NUREG-1033

Final Environmental Statement

related to the operation of WPPSS Nuclear Project No. 3

Docket No. 50-508

Washington Public Power Supply System

U.S. Nuclear Regulatory Commission

Office of Nuclear Reactor Regulation

May 1985

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ABSTRACT

This Final Environmental Statement contains the second assessment of the environmental impact associated with the Washington Public Power Supply System Nuclear Project No. 3 (WNP-3) pursuant to the National Environmental Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations, Part 51, as amended, of the Nuclear Regulatory Commission regulations. This statement examines the environment, environmental consequences and mitigating actions, and environmental benefits and costs. Land use and terrestrial and aquatic resource impacts will be small. Operational impacts to historic and archeological sites will be negligible. The effects of routine operations, energy transmission, and periodic maintenance of rights-of-way and transmission facilities should not jeopardize any populations of endangered or threatened species. No significant impacts are anticipated from normal operational releases of radioactivity. The risk of radiation exposure associated with accidental release of radioactivity is very low. The net socioeconomic effects of the project will be beneficial.

SUMMARY AND CONCLUSIONS

This Final Environmental Statement was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (the staff).

1. This action is administrative.

2. The proposed action is the issuance of an operating license to the Washington Public Power Supply System (applicant, WPPSS), for the operation of WPPSS Nuclear Project No. 3 (WNP-3) (NRC Docket No. 50-508), located in southeastern Grays Harbor County, Washington, approximately 1.6 km (1 mile) south of the Chehalis River near its confluence with the Satsop River. The largest cities within 80 km* (50 miles) of the site are Olympia and Aberdeen. Olympia, the state capital, is 42 km (26 miles) east of the site; Aberdeen is 26 km (16 miles) west of the site. The unit will employ a two-loop, four-pump, pressurized water reactor (PWR) and supporting auxiliary and safety-related systems. The nominal net plant electrical output is 1240 MW. The plant employs a closed-cycle recirculating cooling system with one hyperbolic natural draft cooling tower. Condenser cooling water and service water will be supplied by a groundwater infiltration system of Ranney well collectors located adjacent to the Chehalis River. The river will serve as the receiving water for cooling tower blowdown effluent. In addition, a dry cooling tower is used as an ultimate heat sink. The ultimate heat sink provides heat rejection from the component cooling water system to the atmosphere during normal operation, safe plant shutdown, and accident conditions.

3. After receiving, in March 1974, a joint application for construction permits and operating licenses for twin units, WNP-3 and WNP-5, the staff reviewed impacts that would occur during station construction and operation. That evaluation was issued as the Final Environmental Statement Construction Permit phase (FES-CP) in June 1975. After that environmental review, a safety review, an evaluation by the Advisory Committee on Reactor Safeguards, and public hearings, the U.S. Nuclear Regulatory Commission (NRC) issued Construction Permits Nos. CPPR-154 and CPPR-155 on April 11, 1978 for WNP-3 (Docket No. STN 50-508) and WNP-5 (Docket No. STN 50-509), respectively.

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*Throughout the text of this document, values are presented in both metric and English units. For the most part, measurements and calculations were originally made in English units and subsequently converted to metric. The number of significant figures given in a metric conversion is not meant to imply greater or lesser accuracy than that implied in the original English value.

On January 22, 1982, the WPPSS Board of Directors moved to terminate construction of WNP-5. Termination of WNP-5 reflects the most significant change from the CP review stage to the OL review stage. A controlled termination is being pursued toward disposition of the partially completed unit. The first phase is directed at the possible sale of WNP-5 as a complete plant. During this phase, the equipment, components, and structures will be maintained to preserve the licensability of the unit. Later phases would involve the sale or salvage of individual components.

The applicant has informed the NRC that, as of September 30, 1983, the construction of WNP-3 was about 75% complete. On July 8, 1983, the WPPSS Executive Board adopted a resolution calling for an immediate delay of construction of WNP-3 until an assured source of funding for continued construction can be obtained. By letter dated November 18, 1983, WPPSS informed the staff that the projected fuel load date for WNP-3 ranges from June 1987 to December 1989. A detailed implementation plan for construction delay at WNP-3 was submitted to the NRC on September 15, 1983.

4. The staff has reviewed the activities associated with the proposed operation of WNP-3 and the potential impacts, both beneficial and adverse. The staff's conclusions are summarized as follows:

   (a) Timber will be harvested only from 336 ha (830 acres) for which the applicant has easement rights. Those portions of the 551 ha (1360 acres) used for temporary purposes and not eventually utilized for power production or transmission will be revegetated (Section 5.2.1).

   (b) No significant changes are expected from the impacts of the transmission lines discussed at the CP stage of the review (Section 5.2.2).

   (c) Changes occurring since the CP review will reduce the discharge of toxic forms of chlorine and of copper into the Chehalis River (Section 5.3.1).

   (d) The impacts of water use will be appreciably smaller than evaluated at the CP stage because of the diminished water use resulting from the cancellation of WNP-5 (Section 5.3.2).

   (e) The only plant-related structures that could be affected by the 100-year floodplain would be the discharge structure, the Ranney well intake structures, the associated bank protection, and a barge slip. These structures are considered by the staff to be a relatively minor intrusion on the floodplain of the Chehalis River for which no alternatives are readily apparent. The only likely consequence of these plant-related features would be a small loss in habitat. The applicant calculated the maximum increase in post-construction 100-year flood levels because of these structures to be about 0.1 m (0.2 ft). The staff concurs with this evaluation (Section 5.3.3).

(f) Nonradioactive emissions from the plant, excluding cooling tower emissions, will include exhaust gases from the monthly testing of diesel engines. This test, which is planned for 2 hours a month, should not contribute significantly to regional air pollution (Section 5.4.2).

(g) The staff presently foresees no significant adverse impact of plant operation on terrestrial biota of the plant site or on lands required for access and support facilities (Section 5.5.1).

(h) Assessments of the impact of station operation on aquatic biota and fisheries of the Chehalis River system during the CP review found the impacts minimal and acceptable. Since that time, the termination of WNP-5 has resulted in reduced station requirements for makeup water and a lowering of blowdown volume. Design changes in the effluent diffuser location and in the supplemental cooling system have reduced further the potential for impact. The State of Washington has established limitations upon water withdrawals and discharges and defined an allowable effluent mixing zone for protection of water quality and aquatic biota. Thus, the conclusions of minimal impact of WNP-3 operation remain valid (Sections 5.5.2 and 5.6.2).

(i) The staff believes station operation to have little or no impact on the bald eagle, the only terrestrial threatened species believed to be in the area (Section 5.6.1).

There are no threatened or endangered aquatic species in the WNP-3 site vicinity; therefore, no impacts will result from facility operation (Section 5.6.2).

(j) The staff's preliminary determination is that the operation and maintenance of the station will not adversely affect the use and enjoyment of significant historic resources (Section 5.7).

(k) The socioeconomic impacts of station operation are analyzed in Sections 5.6 and 10.4 of the FES-CP. Changes that have occurred since the issuance of the FES-CP are outlined in Section 5.8 of this report. The impact of these changes will not be significant.

