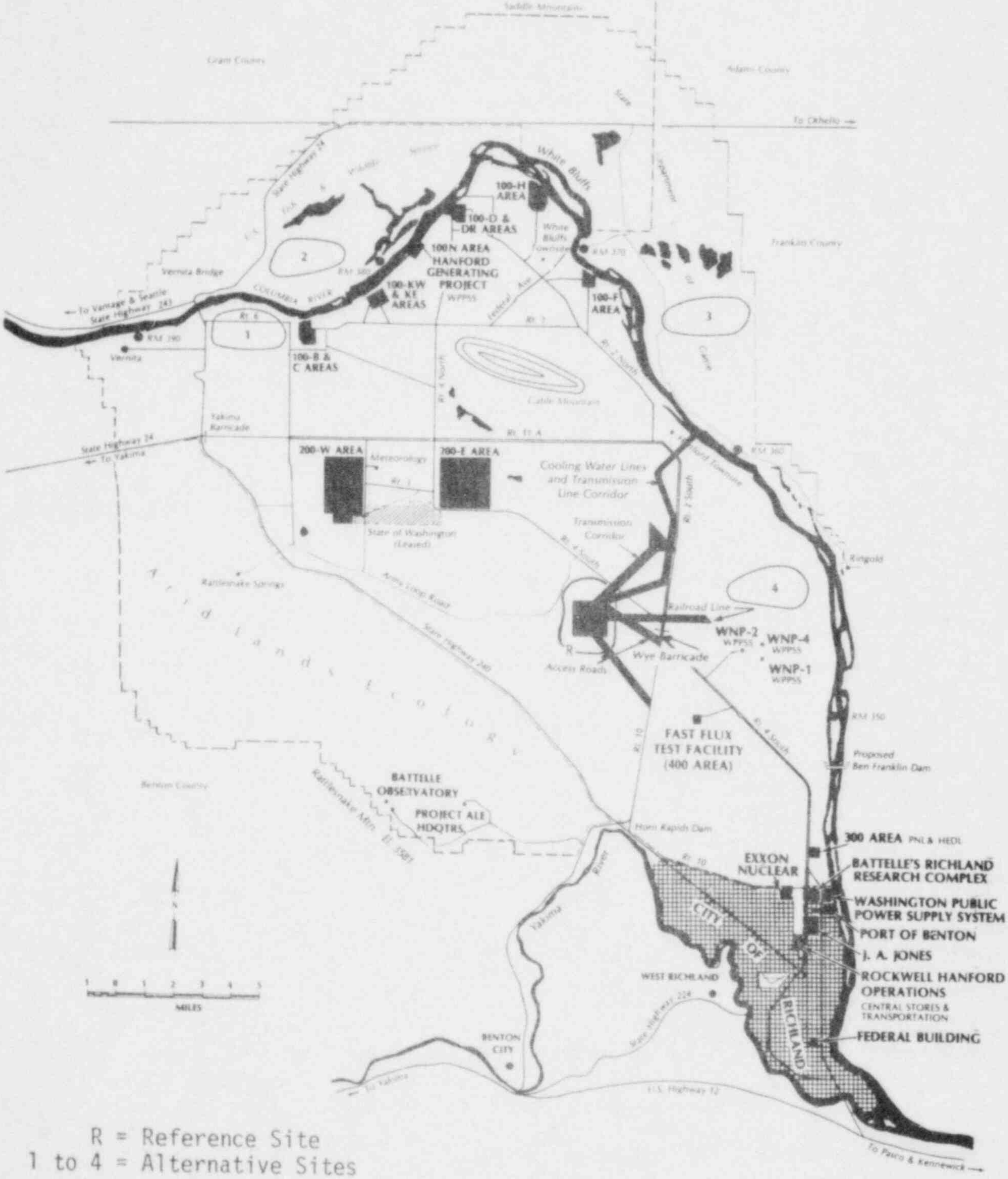
Most of the Hanford Site not included as one of the 100, 200, 300, or 400 Areas is designated as the 600 Area. Included in 600 Area are:

- the Arid Lands Ecology Reserve, a 120-square mile (31,080 ha) tract set aside exclusively for the study of ecology
- 1,000 acres (405 ha) leased to the State of Washington
- 1,089 acres (441 ha) for WPPSS nuclear plant No. 2, and 973 acres (394 ha) for WPPSS nuclear plants Nos. 1 and 4.
- about 2,000 acres (809 ha) of the former Hanford Construction Camp which housed at one time over 40,000 workers
- 2 abandoned townsites, Hanford and White Bluffs
- many support facilities for the Controlled Access Areas (the 100, 200, 300, and 400 Areas)
- 32,000 acres (12,950 ha) managed by the U.S. Fish and Wildlife Service under a revocable permit from DOE
- 54,000 acres (21,854 ha) managed by the Washington State Department of Game under a revocable permit from DOE

These latter 86,000 acres (34,804 ha) of the site north of the Columbia River are being developed as a wildlife refuge area by the U.S. Fish and Wildlife Service and a recreation area by the Washington State Department of Game. In 1964, the AEC leased 1,000 acres (405 ha) of land near the 200 Areas to the State of Washington for commercial nuclear use. U.S. Ecology Incorporated provides commercial solid waste burial service on 100 acres (405 ha) of this tract under a license from the State. The Arid Lands Ecology (ALE) Reserve is established between a public road, State Highway 240 which traverses the southwestern portion of the Site, and the top of Rattlesnake Mountain.

2.3. THE PROPOSED SITE

The reference site of the proposed Puget Sound Power and Light Company (PSP&L) nuclear power station is shown in Figure 3. It is located immediately west of the Wye Barricade near the center of the Hanford Site about seven miles (11 km) from the Columbia River. It is entirely comprised of land which will be acquired from DOE. The terrain is relatively flat, similar to much of the land on the Hanford Site. The site is similar in many respects to those selected by WPPSS for their nuclear plants at Hanford, except that it is more distant from the river.



R = Reference Site
1 to 4 = Alternative Sites

FIGURE 3. Hanford Site Showing Reference Site and General Location of Alternative Sites for Evaluation

Highway access to the site is from the south over Route 10, connecting with State Highway 240 leading to the Tri-Cities to the southeast, Grandview-Sunnyside-Yakima and portions of Grant County to the west (and north), and Benton City to the south. Railroad access to the site via the Hanford railroad system requires construction of about 4 miles (6 km) of new trackage. Barge transportation to the reference site will be similar to that for the WPPSS plants, i.e., large pieces of equipment are unloaded south of the 300 Area and transported by land to the site. Major Bonneville Power Administration 500-kV transmission links pass near the site. This transmission system transmits electric power from the Hanford Site (from the WPPSS plants presently under construction, and from the Hanford Generating Plant) to load centers in the Puget Sound and Willamette Valley.

The site is sufficiently distant from known geologic hazards to avoid potential damage to the proposed facilities from any seismic events. Site elevation is sufficiently high to avoid potential problems arising from flooding of the Columbia River.

2.4. DOE PLANS AND PROGRAMS FOR THE HANFORD SITE

The DOE plans and programs for the Hanford Site are divided into two categories: a) those facilities and programs which are more or less definitely planned, and b) those plans and programs projected to be representative of a possible future for Hanford. The former are described in Area Site Development Plans (United Nuclear Industries 1979; Rockwell Hanford Operations 1979; Hanford Engineering Development Laboratory 1978 and 1980), and cover a time period through about 1985. The latter are intended to be representative of what might occur at Hanford in the next 10 to 25 years. The purpose of describing possible future programs at Hanford is to permit a more thorough evaluation of environmental impacts and to determine compatibility of the proposed action with possible DOE future programs and plans.

2.4.1 Area Site Development Plans

2.4.1.1 100 Areas

The two major activities presently planned for the period to 1985 include continued operation of N Reactor and decommissioning/removal of facilities in 100-F Area. It is likely these activities will continue beyond 1985. Modifications to office facilities, utilities, and roads, as well as modifications related to security, safeguards, safety, conservation, and environmental concerns are also planned. All of these are modest in scope and are generally limited to 100-N Area.

2.4.1.2 200 Areas

The major activities in 200 East and 200 West Areas for the period to 1985 include operation of the radioactive waste management facilities, reactivation of fuel reprocessing facilities, and decommissioning/removal of a number of contaminated facilities. These operations, or similar ones, will continue beyond 1985. Modifications to office and process facilities, utilities, and roads, as well as modifications related to security, safeguards, safety, conservation, and environmental concerns are also planned. In general these are modest in scope and typical of activities related to operation of a major industrial complex.

Immediately adjacent to the 200 Areas, DOE has leased to the State of Washington approximately 1000 acres (405 ha) of undeveloped land for the purpose of encouraging the location of nuclear-related industry at that site. U.S. Ecology, Inc. operates a low-level radwaste facility on a 100-acre (40 ha) parcel of that land. Presumably these operations will continue through 1985.

2.4.1.3 300 Area

A number of new research and development facilities are planned for the 300 Area, including the Fusion Materials Irradiation Test Facility, the Environmental and Energy Technology Facility, the Plant Operations and Maintenance Facility, and the Steam Generator Examination Facility. These facilities are typical of those presently sited in the 300 Area, and suggest that future R&D operations will not be greatly dissimilar to those presently carried on. A number of smaller R&D and support facilities are planned for the 300 Area. Modifications and additions to the utilities serving 300 Area facilities are planned. Transportation, other support services, energy conservation, and safety and security additions and modifications are also planned.

2.4.1.4 400 Area

Development of the 400 Area is in support of the Breeder Reactor Program. At present, 400 Area facilities consist of the Fast Flux Test Facility (FFTF) and temporary buildings in support of the construction and operation of the FFTF. There are plans to construct eleven new buildings within the 400 Area, remodel several others, and to remove temporary or deficient buildings and trailers. Modifications and additions to utilities and other support services, transportation facilities, and modifications required for safety and security reasons are also planned.

2.4.1.5 600 Area

The major portion of other land areas on the Hanford site are classified as the 600 Area. The major nonecology-related DOE activity in the 600 Area is the Near-Surface Test Facility (NSTF) in Gable Mountain, north of the 200 East Area. This facility is part of the Basalt Waste Isolation Program (BWIP), a program to assess the feasibility of the permanent storage of radioactive waste in underground basalt formations. The facility consists of three parallel shafts penetrating 700 feet (213 m) into the mountain's north face. It is scheduled for decommissioning in 1985.

2.4.2 Postulated Plans and Programs

The initial plant of the Puget Sound Power and Light Company site is scheduled to be operational in 1991; thus, construction activities would commence in 1983 (Appendix B). If subsequent plants are scheduled for operation at two-year interval , then construction would commence on the subsequent plants in 1985, 1987, and 1989, assuming a total of four at the station. The Area Site Development Plans with their near-term focus need to be supplemented with longer-term DOE plans and programs to properly evaluate the effect of the proposed action on DOE programs. Since a complete listing of official, long-term DOE program plans does not exist for the Hanford site, several postulated plans have been developed as a substitute for the real future for Hanford. These postulated plans build on past practices at Hanford and likely future DOE programs to give a wide range of activities with which to test the compatibility of the proposed action. The Area Site Development Plans have also been reviewed against the postulated longer-term DOE plans and programs. It should be reemphasized that these future plans, although they are realistic, are at the present time speculation for the purpose of analyzing environmental impacts and compatibility of the proposed action with future DOE programs and plans.

The programs and plans selected for Hanford's future include the following:

1. An increased production mission
2. Fission energy processes development
3. Radioactive waste storage
4. Fusion power development.

2.4.2.1 An Increased Production Mission

The initial (plutonium) mission at Hanford comprised three reactor areas, two chemical processing areas, and a fuels manufacturing and R&D area. The Hanford Site's maximum production capability comprised nine reactors in six areas with expanded facilities for chemical processing and fuel manufacturing. The major thrust of the production mission was accomplished in a 20 to 25 year period, but the mission has continued to the present with the operation of N Reactor and related facilities.

Another production mission might resemble the plutonium mission, though the product might be different and have different end uses. We have assumed an initial production campaign involving three reactors in three areas with three more reactors added at a later time to these three areas.

Additional assumptions include 1) that the production mission will commence in 1990 and last 25 years, and 2) that production areas are restored every 50 years so that existing 100, 200, and 300 Areas, with modest expansions in area, would be used for the new production missions, and 3) that the reactor facilities are dual purpose (product and power) typical of large present-day power reactors, e.g., 1250 MWe, 3750 MWth.

In addition to land areas equivalent to the present 100 Areas, the production reactors will require about 40 cfs (1.1 m^3/s) each for cooling tower operation and will require widened transmission corridors to Hanford-based switching stations. The environmental loading will include 2500 MW of thermal energy per reactor to the atmosphere in the form of evaporated water. Radioactive effluents released to the environment would be similar to those from commercial power reactors, e.g., 5,000 to 10,000 Ci/yr to the atmosphere and 50 to 500 Ci/yr to the river. The sites for the new production facilities are assumed to be 100-B, K, and D Areas, though the plateau near the 200 Areas or land areas adjacent to them would also be satisfactory.

A production fuel reprocessing facility is assumed to be located in 200-E Area (this could be PUREX, a modification of it, or an entirely new facility). Water use is estimated at about 40 cfs (1.1 m^3/s); radionuclides released with gaseous effluents are estimated to total about two million Ci/yr (assumes higher iodine-129 and 131 and krypton-85 removal rates than have been experienced to date in fuel reprocessing plants).

Fuel fabrication is assumed to be located in the 300 Area or adjacent to it.

2.4.2.2 Fission Energy Processes Development

Hanford has been the site for a number of experimental and test reactors, including FFTF, Plutonium Recycle Test Reactor (PRTR), Hanford Test Reactor (HTR), and High emperature Lattice Test Reactor (HTLTR), to name a few, and has been considered as a site for a number of others. Since it is possible that future experimental and prototype reactors will be sited at Hanford, the postulated future for the fission energy processes development program is represented as consisting of the construction and operation of both a prototype or test reactor and a demonstration reactor for each of three potential commercial reactor types. Actual development-type reactors which could be built at Hanford include special-purpose terrestrial reactors, military reactors, or space reactors, for instance, or they could be liquid-metal fast breeder reactors, gas-cooled fast breeder reactors, or advanced thermal reactors.

A prototype/test reactor is assumed to be 400 MWth and a demonstration reactor is assumed to be 400 MWe.

The reactor sites are assumed to be located in the 400 Area in proximity to FFTF. Each reactor is projected to require a site not unlike that required for FFTF (about 200 acres [80.9 ha]). Some supporting R&D facilities would be located in 300 or 400 Areas, including experimental fuel reprocessing and refabrication facilities.

The reactors are assumed to start operation at five-year intervals between 1990 and 2005, and to operate for periods of 10 to 30 years. In addition to land areas of about 200 acres (80.9 ha) per reactor and associated facilities, it is assumed that an additional 75 acres (30.1 ha) would be required for transmission lines, including one to the Ashe switching station. The prototype reactors would require about 5 cfs (0.14 m^3/s) of water for cooling tower purposes and the demonstration reactors would require about 15 cfs (0.42 m^3/s). The environmental loading would include about 250 MWth for each of the smaller reactors and 800 MWth for each of the larger reactors. Releases of radionuclides are assumed to be similar to present commercial power reactors.

2.4.2.3 Radioactive Waste Storage

Future nuclear waste storage operations at Hanford are assumed to comprise the following:

1. Continued waste management activities as described in ERDA 1538, Final Environmental Statement, Waste Management Operations, Hanford Reservation, dated December 1975.

2. Away From Reactor (AFR) spent fuel storage.

3. Geologic storage of commercial and military radioactive wastes.

4. Waste relocation and consolidation resulting from such activities as the possible construction of Ben Franklin Dam or from continued decontamination and decommissioning (D&D) of surplus facilities.

All of these activities are or could be (as in the case of Items 2 and 4) located in the 200 Areas or surrounding area. The underground area presently being considered for the Basalt Waste Isolation Program (BWIP) encompasses all of the present 200 Areas plus some additional land areas. If the BWIP becomes a reality, no surface activities will be permitted which might compromise the integrity of its underground waste envelope. None of those in Items 1 and 4 would compromise it and all could readily fit into the land area available in or surrounding the 200 Areas. Thus, no specific efforts are made to be definitive about their location on the 200 Area plateau.

Adequate space also exists for commercial nuclear waste activities within the space available above the repository should burial operations continue as in the past. In all likelihood future operations will tend to make more conservative use of land as more facilities are constructed or sited at Hanford.

Radiation doses to offsite persons from releases of radioactive materials from nuclear waste storage activities are expected to be well below extant natural background levels. D&D activities would contribute additional radiation exposure. The magnitude of doses from D&D would be dependent upon the technology employed for removal and transport of radioactive materials from existing burial grounds and structures and the decommissioning time frame. Appropriate means would be employed to maintain the combined public radiation dose from all facilities at acceptable levels.

2.4.2.4 Fusion Power Development

One of the major electric power activities likely to occur during the next 30 to 40 years will be fusion development. Achievement of a reactor-grade plasma is expected in the early 1980s. A pilot-scale power reactor or ignition test reactor might be constructed in the mid-1980s prior to constructing one or two (one of the magnetic fusion energy type and one of the inertial confinement fusion type) Engineering Test Facilities (ETF) in the period 1984-1995. Successful operation of an ETF would lead to operation of an Experimental Power Reactor (EPR) soon after the turn of the century and a demonstration fusion power reactor presently projected for 2015.

It is reasonable to assume that the resources of the Hanford area are conducive to siting early fusion devices here.

It is assumed that following completion of the Fusion Material Irradiation Test Facility (FMIT) in the 300 Area, the Magnetic Fusion Energy ETF would be constructed in the 400 Area during the period 1986-1992. This would be followed by construction of the EPR during the period 1997-2003 and the demonstration power reactor in the period 2009-2015. Both of these would be located in the 400 Area.

The ETF and EPR would each be about 1500 MWth and the demonstration reactor about 1500 MW(e). It is assumed that the ETF would operate for about 20 years (1990–2010), the EPR for 30 years (2000–2030), and the demonstration reactor for 40 years (2015–2055). Tritium would be the primary radionuclide emitted from these plants. It is assumed that each would discharge 10 Ci/day. It is assumed that with experience tritium control will improve so that the amounts released by the larger plants would not exceed the release rates of the earlier small plants. Several hundred cubic yards of irradiated structural wastes containing 10^8 or 10^9 Ci would be removed from the larger plants at intervals of several years.

Water requirements will parallel those of other thermal plants, or about 30 cfs (0.84 m^3/s) consumptive use for each 1000 MWe. Land areas required for plants would be similar to FFTF requirements, or about 200 acres (80.9 ha).

It is appropriate to reiterate that the foregoing postulated plans are not a forecast of what will occur at Hanford. They are simply a tool to help ensure that the proposed action is evaluated in a broad context to detect possible impairment of future DOE activities.

The following section evaluates the proposed action in the context of both these planned and assumed DOE activities.

3.0 POTENTIAL ENVIRONMENTAL IMPACTS OF THE PROPOSED ACTION

The potential environmental impacts of the proposed action are considered under nine topics:

1. Land Use Effects
2. Water Use Effects
3. Biological Effects
4. Radiation Exposure
5. Meteorological Effects
6. Socioeconomic Effects
7. Rare and Disruptive Events
8. Site Restoration Considerations
9. Floodplain Management

3.1. LAND USE EFFECTS

The general area within which the reference site is located has been essentially unused for approximately 35 years. No alternative activities are currently being proposed by Federal, state, local, or private entities for this portion of the Hanford Site. The land area proposed for sale and easements is part of a much larger sagebrush/cheatgrass and riparian community which exists within the boundary of Hanford.

Conveyance of Hanford land to a utility and the subsequent use of a portion of that land as a site for nuclear-powered electric generating facilities comes with certain land use effects. The principal activities creating these effects are associated with 1) power plant and support facilities construction and operation, 2) transportation corridor extensions and/or modifications, 3) electrical transmission line extensions and/or upgrading, and 4) river intake and outfall structures.

3.1.1 Power Plant and Support Facilities Construction and Operation

It is assumed that each of the four units is located separately within the reference site. Principal components of the power plant and support facilities at each unit consist of a nuclear reactor and containment building, a general services building and mechanical draft cooling towers. Together the power plant and support facilities are expected to occupy approximately 25 acres (10 ha). Water lines between the unit and the Columbia River will be buried. A fence will be built around the plant and support facilities to control access. The fenced security area associated with each grouping of two units is assumed to contain about 160 acres (64 ha).

3.1.2 Transportation Corridor Extensions and Modifications

The average onsite construction work force at each unit is expected to be over 1200 during the eight-year construction period, with a one-year peak of about 2,300. With a construction start every two years (1983, 1985, 1987, and 1989) the four unit consolidated average onsite work force is expected to be 3,200. A peak construction work force of about 5,000 is expected during a six-year period 1987 through 1992). As construction forces build up at the reference site, the construction forces at the WPPSS sites should phase out.

A highway to the vicinity of the reference site already exists, i.e., Route 10 (Figure 3). Two short roads each about 2 miles (3 km) long will connect Route 10 to the reference site. The southernmost road will be used in conjunction with Route 10, over which DOE will require all construction forces to travel to the site. The northernmost road will be used in conjunction with Route 4 South. Its use will be limited to a) movement of large equipment to the reference site, b) access to the reference site during labor disputes, and c) use by operating personnel as construction is completed.

Thus, if the WPPSS plants are delayed or if DOE undertakes construction of one or more major facilities described in Section 2.4, traffic congestion over Route 4 South will not be exacerbated.

Improvements in Route 10 from the reference site to its junction with Highway 240 are under consideration.

Connecting roads are planned for two areas south of the Hanford Site that have potential to accommodate a large increased population. One of these areas is south of Horn Rapids Dam. A request for annexation to West Richland has been made for about 10,000 acres (4,047 ha) in this area. Development plans call for connecting roads to be built through this area to Hanford Route 10. Another connecting highway would cross the Yakima Twin Bridges and join State Highway 240. A second candidate residential area for Hanford workers is across the Columbia River from Richland. Construction of a bridge across the Columbia north of Richland would provide direct access to the Hanford highway system via Horn Rapids Road.

Both the bridge across the Yakima River near Horn Rapids Dam and the bridge across the Columbia north of Richland are presently under consideration as additions to the local area transportation network. Construction of either or both of these bridges depends upon expected traffic volume. The potential traffic associated with the proposed site is only one factor that will be considered in development of these portions of the local area highway system. Traffic volumes may warrant construction of these bridges without construction of the above proposed nuclear power plants.

A four-mile railroad spur will be necessary to connect the reference site to the Hanford railroad network. Beyond this spur, no additional railroad right-of-way will be required.

In summary, the highway and railroad changes needed to accommodate construction and operation of four nuclear-powered electric generating plants at the reference site are the addition of relatively short sections connecting the site to the existing Hanford highway and railroad system in the vicinity, and possible improvement of Route 10.

3.1.3 Electrical Transmission Line Extensions and/or Upgrading

Effects of transmission lines for new generating plants on Hanford arise from 1) the supplementary lines required offsite for transmitting the power to load centers, and 2) connections into the transmission network on the Hanford site, and 3) a 115 kV extension from the reference site to a pumping station on the Columbia River.

The effects arising from offsite transmission lines are discussed in "The Hanford Nuclear Energy Center--A Conceptual Study" (Harty 1978) for 18 generating plants at Hanford. The potential environmental effects of transmission facilities for these 18 generating units were compared with those of 18 units distributed at possible sites in the Seattle and Portland areas, in the Willamette Valley, at Pebble Springs, and at Hanford. The study did not include consideration of alternative sites within the Hanford site, but the findings indicated that the selection of sites at Hanford would not significantly change the environmental effects throughout the marketing region. These findings would apply also to the seven-unit case being assessed here (3 WPPSS units and 4 new units assumed at the reference site), since the markets are quite distant, and the main corridors for the transmission network are well established.

Within the Hanford site the initial two plants will be serviced by one or two 500-kV transmission lines in a loop from the existing transmission corridor between the Ashe switching station (near the WPPSS sites) and the Hanford switching station. The subsequent two plants are expected to have a similar number of lines to the Gable Mountain switching station.

The exact location of the Gable Mountain station has not been specified, but would likely be directly north of the reference site along the transmission corridor between Ashe and Hanford (near 100-N Area) switching stations. The approximate lengths of new transmission corridors between the reference site and the switching stations are about four miles.

The transmission study referenced above (Harty 1978) indicated that as the generating capacity at Hanford increased beyond 12,000 MW a transmission line between Gable Mountain substation and the Portland area would be needed, including some eight miles of new transmission easement within the Hanford Site. However, this link will not be needed for the 4-unit reference site addition.

A 115 kV transmission line will be constructed between the reference site and a pumping station near the old town of Hanford. The transmission line will be about seven miles long and will parellel the plant cooling water and effluent lines.

3.1.4 River Intake and Outfall Structures

Cooling water for four units at the reference site will flow through three 36-in. buried pipe from the pumping station near the old town of Hanford, a distance of about seven miles (Figure 3). Effluent from the plant will parallel the intake line in two 18-in. buried pipes. The effluent will be discharged to the Columbia River downstream of the intake structure.

The types of land use effects associated with the four mentioned activities are 1) conversion of land uses, 2) soil erosion and consequent risk to vegetation, and 3) introduced structures or activities that restrict adjacent land use.

3.1.5 Conversion of Land Uses

Conveyance of the land to PSP&L and the subsequent use of part of that land for siting a nuclear-powered electric generation facility would result in approximately 170 acres (69 ha) of the Hanford Site's sagebrush/cheatgrass community being converted to other uses. About 500 acres (202 ha) would be used in transmission, cooling water, and transportation corridor extensions. About one-fifth of this acreage is required for highway and railroad extensions and a similar amount for cooling water lines. Transmission line corridors and switchyards require the remainder. Not all of the corridor lands will be converted to other uses, for instance transmission corridors, but will remain as sagebrush/cheatgrass community.