(l) The staff concludes that the risk to the public health and safety from exposure to radioactivity associated with the normal operation of the facility will be very small (Section 5.9.3.2).

(m) Activities off site that might adversely affect the operation of the nuclear plant (nearby industrial, transportation, and military facilities that might create explosive, missile, toxic gas, or similar hazards) has been evaluated. The risk from such hazards has been found to be negligibly small (Section 5.9.4.4(2)).

(n) The staff has concluded that with respect to releases from severe accidents via the atmosphere, there are no special or unique circumstances about the WNP-3 site and environs that would warrant special mitigation features or operating procedures for the WNP-3 plant. On

the other hand, potential releases from severe accidents via the groundwater pathway are much larger for WNP-3 than for typical U.S. power reactors. However, even for WNP-3, the total risk from this pathway is judged to be small compared to the atmospheric pathway. Further, as for the atmospheric pathway, doses from these releases can be reduced if mitigative measures are taken soon after a postulated accident (Section 5.9.4).

(o) The NRC staff has determined that the environmental impact on the U.S. population from radioactive gaseous and liquid releases (including radon and technetium) resulting from the uranium fuel cycle that will support this facility 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 (Section 5.10).

(p) The operation of the WNP-3 unit will provide approximately 6 billion kWh of baseload electrical energy that will be produced annually. This projection, conservatively low, assumes that the unit will operate at an annual average capacity factor of 55%. The addition of the plant will also improve the ability of WPPSS to supply system load requirements by contributing 1240 MW of generating capacity to the northwest region of the U.S.

5. This statement assesses various impacts associated with the operation of the facility in terms of annual impacts, and balances these impacts against the anticipated annual energy production benefits. Thus, the overall assessment and conclusion would not be dependent on specific operating life. Where appropriate, however, a specific operating life of 40 years was assumed.

6. The Draft Environmental Statement was made available to the public, to the Environmental Protection Agency, and to other agencies, as specified in Section 8. Comment letters received are reproduced in Appendix A. The staff's responses to those comments are in Section 9.

7. The personnel who participated in the preparation of this statement and their areas of responsibility are identified in Section 7.

8. On the basis of the analyses and evaluations set forth in this statement, after weighing the environmental, technical, and other benefits against environmental costs at the operating license stage, the staff concludes that the action called for under the National Environmental Policy Act of 1969 and Title 10 of the Code of Federal Regulations, Part 51 is the issuance of an operating license for WNP-3, subject to the following conditions for the protection of the environment (Section 6.1):

   (a) Before engaging in additional construction or operational activities that may result in a significant adverse impact that was not evaluated or that is significantly greater than that evaluated in this statement, the applicant shall provide written notification of such activities to the Director of the Office of Nuclear Reactor Regulation and shall receive written approval from that office before proceeding with such activities.

(b) The applicant shall carry out the environmental monitoring programs outlined in Section 5 of this statement, as modified and approved by the staff, and implemented in the Environmental Protection Plan that will be incorporated in the operating license for WNP-3. Monitoring of the aquatic environment shall be as specified in the National Pollutant Discharge Elimination System (NPDES) permit.

(c) If adverse environmental effects or evidence of irreversible environmental damage occurs during the operating life of the plant, the applicant shall provide the staff with an analysis of the problem and a proposed course of action to alleviate it.

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FOREWORD

This Final Environmental Statement-Operating License Stage (FES-OL) was prepared by the U.S. Nuclear Regulatory Commission (NRC), Office of Nuclear Reactor Regulation (the staff) in accordance with the Commission's regulations set forth in Title 10 of the Code of Federal Regulations Part 51 (10 CFR 51), which implements the requirements of the National Environmental Policy Act of 1969 (NEPA).

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.
- Assure for all Americans safe, healthful, productive, and aesthetically and culturally pleasing surroundings.
- Attain the widest range of beneficial 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 the preparation of a statement on

- the environmental impact of the proposed action
- any adverse environmental effects that cannot be avoided should the proposal be implemented
- alternatives to the proposed action
- the relationship between local short-term uses of the environment and the maintenance and enhancement of long-term productivity
- any irreversible and irretrievable commitments of resources that would be involved in the proposed action should it be implemented.

An Environmental Report (ER-OL) accompanied the application for an operating license. In conducting the required NEPA review, the staff met with the applicant to discuss items of information in the ER-OL, to seek new information from the applicant that might be needed for an adequate assessment, and to ensure that the staff has a thorough understanding of the proposed project. In addition, the staff has obtained information from other sources that have assisted in this evaluation, and visited the project site and the surrounding vicinity. Members of the staff met 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 were deemed useful and appropriate, the staff made an independent assessment of the considerations specified in Section 102(2)(c) of the NEPA and 10 CFR 51.

The evaluation led to the publication of the DES, which was circulated to Federal, state, and local government agencies for comment. A notice of the availability of the ER-OL and the DES was published in the Federal Register, and interested persons also were invited to comment on the proposed action and on the draft statement.

After receipt and consideration of these comments, the staff has prepared this Final Environmental Statement (FES), which includes a discussion of questions and concerns raised by the commenters and the disposition thereof. This FES also contains conclusions as to whether--after the environmental, economic, technical, and other benefits are weighed against environmental costs--the action called for, with respect to environmental issues, is the issuance or denial of the proposed license, or its appropriate conditioning to protect environmental values. The format used in the DES has been used in the FES to facilitate review.

The information to be found in the various sections of this statement updates the environmental statement issued at the construction permit stage in four ways: (1) by evaluating changes to facility design and operation that will result in different environmental effects of operation (including those that would enhance as well as degrade the environment) than those projected during the preconstruction review; (2) by reporting the results of relevant new information that has become available subsequent to the issuance of the construction permit stage environmental statement; (3) by factoring into the statement new environmental policies and statutes that have a bearing on the licensing action; and (4) by identifying unresolved environmental issues or surveillance needs that are to be resolved by means of license conditions.

Copies of this FES are available for inspection at the Commission's Public Document Room, 1717 H Street, NW, Washington, DC 20555 and at the Local Public Document Room at the W. H. Abel Memorial Library, 125 Main Street, South, Montesano, Washington 28563.

Mr. Braj K. Singh is the NRC project manager for WNP-3. Should there be any questions regarding the content of this statement, Mr. Singh may be contacted by telephone at (301) 492-8423 or by writing to

Mr. Braj K. Singh
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, DC 20555

1 INTRODUCTION

1.1 Résumé

The proposed action is the issuance of an operating license to the Washington Public Power Supply System (applicant, WPPSS), for startup and operation of the WPPSS Nuclear Project No. 3 (WNP-3) (NRC Docket No. 50-508). The unit will employ a two-loop, four-pump pressurized water reactor (PWR) and will have a nominal net plant electrical output of 1240 MW. WNP-3 will utilize a closed-cycle recirculating cooling system with a natural draft cooling tower. Condenser cooling water and service water will be supplied by a groundwater infiltration system of Ranney well collectors located adjacent to the Chehalis River. The Chehalis River will serve as the receiving water for cooling tower blowdown effluent. In addition, a dry cooling tower is used as an ultimate heat sink. The ultimate heat sink provides heat rejection from the component cooling water system to the atmosphere during normal operation, safe plant shutdown, and accident conditions.

1.2 Administrative History

In March 1974, WPPSS filed an application with the Nuclear Regulatory Commission (NRC) for permits to construct WPPSS Nuclear Projects No. 3 and No. 5 (WNP-3 and WNP-5). The conclusions resulting from the staff's environmental review were issued as a Final Environmental Statement-Construction Phase (FES-CP) in June 1975. Following reviews by the staff and its Advisory Committee on Reactor Safeguards, public hearings were held before an Atomic Safety and Licensing Board. Construction permits for WNP-3 and WNP-5 (CPPR-154 and 155) were issued on April 11, 1978.

On January 22, 1982, the WPPSS Board of Directors moved to terminate construction of WNP-5. A controlled termination is being pursued toward disposition of the partially completed unit. The first phase is directed at the possible sale of WNP-5 as a complete plant. During this phase, the equipment, components, and structures will be maintained to preserve the licensability of the unit. Later phases would involve the sale or salvage of individual components.

In response to the application for an operating license for WNP-3, the NRC performed an acceptance review and, on August 20, 1982, issued a letter accepting the application. Information received on the WNP-3 application for an operating license was docketed on August 22, 1982.

The applicant informed the staff that as of September 30, 1983, construction of WNP-3 was about 75% complete.

On July 8, 1983, the WPPSS Executive Board adopted a resolution calling for an immediate construction delay of WNP-3 until an assured source of funding for continued construction can be obtained. By letter dated November 18, 1983, WPPSS informed the staff that the projected fuel load date for WNP-3 ranges from June 1987 to December 1989. A detailed implementation plan for construction delay at WNP-3 was submitted to the NRC on September 15, 1983.

Because the potential fuel load date may be as late as December 1989, the issuance of this FES-Operating License stage (FES-OL) could be almost 5 years before the fuel load date. This is earlier than the staff normally has issued FES-OLs. However, because the plant is 75% completed, the staff expects that most of the likely environmental impact due to construction has occurred and the facility operating characteristics are sufficiently known to permit meaningful evaluation. Therefore, the staff judges that the FES-OL, at this time, presents an appropriate assessment. Because the staff recognizes that in the intervening years design changes or some other unexpected change may occur, the staff will continue to follow WNP-3 activities and, as necessary, will consider whether any changes may have an environmental impact that require revision of this statement.

This staff issued the Draft Environmental Statement for public comment in December 1983. It contained the second assessment of the environmental impact associated with the operation of WNP-3, pursuant to the National Environment Policy Act of 1969 (NEPA) and Title 10 of the Code of Federal Regulations, Part 51, as amended, of the Nuclear Regulatory Commission regulations. This statement examined the environment, environmental consequences and mitigating actions, and environmental and economic benefits and costs. A notice of its availability was published in the Federal Register. Comment letters on the draft statement are reproduced in Appendix A, and the staff responses to the comments are in Chapter 9. Changes made to the text or tables since the draft statement was issued are indicated by a vertical line in the margin next to the change. (The majority of changes were made in response to comments received on the DES.) Appendix C was revised to more specifically state that it was addressing the impacts of the LWR-supporting fuel cycle. These changes made do not in any way affect the staff's conclusions as given in the DES.

Appendix B contains the NEPA population does assessment, and Appendix D contains examples of site-specific dose assessment calculations. Material concerning release categories and probabilities for WNP-3 is in Appendix E, and consequence modeling considerations are addressed in Appendix F. The State of Wasington National Pollutant Discharge Elimination System (NPDES) Permit is in Appendix G. Appendix H is a copy of a letter from the State Office of Archaeology and Historic Preservation.

1.3 Permits and Licenses

The applicant has provided in Section 12 of the Environmental Report-Operating License Stage (ER-OL)* a status listing of environmentally related permits, approvals, and licenses required from Federal and state agencies in connection with the proposed project. The staff has reviewed the listing and other information and is not aware of any potential non-NRC licensing difficulties that would significantly delay or preclude the proposed operation of WNP-3. Pursuant to Section 401 of the Clean Water Act of 1977, the issuance of a water quality certification by the State of Washington is a necessary prerequisite to the issuance of an operating license by the NRC. This certification was issued in April 1976. The National Pollutant Discharge Elimination System (NPDES) permit, issued to the applicant by the State of Washington on September 1, 1981, is reproduced in Appendix G of this report.

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*"Environmental Report, Operating License Stage," issued by the applicant. Hereinafter this document is cited in the body of the text as ER-OL, usually followed by a specific section, page, figure, or table number.

2 PURPOSE OF AND NEED FOR ACTION

The Commission amended 10 CFR 51, "Licensing and Regulatory Policy and Procedures for Environmental Protection," effective April 26, 1982, to provide that need-for-power issues will not be considered in ongoing and future operating license proceedings for nuclear power plants unless a showing of "special circumstances" is made under 10 CFR 2.758, or the Commission otherwise so requires (47 FR 12940, March 26, 1982). Need-for-power issues need not be addressed by operating license applicants in environmental reports to the NRC, nor by the staff in environmental impact statements prepared in connection with operating license applications (10 CFR 51.53, 51.95, and 51.106(c)).

This policy has been determined by the Commission to be justified even in situations where, because of reduced capacity requirements on the applicant's system, the additional capacity to be provided by the nuclear facility is not needed to meet the applicant's load responsibility. The Commission has taken this action because the issue of need for power is correctly considered at the construction permit stage of the regulatory review, where a finding of insufficient need could factor into denial of issuance of a license. At the operating license review stage, the proposed plant is substantially constructed and a finding of insufficient need would not, in itself, result in denial of the operating license.

The Commission has determined that substantial information exists to support the contention that nuclear plants cost less to operate than do conventional fossil-fueled plants. If conservation, or other factors, lowers anticipated demand, utilities remove generating facilities from service according to their costs of operation, and the most expensive facilities are removed first. Thus, a completed nuclear plant would serve to substitute for less economical generating capacity (see 46 FR 39440, August 3, 1981 and 47 FR 12940, March 26, 1982).

Accordingly, this environmental statement does not consider "need for power."

3 ALTERNATIVES TO THE PROPOSED ACTION

The Commission amended its regulations in 10 CFR 51, effective April 26, 1982 to provide that issues related to alternative energy sources will not be considered in ongoing and future operating license proceedings for nuclear power plants unless a showing of "special circumstances" is made under 10 CFR 2.758, or the Commission otherwise so requires (47 FR 12940, March 26, 1982). In addition, these issues need not be addressed by operating license applicants in environmental reports to the NRC, nor by the staff in environmental impact statements prepared in connection with operating license applications (10 CFR 51.53, 51.95, and 51.106(c) and (d)).