3.1.6 Soil Erosion

The slow rate of vegetation recovery in semi-arid regions can result in significant soil erosion problems (Harty 1978). Special soil management practices during construction of the power plant and support facilities as well as transportation and transmission line extensions will be required to minimize adverse land and vegetation impacts. The four units and associated corridors are not located close to small streams where erosion may cause concern about turbidity or sediment load caused by a large disturbance of vegetation along the streams' banks.

3.1.7 Land Use Restrictions

A security area of less than 640 acres (259 ha) and an exclusion area of about 6000 acres (2430 ha) are required for the reference plants. For the proposed site approximately 300 acres (122 ha) would be within the transmission corridor extension.

The EIS of the Columbia River Instream Resources Protection Program discusses possible inclusion of the Hanford Reach in the Wild and Scenic Rivers System. In 1977 former President Carter recommended that the main stem of the Columbia River from the McNary Reservoir upstream to Priest Rapids Dam be designated for study as a potential addition to the Wild and Scenic Rivers System. However, the Congress would have to pass an amendment to the Act (PL 90-542) to place the river in study status. If this reach of the Columbia River were ever designated for study, no Federal Energy Regulatory Commission (FERC) licensing could take place during the study period. Also, no department or agency of the United States could assist in the construction of any water resources project that would have a direct and adverse effect on the river until such time as Congress acted (either included the Reach, or withdrew it from consideration) on the study.

Since no airports are in the vicinity of the reference site, aircraft takeoff or landing route restrictions are not created.

Archeological surveys of the Hanford Site have identified two open campsites along the west bank of the Columbia River in the vicinity of the proposed water intake. There are many such sites known in the area (87 between Priest Rapids Dam and the Hanford Site 300 Area). These two sites appear to be of relatively low value as evidenced by the survey description of one of the sites:

> The site consists of scattered concentrations of camp rock but has been completely destroyed by construction of Hanford townsite. The site is 300 ft long and about 150 ft wide (Rice 1969).

No other known archeological sites, areas listed in the National Registry of Historic Places, or Indian religious sites will be affected by the proposed action.

3.2 WATER USE EFFECTS

Siting of power plants typically includes consideration of a) thermal effects, b) ground-water interactions, and c) surface water availability. In a Hanford context one must consider whether heated effluents might exceed Columbia River water temperature standards, whether there may be groundwater table elevation changes which affect radioactive wastes at Hanford, and whether consumptive uses of water preempt competing demands for Columbia River water.

3.2.1 Thermal Effects

3.2.1.1 Thermal Effects

As previously stated, it is assumed that the reference site will contain four 1200 MWe nuclear power plants, each of which will utilize wet cooling towers. Each plant will require about 40 to 50 cfs (1.13 to 1.41 m^3/s) of Columbia River water. Approximately three-fourths will be discharged to the atmosphere while the remainder is returned to the river as blowdown (assumed to be a maximum of 10 cfs [0.28 m^3s] per unit). The thermal effects on the Columbia River can be expected to be minimal since only four reactors are involved, yielding a combined total of 40 cfs (1.13 m^3/s) of heated effluent to the river. Minimum river flow past the reference site is 36,000 cfs (1020 m^3/s). It is not expected that there will be any interaction of the plume with the WPPSS reactors or postulated experimental facility downstream, nor will the postulated production reactors upstream have any effect on the reference site.

3.2.1.2 Groundwater

The major factor which needs to be evaluated with respect to groundwater on the Hanford Site is whether construction of the plants will affect the elevation of the water table and, if it does, whether the elevation change will affect buried radioactive wastes or transport of radioactive materials in the groundwater.

Groundwater is found within the limits of the Hanford Site in both unconfined and confined aquifers. The unconfined aquifer is found in the surficial sedimentary deposits that overlay the basalt that forms the bedrock beneath the Hanford Site. These sediments consist primarily of unconsolidated silts, sands, and gravels and are the result of glaciofluvial deposition. The aquifer boundaries are located along the right bankline of the Columbia River and around the impermeable areas where basalt rises above the water table.

The major artificial recharge of the groundwater to the unconfined aquifer occurs within and adjacent to the 200-East and 200-West Areas. The large volumes of process water released to ponds at these sites have, in the past, caused the formation of significant mounds of water in the water table. Groundwater movement from the 200 Area is northward and eastward toward the Columbia River and would not interact with the reference site.

Since no water will be withdrawn or discharged at the reference site, and only nominal quantities discharged (<100 gpm), no change in groundwater levels is expected to result from the plants sited there.

Based on evaluations made for the WPPSS reactors it is unlikely that plant construction or operation at the reference site would affect buried radioactive wastes on the Hanford Site.

3.2.1.3 Water Availability

The Department of Ecology, State of Washington, has the responsibility of managing the Columbia River and is charged with implementing a balanced use of the river "providing greatest mix of economic and social benefits to the people of Washington and the Pacific Northwest" (Department of Ecology 1980).

The recommended elements of the Columbia River Instream Resources Protection Program, which is part of the Washington State administrative code, are as follows:

1. Existing water rights will not be affected.
2. Minimum average daily flows will be established.
3. Minimum instantaneous flows will be established.
4. Conservation and efficiency fundamentals will be established.
5. Instream requirements for fish and wildlife benefits will be negotiated.
6. Authorization language to include fish and wildlife purposes in Federal projects will be sought.
7. Intervention in FERC licensing of non-Federal projects to seek flow provisions will be sought.
8. Intensive management of the system for all uses will be encouraged.
9. Commitment to consider specific recommendations regarding reservoir fluctuation limits will be made.

Implementation of parts of the program may be difficult; however, the program is viewed as an opportunity to clearly present the State of Washington's position regarding management of the Columbia River. Two aspects of the recommended program are:

1. Minimum Average Daily Flow: The minimum discharge policy at Priest Rapids is 36,000 cfs (1020 m^3/s) throughout the year. The Columbia River Fisheries Council (CRFC) and the Department of Ecology recommended minimum flows (subject to 25 percent reduction during

low flow years) vary from a high of 140,000 cfs (3967 m^3/s) in May to a low of 40,000 cfs (1133 m^3/s) in September from Priest Rapids.

2. Minimum Instantaneous Flow: At no time will the proposed instantaneous flow at Priest Rapids be lower than 36,000 cfs (1020 m^3/s).

It is not likely that the Columbia River Instream Resources Protection Program will have a near-term impact on water availability from a quantity standpoint. The operating policy at Priest Rapids Dam has included the 36,000 cfs (1020 m^3/s) minimum flow requirement. The discharge-duration curve of monthly flow for the Columbia River below Priest Rapids Dam (WPPSS 1977) indicates that the minimum flow to be expected (1929-1958) (adjusted for 1970 conditions) is approximately 60,000 cfs (1700 m^3/s). Depleting the flow 150 to 200 cfs (4.53 to 5.66 m^3/s) for the reference plants would have minimal if even detectable influence on minimum streamflow maintenance as outlined by the program. This amount of withdrawal would not be expected to result in a limitation on DOE withdrawals for programs cited in Section 2.3.

In summary, the reference site introduces no significant problems with respect to thermal discharges to the Columbia River, groundwater interactions, or water availability, nor interferences with respect to future postulated DOE programs at Hanford.

3.3 BIOLOGICAL EFFECTS

3.3.1 Aquatic Ecology

The aquatic resources of recognized economic value that potentially may be affected by the construction and operation of nuclear power plant intake and outfall facilities on the Columbia River consist primarily of the food and recreational fishes in the Hanford Reach of the river (river miles 350 to 393). The locally spawning fall chinook salmon and the steelhead trout are of greatest value. Recent estimates of the value of the local stock of chinook salmon to sport and commercial fisheries are nearly three million dollars annually (Fickeisen 1980). There are an estimated 10,000 adult steelhead spawning annually in the Hanford Reach which produce about 1.6 million smolts. The basis for estimating the value of the local steelhead population is not as good as for chinook, but it is probably more than one million dollars.

Other races of chinook salmon and steelhead and other species of anadromous fishes use the Hanford Reach of the Columbia in passage to and from their spawning grounds and the ocean. The estimated number of adult and juvenile fish passing through the Hanford Reach are given in Table 2. Resident species, including whitefish, smallmouth bass, sunfish, crappie, and sturgeon support a local sport fishery.

TABLE 2. Estimated Annual Anadromous Fish Passage Through the Hanford Reach of the Columbia River

Species	Adults	Juveniles
Chinook Salmon	7000 to 25,000	1,600,000 to 3,900,000
Sockeye Salmon	44,000	1,000,000 to 4,000,000
Coho Salmon	311 to 11,600	600,000
Steelhead Trout	98,000	240,000 to 400,000
Shad	20,000	---

3.3.1.1 Power Plant Impacts

There are several factors that have a bearing on the potential aquatic impacts of the construction and operation of nuclear power plants on the Hanford site. These include:

- The withdrawal of Columbia River water for reactor cooling processes.
- The discharge of heated and chemically-treated reactor cooling water effluents to the Columbia River.

The basic assumptions made in estimating the aquatic impacts are 1) up to four nuclear power plants will be located at the reference site; 2) the cooling water requirements are 40 to 50 cfs (1.13 to 1.41 m^3/s) for each power plant, and will be obtained from the Columbia River; and 3) the discharge of blowdown to the Columbia River from the mechanical cooling towers is up to 10 cfs (0.28 m^3/s) per plant at temperatures of about 15-30°F (8-17°C) above ambient river temperature and with concentration of dissolved solids 8 to 12 times that of the river water.

3.3.1.2 Water Withdrawal

The total rate of withdrawal of river water will be approximately 160 to 200 cfs (4.53 to 5.66 m^3/s) or less than 0.5 percent of the minimum release of 36,000 cfs (1020 m^3/s) at Priest Rapids Dam (RM 397), immediately upstream from the Hanford Reach. Water withdrawal will meet state standards. Water intake structures will be designed to reduce or entirely eliminate the impingement of fish on the intake screens and entrainment of fish and other aquatic organisms in the power plant cooling water. The perforated pipe water intake systems to be used in the water intakes of the Washington Public Power Supply System power plants that are being built at Hanford are expected to cause little or no fish mortality (Richards 1978). Loss of fish by the removal of river water will be small due to the relatively small volume taken from the river and the effectiveness of fish exclusion systems. Invertebrate organisms that are entrained in the cooling water will be destroyed. The prolonged exposures to increased temperatures, higher concentrations of dissolved chemicals and exposure to biocides, such as chlorine, will kill the biota that are removed with the cooling water. The impact of this on the river ecosystem will be imperceptible due to the relatively small proportion of the total river community that will be lost. Water withdrawals many times greater than those expected for the four nuclear plants occurred during the operation of the Hanford plutonium production reactors did not result in observable change to the river ecosystem (Harty 1978).

3.3.1.3 Water Discharges

Up to about 40 cfs (1.14 m^3/s) of cooling tower blowdown will be released to the river. Water discharges will meet state standards. This effluent will be about 15-30°F (8-17°C) higher in temperature than the Columbia River and will contain about 8 to 12 times the concentration of dissolved minerals. Small quantities of a biocide, probably chlorine, used to control slime growth in the cooling towers, will be contained in the effluent. The small volume of discharge is not expected to cause a noticeable effect on the river biota. Proper placement of the discharge pipe will cause rapid effluent mixing and dilution with the river flow.

The old Hanford townsite is downstream of the major chinook spawning areas, which are located from River Mile 365 to 376 and near River Mile 383 and 393. Some spawning does take place near Ringold (RM 354). Power plant water intake and discharge facility construction and operation will have little effect on the upstream migration of adults or downstream passage of juvenile salmon. The discharge of thermal effluents from the Hanford plutonium reactors did not present a barrier to salmon movement. Adult chinook migration is oriented predominately toward the left bank of the river, and away from the power plant water intake and discharge structures.

3.3.2 Terrestrial Ecology

Vegetation on the reference site and the various access corridors is dominated by cheatgrass (Bromus tectorum), bitterbrush (Purshia tridentata) and sagebrush (Artemesia tridentata). This vegetation type is common on the Hanford Site. The area of the Hanford townsite crossed by the proposed cooling water corridor contains several large trees, remnants of previous use of the site as an agricultural settlement.

Construction of water intake and outfall structures and associated pipe and electrical lines at the proposed location near Hanford townsite could potentially impact American bald eagles, listed as "threatened" under provisions of the Endangered Species Act of 1973, as amended. Approximately 20 adult eagles feed along the Columbia River at Hanford each winter. Trees near the proposed intake and pipeline site are used as perch sites. A known roost area is located approximately one mile upstream. These birds are very sensitive to human disturbance and would probably abandon nearby perch sites, at least during construction. Other perch and roost sites occur along the Hanford Reach of the Columbia River. Eagle use of these alternative areas is possible, depending on levels of human activity at these other sites.

In addition to bald eagles, several other animal species of limited distribution could be impacted by the proposed action. The State of Washington (1979) is currently developing an official endangered species list. To date, species proposed for listing as State threatened species and potentially impacted by the proposed action are the white pelican (Pelecanus *erythrorhynchos*) and ferruginous hawk (*Buteo regalis*). Species proposed for listing as "species of concern" include: Swainson's hawk (*Buteo swainsoni*), golden eagle (*Aquila chrysaetos*), sage thrasher (*Oreoscoptes montanus*), white-tailed jackrabbit (*Lepus townsendi*), burrowing owl (*Athene cunicularia*), sage sparrow (*Amphispiza belli*), and barn owl (*Tyto alba*). Barn owls and Swainson's hawks are known to nest in trees at the Hanford townsite. White pelicans frequent adjacent portions of the Columbia River during winter months. The other species listed above may occur in the proposed construction areas, but their distributions and populations are unknown. With the exception of bald eagles and Swainson's hawks, the impact of the proposed action on total Hanford site populations of these various species will probably be slight or negligible. However, continued loss of habitat for these species elsewhere in the state adds to the importance of maintaining Hanford populations.

None of the four plant species listed in Table 1 as candidates for possible endangered species classification is known to occur in the reference site, water intake, or corridor areas.

Though the reference site is used by mule deer and other wildlife, no impacts other than those discussed above are anticipated due to the availability of adequate adjacent habitat.

3.4. RADIATION EXPOSURE

The potential radiological impact of the proposed action to persons living in the vicinity of the Hanford Site was evaluated by calculating radiation doses using approximate meteorological and demographic data. The meteorological data used were from the Hanford Meteorological Station (Stone 1972) while the demographic data for the year 2000 were taken from the WPPSS Environmental Report (WPPSS 1977) and from the Hanford Environmental Impact Statement (ERDA 1975). Potential radiation doses to a maximally exposed individual and to the population within 50 miles of the reference site were calculated using the standard radiation dose codes employed at Hanford (ERDA 1975; Houston and Blamer 1979; Strenge, Watson and Houston 1975). Four generic light water reactors (two BWR and two PWR) were assumed to be operating simultaneously at the site. Radionuclides in effluents released to air and water were those generic release rates used previously in the Hanford Nuclear Energy Center Study (Harty 1978).

The four reactors were assumed to have operated simultaneously for 30 years with buildup of the longer-lived radionuclides in the environment. The radiation doses and the 50-year dose commitments were then calculated for all potentially important pathways during the 30th year.

The results of these calculations are summarized in Table 3 and indicate that no significant radiological impacts are expected from operation of the four reactors at the reference site. Doses are well below NRC/EPA standards. The majority of the radiation doses listed in Table 3 resulted from food pathways associated with gaseous effluent releases. The principal radionuclides contributing to that pathway were ^{3}H and ^{14}C.

Even though the dose results are only order-of-magnitude estimates, they are so low ($\sim 10^{-4}$ rem to the maximum-exposed individual and ~10 man-rem to the population) that increases by a factor of 10 or more would not alter the conclusion that no significant radiological impact is expected. This is not surprising since a previous study (Harty 1978) indicated that the operation of 20 light-water reactors plus associated fuel cycle facilities on the Hanford project would not lead to unacceptable radiological impacts.

TABLE 3. Estimated Potential Radiation Doses from Operation of Four Nuclear Power Reactors at the Reference Site[a]

Organ	First-Year Doses	Fifty-Year Dose Commitment
Maximum Individual (rem)		
Total Body		
Thyroid		
Bone	10^{-4}	10^{-4}
GI-LLI		
Lung		
Population (man-rem)		
Total Body		
Thyroid		
Bone	10^{1}	10^{1}
GI-LLI		
Lung		

(a) Principally from ingestion of contaminated foods.

The maximum individual first-year doses listed in Table 3 are about 1/1000 of the annual dose this individual would receive from natural background radiation (0.1 rem). The first-year doses to the population are about 1/10,000 of the annual dose the 310,000 persons (in year 2000) within the 50-mile (80 km) radius of the plants would receive from natural background radiation (31,000 man-rem).

The estimated radiation doses are also well within existing or currently proposed Federal and state guidelines for radiation exposure from nuclear power reactors. In addition, the expected releases of radioactive effluents should not interfere with existing and planned DOE facilities on the Hanford Site nor with the WPPSS facilities. Estimated radiation doses to workers exposed 2000 hrs to outside air at the WPPSS and FFTF sites would be less than the value of 10^{-4} rem listed for the maximum-exposed individual in Table 3.

However, an exclusion area measuring approximately two miles from the reactor plants will be required to meet the Nuclear Regulatory Commission's Appendix I design objectives. The exact land area requirements will depend on the meteorological conditions at the site and the radionuclide releases from the plants (source term). As previously stated, DOE will meet PSP&L's need for such an exclusion area, presently estimated at about 6000 acres, but there will be no conveyance of land for that purpose.

3.5. METEOROLOGICAL EFFECTS

The climate of the Hanford Site tends to be generally mild with well developed seasonal variations in most climatological elements. The annual precipitation averages about 6 in. The average daily maximum temperature in July is about 92°F (33°C), while the average minimum temperature in January is near 22°F (-6°C). Winter days are generally cloudy with about two-thirds of the annual precipitation falling from October through March. The late fall and winter months are also accompanied by occasional periods of fog. Summer days are generally clear to partly cloudy and tend to be dry with relative humidities averaging about 40 percent to 50 percent and mid-afternoon humidities dropping below 20 percent. The Hanford area does not have high average wind speeds; the long-term average wind speeds are less than 8 mph (12.9 km/h). There are frequent periods with light or calm winds but there are also occasional periods with high winds. The wind has well-defined seasonal and diurnal variations with maxima occurring on late spring and early summer afternoons. These maxima are related to drainage flows caused by the topography of the Columbia Basin. The highest wind speeds occur during storm system passage and tend to be from the southwest. Peak gusts exceeding 60 mph have been observed in all months.

In the late fall and winter there are frequent periods with both low wind speeds and high atmospheric stability. During these periods atmospheric dispersion is relatively poor and stagnation occurs. There is a 50 percent chance that at least once in a given season a stagnation period will extend 10 days or longer, and that there is about a 10 percent chance of a period extending 20 days or more (Jenne 1963). He further indicates that the chance of season passing without the occurrence of at least an 8-day stagnation period is only 1 in 3.

The most complete climatological records for the region are based on meteorological data collected at the Hanford Meteorology Station (HMS), located on the 200-Area plateau near the center of the Hanford Site. Climatologically the HMS is probably representative of the entire Hanford area for temperature, humidity, solar radiation, sky cover, precipitation, and general weather conditions, although there are probably systematic variations due to local topographic features. In particular, Rattlesnake Hills and the Columbia River modify the climate in their immediate vicinities. Climatological records for the HMS have been published (Stone, Jesse and Thorp 1972) and a recent climatological summary is presented in Table 4.

In contrast to the climatological elements listed above, the HMS wind data are not representative for the entire area, although that assumption is usually made and was made in the computations leading to the results presented in Section 3.4. Figure 4 shows wind roses for 12 locations in or near Hanford. The HMS is Station 8. The winds at the HMS are predominantly from the WSW through NW, with only infrequent, weak winds from the SW through SE. In addition, HMS winds are calm or variable about 5 percent of the time. In the SE portion of Hanford, which includes the proposed power plant location, the frequency and strength of winds from the SW through SE are considerably greater. The frequency of calm and variable winds is also greater. This difference is further documented by more recent data collected at the FFTF and WNP-2 sites.

TABLE 4. Averages and Extremes of Climatic Elements at Hanford (based on all available records to and including the year 1975)

TEMPERATURE (°F)

	1912-1975 Averages							1912-1975 Extremes: Daily Maximum				Daily Minimum			
	Daily Maximum	Daily Minimum	Monthly	Highest Monthly	Year	Lowest Monthly	Year	Record Highest	Year	Record Lowest	Year	Record Highest	Year	Record Lowest	Year
Jan	37.0	22.2	29.6	42.5	1953	12.1	1950	72	1971	-2	1950	53	1971	-23	1936
Feb	45.4	27.6	36.4	44.5	1958	21.4	1929	71	1926	-3	1950	55	1932	-23	1950
Mar	56.5	33.7	45.1	49.9	1926	39.4	1955	83	1960	24	1960	56	1947	6	1955
Apr	66.1	39.9	53.1	58.6	1934	47.5	1955	95	1934	41	1945	60	1956	12	1935
May	75.6	45.0	61.9	68.1	1947	56.6	1933	105	1936+	49	1918	70	1956	28	1954
June	83.2	55.4	69.4	75.4	1922	63.0	1953	110	1917	55	1966	81	1928	35	1933
July	91.9	61.1	76.5	81.8	1960	72.4	1963	115	1939	58	1966	82	1975+	41	1935
Aug.	89.4	59.3	74.3	81.5	1967	69.9	1964	113	1961	63	1920	81	1961	40	1918
Sept	79.6	50.7	65.2	71.7	1967	58.8	1926	102	1950	52	1934+	77	1955	25	1926
Oct.	65.3	40.7	53.0	59.0	1952	48.8	1930	90	1933	31	1935	60	1965+	6	1935
Nov.	48.6	31.5	40.0	46.0	1954+	31.3	1955	75	1975	14	1955	52	1958+	-1	1955
Dec.	39.3	26.0	32.7	42.0	1935	18.5	1919	68	1933	-3	1919	56	1975	-27	1919
Year	64.9	41.5	53.1	81.9	July 1960	12.1	Jan. 1950	115	July 1939	-3	Feb 1950+	82	July 1975	-27	Dec 1919

DEGREE DAYS (BASE 65°F)

	Heating 1945-1975 Totals					Cooling 1960-1975 Totals				
	Mean Monthly	Maximum Monthly	Year	Minimum Monthly	Year	Mean Monthly	Maximum Monthly	Year	Minimum Monthly	Year
Jan	1085	1640	1950	694	1953	0	0	-----	0	-----
Feb	779	1347	1956	576	1958	0	0	-----	0	-----
Mar	641	794	1955	476	1947	0	0	-----	0	-----
Apr	386	522	1955	266	1947	1	5	1968+	0	1975+
May	154	255	1962	36	1967	49	99	1971	3	1962
June	34	90	1953	3	1958	192	310	1969	59	1971
July	3	22	1955	0	1975+	408	518	1960	232	1963
Aug.	5	32	1960	0	1974+	338	508	1967	171	1964
Sept	71	179	1972	13	1967	107	216	1967	27	1970
Oct.	377	479	1946	200	1952	7	30	1971	0	1975+
Nov.	787	1008	1955	567	1954	0	0	-----	0	-----
Dec.	990	1224	1964	822	1957	0	0	-----	0	-----
Year	5271	1640	Jan. 1950	0	July 1975+	1093	518	July 1960	0	Oct. 1975+

PRECIPITATION (INCHES) 1912-1975 TOTALS

	Mean Monthly	Maximum Monthly	Year	Minimum Monthly	Year	Max. in 24 Hours	Year	Snow, Ice Pellets (Sleet): Mean Monthly	Maximum Monthly	Year	Max. in 24 Hours	Year	Maximum Depth	Year
Jan	0.92	2.47	1970	0.13	1962+	1.08	1969	5.1	23.4	1950	7.1	1954	12.0	1969
Feb	0.60	3.08	1940	T	1967+	1.74	1916	2.4	26.0	1916	5.6	1975	10.0	1969
Mar	0.37	1.96	1957	0	1967+	0.59	1949	0.3	4.7	1951	2.7	1957+	2.3	1957
Apr	0.38	1.27	1969	0	1933+	0.53	1951	T	T	1975+	T	1975+	0	-----
May	0.47	2.03	1972	0	1931	1.39	1972	T	T	1960	T	1960	0	-----
June	0.56	2.92	1950	0	1919	1.50	1934	0	0	-----	0	-----	0	-----
July	0.15	0.83	1966	0	1939+	0.73	1914	0	0	-----	0	-----	0	-----
Aug.	0.20	1.18	1920	0	1955+	0.69	1975	0	0	-----	0	-----	0	-----
Sept	0.30	1.34	1947	T	1961+	0.92	1947	0	0	-----	0	-----	0	-----
Oct.	0.58	2.72	1957	0	1917+	1.91	1957	T	1.5	1973	1.5	1973	1.5	1973
Nov.	0.86	3.05	1926	T	1939+	0.78	1966	1.3	12.7	1955	4.8	1955	5.1	1946
Dec.	0.99	2.53	1931	0.11	1946	1.00	1958	3.9	19.1	1964	5.4	1965	12.1	1964
Year	6.28	3.08	Feb. 1940	0	Aug. 1955+	1.91	Oct. 1957	13.0	26.0	Feb. 1916	7.1	Jan. 1954	12.1	Dec. 1964

EXTREME AVERAGES OR TOTALS AND YEAR OR SEASON OF OCCURRENCE

1912-1975 TEMPERATURE AVERAGES (°F)

HIGHEST ANNUAL	56.2	1958+
LOWEST ANNUAL	50.2	1929
HIGHEST WINTER (D-J-F)	41.1	1935-36
LOWEST WINTER	24.2	1948-49
HIGHEST SPRING (M-A-M)	58.2	1947
LOWEST SPRING	49.0	1955
HIGHEST SUMMER (J-J-A)	78.2	1958
LOWEST SUMMER	70.3	1954
HIGHEST FALL (S-O-N)	56.6	1963
LOWEST FALL	49.6	1946

1912-1975 PRECIPITATION TOTALS (IN.)