The Commission has concluded that alternative energy source issues are resolved at the construction permit stage and the construction permit is granted only after a finding that, on balance, no superior alternative to the proposed nuclear facility exists. This conclusion is unlikely to change even if an alternative is shown to be marginally environmentally superior in comparison with operation of the nuclear facility because of the economic advantage that operation of the nuclear plant would have over available alternative sources (46 FR 39440, August 3, 1981 and 47 FR 12940, March 26, 1982). By an earlier amendment (46 FR 28630, May 28, 1981), the Commission also stated that alternative sites will not be considered at the operating license stage, except under special circumstances, according to 10 CFR 2.758. Thus, this environmental statement does not consider alternative energy sources or alternative sites.

4 PROJECT DESCRIPTION AND AFFECTED ENVIRONMENT

4.1 Résumé

This section contains a summary of changes that have occurred since the FES-CP was issued in June 1975. The major change since the CP stage, as discussed in Sections 4.2 and 4.3, resulted from the cancellation of WNP-5. This change and its effects are detailed in various sections throughout the report. Section 4.2.3 describes the planned water use methods and water treatment measures for WNP-3. Section 4.2.4 describes the cooling system intake and discharge. Sections 4.2.5 and 4.2.6 describe waste management systems. Section 4.3.1 provides updated data on the hydrology of the area surrounding the plant, including surface water, groundwater, and the supplemental water supply. Also included is a description of water use in the region and for the plant. Section 4.3.2 describes recently collected data on the quality of the water in the region. Section 4.3.3 describes updated meteorology data. Section 4.3.4 describes the terrestrial and aquatic resources in the region, and Section 4.3.5 describes the location of a threatened terrestrial species. No threatened or endangered aquatic species are known. Section 4.3.6 describes community statistics on population, employment, recreation, and land use. Section 4.3.7 describes measures taken to identify historic and archeological sites.

4.2 Facility Description

4.2.1 External Appearance and Plant Layout

A general description of these topics is in Section 3.1 of the FES-CP. Although Figure 4.1 provides more details than did the site layout available at the time of the CP review, the orientation and arrangement of major site structures has not changed. The base diameter of the twin natural draft cooling towers has been reduced from 155.4 m (510 feet) to 128 m (420 feet).

4.2.2 Land Use

The WNP-3 site consists of a central tract measuring 551 ha (1360 acres) that is fee-owned by WPPSS. It includes an adjoining 336 ha (830 acres) for which WPPSS has easement rights (ER-OL, RQ 290.14) as well as five nearby parcels, measuring a total of 154 ha (380 acres), which are used for access and support facilities. In comparison, the FES-CP stated that the main portion of the site encompassed approximately 879 ha (2170 acres).

The minimum distance to the exclusion area boundary, also shown in Figure 4.1, is 1310 m (4300 feet) measured from the center of the WNP-3 containment building. The exclusion area lies completely within the fee-owned and easement rights property.

The land used for access and support facilities was not well defined at the CP stage. These areas include the construction laydown area, construction water wells and game mitigation land, the main and west access roads, the makeup