GREATEST ANNUAL	11.45	1950
LEAST ANNUAL	3.26	1967
SNOW, ICE PELLETS (SLEET) GREATEST SEASONAL	43.6	1915-16
LEAST SEASONAL	0.3	1957-58

1945-1975 WIND SPEED AVERAGE (mph)

HIGHEST ANNUAL	8.1	1968+
LOWEST ANNUAL	6.3	1957

1946-1975 RELATIVE HUMIDITY AVERAGE (%)

HIGHEST ANNUAL	57.9	1950+
LOWEST ANNUAL	49.4	1967

1946-1975 SKY COVER AVERAGES (SUNRISE TO SUNSET, SCALE 0-10)

HIGHEST ANNUAL	6.4	1966
LOWEST ANNUAL	5.1	1949

1953-1975 SOLAR RADIATION AVERAGE DAILY TOTAL (LANGLEYS)

HIGHEST ANNUAL	390	1973
LOWEST ANNUAL	357	1967

WIND (mph) and RELATIVE HUMIDITY (%)

	Wind 1945-1975 Averages						Peak Gusts			RH 1946-1975 Averages					RH 1946-1975 Extremes			
	Prevailing Direction	Mean Monthly Speed	Highest Monthly	Year	Lowest Monthly	Year	Speed	Direction	Year	Mean	Highest Monthly	Year	Lowest Monthly	Year	Highest	Year	Lowest	Year
Jan	NW	6.6	10.3	1972	3.1	1955	80	SW	1972	75.2	88.8	1960	60.0	1963	100	1975+	13	1963
Feb	NW	7.1	9.4	1961	4.6	1963	65	SW	1971	70.0	86.9	1961	54.0	1967	100	1975+	14	1962
Mar	WNW	8.4	10.7	1964	5.9	1958	70	SW	1956	55.9	65.9	1950	44.0	1965	100	1974+	12	1965+
Apr.	WNW	9.1	11.1	1972+	7.4	1958	73	SSW	1972	46.5	64.5	1963	36.9	1966	100	1973+	9	1954
May	WNW	9.9	10.5	1965+	5.8	1957	71	SSW	1948	42.1	61.9	1948	33.2	1966	100	1975+	7	1953
June	WNW	9.2	10.7	1949	7.7	1950+	72	SW	1957	39.5	53.5	1950	30.0	1949	100	1972+	10	1964+
July	WNW	8.6	9.6	1963	6.9	1955	55	WSW	1968	33.8	40.5	1955	21.9	1959	99	1972	6	1951
Aug.	WNW	8.0	9.1	1946	6.0	1956	66	SW	1961	34.9	41.9	1968	26.5	1967	100	1972+	7	1951
Sept	WNW	7.5	9.2	1961	5.4	1957	65	SSW	1953	40.6	55.1	1959	33.2	1974	100	1962+	10	1962+
Oct.	WNW	6.7	9.1	1946	4.4	1952	63	SSW	1950	57.0	74.2	1962	42.5	1952	100	1975+	10	1957
Nov.	NW	6.1	7.9	1965	2.9	1956	64	SSW	1949	73.5	88.1	1972	64.2	1963+	100	1975+	16	1959
Dec.	NW	6.1	8.3	1964	3.9	1963+	71	SW	1955	80.1	90.5	1950	69.0	1968	100	1975+	26	1972
Year	WNW	7.7	11.1	Apr. 1972+	2.9	Nov. 1956	80	SW	Jan. 1972	53.9	90.5	Dec. 1950	21.9	July 1959	100	Dec. 1975+	6	July 1951

SKY COVER (SCALE 0-10) and SOLAR RADIATION (LANGLEYS)*

	Sky Cover 1946-1975 Averages (Sunrise to Sunset)					Solar 1953-1975 Avg. Daily Totals					1953-1975 Extreme Daily Totals			
	Monthly	Highest Monthly	Year	Lowest Monthly	Year	Monthly	Highest Monthly	Year	Lowest Monthly	Year	Highest Monthly	Year	Lowest Monthly	Year
Jan	7.8	9.0	1969	4.3	1949	120	136	1973	98	1955	277	1969	16	1971+
Feb	7.4	8.9	1963	5.9	1964	202	230	1960	164	1954	422	1958	37	1970+
Mar	6.9	7.9	1950	4.9	1965	340	388	1965	305	1961	547	1968	47	1972
Apr.	6.4	8.1	1963	3.7	1951	475	535	1973	374	1963	704	1972	75	1974
May	5.8	7.7	1960	4.5	1949	576	636	1970	511	1962	782	1959	67	1962
June	5.5	7.0	1950	2.8	1961	679	698	1960	561	1953	821	1971	112	1965
July	2.8	4.5	1974+	0.9	1953	699	734	1973	588	1955	808	1974	118	1972
Aug.	3.2	5.9	1967	0.6	1955	558	613	1955	475	1968	721	1957	107	1959
Sept	4.9	6.1	1959	1.4	1975	423	463	1975	354	1959	591	1970	61	1957
Oct.	5.9	8.0	1975	3.9	1952	262	299	1958	236	1975	434	1973	33	1974
Nov.	7.6	9.1	1972	6.2	1957	132	180	1957	97	1964	295	1971	14	1969
Dec.	8.1	9.2	1962	6.8	1954	97	116	1970	52	1969	196	1972	9	1973
Year	5.9	9.2	Dec. 1962	0.6	Aug. 1955	372	734	July 1973	52	Dec. 1969	821	June 1971	9	Dec. 1973

TABLE 4. (Contd)

NUMBER OF DAYS (1945-1975)**

	CLEAR					PTLY CLDY	CLOUDY				
	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR
Jan	3	7	1963	0	1975+	6	22	27	1969	17	1963
Feb.	5	9	1968+	1	1972+	5	18	26	1958	12	1964
Mar	6	12	1965+	2	1961	8	17	27	1968	9	1965
Apr	6	12	1962	1	1963	10	14	21	1963	6	1956
May	9	14	1973	2	1960	10	12	19	1960	6	1958
June	10	21	1961	5	1972+	10	10	15	1973+	5	1960+
July	20	26	1960	13	1970	7	4	9	1970	1	1961
Aug	19	30	1955	11	1968	7	5	13	1968	0	1969+
Sept	15	27	1975	8	1969	7	8	13	1969	1	1975
Oct.	9	14	1970	1	1975	7	15	22	1973	9	1970
Nov	4	10	1957	1	1973+	5	21	25	1973+	15	1961
Dec.	3	7	1972+	1	1962+	5	23	28	1962	18	1962+
Year	109	30	Aug. 1955	0	Jan. 1955+	87	169	29	Dec. 1962	0	Aug. 1969+

	THUNDERSTORMS					HEAVY FOG (VIS. 1/4 MI. OR LESS)				
	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR
Jan	0	0	----	0	----	5	14	1965	0	1949
Feb.	#	1	1972+	0	1975+	3	11	1963	0	1971+
Mar	#	1	1960+	0	1975+	1	5	1951	0	1975+
Apr	1	3	1948	0	1975+	#	1	1975+	0	1974+
May	2	7	1956	0	1974+	#	1	1958	0	1975+
June	3	8	1972+	0	1963+	#	1	1971	0	1975+
July	2	7	1975	0	1973+	0	0	----	0	----
Aug	2	8	1953	0	1974+	#	1	1959	0	1975+
Sept	1	4	1950	0	1975+	#	1	1957	0	1975+
Oct.	#	1	1975+	0	1974+	1	6	1962	0	1974+
Nov	0	0	----	0	----	6	13	1965	0	1960
Dec.	#	1	1971	0	1975+	8	17	1950	7	1968+
Year	11	8	June 1972+	0	----	26	17	Dec. 1950	0	----

	PRECIP. 0.10 INCH OR MORE					SNOW 1.0 INCH OR MORE				
	MEAN	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR
Jan	3	8	1970	0	1972+	2	10	1950	0	1967+
Feb.	2	5	1961+	0	1972+	2	4	1975+	0	1974+
Mar	2	8	1957	0	1973+	#	2	1957+	0	1975+
Apr	1	5	1948	0	1973+	0	0	----	0	----
May	2	4	1962+	0	1968+	0	0	----	0	----
June	2	8	1950	0	1973+	0	0	----	0	----
July	1	3	1974+	0	1973+	0	0	----	0	----
Aug	1	4	1975	0	1974+	0	0	----	0	----
Sept	1	5	1959	0	1975+	0	0	----	0	----
Oct.	2	8	1950	0	1972+	#	1	1973	0	1975+
Nov	3	10	1973	0	1967	#	6	1955	0	1974+
Dec.	3	9	1964	0	1969+	2	6	1964	0	1974+
Year	23	10	Nov. 1973	0	Sept. 1975+	6	10	Jan. 1950	0	----

NUMBER OF DAYS (1945-1975)

	3" OR MORE SNOW ON GND.					PEAK GUST 40 MPH OR GREATER				
	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR
Jan	5	25	1969	0	1975+	3	11	1972	0	1973+
Feb.	3	16	1950	0	1974+	3	6	1961+	0	1973+
Mar	0	0	----	0	----	3	9	1956	1	1973+
Apr	0	0	----	0	----	3	7	1972	0	1967
May	0	0	----	0	----	2	6	1971+	0	1965+
June	0	0	----	0	----	2	6	1971	0	1971+
July	0	0	----	0	----	1	4	1962+	0	1975+
Aug	0	0	----	0	----	1	5	1951	0	1974+
Sept	0	0	----	0	----	2	4	1946	0	1975+
Oct.	0	0	----	0	----	2	8	1967	0	1974+
Nov	#	10	1955	0	1975+	2	5	1973+	0	1974+
Dec	7	14	1955	0	1975+	3	8	1957+	0	1969+
Year	30	25	Jan. 1969	0	----	27	11	Jan 1972	0	----

NUMBER OF DAYS (1912-1975)

	MAX. TEMP. 90 OR ABOVE					MAX. TEMP. 100 OR ABOVE				
	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR
Jan	0	0	----	0	----	0	0	----	0	----
Feb.	0	0	----	0	----	0	0	----	0	----
Mar	0	0	----	0	----	0	0	----	0	----
Apr	#	4	1926	0	1975+	0	0	----	0	----
May	3	11	1924	0	1974+	#	1	1966+	0	1975+
June	9	20	1940+	0	1953	1	9	1970	0	1975+
July	21	29	1941	8	1963	7	16	1971+	0	1963+
Aug	18	29	1915	7	1968	4	16	1962	0	1975+
Sept	5	16	1938	0	1970+	#	2	1955+	0	1975+
Oct.	#	1	1933	0	1975+	0	0	----	0	----
Nov	0	0	----	0	----	0	0	----	0	----
Dec	0	0	----	0	----	0	0	----	0	----
Year	56	29	July 1941+	0	----	12	16	July 1971+	0	----

	MAX. TEMP. 32 OR BELOW					MIN. TEMP. 32 OR BELOW					MIN. TEMP. 0 OR BELOW				
	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR	MEAN MONTHLY	GREATEST MONTHLY	YEAR	LEAST MONTHLY	YEAR
Jan	11	29	1937	0	1962+	29	31	1960+	9	1953	2	14	1950	0	1975+
Feb.	3	15	1956	0	1974+	22	28	1964+	5	1958	1	9	1929	0	1975+
Mar	#	7	1960	0	1975+	16	25	1964+	6	1968+	0	0	----	0	----
Apr	0	0	----	0	----	3	15	1935	0	1974+	0	0	----	0	----
May	0	0	----	0	----	#	3	1938	0	1975+	0	0	----	0	----
June	0	0	----	0	----	0	0	----	0	----	0	0	----	0	----
July	0	0	----	0	----	0	0	----	0	----	0	0	----	0	----
Aug	0	0	----	0	----	0	0	----	0	----	0	0	----	0	----
Sept	0	0	----	0	----	4	4	1933+	0	1975+	0	0	----	0	----
Oct.	#	7	1935	0	1975+	5	12	1916	0	1962+	0	0	----	0	----
Nov	7	15	1955	0	1974+	17	30	1936	4	1949	#	1	1955+	0	1975+
Dec	8	19	1914	0	1934	26	31	1963+	14	1933	1	14	1939	0	1975+
Year	24	29	Jan. 1937	0	----	119	31	Dec. 1963+	0	----	4	14	Jan. 1950+	0	----

NUMBER OF DAYS

CLEAR (0-3 TENTHS SKY COVER, SR TO SS)

GREATEST ANNUAL (1946-75)	141	1955
LEAST ANNUAL (1946-75)	85	1964

CLOUDY (8-10 TENTHS SKY COVER, SR TO SS)

GREATEST ANNUAL (1946-75)	181	1969+
LEAST ANNUAL (1946-75)	84	1949

THUNDERSTORMS

GREATEST ANNUAL (1945-75)	23	1968
LEAST ANNUAL (1945-75)	3	1949

HEAVY FOG (VIS. 1/4 MILE OR LESS)

GREATEST SEASONAL (1945-75)	42	1950-51
LEAST SEASONAL (1945-75)	9	1948-49

PRECIPITATION 0.10 INCH OR MORE

GREATEST ANNUAL (1946-75)	39	1950
LEAST ANNUAL (1946-75)	10	1965

SNOW 1.0 INCH OR MORE

GREATEST SEASONAL (1946-75)	15	1955-56
LEAST SEASONAL (1946-75)	0	1957-58

3 IN. OR MORE SNOW ON GROUND

GREATEST SEASONAL (1946-75)	47	1964-65
LEAST SEASONAL (1946-75)	0	1966-67+

PEAK GUST 40 MPH OR GREATER

GREATEST ANNUAL (1945-75)	41	1961
LEAST ANNUAL (1945-75)	13	1958

MAX. TEMPERATURE 90 OR ABOVE

GREATEST ANNUAL (1912-75)	85	1940+
LEAST ANNUAL (1912-75)	31	1964

MAX. TEMPERATURE 100 OR ABOVE

GREATEST ANNUAL (1912-75)	32	1942
LEAST ANNUAL (1912-75)	1	1954

MAX. TEMPERATURE 32 OR BELOW

GREATEST SEASONAL (1912-75)	53	1955-56
LEAST SEASONAL (1912-75)	1	1917-18

MIN. TEMPERATURE 32 OR BELOW

GREATEST SEASONAL (1912-75)	141	1916-17
LEAST SEASONAL (1912-75)	75	1957-58

MIN. TEMPERATURE 0 OR BELOW

GREATEST SEASONAL (1912-75)	18	1949-50
LEAST SEASONAL (1912-75)	0	1974-75+

REFERENCE NOTES

- * CALORIES/cm²
- ** SKY COVER AND PRECIPITATION OBSERVATIONS NOT BEGIN UNTIL 1946
- # LESS THAN 1/2
- \+ ALSO ON EARLIER YEARS

LOCATION AND HISTORY

PRESENT LOCATION 25 MILES NW OF RICHLAND, WASHINGTON

LATITUDE 46°34' N; LONGITUDE 119°36' W ELEVATION 733 FEET

OBSERVATIONS FROM 1912 TO 1944 WERE BY UNITED STATES WEATHER BUREAU COOPERATIVE OBSERVERS AT A SITE ABOUT 10 MILES ENE OF PRESENT LOCATION. SINCE 1944 OBSERVATIONS HAVE BEEN MAINTAINED ON A 24 HOUR A DAY BASIS BY THREE DIFFERENT ERDA CONTRACTORS.

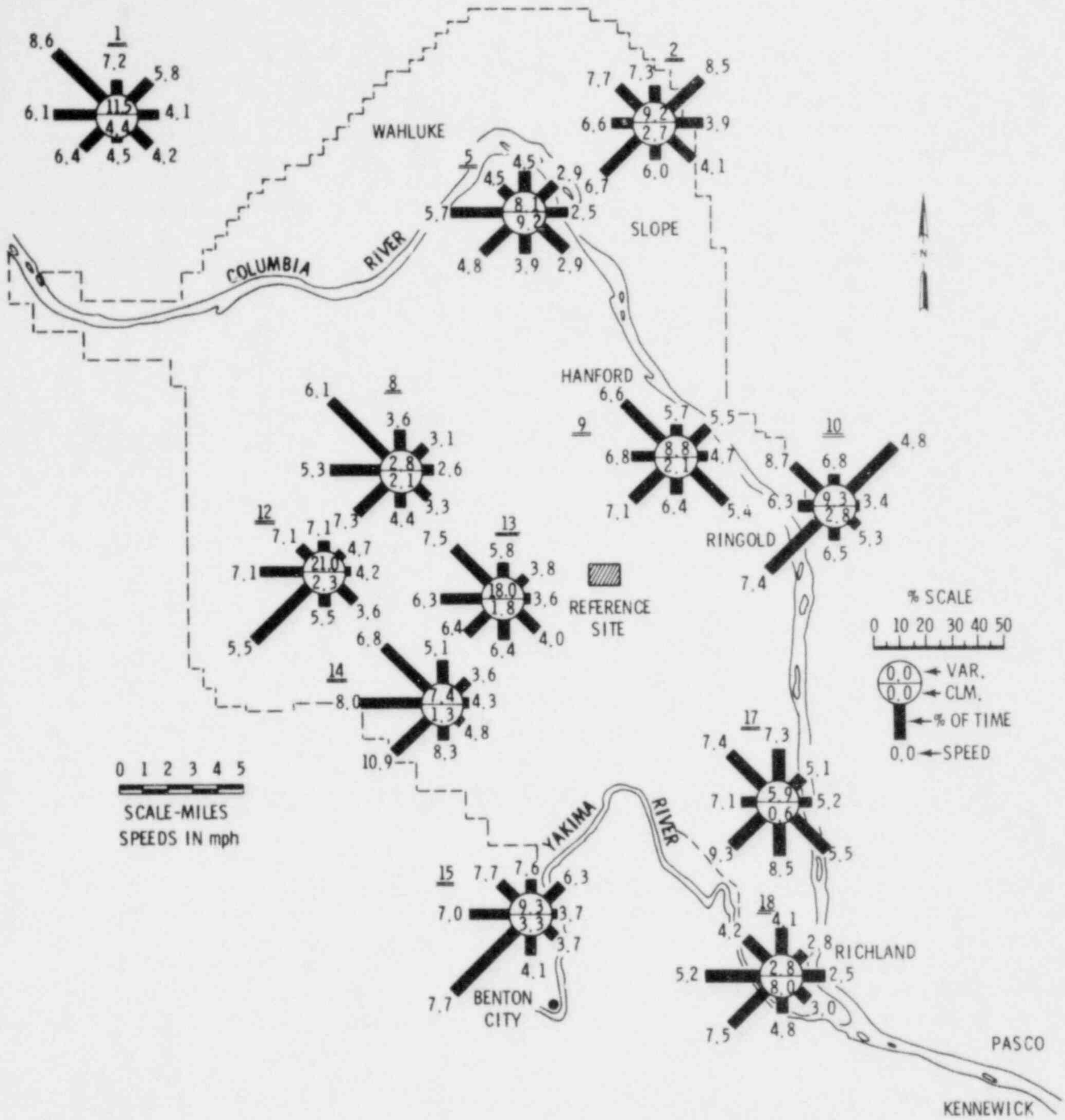


FIGURE 4. Wind Roses for Various Locations at Hanford (frequencies of occurrence are plotted by wind direction, i.e., the frequency of north winds is plotted in the north position)

Much of the spatial variability in the winds can be explained by the influences of local topographic features. For example, the high frequency of SW winds at Station 15 is the result of funneling of the wind along the Yakima River between Rattlesnake Hills and Red Mountain; at Station 12 it is the result of directed flow between Rattlesnake Hills and the Yakima Ridge. Similarly, Stations 5 and 9 show a tendency for the wind to flow along the Columbia River. The proposed power plant location, about halfway between Stations 13 and 17, slopes slightly down toward the SW and S. Small scale topographic features are super-imposed upon this slope. The effect of these features on atmospheric transport and diffusion may be significant, especially during periods of low wind speeds and high atmospheric stability.

Severe weather events do not occur with great frequency at Hanford. Thunderstorms occur on an average of 11 days per year, but they are not as violent as those found in the east of the Rocky Mountains and along the Gulf Coast. Damage from thunderstorms is generally limited to occasional grassfires started by lightning. Tornadoes are rare in this area and tend to be small. There has been only one confirmed tornado sighting at Hanford and there have been only 14 confirmed sightings within a radius of 100 miles (160 km) since 1912.

The primary meteorological effects of the construction of the proposed power plants will be an increase in atmospheric dust loading due to removal of existing ground cover during construction activities, and a decrease in air quality due to increased levels of pollutants related to automobile exhaust. The increased dust loading will be confined to the vicinity of the construction site during low wind speed conditions. During high wind speed conditions when the construction-related dust might be carried to more populated areas, the natural dust loading is sufficiently high that any increase related to construction would be negligible. In contrast to dust loading, the vehicular emissions and their effects will not be localized. Rather, they will be distributed between the construction site and the population centers supporting the construction workers.

The primary meteorological effects of operation of the proposed power plants will occur as a result of heat and moisture released from the plant cooling systems. The results of previous studies of the potential effects of cooling system effluents at Hanford indicate that increases in cloudiness and fog with corresponding decreases in solar radiation can be expected from the proposed plants (Ramsdell 1977, 1978). The decrease in solar radiation would be the most easily measured change, but would still be difficult to support statistically. The increase in fog might amount to more than 100 hours per year near the plants and would be an order of magnitude less at distances greater than 10 miles from the plants. These effects would occur primarily during the late fall and winter months.

Though these modifications might be difficult to detect or confirm statistically, there is a reasonable likelihood that plumes of condensed moisture could be traced visually to the cooling towers. This is likely to provide convincing evidence to large segments of the public that the cooling system effluents were responsible for any unusual periods of cloudiness or fog.

The cooling system effluents could also increase the precipitation frequency or amount (Ramsdell 1977, Harty 1978). Careful measurements might detect these changes during a specific storm. However, it is unlikely that any change in the long-term precipitation climatology would be detectable. It is also unlikely that the increases, even if detectable, would be environmentally significant because they would most likely occur from late fall through early spring when precipitation is greatest.

Possible effect of cooling system effluents on severe weather have also been examined. Even with the thermal and moisture additions of 20 to 40 power plants of the proposed size initiation or enhancement of severe storms is unlikely at Hanford (Ramsdell 1977; Wolf, Hane and Drake 1977).

Finally, the operation of mechanical draft cooling towers will be accompanied by a small amount of drift. Drift is composed of small droplets of cooling system water carried out of the tower by the updraft. It differs from the condensate plume in that it has approximately the same chemical composition as the cooling water, whereas the condensate is essentially distilled water. Small droplets will disperse over a large area and may evaporate prior to settling to the ground. Larger drift droplets may fall to the ground near the tower, possibly contaminating the soil with chemicals used in treatment of the cooling water.

Over the operating life of the power station sufficient minerals or treatment chemicals contained in the cooling water may accumulate in the soils near the station to affect plant growth. Cheatgrass (Bromus tectorum) is the dominant vegetation at the prime site. The sensitivity of this species to soil salinity is presently unknown. If the long-term salt buildup were to reduce cheatgrass germination accelerated soil erosion would result.

In summary, the meteorological effects arising from construction and operation of the reference plants are not expected to be significant, and interactions with DOE facilities or those postulated for Hanford are minimal.

3.6 SOCIOECONOMIC EFFECTS

The primary socioeconomic benefits of the proposed four unit nuclear power plant complex at the reference site are those inherent in the value of the generated electricity which is delivered to customers throughout the Pacific Northwest as well as adjacent regions which may need to rely on Pacific Northwest power in emergency situations.

Generally, socioeconomic impacts are projected whenever large construction projects occur in conjunction with areas of low assimilative capacity. At the local level, impacts result from a mismatch of facility construction characteristics (number of man-years of work, schedule, skills required) and the nature of the host community (size, extent of services available, economic well being, experience with changes). Sudden increases in construction labor force requirements or a sudden decline from a large construction labor force to a permanent operating work force can produce socioeconomic problems.

As discussed previously in Section 3.1, "Land Use Effects", the average onsite construction work force over the 14-year construction period from 1983 through 1996 is expected to be about 3,200 with about 5,000 during a six-year period 1987 through 1992. The buildup of the construction work force at the reference site may coincide with the reduction of construction work force at WNP 1 and 4, even assuming a two-year delay in construction activities on WNP-4. The WNP 1 and 4 work force is expected to average about 1,400 workers over a ten-year period 1975 through 1984. A peak work force of over 6,000 was reached during both 1980 and 1981. The construction of the PSP&L units will maintain a significant nuclear power plant construction labor force in the local area.

None of the DOE programs described in the Area Site Development Plans (Section 2.4) should be significantly impacted by construction activities at the reference site. Of the postulated activities, the major potential socioeconomic effects would arise from an expanded production mission assumed to commence in 1990. But even here, the construction work force at the reference site would begin to decrease in 1991 as the DOE work force was building up.

The Tri-Cities area in particular is accustomed to large Hanford Site construction projects. As discussed in Section 3.1, "Land Use Effects", the Tri-Cities area is developing a transportation network which provides access to two residential growth areas south of the Hanford Site. Both the area west of Pasco and West Richland are preparing for substantial population growth. With construction of the I-82 bridge and, possibly, a second Columbia River bridge north of Richland, the area west of Pasco has a projected population for the year 2000 of over 10,000. Population projections for the Angus Ranch in the northwestern part of West Richland and south of Horn Rapids Dam are for over 10,000 by the year 2000. About two-thirds of the onsite construction workers are expected to reside in the Tri-Cities area (including West Richland and the area west of Pasco). Some of the remaining workers will use State Routes 240 and 24 and reside in Yakima and lower Yakima Valley cities. With the Angus Ranch area and the West Pasco area preparing for substantial growth, it is likely that a much larger fraction of construction workers residing in the Tri-Cities area will locate in these two areas than has occurred in past Hanford construction projects.