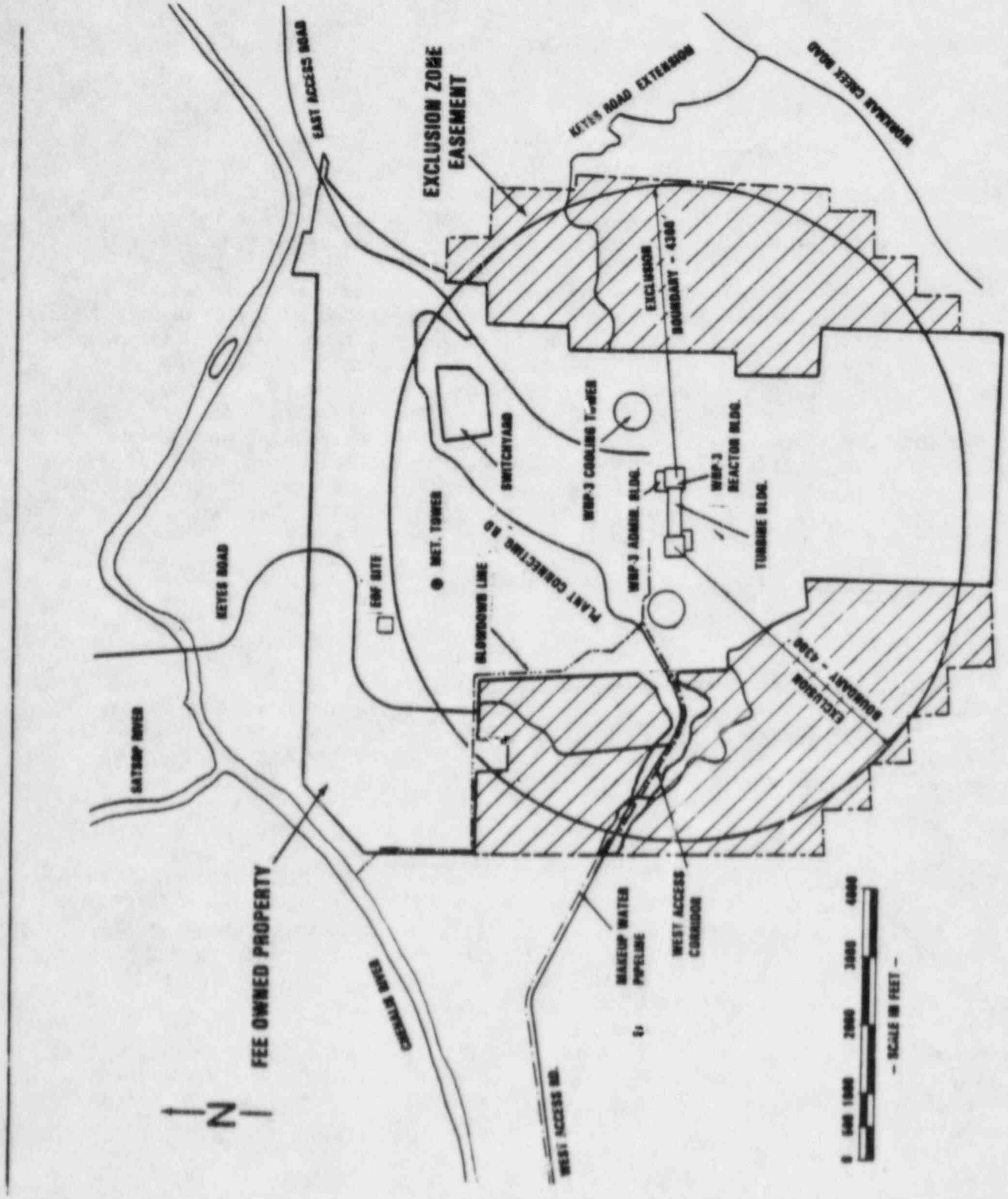

Figure 4.1 Site layout

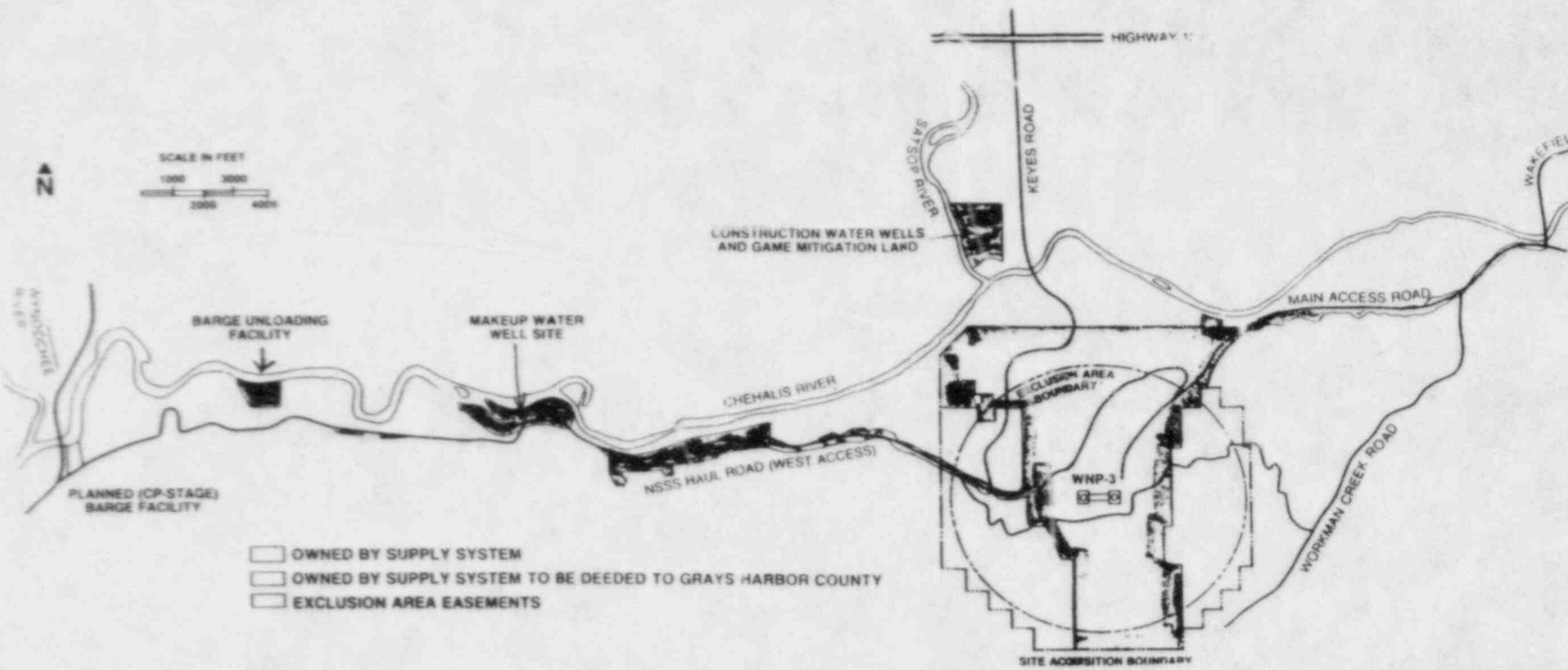

Figure 4.2 Site layout, showing additional features

water well site, and the barge unloading facility (see Figures 4.1 and 4.2 of this report and FSAR Figure 1.2-1).

The U.S. Soil Conservation Service (1982) classified the land on the continuous portion of the site as "Prime Forestlands-Timber," with a maximum mean annual equivalent productivity of 165+ ft^3/acre/year of wood.

4.2.3 Water Use and Treatment

4.2.3.1 Water Use

The planned water use methods at WNP-3 remain essentially the same as those reviewed in the FES-CP. The water use for the plant has changed significantly since issuance of the FES-CP, primarily because of cancellation of WNP-5. Total water withdrawal of about 1.1 m^3/sec (40 ft^3/sec) is anticipated for full-power single-unit operation; of this 0.9 m^3/sec (32 ft^3/sec) will be used consumptively, down from the estimated 2.1 m^3/sec (72.5 ft^3/sec) for two-unit operation. Average daily withdrawal will be about 1.0 m^3/sec (35 ft^3/sec), of which about 0.8 m^3/sec (28 ft^3/sec) will be used consumptively. All station water will be drawn from a groundwater collection system adjacent to the Chehalis River. The water will be essentially river water infiltrating into the collection system. The state Energy Facility Site Evaluation Council (EFSEC) has prohibited withdrawing more than 0.06 m^3/sec (2 ft^3/sec) from the system when flow in the Chehalis River is less than 16 m^3/sec (550 ft^3/sec). The applicant has also purchased storage capacity in the Wynoochee Reservoir to supplement downstream flow in the Chehalis River when it is necessary to compensate for evaporative losses.

The cancellation of the second unit at the site (WNP-5) has resulted in revisions to the water use projections given in the FES-CP. Generally, as might be expected, estimates of water usage have been reduced by roughly 50%. Design refinements since the FES-CP was issued have resulted in small changes to several of the flow rates.

Figure 4.3 presents a schematic flow diagram showing predicted average and maximum flow rates at various intermediate points within the plant.

4.2.3.2 Water Treatment

Revisions to plans for water treatment since the FES-CP was issued are minor. These changes are identified in Section 4.2.6 below, where the treatment of water treatment wastes is discussed.

4.2.4 Cooling System

WNP-3 will utilize a closed-cycle recirculating cooling system with one hyperbolic natural draft cooling tower. Condenser cooling water and service water will be supplied by a groundwater infiltration system of Ranney well collectors located adjacent to the Chehalis River. The river will serve as the receiving water for cooling tower blowdown effluent.

The FES-CP and the ASLB Partial Initial Decision of April 8, 1977 (LBP-77-25, 5 NRC 964 (1977)) reviewed the cooling system that was designed for the two-unit