Of the communities near the Hanford Site the Tri-Cities area appears to be most capable of handling a large increase in Hanford construction workers while minimizing the stress that such a large work force will have on local roads, housing, schools, water and sewer capacities. Stress will occur on the region's infrastructure as the result of construction at the reference site. However, the service area has a large assimilative capacity for construction workers working at this site.

3.7 RARE AND DISRUPTIVE EVENTS

Rare or disruptive events occurring at Hanford could cause commercial facilities to disrupt DOE programs and facilities. If a catastrophic failure of commercial facilities were to occur, the impact could differ by reason of the site's location relative to other facilities, the wind directions, and the point of water intake/discharge in the river. For this reason additional nuclear power plants on Hanford land should be sited so as to minimize exposure to other facilities from natural disruptive events. Typically, plants would be constructed to protect against serious failures with or without a causitive natural event. Presumably, the probability of occurrence of a particular type of catastrophic event would be extremely low and would probably be approximately equal for the alternative construction sites.

The natural events that could cause catastrophic failures include earthquake, river channel blockage, tornado, and other types of events studied in "Reliability of Generation at a Hanford Nuclear Center" (Clark and Dowis 1977). Catastrophic events not caused by natural disturbances would be those caused by multiple failures of equipment and containment beyond the credible combinations upon which plant designs are based.

Consequences of such rare or disruptive events include:

- Release of radioactive aerosols, causing temporary air contamination, long-term contamination of land in the path of the plume and exposure of off-site populations; possibly resulting in shutdown of exposed facilities and evacuation of ersonnel until cleanup measures can be taken.

- Release of toxic nonradioactive gases that could affect the operation of downwind facilities, the release being from the plant or from tanks being transported along supply routes.

- Release of liquid contaminants to the river that conceivably could occur, although a scenario for such a release has not been constructed. The probabilities are deemed to be extremely low.

- Loss of electric power production that could not be offset by system reserves. Possibly a different environmental effect of this kind could result from the plant being at different sites along the river in the event of river blockage within the Hanford Site. This type of effect would be due to loss of electrical production rather than release of objectionable materials, and would be contingent on insufficient reserves on the system at the time of the event.

3.7.1 Radioactive Releases

While the wind blows in all directions at the reference site (Figure 4), the prevailing winds would probably carry releases in a sector encompassing the northeast to southeast. This would include the WPPSS facilities about 5 miles (8 km) due east and DOE's FFTF facilities a similar distance to the southeast. The 200 Areas are about 5 to 8 miles (8 to 11 km) to the northwest, and there is a significant wind fraction in that direction. The nearest population center would be the Angus Ranch area of West Richland and the Horn Rapids Triangle of Richland, both of which are 7 to 8 miles distant, being south or south-southeast of the reference site. The effects of releases on DOE facilities (and offsite activities) would probably be minimal for these distances. These distances are substantially greater than between the production reactor areas, for instance.

3.7.2 Toxic Gases

A release of toxic gas, of which chlorine is probably the most important example, would follow dispersion patterns similar to those of radioactive releases. With the amounts of inventory, and expected dilution under different wind conditions, adverse environmental effects would probably not be felt at distances greater than three or four miles from the source of release.

If it is assumed that supplies of toxic or explosive materials would be transported in tank trucks over Route 10 from the south to the reference site, distances from DOE facilities are well over several miles (apart from 400 Area, which is two miles distant).

The Hanford railroad system tends to parallel Route 4 south past the 300 Area and WPPSS plants. Accidents on the railroad system could be disruptive to these facilities but not to other DOE facilities.

3.7.3 Release of Liquid Contaminants to the River

With the large flows in the Columbia River, even at low flow periods, any releases would probably be greatly diluted by the time they reach the southern boundary of the Hanford Site. Releases within the Hanford Site would probably not affect DOE facilities since the reference site is downstream of DOE facilities, apart from 300 Area. Further, the long effluent line (about 8 miles-11 km) would offer an opportunity to control the effluent before release to the river.

3.7.4 Reliability of Electric Power Supply

The concentration of electrical generation at a single location leads to the possibility of loss of significant generating capacity due to a single unusual or rare event. Such an interruption could deprive DOE facilities of electric power. "Reliability of Generation at a Hanford Nuclear Center" (Clark and Dowis 1977) considered the effect of a number of rare events on reliability of electric power supply. It was concluded that the probability of a serious shortage of electric power in the PNW because of a disruptive event at an HNEC was about once in 10,000 years. Since the conditions evaluated by Clark and Dowis (1977) differ from those under consideration here in the number of plants, i.e., 20 versus up to 7, less of a risk is involved. The risk is judged acceptable.

In summary, it is very unlikely that any of the environmental impacts discussed here would infringe on the operation of DOE facilities (or other commercial facilities) because of the extremely low probability of occurrence of the causitive events or combinations of subsequent events.

3.8 SITE RESTORATION CONSIDERATIONS

Site restoration requirements will be determined by the terms of the conditional sale contract and deed and the requirements of the Nuclear Regulatory Commission (NRC) relating to plant decommissioning. DOE will include in the sale agreement a provision that the utility comply with all applicable license requirements and that the land revert to DOE at the end of the plant's useful life (DOE 1980).

Current NRC decommissioning requirements are in 10 CFR 50.33(f) and 50.82. Guidance is provided in Regulatory Guide 1.86, "Termination of Operating Licenses for Nuclear Reactors." NRC decommissioning requirements are currently under active review with the objective of providing more specific decommissioning guidance. 10 CFR 50.82 provides that the decommissioning should not be "inimical to the common defense and security or to the health and safety of the public". Regulatory Guide 1.86 identifies four retirement alternatives acceptable to NRC for meeting the above health and safety requirement: mothballing, in-place entombment, removal of radioactive components and dismantling, and conversion to a new nuclear system or a fossil fuel system. The Guide also specifies that the facility have controlled access and that environmental radiation surveys be performed regularly at the plant and in the surrounding area. Acceptable surface contamination levels that must be met prior to license termination are given.

It is believed that the reference site can be successfully decommissioned and meet NRC requirements. There appear to be no site-specific features which would complicate the decommissioning process.

3.9 FLOODPLAIN MANAGEMENT

The reference site will have acceptable flood protection from the probable maximum flood (PMF) established by the U.S. Army Corps of Engineers for the Hanford Reach of the Columbia River, and even a more severe flood corresponding to artificial destruction of portions of Grand Coulee Dam. The approximate elevation of the reference site is 540 ft (164 m), well above the projected elevation of 460 ft (140 m) for floods emanating from destruction of Grand Coulee Dam.

One of the NRC design criteria for nuclear power plants, 10 CFR 50 Appendix A Criterion 2, specifies that the structure must be designed to withstand the effects of floods. Consideration is to be given to natural phenomena and accidental conditions that can lead to a flood. Regulatory Guide 1.59 provides additional guidance for flood protection. Section C of the Regulatory Guide 1.59 states that the conditions resulting from hydrometeorological conditions, seismic activity, or both with attendant wind generated activity constitute the design basis flood conditions. Usually, the probable maximum flood (PMF), estimated by the U.S. Army Corps of Engineers as the flood discharge that may be expected from the most severe combination of meteorological and hydrologic conditions that are reasonably possible in the region, is utilized as the design basis flood condition. The matter of floodplain management at Hanford is complicated by the fact that in the licensing process for the Washington Public Power Supply System nuclear plant WNP-2, the Atomic Energy Commission (the predecessor licensing organization of the Nuclear Regulatory Commission) determined that a failure of Grand Coulee Dam leading to a flow rate at the plant site of 4,800,000 cfs (136,000 m^3/s) could be considered as the limiting case flood (AEC 1972). This flood corresponds to Artificial Flood Number 1 in a 1951 U.S. Army Corps of Engineers Study (1951) and assumes that 25 percent of the center cross-sectional area of the Grand Coulee Dam would be instantaneously destroyed by the detonation of a bomb with the equivalent of 20,000 tons of TNT, a pool elevation behind Grand Coulee of 1290 ft (393 m) and a base river flow of 50,000 cfs (1416 m^3/s) (ERDA 1976). The 4,800,000 cfs (136,000 m^3/s) flow rate exceeds the PMF from hydrometeorological conditions by a wide margin. The PMF estimated by the U.S. Army corps of Engineers for the Hanford Reach of the Columbia River is 1,440,000 cfs (40,780 m^3/s) (ERDA 1976).

Because the NRC regulations refer to natural and accidental flood conditions, it is not clear that intentional detonation of a bomb at Grand Coulee Dam must or should be considered as the limiting case flood. This issue will likely be considered in depth if the proposed nuclear plant(s) proceeds to the licensing stage. Grand Coulee Dam and the Hanford Site are in Seismic Zone 2, a zone of moderate earthquake activity. (Seismic accelerations of 0.25 g horizontally and 0.125 g vertically were used as the design basis earthquake for the Fast Flux Test Facility at Hanford, and the safe shutdown earthquake for the WPPSS WNP-2 plant.) The Bureau of Reclamation concluded in letter reports to the AEC in 1970 and 1971 that the maximum earthquake anticipated at Grand Coulee would not result in a flood exceeding the PMF (ERDA 1976). This result was confirmed in an April 1971 study conducted at the Westinghouse Hanford Company (ERDA 1976).

In November 1970, the U.S. Army Corps of Engineers published a series of water surface profiles for the Hanford Reach of the Columbia River for various flood conditions including Artificial Flood No. 1 and the PMF. These profiles were used to estimate water levels at the reference and alternative sites for the PMF and Artificial Flood No. 1.

In summary, comparison of the site elevations to the water profiles developed by the Corps indicates that the reference site is well above the elevation reached by the PMF or the water level of Artificial Flood No. 1. Both the PMF and Artificial Flood No. 1 would inundate the river water pumphouse, the only PSP&L activity located in the floodplain, but this facility is not essential to the post-shutdown cooling of the reactors (Puget Power 1981).[a]

3.10 SUMMARY OF POTENTIAL IMPACTS OF THE PROPOSED ACTION

The environmental impacts of the proposed action are summarized below:

1. Land Use Effects--The reference site location has been essentially unused for 35 years, and no alternative uses for the land have been proposed. Modest highway, railroad, and electrical transmission additions will be required. Buried cooling water intake and discharge lines parallel highways for most of the distance to the river pump house and outfall structure. No significant archeological sites are involved in the siting process.

(a) Because the river water pumphouse and associated intake and discharge facilities are located in a floodplain, Executive Order 11988 applies. The Department of Energy established Part 1022 of Chapter X of Title 10 of the Code of Federal Regulations to comply with Executive Order 11988--Floodplain Management. This regulation refers to considerations of a base flood or 100-year flood, and a critical action or 500-year flood for which even a slight chance of flooding would be too great. The 100-year flood in the Hanford Reach of the Columbia River is approximately 440,000 cfs on the developed and regulated Columbia River. It is not expected that this flood would render the river water pumphouse and associated intake and discharge structures inoperable. The 500-year flood would inundate the pumphouse, but would not impact the post-shutdown cooling of the reactors.

2. Water Use Effects--Water requirements for the proposed plants are very nominal compared to minimum river flows in the Hanford Reach (40 to 50 cfs per reactor versus 36,000 cfs river flow). Withdrawals and thermal discharges are not expected to result in a limitation on future DOE withdrawals. Construction and operation of the plant(s) will not affect the groundwater regime at Hanford.

3. Biological Effects--Neither withdrawal nor discharge of cooling water are expected to result in observable change to the river ecosystem. Of the five plant and animal species known to occur at Hanford and contained in the Endangered Species Act of 1973, only the bald eagle could be potentially impacted by the proposed plant.

4. Radiation Exposure--Expected releases of radioactive effluents should not interfere with existing and planned DOE facilities at Hanford nor the WPPSS facilities.

5. Meteorological Effects--The meteorological effects arising from construction and operation of the proposed plants are not expected to be significant, and interactions with DOE facilities or those postulated for Hanford are minimal.

6. Socioeconomic Effects--The Tri-Cities area is accustomed to large Hanford Site construction projects. Stress will occur to the region's infrastructure as a result of construction at the reference site, especially if it overlaps with other major construction activities at Hanford, but the service area has a large assimilative capacity for construction workers and related activities.

7. Rare and Disruptive Events--An analysis of both natural events and other events (such as release of radioactive aerosols, toxic nonradioactive gases, and liquid contaminants to the river) and the loss of electric power show that is is very unlikely that any would impinge on the operation of DOE facilities or other commercial facilities at Hanford.

8. Site Restoration--It is believed that the reference site can be successfully decommissioned and meet NRC requirements. There appears to be no site-specific features which would complicate the decommissioning process.

9. Floodplain Management--While supportive discharge/intake structures will be located on a floodplain (and thus will require compliance with Executive Order 11988), the reference site itself is not located on a floodplain. None of the projected river flows, even those arising from a hypothetical breach of Grand Coulee Dam would flood the site.

4.0 ALTERNATIVES

4.1 ALTERNATIVE USES

Use of the Federally-owned Hanford Site has been controlled by the following guidelines:

- Hanford must remain a controlled Federal site for the foreseeable future:
  - to ensure the existence of resources for current and future DOE programmatic missions;
  - to assure continued safe and environmentally sound management of the large inventories of operational radioactive waste stored at Hanford;
  - to provide buffer zones and areas of access controls necessary for safety, security, and environmental protection.
- To the extent that Hanford lands are not reserved for anticipated future programmatic use, they may be considered for use for other activities related to the energy missions of the Department of Energy. The sale of the proposed reference site to PSP&L is authorized by Section 161g of the Atomic Energy Act of 1954, as amended, in order to assist in the development and utilization of atomic energy for peaceful purposes. It is noted that the Conference Report (Report No. 96-1366, September 22, 1980) for Energy and Water Appropriations for FY 1981 provided in relevant part:

  The conferees agree with the Senate report language encouraging the Department to use its authority under Section 161g of the Atomic Energy Act of 1954, as amended, to sell land on the Hanford Reservation to utilities wishing to purchase such land for construction of nuclear powerplants to serve the region when such sales do not jeopardize Department activities.

No alternative uses of the reference site have been proposed. Light industry would not be a compatible use and could be more suitably located in nearby commercial industrial parks. Use of the land for agriculture would not be a compatible use and could alter groundwater conditions, thereby eroding barriers to radioactive material transport and complicate future siting of facilities at Hanford.

The reference site could be used for some other energy generating means, particularly solar. A coal-fired power plant located at this site is probably marginal because of air quality considerations in the Hanford air basin. Utilization of geothermal resources is highly unlikely at this location. Since there are superior sites for solar generation on the Hanford Site, it is concluded that there are no higher uses for the reference site for energy generation purposes.

4.2 ALTERNATIVE SITES

Having considered the Hanford environs, existing and postulated future activities on the Hanford Site, and the characteristics of the reference site, it is appropriate to examine whether alternative sites at Hanford might minimize the environmental impacts and be more compatible with existing and projected DOE programs compared to the reference site. Because of the large size of the Hanford Site and the considerable length of the Hanford Reach of the Columbia River, many excellent sites are available. PSP&L has been investigating some of them. The final selection of alternative sites by PSP&L depends on many factors which, at this writing, have not been completely analyzed. Therefore, four potential sites have been selected for comparison purposes that appear to bracket the alternative sites that might be finally selected. Following are descriptions of alternate sites that were selected.

Alternative Site No. 1 is upstream of the 100 Areas (Figure 3). It is intended to represent any site that might be selected on the right side of the Columbia River (looking downstream) upstream of the 100 Areas.

Alternative Site No. 2 is across the Columbia River from the 100 Areas, on the north western portion of the Hanford Site.

Alternative Site 3 is across the Columbia River from the old townsite of Hanford, near the eastern boundary of the Hanford Site. Sites 2 and 3 are intended to be representative of sites that might be selected along the northern rim of the Hanford Site.

Alternative Site 4 is upstream of the Washington Public Power Supply System nuclear plants.

Alternative Sites 1 to 4 are intended to be representative of any site which might be selected along the right side of the Columbia River. Further, any environmental impacts arising from selection and use of any of the four alternative sites would approximate those sustained by other sites within the bounds of the alternatives.

It is assumed that power plant layouts, easements for transmission lines, etc., would have similar requirements at each of the alternative sites. For instance, if reliability and load flow requirements dictated multiple transmission corridors at the reference site, similar requirements would hold for the alternative sites.

5.0 POTENTIAL ENVIRONMENTAL IMPACTS OF ALTERNATIVES TO THE PROPOSED ACTION

In this section the potential programmatic and environmental impacts arising from building the four nuclear plants at each of the alternative sites are compared with those of the reference site. Only incremental impacts are identified; the absolute impacts will be thoroughly examined in the State and NRC licensing processes. Each of the topics previously identified (e.g., land use effects, water use effects, etc.) is examined for the alternative sites and the potential impacts are compared to the reference site.

In addition to evaluating the alternative sites, a "no-action" alternative is considered.

5.1 POTENTIAL ENVIRONMENTAL IMPACTS ARISING FROM USE OF ALTERNATIVE SITES

5.1.1 Land Use Effects

The land use effects of construction and operation of nuclear powered electric generation facilities at each of the four alternative sites are similar to those at the reference site except as noted below. The land converted to power plant and support facility (four units) use is essentially 100 acres (40 ha) for the reference site and each of the alternative sites. That portion of the lands at each site fenced off as security area amounts to about 300 acres (121 ha). The major differences in land use effects are associated with the extensions and modifications needed in the transportation and electrical transmission corridors, and river intake and outfall structures and associated pipelines to the site.

5.1.1.1 Alternative Site 1

Alternative Site 1 is located in an old field area of the Hanford Site now dominated by cheatgrass. State Highway 240 provides the most direct route from the Tri-City area to this area. The highway is a paved two-lane road that would have to be upgraded to accommodate high traffic volumes. In addition, traffic on State Highway 24 from the Hanford Site toward Yakima would be increased. This route includes some tight turns which could be hazardous specifically during winter driving conditions. Upgrading of both of these highways would probably be necessary.

The Hanford railroad system passes through the site. A shorter spur would be required compared to the reference site. The electrical transmission corridor between the Hanford switching station and Alternative Site 1 would be approximately 8 miles (12.8 km) long, skirting the B-C and K Areas. Four single circuit lines or two double circuit lines would probably be required. The environmental effects would be considerably greater than those of the reference site. All of the power flow would be through one switching station rather than being divided between two switching stations with a consequent small reduction in transmission reliability.

5.1.1.2 Alternative Site 2

Alternative Site 2 is located in the sagebrush/cheatgrass community north of the Columbia River on the Saddle Mountain Wildlife Refuge managed by the U.S. Fish and Wildlife Service. State Highway 24 is in the vicinity of this area. To drive to the site, construction workers would use State Highways 240 and 24. As discussed above for Site 1, both of these highways would need to be upgraded.

Railroad access to the site would require a major extension of a Burlington Northern Railroad line from Othello or from the now abandoned Milwaukee Railroad line between Othello and Beverly. To be served by this trackage, a spur of about 20 miles or more (32 km) would need to be built to provide railroad service to Site 2.

In order for the power plant to feed into the region's transmission system at the Hanford switching station a minimum of 4 miles (6.4 km) of new corridor for four lines, and a river crossing, would be required. Here again all feed would be into one switching station.

5.1.1.3 Alternative Site 3

Alternative Site 3 is also located in the sagebrush/cheatgrass community north of the Columbia River. This area is currently managed by the Washington State Department of Game. This site is much more isolated from major transportation corridors than Alternative Sites 1 and 4, and about the same as Site 2. All the roads in this portion of western Franklin County are farm-to-market roads. They are designed for low-volume traffic and some are considered substandard with respect to today's standards for width, alignment, and loading. There are no plans at this time for building a high-volume highway in this area. Thus, a new major highway construction program would be necessary in order to accommodate the high traffic volumes associated with construction of four nuclear power plants at Alternative Site 3.

Alternative Site 3 could feed into the Hanford or Gable Mountain switching station or both. Connections to the Hanford switching station would require about 5 miles (8 km) of new corridor, 11 miles of upgraded corridor, and a river crossing. Connections to Gable Mountain switching station would require 7 miles (11.2 km) of new corridor and a river crossing. Any of the alternatives would involve greater environmental effects than the reference site.

5.1.1.4 Alternative Site 4

Alternative Site 4 is located near the dunes study area of the Hanford Site. This area contains cheatgrass, needle and thread grass and some sagebrush. It is an important winter area for deer. The highway and railroad transportation corridors serving Alternative Site 4 are the same ones serving the reference site. The length of new highways and railroad lines connecting each of the four units to the Hanford system could be of similar length to those required of the reference site. The length of new transmission corridors would be about the same as that required for the reference site, again assuming ties to both the Ashe and Gable Mountain switching stations.

Based on the descriptions above, comparative land use effects between the reference site and alternative sites are summarized in Table 5.

TABLE 5. Comparative Land Use Effects

Impact on	Alternative Site 1	2	3	4
Land Conversion	0	-	-	0
Soil Erosion	0	-	-	0
Land Use Restrictions	0	-	-	0

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
- -Impacts less environmentally acceptable than those of proposed action.

5.1.2 Water Use Effects

The water use effects are discussed under the same topics as listed in Section 3.3: 1) thermal effects, 2) groundwater, and 3) water availability. Based on these considerations a comparative evaluation is made of the five sites (the reference site and four alternatives).

5.1.2.1 Thermal Effects

As previously stated, the thermal effects can be expected to be minimal since four reactors discharge a combined total of less than 40 cfs (1.13 m^3/s) of heated effluent to the river. River water conditions at Sites 1, 2, 3, and the reference site would all be typical. This may not be the case with Site 4 which is located just upstream of WNP 1, 2, and 4 power plants. In this case there is a possibility that the heated effluent from the four reactors could combine with the effluents from the WPPSS reactors and increase the time that temperature standards would be exceeded. To remedy this possibility might require special attention to the design and location of the outfall structure. A similar situation might exist at Site 1 where the heated effluent could combine with effluents from postulated production reactors. In summary, from a thermal effects point-of-view the incremental effects of all sites are equal except for Sites 1 and 4, which could be less desirable due to possible interference with the WPPSS reactor's or production reactors' thermal plumes.

5.1.2.2 Groundwater

The groundwater movement from the 200 Area northward and eastward toward the Columbia River could interact with Alternative Sites 1 and 4 during construction. As previously stated, these sites are located along the river bankline where the water table is subject to local variations due to the seasonal rise and fall of the Columbia River.

The estimated water table elevation at the right bank sites are shown in Table 6 and compared to the reference site. The reference site has the greatest distance to groundwater with an average ground surface elevation above the water table of about 142 ft (43 m). Based on this consideration the reference site would be the most desirable and Site 1 the least.

TABLE 6. Approximate Water Table Elevations (Hanford Site Water Table Map, Rockwell International, December 1980)

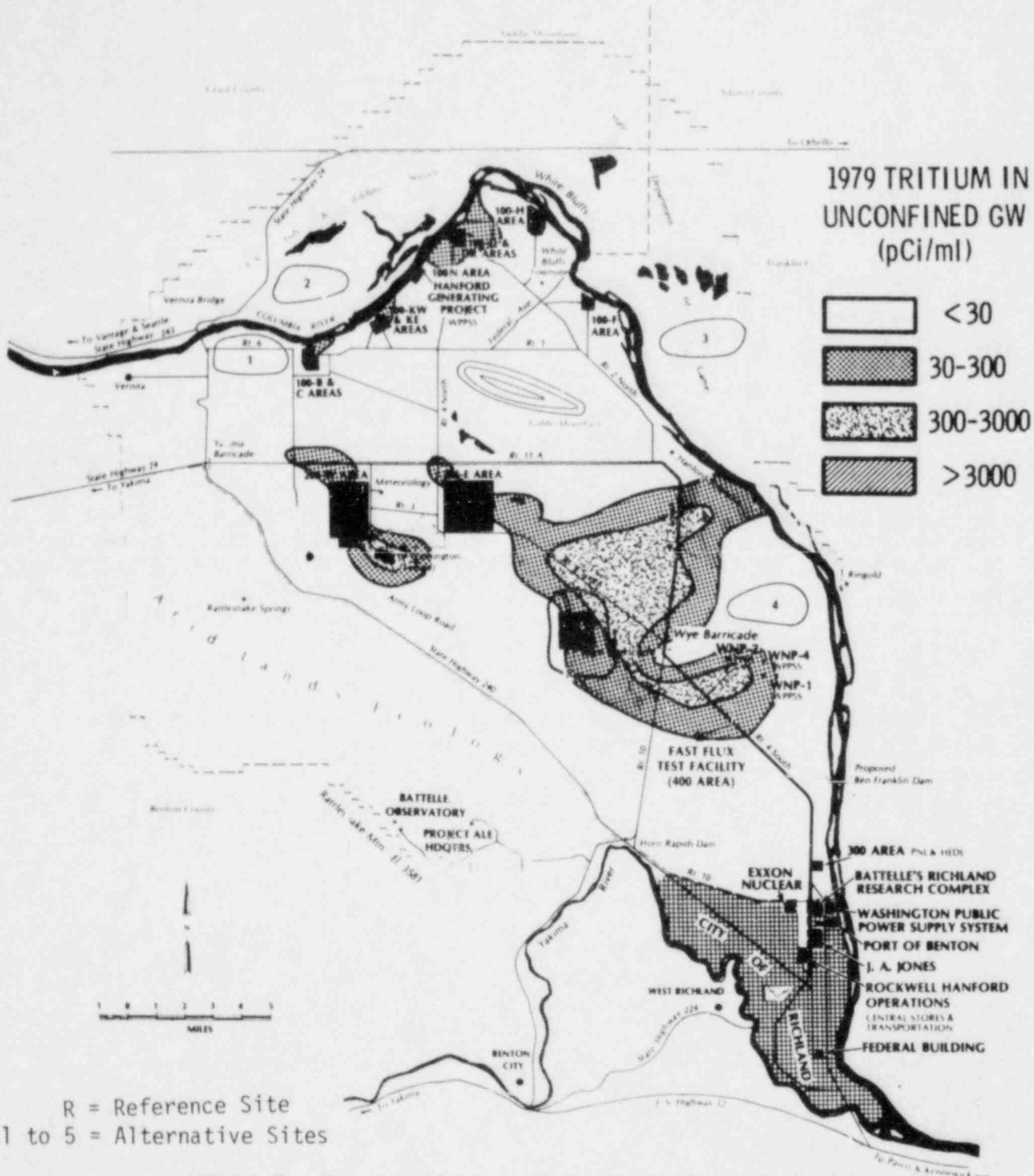
	Reference Site	Site 1	Site 4
Ground Surface Elevation (ft-msl)[(a)]	540	440	460
Water Table Elevation (ft-msl)	398	398	365 to 375

(a) ft-msl: feet above mean sea level.