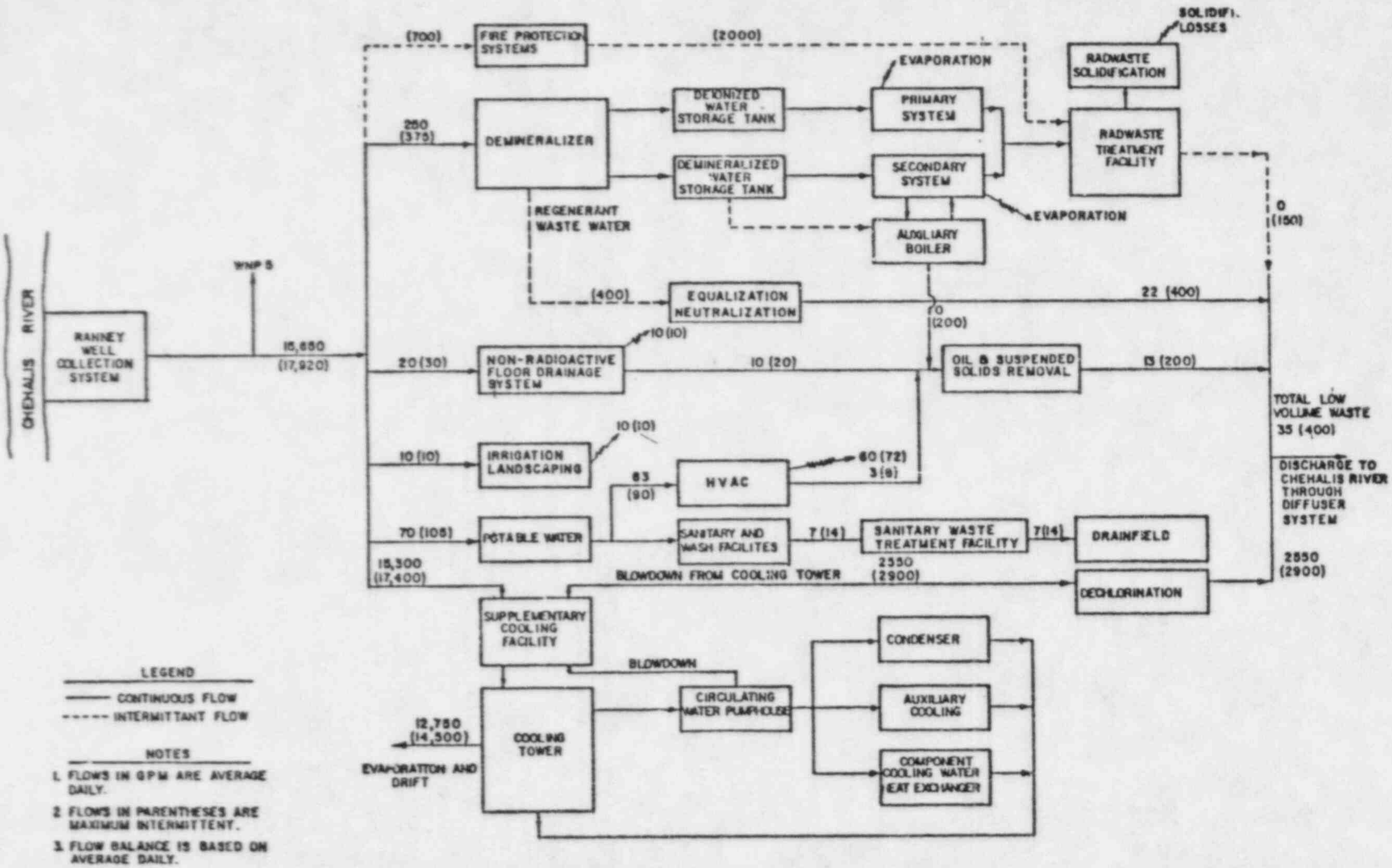

Figure 4.3 Schematic flow diagram at points within the WNP-3 plant
Source: ER-OL Figure 3.3-1

operation of WNP-3 and WNP-5. Because the applicant terminated construction of WNP-5 during January 1982, the site now accommodates only one unit and the cooling system water withdrawal and discharge rates are less than those evaluated during the FES-CP review.

Intake

Cooling water will be supplied by two Ranney well collectors located on the south bank of the Chehalis River at about river mile 18 (km 30). The maximum makeup water requirement is about 1.1 m^3/sec (40 ft^3/sec) and is expected to have a maximum monthly range between about 0.8 -1.1 m^3/sec (30-39 ft^3/sec). A single collector can supply this amount of water (ER-OL, Section 3.4.5 and RQ 291.05). The design makeup water requirements for two-unit operation considered at the CP stage was 2.1 m^3/sec (72.5 ft^3/sec) (5 NRC page 981).

Water will be withdrawn through horizontal lateral screens at a depth of 34 m (111 feet). The wells will withdraw a mixture of surface water infiltrated from the river (88%) and groundwater (12%). This will result in a drawdown in the river of 3 cm (0.1 foot) or less (ER-OL, Sections 2.4.2.1 and 3.4.5). River drawdown for two-unit operation was predicted to be 6.1 cm (0.2 foot) during low flow (5 NRC page 982). A schematic diagram of a Ranney collector is shown in Figure 4.4.

The State of Washington has imposed limitations on the withdrawal of water in relation to river flow via the Site Certification Agreement (dated October 1982) between the State and the applicant. The limitations are described in Section 4.3.1.1.

The applicant has contracted with the City of Aberdeen for the purchase of 1.8 m^3/sec (62 ft^3/sec) of water to be released from the Wynoochee River reservoir industrial supply during low flow periods. This will mitigate any impacts associated with consumptive use of river water (through the Ranney well system) (5 NRC 982; ER-OL, RQ 291.21).

Discharge

Cooling tower blowdown will enter the Chehalis River at river mile 20.5 (km 33), approximately 3.2 km (2 river miles) upstream of the Ranney well intake area. The effluent pipe will be buried beneath the river bottom. It will run in a northerly direction from the south river bank for about 46 m (150 feet) where it will connect with a 9-m (30-foot) long multiport diffuser (also buried beneath the river bed). The diffuser is a 46-cm (18-inch) diameter pipe perforated with 46 discharge ports (or nozzles) that project 30 cm (1 foot) above the river bottom and discharge in a downstream direction at a 12-degree angle above the horizontal. The ports are 51 mm (2 inches) in diameter and are spaced at 20-cm (8-inch) intervals. Average discharge velocity will be about 1.9 m/s (6.25 fps). Maximum discharge volume will vary between about 1.8 to 2.0 m^3/s (5.9 to 6.4 ft^3/sec). The design and location of the diffuser are shown in Figure 4.5 (ER-OL, Section 3.4.4 and RQ 291.09, 291.10).

Design changes that have been made since the CP stage review are as follows: (1) the discharge diffuser location has been changed from about 9 m (30 feet)