Very little information is available concerning specific water table elevations for Sites 2 and 3 located on the left bank of the Columbia River. However, a bankline stability problem is known to exist in the Site 3 area (Harty 1979) arising from groundwater associated with irrigation and from the irrigation wastewater. The pathway through the left bank soils is toward the river where the seepage exists about midway up the bluff face and has caused numerous landslides to occur. This seepage extends intermittently along the left bank bluffs for several miles due to the scattered locations of the ponds and irrigation returns. Minor seepage does occur in the general area of Site 3 but has not resulted in landsliding or erosion so far. This does not rule out the possibility of a conflict with the Columbia Basin irrigation project over irrigation groundwater changes or the dumping of wastewater and resulting bankline instability. No information is available defining the general water table characteristics near Site 3 and, although the irrigation groundwater wastewater problem does not affect Site 2, there are no groundwater data available to allow an evaluation of that site either.

While radiological contamination of the groundwater beneath the reference site has occurred as of 1979, no interaction between the groundwater and the construction activities is anticipated (nor, as previously stated, with operating activities). Alternative Site 4, as of 1979, has not experienced radiological contamination of the unconfined aquifer. However, movement of the tritium plume originating from the 200-E Area is advancing in the general direction of Site 4. There is no evidence of increased tritium levels in the groundwater of Alternative Site 1 and no future contamination is expected. The location of Hanford tritium plumes as of 1979 is shown in Figure 5. Because tritium enters the unconfined groundwater aquifer as a part of the water molecule it is transported by the groundwater flow and remains mostly unaffected by geologic conditions. Therefore, tritium is an effective indicator of the spatial extent of radiological contamination of groundwater (Gephart 1970).

Table 7 contains the results of tritium sampling of wells near the specified sites during 1979 (Eddy 1980).



R = Reference Site
1 to 5 = Alternative Sites

FIGURE 5. Tritium Plume in Groundwater Beneath Hanford (Eddy and Wilbur 1980)

TABLE 7. Tritium Concentrations in Wells

	Well No.	1979 Tritium (pCi/ml) Maximum	Average	Minimum
Reference Site	15 to 26	310	275	260
Site 1	72 to 80	8.2	7.8	7.4
	72 to 92		8.6	
Site 4	24 to 1P		<0.7	
	20 to E5A		9.6	

Alternative Sites 2 and 3 are not subject to radiological contamination but are susceptible to agricultural chemical contamination, especially Site 3. The evaluation of the severity of these contaminants is beyond the scope of this assessment, but considering the information available, Site 2 seems to be the best choice to avoid a groundwater contaminant problem. The other four sites require a more detailed evaluation to be able to rank them in any order. As stated previously, it is unlikely that the reference site or alternative sites on the right bank would affect buried radioactive wastes on the Hanford Site. Certainly the alternative sites on the left bank would not.

5.1.2.3 Water Availability

Since all sites are located along the same reach of river and are subject to the same flow conditions they all can be considered on an equal basis regarding water availability. A similar situation exists covering irrigation depletions. Although irrigation withdrawals from the Columbia River system can be significant none are made from the stretch of the river bordered by the Hanford Site. Therefore, water availability would not enter the selection of one site over another.

The vertical distance cooling water would have to be pumped to the various sites differs from site to site. The higher the site elevation above the channel bed the less economical the location will be with respect to pumping costs. Table 8 summarizes the pumping lifts for the sites. Sites 1, 2, and 4 are superior to the reference site and Site 3. The reference site requires about twice the lift of the WPPSS plants. Site 3 would require the most vertical lift of cooling water and because of this requirement (455 ft, 139 m) it may be more economical to consider other sources such as irrigation wastewater.

TABLE 8. Pumping Lifts for Hanford Sites

Site	Surface Elevation (ft msl/m)	Channel Bed[(a)] Elevation (ft msl)	Required Pumping Lift (ft)/(m)
Reference Site	540 (164 m)	340	200 (60 m)
Site 1	440 (134 m)	365	75 (23 m)
Site 2	500 (152 m)	365	135 (41 m)
Site 3	800 (244 m)	345	455 (139 m)
Site 4	440 (134 m)	330	110 (36 m)

(a) Estimated by allowing for a 25-ft (8-m) depth below approximate water surface elevation contoured on USGS topographic maps.

In summary, the five sites have been evaluated on an incremental basis from a water use standpoint. All are competent sites. None of the sites considered appear to have any significant foreseeable impact on either the Basalt Waste Isolation Project (BWIP), the 200 Area waste storage tank farms, or other present or postulated future DOE programs. As previously stated, none of the sites appears to conflict with the Columbia River Instream Protection Program. The evaluations of the sites are summarized in Table 9.

TABLE 9. Water Use Impacts--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Thermal Effects	-	0	0	-
Groundwater Contamination	-	+	+	-
Water Table Effects	0	Unknown	-	-
Water Availability	0	0	0	0
Irrigation Depletions	0	0	0	0
Pumping Requirements	+	+	-	+

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
- -Impacts less environmentally acceptable than those of proposed action.

5.1.3 Biological Effects

5.1.3.1 Aquatic Ecology

The expected impacts on the aquatic environment for the alternate sites are much the same as those for the reference site discussed in Section 3.3, and are those associated with withdrawal of water from the Columbia River and the discharge of effluents from the power plants to the river.

Alternative Sites 1 and 2 are upstream of much of the anadromous fish spawning areas in the Hanford Reach. An exception is the major fall chinook salmon spawning area near Midway (RM 393). Site 3 is downstream, with the exception of the Ringold Area, of the fall chinook salmon production areas; Site 4 is near the lower end of the Hanford Reach salmon spawning area. Since no adverse effects of power plant operation on the river ecology is anticipated, the location of the power plants with respect to the salmon spawning areas is probably not significant.

There are a series of permanent ponds near Alternative Site 2 that have been created by the discharge of irrigation water from the irrigated farm land on the south slope of the Saddle Mountains. These ponds do have some potential for the development of recreational fishing. The establishment of power plants adjacent to this pond area may exclude it from possible future development and public use in order to provide the usual buffer zone for the power plants. The ponds presently comprise a waterfowl refuge managed by the U.S. Fish and Wildlife Service.

Although no discernible aquatic impacts are anticipated from the establishment of nuclear power plants at any of the sites, the location of the plants at Alternative Site 4 would carry the lowest risk of detrimental effect because Site 4 is near the downstream portion of the anadromous fish production areas and near the lower end of the free flowing stretch of the river.

The comparative aquatic impacts are summarized in Table 10.

TABLE 10. Aquatic Ecological Impacts--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Anadromous Fish	–	–	0	0
Development of Recreational Pond Fishery	0	–	0	0

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
– -Impacts less environmentally acceptable than those of proposed action

5.1.3.2 Terrestrial Ecology

Terrestrial ecological effects of constructing the proposed power plants at any of the alternative sites can be compared to probable impacts at the reference site by considering:

- Effects on species of special concern (including officially protected rare, threatened, or endangered species),
- Effects on wildlife populations, and associated recreational use where appropriate,
- Effects on areas of special scientific value.

If construction were to occur at Alternative Sites 2 and 3, both located north of the Columbia River, minor impacts on bald eagles are possible. Site 2 is on lands presently administered by the U.S. Fish and Wildlife Service as a wildlife refuge. The site is adjacent to approximately 500 acres (202 ha) of ponds fed by irrigation wasteways. These ponds are heavily used by waterfowl as safe resting areas during migration. Waterfowl and eagle use would certainly be interrupted during the period of construction and could be permanently lost or reduced, depending on the specific location of the power plants. The loss of about 4000 or 5000 acres (1600 to 2000 ha) from the refuge would also negatively impact other forms of wildlife, principally mule deer.

Similar impacts might be expected if construction were to occur at Alternative Site 3. This site too is adjacent to wastewater ponds extensively used by waterfowl and bald eagles. The site lies in an area administered by the Washington Department of Game. It is currently open to hunting. Construction at this site would thus result in the loss of public recreation area in addition to impacts on wildlife.

None of the four alternative sites is known to be uniquely important habitat for any of the other species of special concern discussed in Section 3.3.2.

Of the four alternative sites, only Site 4, just north of the present WPPSS power plants, would impact areas of special scientific value. Much of this site is covered by active sand dunes which support an unusual plant and animal association. The sand dunes area occupies approximately 3800 acres (1538 ha), up to half of which could be lost if construction were to occur at this site. Comparable areas for scientific study are rare in the region. Two similar dune areas occur within a 50-mile (80-km) radius but neither is as free from human disturbance.

In summary, as indicated in Table 11, only Alternative Site 1 is superior to the reference site on the basis of terrestrial ecological effects alone. This is because no potential ecological impacts can be anticipated at Site 1, whereas there is some potential for damage to one threatened species (bald eagle) and three species of state-wide special concern at the reference site. Alternative Sites 2, 3, and 4 are probably less desirable than the reference site from an ecological point of view because of the strong probability of substantial damage to waterfowl in the case of Sites 2 and 3 and to an area of special scientific value at Site 4.

TABLE 11. Terrestrial Ecological Impacts--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Species of Special Concern	+	+	+	+
Wildlife Populations	0	–	–	0
Areas of Special Scientific Value	0	0	0	–

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
– -Impacts less environmentally acceptable than those of proposed action

5.1.4 Radiological Effects

The principal items affecting the relative radiological impacts of the alternative sites include: 1) the number of persons residing within the 50 mile (80 km) radius of the site, 2) atmospheric dispersion of the gaseous effluents, and 3) agricultural uses of the surrounding land, 4) the travel time in air and in the Columbia River from the points of release to the exposed populations. .... fourth item is not very important since most of radiation dose estimated for reactors located at the reference site resulted from nuclides whose half-lives were long relative to the travel times, e.g., ^{3}H, ^{14}C, ^{90}Sr, ^{137}Cs. Relative location on the Hanford Reach of the Columbia River does not significantly affect the total population radiation dose because most of the dose is projected to result from the release of gaseous effluents. In addition, it was assumed in the dose calculations that the maximally exposed individual might be able to fish and engage in aquatic recreation in relatively close proximity to the reactor effluent release points regardless of where the plants were located on the Columbia River.

5.1.4.1 Alternative Sites 1 and 2

These two sites are both located near the upstream boundary of the Hanford Reach of the Columbia River. They are essentially similar to one another in terms of distance and directions to population centers and travel time in the Columbia River. They are both about 20 river miles (32 km) further upstream from the Tri-Cities area than is the reference site. As mentioned above, the extra river travel time and concommitant radioactive decay does not significantly lower the total radiation doses below those estimated for the reference site.

Moving the proposed site to either Alternative 1 or 2, 15 to 20 miles (24 to 32 km) northwest of the reference site, increases the straight line distance to the Tri-Cities population by about 10 miles (16 km) but brings the population centers of Yakima and Ellensburg within the 50-mile (80-km) circle.

The net change in population doses from the gaseous pathways should, however, be downward because the wind very seldom blows towards the latter two population centers from Alternative Sites 1 and 2. It is projected that the decrease in total population doses between Alternative Sites 1 and 2 and the reference site would be in the range of 50 percent. The exact change cannot be predicted at this time because of limited meteorological data now available for Alternative Sites 1 and 2.

5.1.4.2 Alternative Site 3

The radiological impact of locating four reactors at Alternative Site 3 should be slightly less than that estimated for the reference site. Depending upon the exact location of Alternative Site 3, there could be some small increase in distance to the Tri-Cities via both air and water pathways. The effect on total radiation doses should be a decrease of about 50 percent below those estimated for the reference site.

5.1.4.3 Alternative Site 4

This site is just north of the existing WPPSS power reactor sites and as such is about equidistant to the Tri-Cities compared to the reference site. Travel times in air and water and atmospheric dilution to these cities are projected to be similar to the reference site. The resulting radiation doses should be similar to those estimated for the reference site.

In general, it appears that none of the alternative sites would be less acceptable on the basis of radiological impact than the reference site (Table 12). The population doses at the alternative sites are projected to be within ±50 percent of the low doses estimated for the reference site. Any of the five sites should be capable of meeting any existing or currently proposed Federal and state radiation exposure guidelines with two boiling water reactors (BWR) and two pressurized water reactors (PWR) operating plants.

TABLE 12. Radiological Impacts--Comparison of Reference Site to Alternative Sites

Impact on	1	2	3	4
Public Radiation Dose	0	0	0	0

Since the radiation doses estimated for the reference site are small, the estimated differences between the various sites are not significant.

5.1.5 Meteorological Effects

The environmental effects described for the proposed plant site are typical of the effects that can be expected for any sites at Hanford. The climatological data base is not adequate to quantitatively distinguish between effects at the various alternative sites. Qualitatively it might be expected that sites near the river would result in larger increases in the occurrence of fog than sites more distant from the river. The analyzed wind data base does not permit realistic evaluation of the interaction of plumes (of moisture or radiological effluents) from the proposed plant with those from existing or future DOE and WPPSS facilities.

A qualitative comparison of the alternative sites is presented based on subjective evaluation of the wind data shown in Figure 4 and wind data for the FFTF and WPPSS sites given in WPPSS Environmental Report (WPPSS 1977). The comparison is limited to three aspects: the potential contamination of various locations and facilities following a major nuclear accident in the proposed power plant complex; the potential frequency of occurrence of weather modification at various locations due to cooling system effluents from the proposed plants; and the change in air quality during construction. The following subjective evaluations are based on consideration of a number of factors including: the wind roses in Figure 4, topography, the distances involved, atmospheric transport and diffusion models, and a general familiarity with airflow patterns over Hanford.

The addition of each nuclear facility at Hanford increases the probability that the operation of some DOE facility will be adversely affected by a release of radioactive material following an accident at another facility, or that significant offsite contamination will occur. Compared to the location of the power plants at the reference site, locating them at Alternative Sites 1 or 2 would increase the probability of such a release affecting DOE activities along the Columbia River in the 100 Areas, in the 200 Areas, and in the vicinity of Gable Mountain. The risks to facilities in the 100 Areas associated with locating them at the reference site or Alternative Sites 3 or 4 would be about the same. The probabilities of an accidental release affecting the 200 Areas would be about the same for facilities located at the reference site or Alternative Site 3, and the probability would be least for facilities located at Alternative Site 4. Facilities located at Alternative Site 3 would be more likely, and facilities located at Alternative Site 4 would be less likely to affect operations in the vicinity of Gable Mountain than similar facilities located at the reference site.

Locating the proposed facilities at any of the alternative sites would reduce the probability that an accidental release from those facilities would affect the FFTF or fusion research facilities. Similarly, locating them at Alternative Sites 1, 2, or 3 would reduce the risk to the WPPSS facilities and the Tri-Cities. Conversely, locating them at Alternative Site 4 would increase the risk to the WPPSS facilities. It would result in about the same risk to the Tri-Cities.

With respect to potential contamination of agricultural lands in the event of an accident, Alternative Site 1 is more favorable and Alternative Sites 3 and 4 are less favorable than the reference site. The risks associated with locating the facilities at the reference site or at Alternative Site 2 are, in this case, about comparable. These comparisons are summarized in Table 13.

TABLE 13. Potential Involvement Following a Major Accident--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Production Areas	-	-	0	0
Fuels Processing Area	-	-	0	+
Waste Isolation Area	-	-	-	+
FFTF/Fusion	+	+	+	+
WPPSS	+	+	+	-
Tri-Cities	+	+	+	0
Offsite Agriculture	+	-	-	-

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
- -Impacts less environmentally acceptable than those of proposed action.

Moisture from the power plant cooling systems can be expected to result in local weather modification. The most obvious modification will be occasional visible plumes from the cooling towers. These plumes may cause local reductions in visibility and solar radiation. During the winter, they may also result in increased deposition of ice on exposed surfaces. Locating the proposed power plants at the reference site or at Alternative Sites 1 or 2 will result in approximately the same likelihood that these weather modifications will adversely affect major offsite transportation routes. Locating the plants at Alternative Sites 3 or 4 would be less likely to adversely affect major transportation routes.

The likelihood that weather modification would adversely affect the Tri-Cities is about equal for cooling systems located at either the reference site or Alternative Site 4. It would be considerably less for cooling systems located at the other alternative sites.

The probabilities that any weather modification resulting from cooling systems for the proposed plants would adversely affect agricultural lands or the Arid Land Ecology Reserve are small. Locating the proposed plants at any of the alternative sites would result in lower probabilities of affecting the Arid Land Ecology Reserve than would locating them at the reference site. In relation to agricultural lands, Alternative Sites 3 and 4 appear somewhat worse, and Alternative Site 1 appears somewhat better than the reference site. Alternative Site 2 and the reference site appear to be equivalent in this respect.

Table 14 summarizes these comparisons.

TABLE 14. Frequency of Occurrence of Modified Weather--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Offsite Transportation Routes (Wash. 24, 240, U.S. 395)	0	0	+	+
Tri-Cities	+	+	+	0
Agricultural Lands	+	0	-	-
Arid Land Ecology Reserve	+	+	+	+

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
- -Impacts less environmentally acceptable than those of proposed action.

During the construction of the proposed plants, daily transportation of the work force will contribute significantly to the air pollution load in the basin. The extent of the reduction in air quality will depend upon the number of vehicle-miles/day used in transportation. It is anticipated that the reduction would be about the same if the plant were located at either the reference site or at Alternative Site 4. Locating the plants at any of the other alternative sites would significantly increase the number of vehicle-miles/day and would therefore result in a larger decrease in air quality.

5.1.6 Socioeconomic Effects

The level of electrical generation is assumed to be independent of the location chosen on the Hanford Site for construction and operation of the four-unit nuclear power plant complex. Also, the level of construction work force, schedule, and skills required for construction of four nuclear power plants are assumed to be the same for the four alternative sites as they are for the reference site. However, the service area relied upon to provide housing, schools, water and sewer, and related services may differ from site to site. Differences in socioeconomic impacts arise from the different assimilative capacities of these service areas. The discussion below identifies where road congestion or the severity of stress on housing, schools, water and sewer services would differ from the reference site.

5.1.6.1 Alternative Site 1

Alternative Site 1 is approximately 15 miles (24 km) northwest of the reference site. The fraction of construction workers residing in the Tri-Cities area will be less than that expected from the reference site. A larger fraction of construction workers will reside in Yakima and the lower Yakima Valley. In addition, some workers may reside in the Othello area. The work force will assume a more dispersed residential pattern. This will reduce the traffic volume going in any one direction, but the volume will be over roads less capable of handling high volumes. State Highways 240 and 24 leading to the area are two-lane highways and will be heavily congested during peak hours. Use of the Hanford highway system as a supplemental route for the Tri-Cities workers could reduce this congestion. In general, the service area for Alterrate Site 1 has about the same capacity to assimilate the construction work force as the reference site.

5.1.6.2 Alternative Site 2

Alternative Site 2, located in Grant County, is distant enough from major urban areas that severe stress would be placed in rural and small communities nearer the site. The area within 40 miles (64 km) of this site is rural with the exception of Othello, with a population less than 5,000. Major highways to the site are State Highways 24 and 240.

5.1.6.3 Alternative Site 3

Alternative Site 3 is located in western Franklin County. The area within 20 miles (32 km) of this site is zoned principally agricultural. Without a high volume highway directly to the site from the Tri-Cities area, severe stress will be placed on the small communities and rural areas nearer the site.

5.1.6.4 Alternative Site 4

Alternative Site 4, located just north of WNP 2 and 4, could reduce some of the traffic congestion near the Wye Barricade if the site's access road were to join Hanford Route 4 South prior to the security barricade. The service area for construction workers is essentially that for the reference case. Stresses on housing, schools, water and sewer services would be comparable.

For the reasons discussed above, comparative socioeconomic effects between the reference site and alternative sites are shown in Table 15.

TABLE 15. Socioeconomic Effects--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Regional Power Availability	0	0	0	0
Traffic Congestion	-	-	-	- or 0
Housing, Schools, Water Services, Sewer Services	-	-	-	0

Key: 0 -impacts similar in kind and severity to those of proposed action.
+ -impacts more environmentally acceptable than those of proposed action.
- -impacts less environmentally acceptable than those of proposed action.

5.1.7 Rare and Disruptive Events

As previously stated (Section 3.7), if a rare or disruptive event were to occur at one of the alternative sites, the environmental impact could differ by reason of the site's location relative to other facilities, the prevailing wind directions, and the point of water intake from the river. The comparative environmental consequences of rare and disruptive events at the alternative sites are characterized in this section for the same topics as discussed in Section 3.7: Radioactive Releases, Toxic Gases, Release of Liquid Contaminants to the River, and Reliability of Electric Power Supply.

5.1.7.1 Radioactive Releases

The transport of released radionuclides are discussed in Section 5.1.5, Meteorological Effects. The effects of major releases would probably be felt within a radius of several miles, depending on wind direction and velocity. The reference site could impact FFTF (or other experimental facilities in the 400 Area) or WPPSS facilities. Alternative Sites 1 and 2 could impact DOE facilities in the 100 Areas. Alternative Site 4 could impact the WPPSS plants. The distance of the other sites from the DOE and WPPSS facilities is probably great enough that such direct adverse effects could be avoided. Nevertheless, under certain circumstances, an accident at any of the sites could have an adverse effect on DOE facilities.

5.1.7.2 Toxic Gases

A release of toxic gas, of which chlorine is the most important example, would follow dispersion patterns similar to those of radioactive releases, but the distance over which the environmental effects would be felt would be less because of the rapid dilution to harmless levels. Here the distance from adjacent facilities is a more important parameter. With the amounts of inventory and expected dilution under different wind conditions, adverse environmental effects would probably not be felt at distances greater than 3 or 4 miles (5 to 7 km) from the source of release. If so, all sites would be equal in this respect except Site 4 which would be more adverse than the reference site for possible impact on the WPPSS and FFTF facilities.

If it is assumed that supplies of toxic or explosive materials would be transported in tank trucks over State Highway 240 to Alternative Sites 1 and 2; over the main Project Highway (Routes 10 or 4 South) to the reference site and (additionally over Route 2) to Alternative Site 4; and over roads out of Pasco (State Highway 24) to Alternative Site 3--the potential impacts, combined with those from the site itself, could be judged as shown in Table 16.

TABLE 16. Comparative Potential Impacts of Toxic Gases--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Production/100 Areas	-	-	0	0
Basalt Waste Isolation	0	+	+	0
FFTF/Fusion/300 Area	+	+	+	0
WPPSS	+	+	+	0
City of Richland	+	+	+	0

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable table than those of proposed action.
- -Impacts less environmentally acceptable than those of proposed action.

As previously stated, the possible impact of releases from rail cars has not been analyzed.

5.1.7.3 Release of Liquid Contaminants to the River

As previously stated in Section 3.7, with the large flows in the Columbia River, even at low flow periods, any releases would be expected to be greatly diluted by the time they reach the southern boundary of the Hanford Site, so that offsite impacts would be equal for all sites considered. Impacts within the Hanford Site would depend on river water withdrawal points downstream from the site, and how far they are from the site. Mixing of the contaminated effluent with river water would not be as complete at intake points closely downstream from the point of release; water pumped at these points could be more contaminated than at more distant downstream withdrawal points.

As a result, Alternative Sites 1 and 2 would be less favorable than the reference site with respect to the production and Basalt Waste Isolation areas; Alternative Site 3 would be about the same as the reference site; and Alternative Site 4 would be less favorable with respect to WPPSS, FFTF, 300 Area, and the City of Richland, as shown in Table 17.

TABLE 17. Liquid Contaminants to River--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Production/100 Areas	-	-	0	0
Basalt Waste Isolation	0	0	0	0
FFTF/Fusion/300 Area	+	+	+	-
WPPSS	+	+	+	-
City of Richland	0	0	0	-

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
- -Impacts less environmentally acceptable than those of proposed action.

5.1.7.4 Reliability of Electric Power Supply

As pointed out in "Reliability of Generation at a Hanford Nuclear Energy Center" (Clark and Dowis 1977), a major river blockage would cut off flow to downstream plants temporarily then release a wave of water as the blockage is overtopped. The river level at upstream plants would be raised temporarily. The severity of effects would depend on river flow at the time the blockage occurred. Recent information indicates that the most likely place for a blockage is near the northern point of the river bend, near the 100-H Area (Harty 1979).

The flooding of river pump houses of upstream facilities could cause longer outages of those facilities than the temporary loss of water supply would cause at downstream facilities. However, a wave of water following overtopping of the temporary dam could also flood downstream river pump houses. These possible effects make it unclear whether there would be any difference in environmental impact in this respect among Alternative Sites 1, 2, and 3, and the reference site. Alternative Site 4 may have an advantage over the reference site and the other alternative sites since it is farther from the point of the assumed blockage. Its chances of avoiding flooding are somewhat better, and its supply from backup from the lower river may keep the water level above the suction pipe opening. These factors are summarized in Table 18.

TABLE 18. Reliability of Electric Power Supply--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Production/100 Areas	–	–	0	0
Basalt Waste Isolation	–	–	0	0
FFTF/Fusion/300 Area	+	+	+	–
WPPSS	+	+	+	–
City of Richland	0	0	0	–

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
– -Impacts less environmentally acceptable than those of proposed action.

After subjective weighting of the various potential environmental impacts from rare and disruptive events, it is concluded that Alternative Site 3 may have a slight advantage over the reference site as far as forced shutdowns are concerned, and that all other alternative sites would have less acceptable impacts than the reference site (Table 19). With respect to offsite contamination, Alternative Site 1 appears to have a slight advantage. It is very unlikely that any of the environmental impacts discussed above would ever be experienced during plant lifetimes, because of the extremely low probability of occurrence of the causative events or combinations of events.

TABLE 19. Overall Rare and Disruptive Events--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Forced Shutdown of Adjacent Facilities With Loss of Production	–	–	+	0
Offsite contamination	+	0	–	0

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
– -Impacts less environmentally acceptable than those of proposed action.

5.1.8 Site Restoration Considerations

None of the four alternative sites to the proposed nuclear power plant site offer a superior capability to facilitate site restoration. None would interfere with present or postulated future activities on the Hanford site. The sites on the north side of the Columbia River present possible disadvantages that the reference site and the alternative sites on the south side of the river do not have.

Any of the sites under consideration could successfully be decommissioned and meet NRC requirements. The alternative sites north of the Columbia River present special considerations that are slightly different from sites south of the river. First, none of the Hanford Site land north of the river has ever been used for the release to land of radioactive wastes. Opening up this land to nuclear power reactors introduces the possibility of potential contamination. DOE policy has been and will continue to be to minimize potentially contaminated land area. The alternative sites north of the river may also be more difficult to protect from a security standpoint because this area is less frequently patrolled and is consequently more vulnerable to intrusion.

Ultimately, sites north of the Columbia River may be used for nuclear facilities. Apart from being further removed from potential radwaste disposal sites, they offer no advantage over sites south of the river from the standpoint of site restoration. The two alternative sites south of the river and the reference site appear to be equally advantageous from the standpoint of site restoration. Alternative Sites 1 and 2, however, are slightly more vulnerable to intrusion because of close proximity to State Highways 240, and 24, respectively. These factors are summarized in Table 20.

TABLE 20. Site Restoration--Comparison of Reference Site to Alternative Sites

Impact on	Alternative Site 1	2	3	4
Site Intrusion	-	-	0	0
Possible Land Contamination	0	-	-	0

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
- -Impacts less environmentally acceptable than those of proposed action

5.1.9 Floodplain Management

Apart from the river water pumphouse and associated intake and discharge structures, the reference site, and Alternative Sites 2, 3, and 4, are not in a floodplain as defined in 10 CFR 1022(4)(i). Further, they have elevations above both the probable maximum flood (PMF) and Artificial Flood No. 1. If Site 1 were located about 2.5 miles (4 km) south of the Columbia River, it would have an adequate margin of safety against a PMF, and if located 2-1/2 to 3 miles (4 to 5 km), for the Artificial Flood No. 1 as well. The approximate river mileages and elevations of the reference and alternative sites are shown in Table 21. Table 22 summarizes the comparative flooding impacts.

TABLE 21. Approximate Elevations and River Mileages of Reference and Alternative Sites

	River Mile	Elevation (ft)/(m)[(a)]
Reference Site	360	540 (164 m)
Alternative Site 1	386	440 (134 m)
Alternative Site 2	385	500 (152 m)
Alternative Site 3	366	800 (244 m)
Alternative Site 4	355	440 (134 m)

(a) Elevations were estimated from the U.S. Geological Survey maps.

TABLE 22. Flood Impacts--Comparison of Reference Site to Alternative Sites

	Alternative Site			
Impact on	1	2	3	4
Possible Flood Damage from PMF	-	0	0	0
Possible Flood Damage from Artificial Flood No. 1	-	0	0	0

Key: 0 -Impacts similar in kind and severity to those of proposed action.
+ -Impacts more environmentally acceptable than those of proposed action.
- -Impacts less environmentally acceptable than those of proposed action.

5.2. NO-ACTION

No-action alternatives may take two forms: 1) siting the proposed facilities elsewhere than Hanford, or 2) not to make the land available to PSP&L.

5.2.1 Siting the Facilities Elsewhere[a]

Selection of the Hanford Site for the proposed plants as compared to other possible locations in the Pacific Northwest is based on the following events and considerations.

During the summer of 1978, six private utilities (Pacific Power and Light Company, The Washington Water Power Company, Portland General Electric Company, Puget Sound Power and Light Company, Idaho Power Company, and the Montana Power Company) organized the Regional Siting Program (RSP) to identify power plant sites within the Pacific Northwest.

RSP's first major siting effort was an early nuclear siting program in which Pacific Power and Light Company, Portland General Electric Company, Puget Sound Power and Light Company, and The Washingon Water Power Company participated.

A key objective of that program was to identify nuclear power plant sites for which the Federal and state licensing process and construction could be completed in time for commercial operation of the first unit during 1990. To meet this objective, siting criteria were specifically chosen to identify those sites having the least potential for licensing delays. A second important objective of that program was to select sites with sufficient water resources and land to accommodate four light water reactor units of 1250 MWe each.

The result of the early nuclear siting study was the identification of 13 candidate sites within the geographic region of interest, which included the states of Oregon and Washington. Table 23 lists the 13 candidate sites. Figure 6 shows their locations. These sites are located in five areas possessing diverse land and water resources. The 13 candidates sites were screened from over 65 potential sites within several environmentally diverse areas.

TABLE 23. Candidate Sites

Site	Location	Water Resource
Johnson Creek	N.E. of Vancouver, WA	Lower Columbia River
Lyons Road	N. of Vancouver, WA	Lower Columbia River
Centerville	S.W. of Goldendale, WA	Mid-Columbia River
Rock Creek	W. of Roosevelt, WA	Mid-Columbia River
Pebble Springs South	Arlington, OR	Mid-Columbia River
Hanford 22-1	N.W. of Richland, WA	Upper Columbia River
Hanford 22-2	N.W. of Richland, WA	Upper Columbia River
Hanford 23	N.W. of Richland, WA	Upper Columbia River
Eltopia	N.E. of Richland, WA	Upper Columbia River
Magallon	N.E. of Lower Monument Dam, WA	Snake River
Tucannon	N.E. of Starbuck, WA	Snake River
Cusick	N.E. of Cusick, WA	Pend Oreille River
Scotia	S.W. of Newport, WA	Pend Oreille River

(a) The material in this section is abstracted fom the following report: Summary Report, Nuclear Power Plant Siting Program, 1990 Unit, Selection of Hanford Site 22-1 as Proposed Site for 1990 Unit. Regional Siting Program, June 1980. Harris Falkin.

FIGURE 6. Regional Siting Program--Final Candidate Resource Areas and Candidate Sites

The candidate sites were compared against environmental, engineering, and geologic criteria and then ranked in terms of their relative suitability. All thirteen candidate sites appear to be licensable. Composite ratings consisting of environmental, geotechnical, and engineering economic evaluations were developed for each site. Sensitivity analyses were then performed to assess the effect of assigning various weights to each rating criteria and to observe any variations of the ranking of the sites.

Of the thirteen candidate sites, the Hanford 22-1, or the reference site[(a)] was selected as the site preferred for satisfying project requirements. Numerous reasons support the selection of the Hanford Site in general and the reference site in particular. These reasons are described below.

- Siting Study Results--When the ratings for environmental, geotechnical, and economic factors were combined into a single composite rating, the Hanford Reservation sites (Hanford 22-1, Hanford 22-2, and Hanford 23) ranked among the top grouping of six sites. While the differences in the composite rating for these six sites are slight, the Hanford 22-1 and Hanford 22-2 sites consistently placed at the top of the composite rating, even when the weightings chosen for environmental, geotechnical, and economic factors were varied. Generally, the Hanford 22-1 and Hanford 22-2 sites ranked highest and next highest over the range of weightings chosen. Only when the economic rating was weighted quite heavily did another site (Centerville) finish ahead of Hanford 22-2. In that instance, the Centerville and Hanford 22-1 sites rated evenly. For the other weightings the Hanford 22-1 site ranked highest throughout the remaining range of comparisons. When economic factors were excluded from the analysis, the combined environmental and geotechnical rating showed the Hanford 22-1 and Hanford 22-2 sites as the highest rated over the range of weightings chosen. Environmental and geotechnical considerations, more so than economic issues, presently dominate the licensing process. Hence, the composite environmental and geotechnical rating is particularly important to the goal of selecting a site that can be expeditiously licensed. From the standpoint of licensability Hanford Sites 22-1 and 22-2 appear to be preferred.
  The high composite ratings for the Hanford 22-1 and Hanford 22-2 sites result from excellent and very good ratings assigned to many different siting factors.
  Specific advantages offered by the reference site which were not highlighted in the siting study include:

  - The reference site is about 10 miles closer to the Tri-Cities labor force than is the Hanford 22-2 site. Consequently, the travel associated costs for a large construction force would be less.

(a) The reference site was moved several miles from the initially selected site following more detailed field studies of the initial site. Hanford 22-2 is approximated by Alternative Site 1. Hanford 23 is approximated by Alternative Site 3.

- A security checkpoint (the Wye Barricade) can be avoided in travel to and from the reference site. This might not be possible for Hanford 22-2 site due to its location deeper within the reservation. The differences between the reference site and Hanford 22-2 site are very slight; in fact, the sites are both excellent. The slight differences, however, do permit some distinction to be made between the two sites. Hence, the reference site was preferred.

- Licensing and Operating Experience--In the past decade, Washington Public Power Supply System Units 1, 2, and 4 have been licensed at the Hanford site. In addition, Hanford has successfully accommodated plutonium production reactors, fuel fabrication plants, and spent fuel reprocessing plants. As a result of these efforts and of scientific studies at the reservation over the past several decades, the environmental, socioeconomic, and geotechnical setting is generally well known. This extensive data base for the reservation offers a strong foundation for future licensing efforts. Moreover, considerable experience with nuclear power at Hanford has been gained, without adversely impacting the health or environment of the surrounding communities.

- An Experienced and Supportive Community--The Tri-Cities communities are well acquainted with and vocally support nuclear power. Local governmental authorities actively support the development of nuclear power at Hanford. There have been state legislative efforts to direct the siting of future nuclear plants to Hanford. The communities adjacent to Hanford contain a work force trained and experienced in the construction and operation of nuclear power plants, several nuclear construction projects are underway. The proposed projects might possibly be scheduled to utilize the labor force leaving the existing construction programs. Such timing, to the extent feasible, would help reduce potential negative impacts to the communities providing the work force for current construction.

- Federal Controls and Programs--The reference and Hanford 2 Sites are located within the central portion of the Hanford Site. Federal control of this reservation will ensure that these sites will remain remote from populated areas.

  The Federal Government may site a deep nuclear waste repository at Hanford. If a repository were built, the proximity to it of the reference site would eliminate public exposure to nuclear wastes being transported from the nuclear power plants to the repository. This proximity of repository and reactor units would also reduce transportation costs and the possibility for accidents.

In summary, DOE concurs that Hanford provides a set of circumstances uniquely favorable to the development of nuclear power. The adjacent community houses highly trained and experienced personnel who can provide the engineering management and construction skills necessary for nuclear power development. The community is well acquainted with nuclear power and, as a result, is vocally supportive of the nuclear option. Support for nuclear power plant siting at Hanford is also apparent at the state level. Perhaps more importantly an ability to license and safely accommodate nuclear facilities has been successfully and repeatedly demonstrated at the Hanford area.

5.2.2 Making the Land Unavailable to PSP&L

Based on PSP&L experience at their Skagit site in Western Washington, and Portland General Electric Company's experience at their Pebble Springs site in Eastern Oregon, it is unlikely that nuclear plants can be sited in the Pacific Northwest at any location other than Hanford in the near future with any degree of certainty. The need for additional electric power in the Pacific Northwest is clear. The Northwest Regional Forecast of Power Loads and Resources for the period July 1981 to June 1992 reviews the electrical power situation in the Pacific Northwest as follows:

> ...Although the Forecast shows a deficiency in each of the eleven years of the period, the deficiencies are substantially less than in past years. While the area considered in this year's forecast differs from the area analyzed in prior forecasts, only a small part of the change in deficiency may be attributed to the change in planning area.
>
> Differences in the magnitude of 1980 and 1981 projected deficiencies are best understood by comparing the 1980 West Group Forecast with the 1981 West Group Area summary. The reductions are due primarily to: (1) an increase in estimated savings due to conservation programs; (2) a decrease in load-growth for reasons other than conservation programs, including a one-time, nonrecurring downward adjustment made by BPA in estimated loads of its public agency, cooperative, DSI, and Federal agency customers; and (3) an increase in the rate of addition of conventional resources during the latter years of the decade. The nonrecurring adjustment made by BPA to estimated loads of DSI customers reduces their loads to less than contract entitlements.
>
> The primary value of the Forecast lies in its use in determining the Region's electric resource sufficiency; that is, whether the Region's resources as currently scheduled are needed or sufficient to carry its loads with a reasonable degree of assurance. Two measures of potential sufficiency or shortage are used since no single measure is entirely adequate. They are: (1) the load-resource comparison under adverse water conditions; and (2) the probability of insufficient resources in each year. Each must be used with an understanding of its significance, but neither completely answers the question of the need for power.

In this report, the firm energy resource is based on the assumption of adverse water conditions for hydro generation, average scheduled- and forced-outage rates for thermal generation, and the initial operation of all plants on their probable energy dates. The actual shortages will be less: if purchases from outside the Region can be increased; if the Region experiences streamflows in excess of adverse hydro; if thermal outage rates are smaller than expected; if a greater than anticipated part of the conservation potential is achieved; or if loads increase at less than the forecast rate for other reasons. On the other hand, actual shortages will be greater: if loads increase at a higher rate than forecast; if thermal generation experiences greater outage rates; or if new plants are delayed beyond the probable energy dates used.

Studies made with the Energy Reserve Planning Model, using probability distributions for hydro and thermal-unit output, show that, even where the deficiency indicated with adverse hydro is negligible, there is some substantial level of probability that the Region's resources will be insufficient to meet even firm load in at least one four-month period of a year. The probability of not meeting the firm load varies after the first year from a low of 12 percent in 1987-88 to highs of 26 to 28 percent in 1991-92 and 1984-85 respectively. The probability of not meeting the total load varies from 35 to 52 percent after the first year. Unlike the deficiency measure, which is calculated from adverse-hydro and average thermal energy, the probability measure considers all historical water years and the full range of possible thermal-unit outage conditions.

...As in recent years, the utility loads are forecast to grow at a slower rate than they have in the past. The relatively sharp reduction this year results from four factors:

- Lower forecasts of economic activity (primarily in the 81-82 period);
- Adoption of forecasting procedures which explicitly account for conservation and energy saving technologies;
- Inclusion in the forecast of proposed utility efforts such as expanded weatherization programs and conservation-inducing rate designs;
- A change in BPA System load estimate, which accounts for between 45 and 55 percent of the total reduction in each forecast year.

This last factor reflects recent operating experience and changed expectations of additional nonfirm energy and peak requirements for pollution control of the DSI load. Additionally, BPA made a one-time reduction of about 7 percent in its estimate of total BPA firm system load. This adjustment was based upon a statistical analysis comparing past forecast loads with actual loads.

...Several significant changes have been made to the forecast of energy resource capabilities, some of which tend to increase deficiencies, others of which tend to decrease them. All of the planned nuclear units, including the unlicensed Skagit #1, are experiencing further delays. However, the energy shortfall caused by the delays is less than it was last year. The energy rating of Portland General Electric's Beaver combined cycle plant is reduced by 173 MW after 1989. On the other hand, Washington Water Power has progressed in the licensing process for its proposed Creston plant to the point that it is now considered a Planned Resource, rather than a Prospective Resource, as it was last July. In addition, Washington Water Power is planning a third unit at the Creston plant. The proposed near-term construction slowdown of Washington Public Power Supply System units 4 and 5, which could have an important impact on the Region's resource capabilities, is not considered in this report.

Imports and exports have been increased in this Forecast. This is a result of expanding the definition of the data included in these categories. Each of these categories is a total of (1) contracts and (2) intracompany transfers. Existing firm sales agreements among utilities inside the Region with others outside the Region are included as contracts. Intracompany transfers apply to those utilities whose service territories cross the Region boundary. Their estimates of load within the Region that will be served by their own resources are accounted for by intracompany transfers.

The 1981 Forecast is encouraging from the standpoint that the gap between loads and resources has been reduced, compared with forecasts of previous years. On the other hand, we must not lose sight of the fact that all of the data in the Forecast are predicated on planned thermal resources operating on the schedules indicated and conservation programs having a predictable effect on load forecasts. Consequently, it is as important now as it was a year ago that we continue to emphasize the need for effective conservation programs and maintaining schedules of planned firm-power resources.

The likely alternative for PSP&L if the no-action alternative is invoked is to build coal-fired generating plants using coal from Montana, Wyoming, or Alaska. Presumably, sites are available for coal-fired plants in the PNW elsewhere than the Hanford Site. The time required for building a coal-fired thermal plant in the Pacific Northwest is shown in Appendix B, and is shorter than for nuclear plants. However, the cost of power from new coal-fired plants may be greater than for new nuclear plants (EPRI 1981; AIF 1981).

6.0 PLANS AND PROGRAMS OF OTHER FEDERAL, STATE, REGIONAL, AND LOCAL ENTITIES

6.1. EXISTING PROGRAMS

6.1.1 Federal Programs

Interest and controversy over the use of the Hanford Reach for power generation, navigation, preservation, and recreation have existed for years. In 1959 the U.S. Army Corps of Engineers was authorized by a Senate Public Works Committee Resolution to investigate the potential of water resource management plans for the Hanford Reach. This investigation was suspended in 1969. The 1979 Congressional Appropriations Act directed the resumption of this investigation since no water resource management plan existed for the Hanford Reach.

The Act included $100,000 for the reconnaissance phase of the study. A public workshop was held in Richland, Washington, on January 29, 1980, in which four issues, those relating to hydropower, navigation (dredging), preservation/recreation, and continuation of past/present uses, were discussed.

DOE-RL had previously studied the effect of a Ben Franklin Dam on the Hanford Site (Harty 1979). With respect to siting commercial nuclear plants in this general area of the Hanford Reach, it was concluded that modest additional costs would accrue to the nuclear plants as a result of the Dam, but the Dam would not preclude them. The effect of navigation on nuclear plant siting was not studied, but it is unlikely that there would be any significant effect.

The Hanford Reach of the Columbia River is eligible for inclusion in the National Wild, Scenic and Recreational Rivers System Act and has been designated jointly by the Secretaries of Agriculture and Interior as having potential for this classification (Lundy 1980), though in earlier action (1977) it was deleted as a potential addition to the Wild and Scenic Rivers System. The final decision to classify the Hanford Reach under the Wild and Scenic Act is up to Congress. This could be a restriction on the use of the Hanford Reach of the Columbia for siting nuclear power plants. The law does permit some discretion in the allowable uses of designated rivers and has included water withdrawals for irrigation and the removal of sand and gravel in certain streams (Fuquay 1980). If the Hanford Reach is included under the Act, specific authorization will be required from Congress to allow the construction of water intake and discharge systems in the river.

6.1.2 State Programs

Alternative Site 2 is located in a portion of the Hanford Site managed, under permit, by the U.S. Fish and Wildlife Service as the Saddle Mountain National Wildlife Refuge. The permit to manage the area in this manner may be canceled, in whole or in part, if the area is needed by the DOE. Similarly, Alternative Site 3 is in an area administered under a revocable permit to the Washington State Department of Game.

Wildlife managers from the Fish and Wildlife Service and the Department of Game have expressed concern that development at Alternative Sites 2 and 3 would have substantial impacts on their programs to manage the permit lands. Major problems identified include:

- Disturbance of resting areas and ponds used by thousands of wintering and migratory waterfowl,

- Difficulty in protecting remaining portions of the permit areas from illegal trespass,

- Closure of part or all of the state-administered lands to public hunting.

It is uncertain whether either permit area would remain a viable management unit, as administered by these agencies, if construction were to occur at Alternative Sites 2 or 3.

Representatives of both agencies indicated that if the proposed development were to occur at the reference site or Alternative Sites 1 or 4 they would expect no significant impacts on their present or future management of the permit lands.

6.1.3 Regional Programs

The Washington Public Power Supply System (WPPSS) is currently constructing a three-reactor nuclear power station on the Hanford Site about six miles (10 km) east of the reference site. The three reactors are designated WNP 1, 2, and 4. WNP 2 is scheduled for commercial operation in February 1984 and WNP 1 in June 1986 (Pacific Northwest Utilities Conference Committee 1981). Construction on WNP 4 is being delayed pending review of Pacific Northwest Power requirements.

6.2 DETERMINATION OF ENVIRONMENTAL SIGNIFICANCE OF PROPOSED ACTION AND ADEQUACY OF ENVIRONMENTAL PROTECTION PROVIDED FOR IN SUBSEQUENT LICENSING ACTIONS

6.2.1 State Agencies

The Washington State Energy Facility Site Evaluation Council will provide the environmental review for the proposed power plants in their review of an application for State Site Certification. The council consists of the directors, administrators or their designees of departments (9), agencies (1), commissions (1), and committees (1), plus a member of the local county or port district.

The Council will utilize their guidelines in reviewing the environmental impact. Upon receiving an application for an energy facility site certification, the Council commissions an independent study to measure the consequences of the proposed energy facility on the environment. The applicant prepares an environmental report for Council review. The Council reports its recommendations to the Governor as to the approval or disapproval of the application. It is the intent of the legislation establishing the Council that appropriate consideration be given to protecting and preserving the quality of the environment. This Council can be expected to be as restrictive as the Federal Government in the quality of water discharged and the quantity of water withdrawn. The composite effects of releases and effluents, including the impact on aquatic life of intakes and intake structures and the temperature of effluent releases, can be expected to be specifically reviewed.

6.2.2 Nuclear Regulatory Commission (NRC)

The Directorate of Licensing will issue an environmental statement summarizing the environmental impact and effects of any proposed plant. The environmental impact review will include the site and environmental interface, the station environmental effects of site preparation and plant construction, environmental effects of station operation, and environmental effects of accidents. Included in the site review will be the geology of the area. The Federal codes relative to siting are currently being revised (10 CFR 51). Alternative site reviews will be reinforced with population densities and distance to population centers possible being required considerations. The probability and the consequences of Class 9 accidents, which were formerly excluded from environmental reviews, may be required (10 CFR 50, 51).

However, neither this nor other contemplated changes by NRC are likely to be burdensome to the environmental analysis of the proposed facilities, largely because of the generally acceptable siting features of the area.

6.2.3 Other

No known proposed actions or changes from the Environmental Protection Agency (EPA) are expected to further impact the environmental requirements for these facilities except for sections of 10 CFR 51 as noted above.

7.0 CONCLUSIONS

A qualitative comparison is made in Table 24 of the impacts which might be expected to result should the proposed action (sale of land and granting of easements for a commercial nuclear power station) be taken at alternative sites on the Hanford Site. The following conclusions can be made:

1. Dedication of the reference site for up to four large commercial nuclear power plants does not appear to interfere with present DOE activities nor those of other tenants on the Hanford Site, or preclude postulated future DOE programs.

2. While all possible locations on the Hanford Site were not examined, the reference site, on balance, is equally or more satisfactory than the alternative sites considered, based on data available on the sites. Studies of site geology, seismology, etc., required for licensing or prelicensing activities for the station will provide more detailed information about the reference site and some of the alternative sites, and could alter this conclusion.

3. Use of the reference site for up to four commercial nuclear power plants does not appear to preclude present plans or programs of other Federal agencies or regional, state, or local groups.

4. No alternative uses for the reference site were identified which could not be carried out at least as well in other potentially available areas of the Hanford Site.

TABLE 24. Comparison of Impacts Among Alternative Hanford Sites

Impact Type or Consideration	Proposed Action or Likely Effects	Alternative Sites 1	2	3	4	No-Action Alternative
Land Use	Location and attributes of 2000 acres of land on the Hanford Site	-	-	-	0	+
Water Use	Thermal effects, groundwater interactions, water availability, irrigation depletions, and pumping requirements	0	0	0	0	+
Aquatic Ecology	Entrapment and entrainment losses of aquatic species	-	-	-	+	+
Terrestrial Ecology						
Species of Special Concern	Possible loss of eagle perch area, nest sites for species of State concern	+	+	+	+	+
Wildlife Populations	Loss of populations	0	-	-	0	+
Areas of Special Scientific Value	Encroachment or loss	0	0	0	-	+
Radiation Exposure	Increased radiation dose to personnel on DOE programs, other Hanford site tenants, or the public	0	0	0	0	+
Meteorology	Site specific analyses required to define actual effects. Reduction of air quality from vehicular exhaust; potential contamination of DOE and WPPSS facilities from major accidents releasing radioactivity, and local weather modifications	+	+	+	+	+
Socioeconomic Factors						
Regional Power Availability	Shortage of power	0	0	0	0	-
Traffic Congestion	Degree of congestion	-	-	-	+	+
Housing, Schools, Water Services, Sewer Services	Availability of facilities without significant new construction	-	-	-	0	+
Rare and Unusual Events	Potential for release of toxic gases or radioactive materials impinging on other facilities onsite (e.g., DOE, WPPSS) or on the public offsite	-	-	0	-	+
Site Restoration						
Site Intrusion		-	-	0	0	+
Possible Land contamination	Ability to remove facilities from site, including radioactive components, to restore site to original condition	0	-	-	0	+
Comparative Flood Impacts						
Station Site Located Above Probable Maximum Flood (PMF)	Increased construction cost for plant construction	-	0	0	0	+
Station Site Located Above Artificial Flood No. 1	Increased construction cost for plant	-	+	+	+	+

Key: 0 - impacts similar in kind and severity to those of proposed action.
+ - impacts more environmentally acceptable than those incurred by the reference site.
- - impacts less environmentally acceptable than those incurred by the reference site.