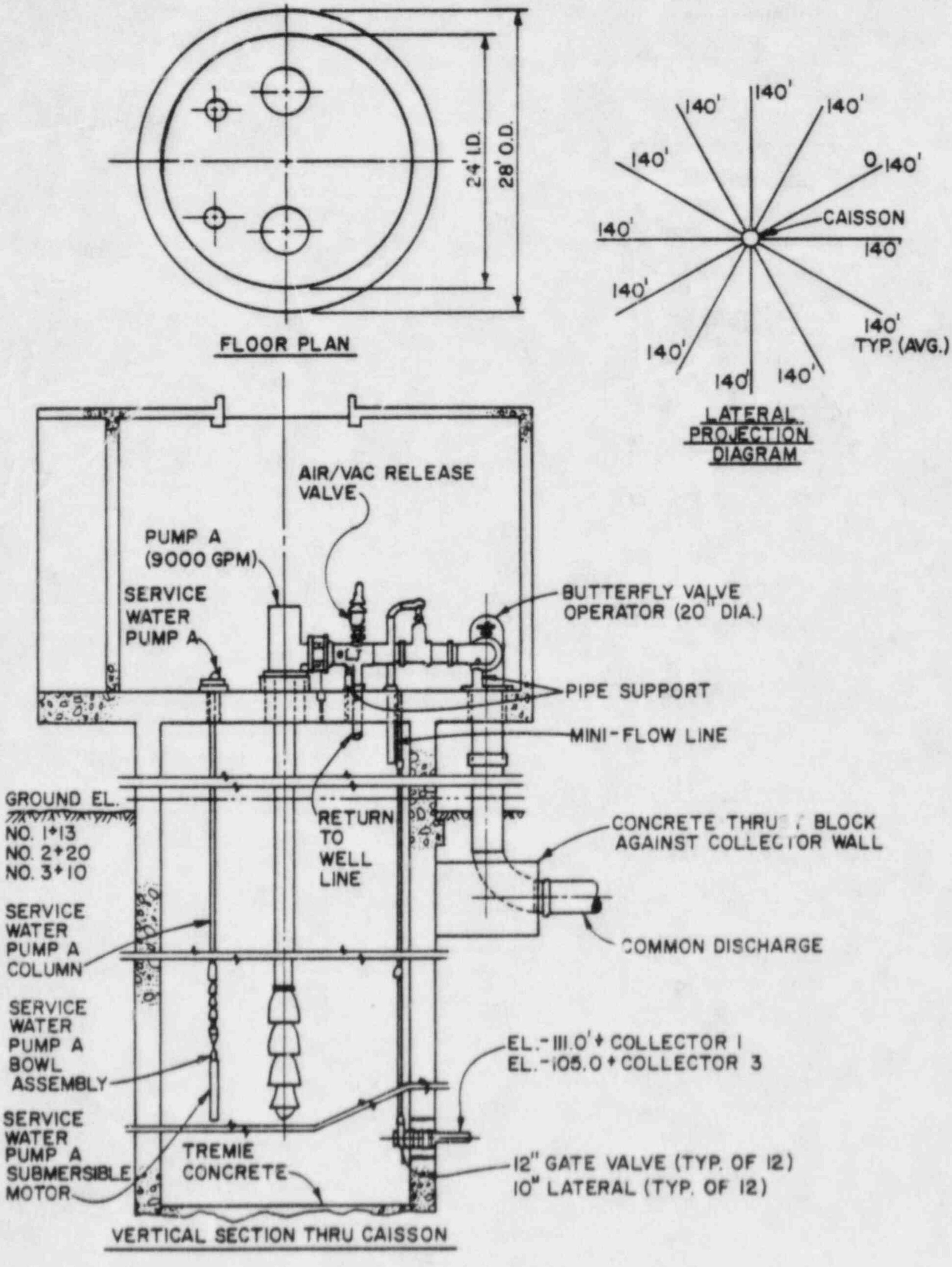

Figure 4.4 Schematic plan of a Ranney well collector
Source: ER-OL Figure 3.4-6.

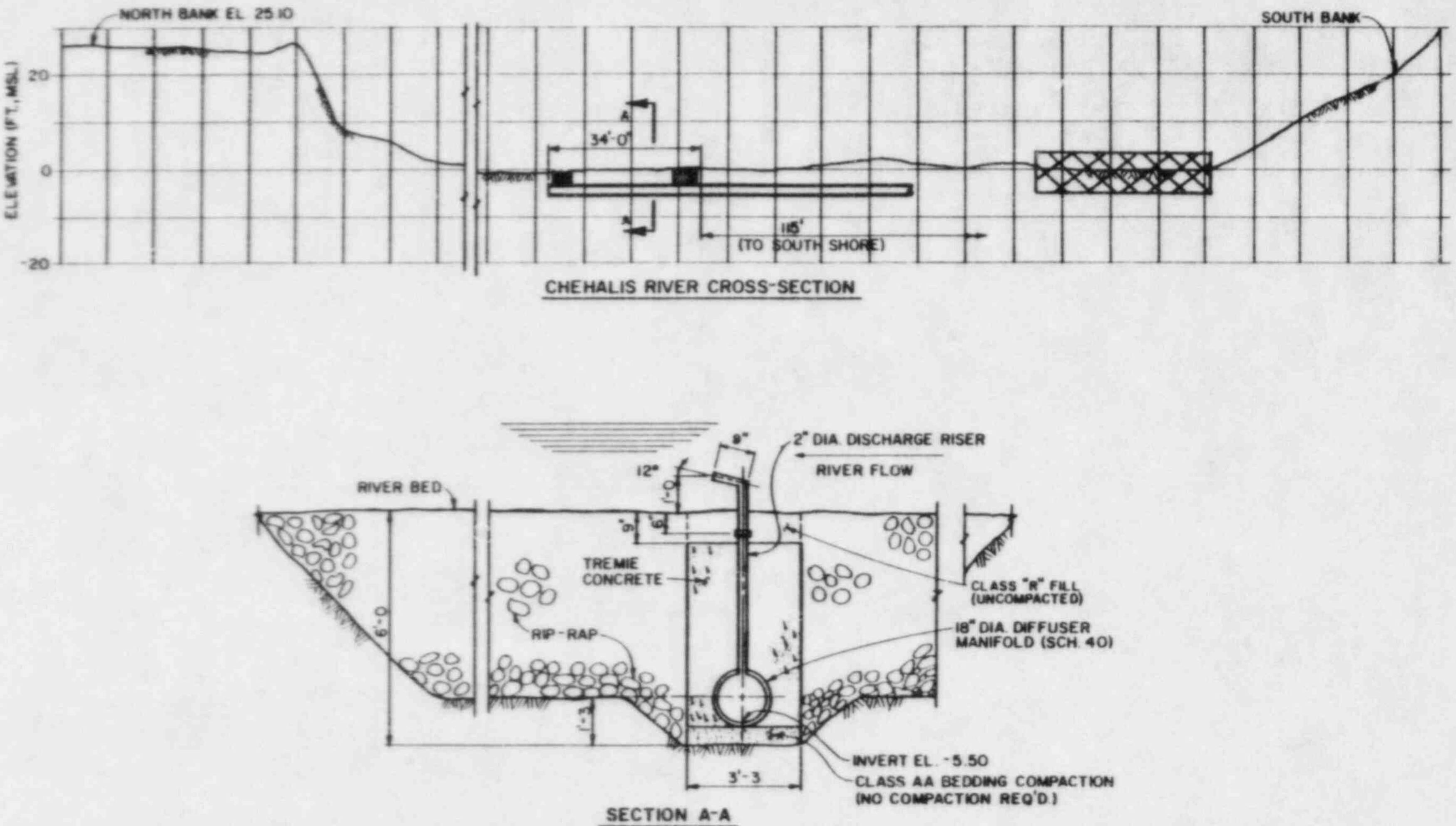

Figure 4.5 (Top) Cross-section of the Chehalis River showing the present location of the blowdown diffuser discharge near midstream, and its approximate location near the southbank (cross-hatched area) during the CP stage review. (Bottom) Schematic cross-section of the diffuser discharge. Source: ER-OL Figure 3.4-4.

offshore to about 46 m (150 feet) offshore (nearly mid-channel) and (2) the angle from horizontal for the diffuser ports has been changed from 20 degrees to 12 degrees.