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APPENDIX A

LISTING OF AGENCIES AND PERSONS CONTACTED

APPENDIX A

LISTING OF AGENCIES AND PERSONS CONTACTED

1. James Chasse, Senior Environmental Engineer, Washington Public Power Supply System, Richland, Washington.

2. Ron Chitwood, Licensing, Washington Public Power Supply System, Richland, Washington.

3. Keener Earle (for Gerald Sorenson), Licensing, Washington Public Power Supply System, Richland, Washington.

4. William Fitch, Washington State Energy Facility Site Evaluation Council, Olympia, Washington.

5. David Goeke, Manager, Columbia National Wildlife Refuge, U.S. Fish and Wildlife Service, Othello, Washington.

6. Howard Hill, Manager, McNary National Wildlife Refuge, U.S. Fish and Wildlife Service, Burbank, Washington.

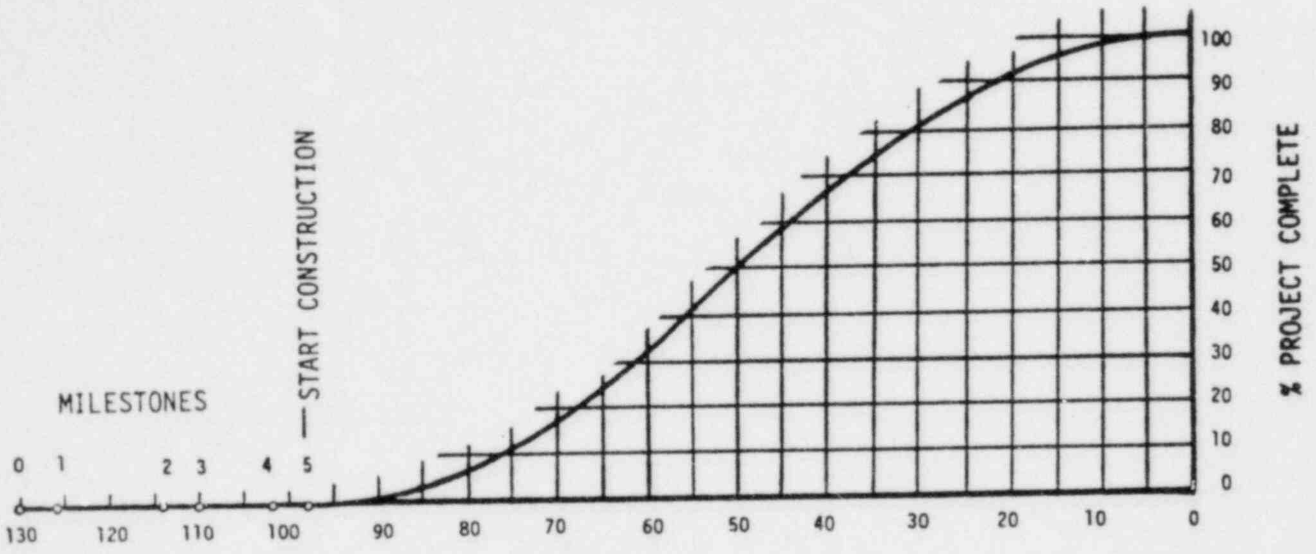
7. Lee Stream, Wildlife Biologist, Washington Department of Game, Yakima, Washington.

APPENDIX B

MILESTONES FOR PLANT CONSTRUCTION IN THE PACIFIC NORTHWEST

APPENDIX B

MILESTONES FOR NUCLEAR THERMAL PLANT CONSTRUCTION IN THE PACIFIC NORTHWEST

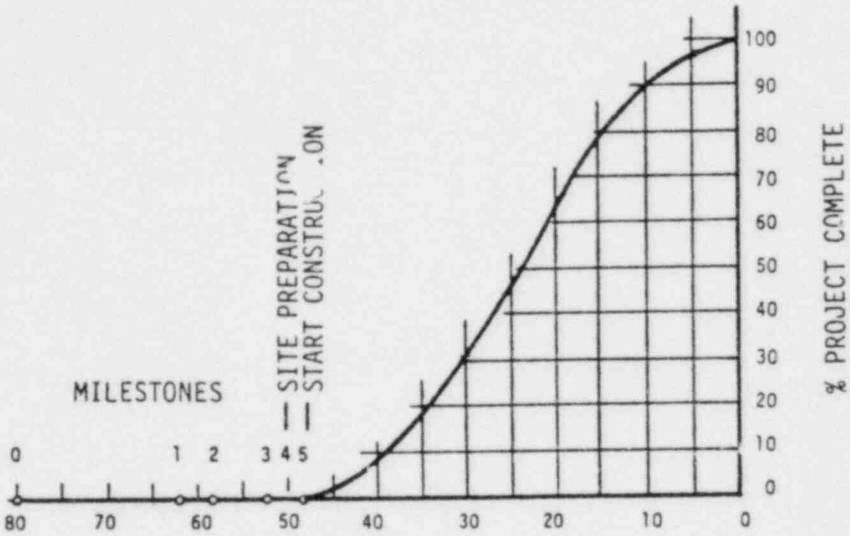


PRECONSTRUCTION MILESTONES

MILESTONE 0	130 months	(Oregon only) Notice of Intent filed with state
MILESTONE 1	126 months	Regional selection of unit (Oregon only) Application for Site Certificate filed
MILESTONE 2	114 months	Following Actions completed: (a) NSSS contract awarded (b) AE selected (c) (Except Oregon) Site selected
MILESTONE 3	110 months	Project becomes firm resource after following actions completed: (a) Environmental Report filed (b) Preliminary Safety Analysis Report filed (c) (Except Oregon) State site application filed
MILESTONE 4	102 months	Site certified by state
MILESTONE 5	98 months	Construction Permit or Limited Work Authorization issued by NRC

SOURCE: West Group Forecast of Power Loads and Resources, July 1980 - June 1981, Pacific Northwest Utilities Conference Committee, March 1980.

MILESTONES FOR COAL-FIRED THERMAL PLANT CONSTRUCTION IN THE PACIFIC NORTHWEST



MONTHS TO PROBABLE ENERGY DATE

PRECONSTRUCTION MILESTONES

MILESTONE 0	80 months	(Oregon only) Notice of Intent filed with state
	76 months	(Oregon only) Application for Site Certificate filed
MILESTONE 1	62 months	Final site selection
MILESTONE 2	58 months	Boiler and Turbine Generator ordered
MILESTONE 3	52 months	Environmental and Siting Permits, Licenses, etc., issued
MILESTONE 4	50 months	Start site preparation
MILESTONE 5	48 months	Start construction

SOURCE: West Group Forecast of Power Loads and Resources, July 1980 - June 1981, Pacific Northwest Utilities Conference Committee, March 1980.

APPENDIX J

ENVIRONMENTAL ANALYSIS REPORT

OF THE

SKAGIT/HANFORD NUCLEAR PROJECT

TRANSMISSION INTEGRATION

PREPARED BY

BONNEVILLE POWER ADMINISTRATION
U.S. DEPARTMENT OF ENERGY
PORTLAND, OREGON

APPENDIX J

ENVIRONMENTAL ANALYSIS REPORT

SKAGIT/HANFORD NUCLEAR PROJECT
TRANSMISSION INTEGRATION

INTRODUCTION

This report documents the results of the Bonneville Power Administration's (BPA's) review of the site application studies completed by Puget Sound Power and Light for the integration of 2550 MW of power produced by the Skagit/Hanford Nuclear Project. It also includes BPA's own analysis, in response to the request from the Nuclear Regulatory Commission (NRC), the Federal lead agency, for commentary from Bonneville, a cooperating agency.

Bonneville will use the Final Skagit/Hanford EIS in making decisions on interconnection and transmission services. These include:

1) Decisions related to which points of interconnection are technically and environmentally viable;

2) Decisions to wheel the output from the plant over the Federal system; and

3) Decisions on Federal construction, operation, and maintenance of the interconnecting facilities.

PURPOSE AND NEED FOR ACTION

When Puget Sound Power and Light (PSP&L) originally planned to construct two 1275 MW nuclear generator units at Skagit, Bonneville prepared a Draft Facility Planning and Location Supplement in the Facility Evaluation Appendix as part of its FY 1975 Program EIS, which covered the transmission required to integrate that proposed project. Since then, PSP&L has changed planned location of the generator units to the Hanford Reservation. The present document addresses impacts of building transmission lines to integrate output of those units.

To integrate power from the first unit (1991), the existing Ashe-Hanford 500-kV line No. 1 must be looped into a new 500-kV substation at the plant site (see Figure J.1).

A second Ashe-Hanford, 500-kV single-circuit line will be required with either the first or second unit at the new site. The timing depends on whether the WPPSS No. 4 unit which is presently planned to be terminated is, in fact, completed. The second Ashe-Hanford line is needed to provide a reliable transmission system for integrating generation in the Hanford area when the total number of units at Ashe, plus the new site, reaches four units. If the WPPSS No. 4 unit is completed at Ashe, then the second Ashe-Hanford 500-kV line will be required when the first Skagit/Hanford unit is built. If the WPPSS

No. 4 line is not completed, the second Ashe-Hanford 500-kV line will be required with the second unit at the new site. Terminal work will be required at Ashe and Hanford Substations with the addition of the second Ashe-Hanford 500-kV line. These installations can most likely be built within the confines of the existing substation sites.

When the second unit is completed (1993), the second Ashe-Hanford 500-kV line must be looped into the new substation to integrate the additional power.

BPA and PSP&L have worked together to determine this plan for integrating the new units; both parties agree on the overall plan of service. BPA proposes to construct all the 500-kV lines and the new 500-kV substation. However, the ownership of facilities has not yet been resolved with PSP&L.

ALTERNATIVES INCLUDING THE PROPOSED ACTION

Proposed Action

Transmission

Four 500-kV single-circuit transmission lines would be constructed from the plant substation approximately 3.2 miles northeasterly on a 740-foot-wide corridor to link up with 500-kV lines on BPA's Ashe-Hanford right-of-way (ROW). Two of the four lines would be constructed by 1991, to integrate power from Unit 1 by looping in the existing Ashe-Hanford 500-kV line No. 1. The two remaining lines, to be constructed in the corridor between the first lines, would serve Unit 2, looping a new Ashe-Hanford 500-kV line through the Plant Substation. Figure J.1 shows the proposed transmission system after construction. Figure J.2 shows the line spacing on the link up corridor. The 420-foot space between the inner single-lines is left for future line development. Figure J.3 shows line spacing for the second Ashe-S/HNP-Hanford line where it parallels the No. 1 line.

Steel lattice, single-circuit, delta-configured, 500-kV towers would be used for the first lines (see Figure J.4). The towers would average 125 feet in height and 52 feet in width. The average spacing between towers would be 1150 feet. Three-conductor bundles would be used for each phase of the line, with the average conductor ground clearance being 51 feet. Land requirements for each tower would average 680 square feet. An access road would be required on the new corridor between the plant substation and the Ashe-Hanford corridor. Existing access along the Ashe-Hanford corridor would be used to reduce new access road requirements for the future Ashe-Hanford 500-kV line (No. 2).

Plant Substation

The Plant Substation would be built to allow the looping of the 500-kV Ashe-to-Hanford No. 1 and 2 lines into and out of the station. It would include approximately four substation equipment bays consisting of dead-end towers, high voltge busworks, power circuit breakers, disconnect switches, and so on.

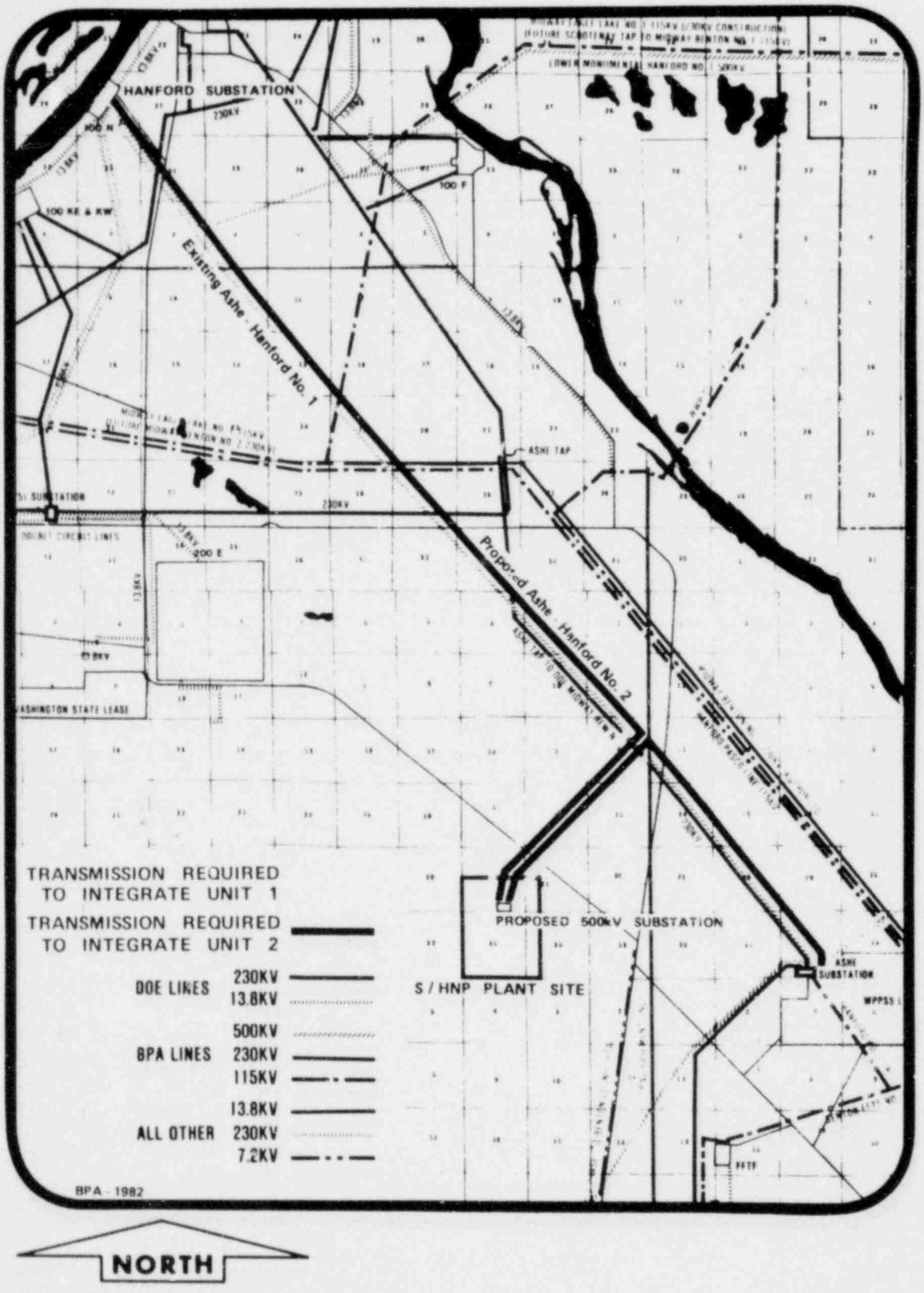


Figure J.1 Skagit/Hanford Nuclear Project Integration

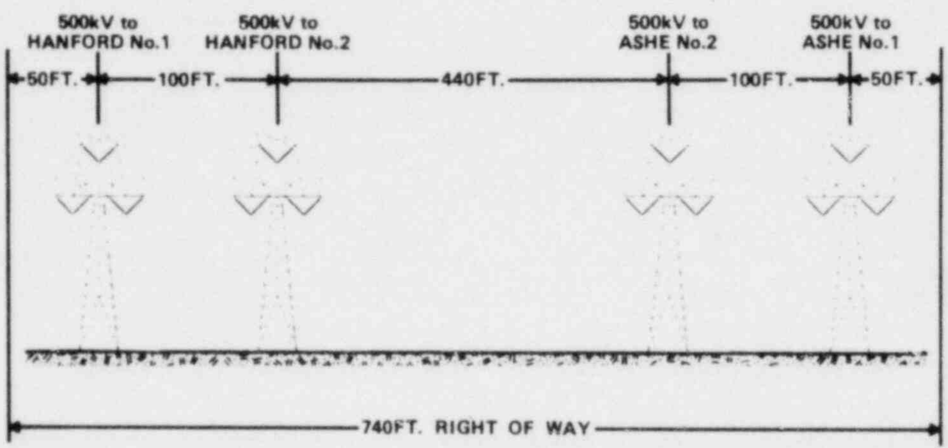
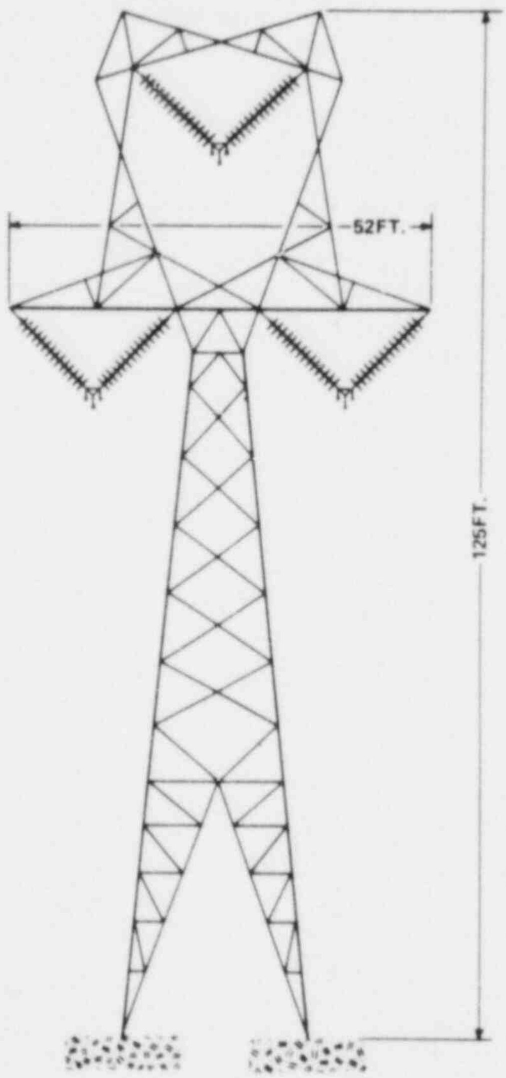
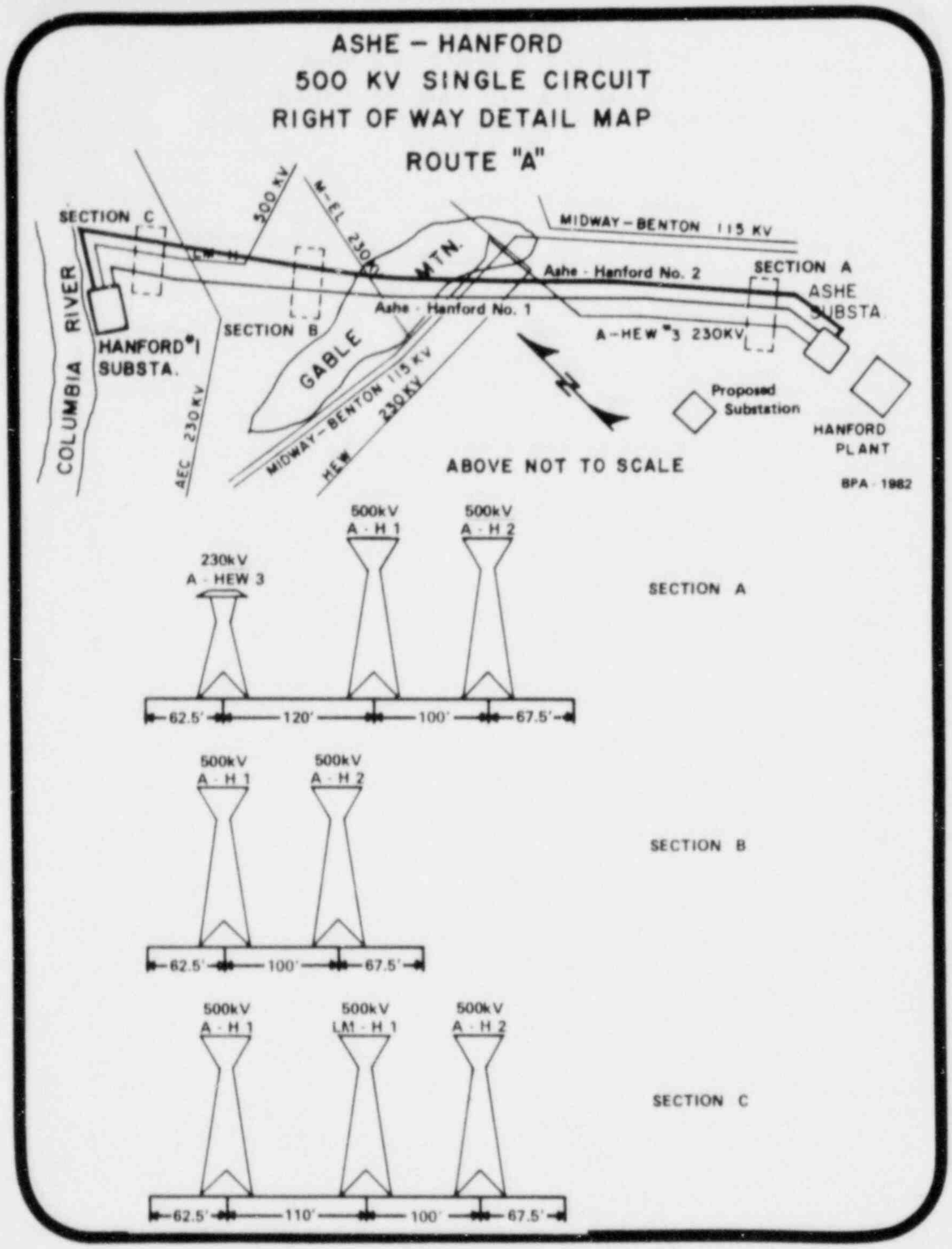


Figure J.2 Typical cross-section project right-of-way 500-kV lines



SPAN LENGTH	TOWER BASE REQUIREMENTS		GROUND CLEARANCE
AVERAGE	SUSPENSION	DEAD END	MINIMUM
1150FT.	26FT.^{2}	44FT.^{2}	35FT.

Figure J.3 Environmental analysis report: single-circuit 500-kV delta configuration



R/W	RIGHT OF WAY
A-H	ASHE-HANFORD
A-HEW#3	ASHE TAP TO HEW#3
LM-H	LOWER MONUMENTAL-HANFORD
M-EL	MIDWAY-EAGLE LAKE
HEW	HANFORD ENERGY WORKS

Figure J.4 Existing Ashe-Hanford corridor

It would also contain two 500/69-kV transformers to provide the two off-site sources of power for each generating unit. The Substation would be located about 1,500 feet north of the units, and would occupy an area approximately 1,100 feet by 750 feet (19 acres). Access to the substation would be from a plant access road.

Alternative Actions

No Action

Without the proposed transmission facilities, the Skagit/Hanford units could not operate and the region would not benefit from the 2550 MW of potential generation.

Transmission

There are no reasonable transmission planning alternatives for integrating power from the two generating units and providing the power to the participating utilities. The use of the existing BPA transmission system will avoid the duplication of facilities that would occur if the participating utilities were to build their own transmission. The greater impacts would result from having to build new transmission to distant load areas such as Seattle. Independent transmission integration would also be much more costly and would have a much greater environmental impact than the proposed plan.

Location Alternatives

An alternative location for the Ashe-Hanford No. 2 line was analyzed in the Bonneville Final Program EIS for the Fiscal Year 1975 proposed program as an alternative location for the present Ashe-Hanford No. 1 line. The No. 1 line location was determined then to be the better location. The same considerations would still apply to the No. 2 line. To build on a new ROW would eliminate the environmental advantages of parallel construction.

An alternative location for the linking lines was identified by the Puget Sound Power and Light Co. It consists of two ROW's originating at the plant substation (see Figure J.5). One ROW would proceed to the east for a distance of 3.7 miles to a point approximately 1 mile from the Ashe Substation on the Ashe-Hanford No. 1 corridor. One circuit on this ROW would interconnect with the Ashe-Hanford No. 1 line, the other would parallel the No. 1 line for approximately 1 mile to the BPA Ashe Substation. The other ROW proceeds to the north for 4.6 miles (Figure J.5) to the Ashe-Hanford No. 1 line corridor. One circuit would interconnect with the No. 1 line while the second circuit would parallel the No. 1 line for approximately 11 miles to the BPA Hanford Substation. Approximately 7 miles of the Ashe-Hanford No. 1 line would have to be removed with this alternative (see Figure J.5 for location of replaced lines).

The basic considerations for locating the alternative route for the 500-kV lines were:

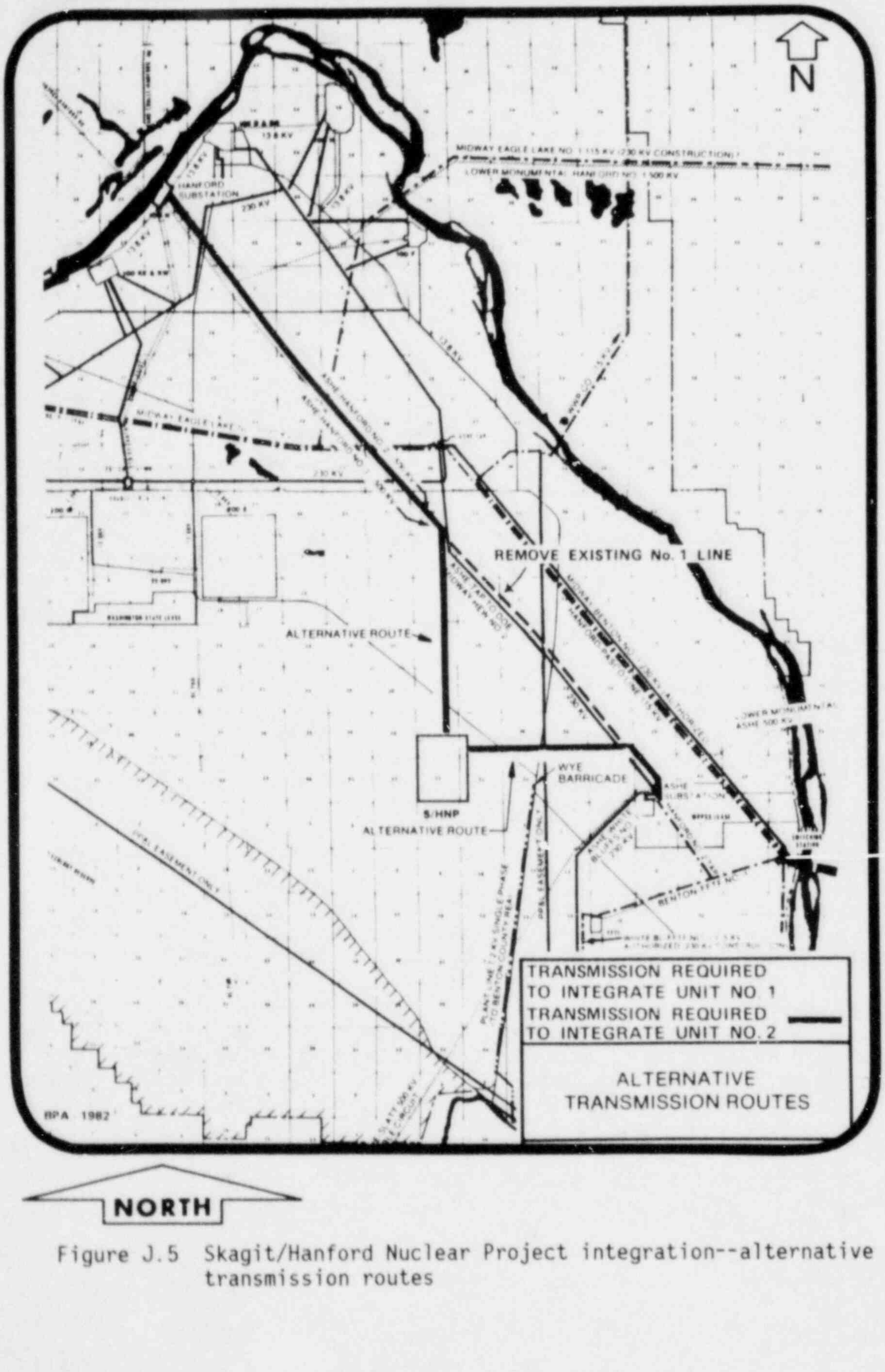


Figure J.5 Skagit/Hanford Nuclear Project integration--alternative transmission routes

a. Transmission Line Costs

b. Land use Considerations

c. Environmental and Cultural Resource Impacts

This alternative requires approximately 35 acres less ROW than the proposed route and 0.4 acre less for the tower site than the proposed route would require. However, the alternative route requires 8.3 miles of new ROW, whereas the proposed route involves only 3.2 miles of new ROW. Because the alternative will require at least 5.1 miles more new access road construction, the physical and material resource impact of the alternative route will be much greater than the proposed route. The alternative also establishes two new corridor segments, whereas the proposed route established only one. The single route will therefore reduce soil and land use and visual impacts. Based on these greater environmental impacts and higher construction costs, the alternative route is not considered to be as desirable as the proposed route.

There are no reasonable substation site alternatives. To build on any location away from the plant site would affect a previously undisturbed area of unstable soils, an undesirable option.

AFFECTED ENVIRONMENT

The environment potentially affected by Skagit/Hanford integrating transmission is described in detail in Chapter 2, Volume 1 of the Skagit/Hanford Nuclear Project Application for Site Certification/Environmental Requirements (December 21, 1981). It is also discussed in the Bonneville Power Administration Environmental Statement on its Fiscal Year 1975 proposed program facility evaluation appendix pages SA 3-2 to SA 3-8.

ENVIRONMENTAL CONSEQUENCES

The following section describes the impacts and mitigation measures which would be experienced in construction of the proposed and alternate transmission line locations identified for integrating Units 1 and 2 (see Figure J.1). The impacts of constructing the substation site are also discussed. This discussion is followed by a transmission summary and summary of Federal consultation, review, and permit requirements for the transmission system.

Scenic

Except for Gable Mountain, proposed and alternate routes do not cross any scenic resources. Towers may be visible to the public from outside the reservation. However, existing visual effects from the existing No. 1 line will not be much increased by the new line. The scenic quality of Gable Mountain will be further impacted by the Ashe-Hanford No. 2 line.

Wildlife and Vegetation

Approximately 373 acres of ROW could be affected by construction activities on the proposed route, and 338 acres for the alternate. When comparing the impacts of the proposed and alternative routes, the previous impact of the alternative route would result from the construction of 5.1 miles more new access road. Access road and tower site construction would cause long-term removal of vegetation cover and produce a greater impact on wildlife.

Adverse effects upon resident wildlife, including the sage grouse, will be largely limited to the construction period. The proposed and alternate routes do not cross any streams.

Clearing of sagebrush from access roads and tower sites will temporarily disturb song birds, birds of prey, and upland birds within the vicinity. Some habitat will also be lost.

Crossing at Gable Mountain may also disturb plant communities that occur on thin, stony soils.

Threatened and Endangered Species

No Federally threatened or endangered plant species occur in the project area. Two Federally-listed animal species, the peregrine falcon (listed as endangered) and bald eagle (listed as threatened), are known to occur near the project area (Fickeisen et al., 1980). Peregrine falcons appear infrequently as migrating individuals. Bald eagles winter along the Hanford Reach of the Columbia River and may use the adjacent sagebrush/cheatgrass habitat for hunting. No nesting of either species occurs in the area.

Construction of the transmission line facility should not affect the bald eagle or peregrine falcon as it does not cross areas considered prime habitat for these species.

PHYSICAL SENSITIVITY

Erosion

The potential for wind erosion of sandy loam soil in this dry climate is extremely high. If vegetative cover were removed or soil were disturbed, as during construction and clearing of access roads, tower sites, and the 19-acre substation, strong spring-time winds would move the soil so much that new vegetation would not be reestablished for many years. Blowouts, dunes, and other wind produced features are found widely scattered across the area.

The parallel route along the Ashe-Hanford No. 1 corridor will cross 2 miles of sand dunes. Some sand dunes are not stable due to lack of vegetation cover, and construction will impact on these as well as on stabilized dunes with a high potential for additional erosion. Sand dunes are up to 30 feet high and can move eastward at a rate of about 1 foot per year.

Water Quality

The proposed routes or substation sites do not cross any streams or come near the Columbia River; therefore, no siltation of the Columbia is expected.

Cultural Resources

Land Use

Since the land affected by the proposed routes and substation site is mostly open space, impacts will be minimal. If the DOE were to open the reservation for public use, existing cover and potential land use could be disrupted to the extent quantified for easement, access road and substation site requirements (Table J.1). All locations are within DOE's Hanford Reservation, where the public use is restricted by the DOE for safety and security reasons. The proposed route would cross the Explosive Testing Area; however, there would be little interference with actual testing. BPA and the Department of Energy previously reached an agreement which calls for relocation of certain test facilities in the area for the original Ashe-Hanford No. 1 line.

Historic and Archeologic

Neither route on the substation site affects any identified historical or archeological sites.

The Washington Archeological Resource Center conducted a survey in March 1974 and concluded that no archeological, historical or paleontological sites will be endangered along the Ashe-Hanford No. 1 line. However, an archeological survey of the final centerline and substation sites will be completed prior to construction of the No. 2 line. Any sites discovered will be excavated or avoided prior to construction. The likelihood of any sites being discovered is low.

Health and Safety

The proposed line and substation will be built in accordance with the National Electric Safety Code. The lack of intensive land use on or near the proposed locations will avoid any potential impacts.

Radiated electrical interference should be insignificant beyond 1,000 feet from the ROW, and no receptors are anticipated within this range due to the land classification.

The 500-kV lines will be designed to minimize acoustic noise. Acoustic and electrical noise can result in environmental annoyance, and can cause operational line losses. The associated noise characteristics should be within the standards set by the Environmental Protection Agency. Radio interference, television interference, and audible noise may result from a 500-kV line. The severity usually is greater in foul weather and can be effectively mitigated.

Construction and operation of the line on this route will create no noise impacts upon the general public.

The proposed corridor might have some effects of noise interference on telephone lines. The magnitude of effects will not be known until after the transmission line has been energized. Any adverse effects on telephone lines will be corrected.

Mitigation

Standard Bonneville mitigation measures will be incorporated into BPA design and construction specifications. These measures are described in the Bonneville Power Administration's Transmission Engineering Standard Construction Specifications (1978) and Appendix B, Power Transmission, to the Draft EIS on the role of BPA in the Pacific Northwest Power Supply System (July 22, 1977). The following measures have been identified to meet the unique impacts of this project and will supplement BPA's Standard Construction Specifications.

Access Roads

1. As few access roads as possible will be built. Where parallel construction occurs on the existing Ashe-Hanford No. 1 line, access will be use with spur roads to new tower sites kept to the minimum possible.

2. Access roads and tower sites in unstable areas will be rocked to minimize erosion.

3. Spur roads will not be graded unless absolutely necessary.

4. Temporary access roads and tower sites will be replanted with appropriate grass species to prevent wind erosion. In addition, BPA is investigating the use of chemical oxide sprays for treating disturbed sand area to hold dust and prevent wind erosion.

5. The substation site will be sited, graded, and reseeded to avoid excessive wind erosion. A landscape plan will be designed to take into account the prevention of wind erosion.

6. The substation site design will be coordinated with the design concept used for the plant.

Unavoidable Adverse Impacts

Construction will have few unavoidable adverse impacts. Principal unavoidable impacts include soil erosion by wind, loss of vegetative cover, or habitat.

Relationship Between Short-Term Use of the Environment and Long-Term Productivity

Based on present technology, this line and associated facilities will have an expected life of 50 years. Experience in past years has shown that, in most cases, transmission corridors are upgraded to higher capacity in response to technological advancements and energy demands. This, along with BPA's policy of constructing new facilities on or parallel to existing corridors, may result in a long-term use of this corridor. However, if required, complete removal of these transmission facilities, including tower footings, would be possible in order to make the land available for other uses.

Irreversible and Irretrievable Commitments of Resources

That part of the steel, aluminum, and other materials used for towers, conductors, and other hardware which could not be recycled will be irretrievably committed. Manpower and fuel for construction and maintenance equipment are resources which will be irretrievably spent. Although it would be possible to remove the entire facilities, including tower footings, at a future time, it is likely that the land used for transmission corridors will be irreversibly committed. The land taken for tower footing will be unavailable for any other land use.

Transmission Summary

Table J.1 summarizes the principal right-of-way (ROW), tower site and other design requirements which will have a major influence on the future design of the Skagit-Hanford Integrating Transmission. It also provides information useful in quantifying impacts.

Table J.1

Transmission Summary*

	Proposed Routes	Alternate Route	Substation Site
ROW Length (Miles)	28.1	20.5	NA
ROW Width (Feet)	2 @ 195	195	NA
New ROW Acreage	2 @ 88 or 176	213	NA
ROW Eliminated (Miles)	NA	7	NA
Parallel ROW Acreage	197	125	NA
Number New Tower Sites	130-155	130-140	NA
Number Tower Sites Removed	NA	30-35	NA
Total Tower Site Acreage**	2	1.6	NA
Crossings			
Roads			
4-Lane Highway	2	2	NA
2-Lane Highway	4	4	NA
Main Dirt and Gravel	9	9	NA
Transmission			
Low Voltage	2	2	NA
115-kV	2	2	NA
230-kV	5	4	NA
Railroads	3	3	NA
Telephone	6	6	NA
Substation Site Acreage	NA	NA	19

*All comparisons based on ultimate corridor requirements for integrating units 1 and 2.

**Considers the elimination of 7 miles of existing 500-kV single-circuit Ashe-Hanford No. 1 ROW.

APPENDIX K

FLORISTIC LIST OF PLANT TAXA FOUND WITHIN THE SAGEBRUSH-BITTERBRUSH/CHEATGRASS COMMUNITY AND THE RIPARIAN COMMUNITY OF THE HANFORD RESERVATION

Table K.1 Floristic list of plant taxa found within the sagebrush-bitterbrush/cheatgrass community of the Hanford Reservation

Scientific Name	Common Name
Grasses:	
Bromus tectorum L.*	cheatgrass
Festuca octoflora Walt.	slender fescue
Oryzopsis hymenoides (R&S) Ricker	Indian ricegrass
Poa sandbergii Vasey	Sandberg's bluegrass
Sitanoin hystrix (nutt.) Smith	bottlebrush squirreltail
Stipa comata Trin. & Rupr.	needle-and-thread
Forbs:	
Achillea millefolium L.	common yarrow
Ambrosia acanthicarpa Hook.	annual bursage
Amsinckia lycopsoides Lehm.	tarweed fiddleneck
Astragalus sclerocarpus Gray.	stalked-pod milkvetch
Balsamorhiza careyana Gray	Cary's balsamroot
Brodiaea douglasii Wats.	Douglas' brodiaea
Cryptantha circumscissa (H. & A.) Johnst.	matted cryptantha
Cryptantha pterocarya (Torr.) Greene	winged cryptantha
Comandra umbellata (L.) Nutt.	bastard toad-flax
Cymopterus terebinthinus (Hook.) T. & G.	turpentine cymopterus
Descurainia pinnata (Walt.) Britt.	western tansymustard
Draba verna L.*	spring whitlow-grass
Eriogonum niveum Dougl.	snow buckwheat
Erysimum asperum (Nutt.) DC.	rough wallflower
Gilia minutiflora Benth.	small-flowered gilia
Holosteum umbellatum L.*	jagged chickweed
Lactuca serriola L.*	prickly lettuce
Machaeranthera canescens (Pursh.) Gray	hoary aster
Melilotus officinalis (L.) Lam.	common yellow sweet clover
Oenothera pallida Lindl.	pale evening-primrose
Opuntia polycantha Haw.	starvation cactus
Phacelia linearis (Pursh.) Holz	threadleaf phacelia
Phlox longifolia Nutt.	long-leaf phlox
Salsola ibericus L.*	Russian thistle
Sisymbrium altissimum L.*	Jim Hill mustard
Sphaeralcea munroana (Dougl.) Spach	Munro's globemallow
Tragopogon dubius Scop.*	yellow salsify

*Introduced

Table K.1 (continued)

Scientific Name	Common Name
Shrubs:	
Artemisia tridentata Nutt.	big sagebrush
Atriplex spinosa (Hook.) Collotzi	spiny hopsage
Chrysothamnus nauseosus (Pall.) Britt.	common rabbit-brush
Chrysothamnus viscidiflorus (Hook.) Nutt.	green rabbit-brush
Purshia tridentata (Pursh) DC.	bitterbrush
Trees:	
Eleagnus angustifolia L.*	Russian olive
Morus alba L.*	white mulberry
Robinia pseudo-acacia*	black locust

*Introduced
Source: S/HNP ASC/ER, Amendment 4

Table K.2 Floristic list of plant taxa within the riparian community of the Hanford Reservation

Scientific Name	Common Name
Grasses:	
Panicum capillare L.	common witchgrass
Phalaris arundinacea L.*	reed canary grass
Polypogon monspeliensis (L.) Desf.*	rabbitfoot polypogon
Forbs:	
Artemisia dracunculus L.	tarragon
Artemisia ludoviciana Nutt.	wester mugwort
Asclepias speciosa Torr.	showy milkweed
Cirsium arvense (L.) Scop.*	Canadian thistle
Clematis ligusticifolia Nutt.	western clematis
Coreopsis atkinsoniana Dougl.	Columbia coreopsis
Gaillardia aristata Pursh.	gaillardia
Grindelia columbiana (Piper) Ryd B.	Columbia River grindelia
Helenium autumnale L.	sneezeweed
Lactuca serriola L.	prickly lettuce
Limnosella aquatica L.	mudwort
Lycopus asper Greene	rough bugleweed
Polygonum persicaria L.	spotted ladysthumb
Ranunculus flammula L.	creeping buttecup
Rotala ramosior (L.) Koehne.	toothcup
Solidago occidentalis (Nutt.) T. & G.	western goldenrod
Shrubs:	
Salix exigua Nutt.	sandbar willow

*Introduced
Source: S/HNP ASC/ER, Amendment 4

APPENDIX L

WATERFOWL, FISH-EATING SPECIES, AND RAPTORS THAT OCCUR AT THE HANFORD RESERVATION

Table L.1 Waterfowl and fish-eating species that occur at the Hanford Reservation

Scientific name	Common name
Order--Podicipediformes	
Family--Podicipedidae:	
Podiceps auritus	Horned grebe
Podiceps caspicus	Eared grebe
Aechmophorus occidentalis	Western grebe
Podilymbus podiceps	Pied-billed grebe
Order--Pelicaniformes	
Family--Pelecanidae:	
Pelecanus orythrorhynchos	White pelican
Family--Phalacrocoracidae:	
Phalacrocorax auritus	Double-crested cormorants
Order--Ciconiiformes	
Family--Ardeidae:	
Ardea herodias	Great blue heron
Nycticorax nycticorax	Black-crowned night heron
Botaurus lentiginosus	American bittern
Order--Anseriformes	
Family--Anatidae:	
Olor columbianus	Whistling swan
Branta canadensis	Canada goose
Anas platyrhynchos	Mallard
Anas strepera	Gadwall
Anas acuta	Pintail
Anas carolinensis	Green-winged teal
Anas discors	blue-winged teal
Anas cyanoptera	cinnamon teal
Mareca americana	American wigeon
Spatula clypeata	Shoveler
Aythya americana	Redhead
Aythya collaris	Ring-necked duck
Aythya valisineria	Canvasback
Aythya marila	Greater scaup
Aythya affinis	Lesser scaup
Bucephala clangula	Common goldeneye
Bucephala islandica	Barrows goldeneye

Table L.1 (continued)

Scientific name	Common name
Bucephala albeola	Bufflehead
Clangula hyemalis	Old squaw
Oxyura jamaicensis	Ruddy duck
Lophodytes cucullatus	Hooded merganser
Mergus merganser	Common merganser
Order--Charadriiformes	
Family--Laridae:	
Larus californicus	California gull
Larus delawarensis	Ring-billed gull
Larus philadelphia	Bonaparte's gull
Sterna forster	Forster's tern

Source: S/HNP ASC/ER, Amendment 4.

Table L.2 Number of individual adult raptors and successful nests observed on the Hanford Reservation during the 1975 through 1978 nesting seasons

Species	1975	1976	1977	1978
Great horned owl	16/4*	19/5	15/4	11/2
Long-eared owl	13/3	18/8	17/8	18/6
Short-eared owl	4/2	5/1	4/2	4/2
Barn owl	8/1	9/2	5/1	4/2
Burrowing owl	52/23	40/16	50/22	44/19
Marsh hawk	10/5	10/5	10/5	10/5
Red-tailed hawk	19/8	35/13	50/19	45/17
Swainson's hawk	35/13	32/13	30/9	37/12
Prairie falcon	4/2	4/1	4/2	6/2
American kestrel	20/10	20/10	20/10	20/10
Total raptors	181	192	205	199
Total estimated biomass (kg)	107.39	127.38	135.32	130.90
Biomass per area (kg/km^2)	0.073	0.086	0.092	0.089
Population densities ($individuals/km^2$)	0.120	0.130	0.140	0.135

*Individual adult raptors/number of successful nests.
Source: S/HNP ASC/ER, Amendment 4.

APPENDIX M

MAMMALS THAT OCCUR ON THE HANFORD RESERVATION

Table M.1 Mammals that occur on the Hanford Reservation

Family	Scientific Name	Common Name
Soricidae	Sorex vagrans	Vagrant shrew
Leporidae	Lepus californicus	Black-tailed hare
	Lepus townsendii	White-tailed hare
	Sylvilagus nuttalli	Nuttall cottontail
Sciuridae	Spermophilus townsendii	Townsend ground squirrel
Geomyidae	Thomomys talpoides	Northern pocket gopher
Hetermyidae	Perognathus parvus	Great Basin pocket mouse
Castoridae	Castor canadensis	Beaver
Cricetidae	Reithrodontomys megalotis	Western harvest mouse
	Peromyscus maniculatus	Deer mouse
	Onychomys leucogaster	Northern grasshopper
Mouse	Neotoma cinerea	Bushy-tailed wood rat
	Lagurus curtatus	Sagebrush vole
	Microtus montanus	Montana meadow mouse
	Ondatra zibethica	Muskrat
Muridae	Rattus norvegicus	Norway rat
	Mus musculus	House mouse
Erethizontidae	Erethizon dorsatum	Porcupine
Cadidae	Canis latrans	Coyote
Procyonidae	Procyon lotor	Raccoon
Mustelidae	Mustela vision	Mink
	Mustela frenata	Long-tailed weasel
	Taxidea taxus	Badger
	Mephitis mephitis	Striped skunk
Felidae	Lynn rufus	Bobcat
Cervidae	Odocoileus hemionus	Mule deer
	Cervus canadensis	Elk
Vespertilionidae	Myotis lucifugus	Little brown myotis bat
	Myotis thysanodes	Fringed myotis bat
	Myotis californicus	California myotis bat
	Myotis subulatus	Small-footed myotis bat
	Myotis volans	Hairy-winged myotis bat

Table M.1 (continued)

Family	Scientific Name	Common Name
	Myotis evotis	Long-eared myotis bat
	Lasiurus cinereus	Hoary bat
	Lasionycteris hectivagans	Silvery-haired bat
	Eptesicus fuscus	Big brown bat
	Pipistrellus hesperus	Western pipistrelle bat
	Antrozous pallicus	Pallid bat
	Plecotus townsendii	Lump-nosed bat

Source: S/HNP ASC/ER, Amendment 4.

APPENDIX N

DESCRIPTION OF SOIL TYPES WITHIN THE SITE AND ASSOCIATED AREAS WITH CROSS-REFERENCES TO OTHER CLASSIFICATION SCHEMES

Table N.1 Description of soil types within Hanford Reservation and associated areas with cross-references to other classification schemes

Soil type	Description	Other classifications
Rupert sand (Rp)	The surface is a brown to grayish brown (10YR5/2) course sand, which grades to a dark grayish brown (10YR4/2) sand at about 90 cm. Rupert soils developed under grass, sagebrush, and hopsage in course sandy alluvial deposits which were mantled by wind-blown sand. Relief characteristically consists of hummocky terraces and dune-like ridges. Active sand dunes are present. Some dune areas are separated; however, many small dunes, blow-outs, and associated small areas of Ephrata and Burbank soils are included.	Regosol* Typic Torripsamment**
Burbank loamy sand (Ba)	This is a dark-colored [surface is very dark grayish brown (10YR/2) subsoil is dark grayish brown (10YR4/2)], course-textured soil which is underlain by gravel. The surface soil is usually about 40 cm thick but can be 76 cm thick. The gravel content of the subsoil may range from 20 to 80 volume percent. Areas of Ephrata and Rupert are included.	Regosol* Typic Torripsamment**
Ephrata sandy loam (El)	This is a dark-colored [surface is very dark grayish brown (10YR3/2); subsoil is dark grayish brown (10YR4/2)],	Sierozem* Andic Mollic Camborthid**

*Baldwin, B, C. E. Kellogg, and J. Thorpe, 1938. Soil classification in Soils and Man, U.S. Dept. Agric., Yearbook pp. 979-1001.

**Soil Survey Staff. 1960. Soils Classification, A Comprehensive System, 7th Approximation, Soil Cons. Serv., U. S. Dept. Agriculture.

Table N.1 (continued)

Soil type	Description	Other classification
	medium-textured soil which is underlain by gravelly material which may continue for several meters. This soil is associated with the Burbank soil and many small areas were included in delineations of this soil type. The topography is generally level.	
Dune sand (D)	This unit represents a miscellaneous land type which consists of hills or ridges of sand-sized particles drifted and piled up by wind and are either actively shifting or so recently fixed or stabilized that no soil horizons have developed. In places, recently blown-out land and areas of Rupert sand are included. Many small active dunes and accompanying blown-out areas are included with other soils, mostly Rupert, Hezel, and less frequently Burbank.	

Source: S/HNP ASC/ER, Amendment 4.

*U.S.GOVERNMENT PRINTING OFFICE : 1982 O-361-297/2124

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16. ABSTRACT *(200 words or less)*

This draft environmental statement contains an assessment of the environmental impact associated with the construction of Skagit/Hanford Nuclear Project, Units 1 and 2 (S/HNP) pursuant to the National Environmental Policy Act of 1969 (NEPA) and 10 CFR 51, as amended, of the NRC's regulations. This statement examines: the purpose and need for the S/HNP project, alternatives to the project, the affected environment, environmental consequences and mitigating actions, and environmental and economic benefits and costs. No water-use impacts are expected from cooling-tower makeup withdrawn from, or blowdown discharged into, the Columbia River. Land-use and terrestrial- and aquatic-ecological impacts will be small. Air-quality impacts from cooling-tower drift and other emissions and dust will also be small. Impacts to historic and prehistoric sites will be negligible with the development and implementation of the applicant's cultural-resources management plan. No significant impacts are anticipated from normal operational releases of radioactivity. The risk associated with accidental radiation exposure is very low. The net socio-economic effects of the project will be beneficial. The action called for is the issuance of a construction permit for Skagit/Hanford Nuclear Project, Units 1 and 2.

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