The State of Washington NPDES Permit No. WA-002496-1 (issued September 14, 1981)* imposes limitations on thermal discharges to the Chehalis River as follows:

- No discharge is permitted when instantaneous river velocity is less than 9.1 cm/sec (0.3 fps) (in a downstream direction) at the discharge point.
- When ambient river temperature is 20°C or less, the temperature of the effluent at the point of discharge shall be 20°C or less and shall not exceed the ambient by more than 15°C.
- When ambient river temperature is greater than 20°C, the temperature of the effluent at the point of discharge shall be equal to or less than the ambient river temperature.
- The dilution zone within the river shall have boundaries extending (from water surface to river bottom) 15.2 m (50 feet) upstream, 30.5 m (100 feet) downstream, and 7.6 m (25 feet) laterally from the midpoint of the diffuser. This translates to an area of 697 m^2 (7500 ft^2), or about 0.07 ha (1/6 acre).

The WNP-3 cooling system is designed to ensure that effluent temperatures will be within the NPDES limits by use of a supplemental cold-side heat exchanger. Thermal monitoring will occur via sensors for the river, for makeup Ranney well water, and for cooling tower blowdown. If blowdown temperature is not within acceptable limits, the blowdown flow can be cycled through the supplemental system before it is discharged to the river. The heat exchanger uses makeup water (from the Ranney wells) as the cooling medium and is designed to cool the effluent to within 1.7°C of the makeup water temperature. This system can be used continuously or as needed to control effluent temperature. It is probable that the supplemental system will be used primarily during late spring through summer or early fall; however, the actual mode of operation will be derived from experience (ER-OL, Sections 3.4.3, 3.4.4, 5.1.1 and RQ 291.08, 291.09, 291.10, 291.22).

Changes made in the cooling system since the CP stage review are as follows: (1) the effluent volume has been reduced from about 0.37 m^3/sec (13 ft^3/sec) to 0.17 m^3/sec (6 ft^3/sec) as a result of the cancellation of WNP-5; (2) the supplemental cooling system is a heat exchanger design rather than the previously proposed two-cell mechanical draft cooling tower (see Section 5.5.2.2); and (3) the State of Washington has determined the allowable mixing zone.

4.2.5 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

*Reproduced as Appendix G to this statement.

to keep 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 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 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's Safety Evaluation Report. The quantities of radioactive material that the staff calculates will be released from the plant during normal operations, including anticipated operational occurrences, are in Appendix D of this environmental 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, is in Chapter 11 of the SER.

As part of the operating license for this facility, the NRC will require Technical Specifications that limit release rates for radioactive material in liquid and gaseous effluents and that require 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.

4.2.6 Nonradioactive Waste Management Systems

4.2.6.1 Demineralizer Wastes

High purity, demineralized makeup water for the primary and secondary cooling systems will be produced from the raw makeup water by a system consisting of a cation exchange unit, an anion exchange unit, and a mixed-bed unit. These systems, the quality of the resulting waste streams, and the proposed method of treatment and disposal are essentially unchanged from those evaluated during the CP review. The waste volume will be reduced to half because of the cancellation of WNP-5.

Condensate in the secondary water system will be treated by a mixed-bed ion exchange column. When radiation levels permit, wastes from the condensate treatment will be discharged through the same low-level waste treatment system. Should primary-to-secondary leakage result in radioactive contamination of the condensate, the regenerant waste will be routed to radwaste systems.

The low-level waste treatment system may also occasionally receive treated water from the liquid radwaste and secondary high-purity waste treatment systems when it is necessary to control the inventory in these systems. These waste streams will be of higher purity chemically than other wastes routed through the low-level waste systems.

Wastes routed to the low-level system will contain particulates from ion exchange material and from corrosion products as well as chemical precipitates. The pH values of waste streams will range from highly acidic to highly caustic. The treatment system will provide neutralization and sedimentation of the waste streams.

4.2.6.2 Corrosion, Scale, and Biofouling Control Chemicals

Chemicals are added to some of the water systems to control corrosion, scaling, and biological growth in critical components. Hydrazine will be used in the primary and secondary cooling water systems and in the auxiliary boiler as an oxygen scavenger and corrosion inhibitor. Hydrazine reacts with oxygen to form nitrogen and water. Hydrazine is highly reactive and is not expected in the station discharge in the unreacted form.

Ammonia will be used to control pH in the secondary feedwater system, the component cooling water system, and the auxiliary boiler. Potassium chromate will be added to the closed component cooling system for corrosion control. Discharges and leakage from the systems to which hydrazine, ammonia, or chromate will be added will be routed to the secondary high purity waste system (SHP). This system (1) processes the flow streams, which will all be low in dissolved solids and particulates, and (2) recovers water for reuse as secondary makeup water. When water quality is inadequate, the product water will be sent to the low-volume waste treatment system. Hydrazine and ammonia concentrations in the product water will be negligible. Although the SHP includes an ion-exchange process, the applicant has not indicated any plan to regenerate and dispose of removed materials or to otherwise return them to any flow stream.

The applicant has increased by about 60% the estimate of the requirement of sulfuric acid to control scale in the circulating water system, to regenerate ion exchange resins, and to adjust pH. During the CP review, the applicant estimated that about 2180 kg/day (4800 lbs/day) of acid would be required per unit (ER-CP, Table 3.6-5). The current estimate is for an average daily use of about 3360 kg/day (7400 lbs) (ER-OL, Table 3.6-2). Total use--and thus the total discharge to the Chehalis River--will be less now because only one unit is planned. Because the usage for the one unit is higher than previously planned, the discharge concentration will be higher than previously evaluated. But, with the greater dilution for the single unit, after the discharge mixes with the river flow the incremental concentration in the river will not be as great as previously evaluated.

Plans for chlorination to control biofouling have been revised since the CP review. At the CP stage, the applicant planned to add gaseous chlorine to the circulating and service water systems to control biofouling (FES-CP, Section 3.6.2). Discharge concentration objectives were to be met by delaying blowdown when concentration exceeded 0.1 mg/l. Only one of the two units was to be chlorinated at any one time to provide additional dilution of the chlorinated effluent stream before discharge.

As currently planned, sodium hypochlorite rather than gaseous chlorine will be the source of free chlorine residuals. The condensers will also be fitted with a mechanical tube cleaning system (Amertap), which should result in some reduction in the chemical requirements. Hypochlorite will be added, as needed, up to two times a day for about 20 to 30 minutes each time. One hundred and eight kg (400 lbs) of hypochlorite will be required for each addition; however, the applicant estimates that the actual average daily use of hypochlorite will be 91 kg (200 lbs).

The applicant anticipates that the residual chlorine concentration in the cooling tower blowdown will be low, at or below 0.02 mg/l, and the applicant has provided a system for sulfur dioxide addition to completely reduce that residual chlorine. The addition of sulfate by this system is extremely small relative to the addition of acid for control of scaling. Roughly 14 kg (30 lbs) of sulfur dioxide per day will be utilized, producing roughly 22 kg (48 lbs) per day of sulfate.

4.2.6.3 Other Chemical Discharges

The applicant now plans to use stainless steel condenser tubes instead of the copper-nickel tubes planned for use at the CP stage (FES-CP, page A-11). Based on concentrations of the edge of the mixing zone, copper addition to the cooling water by corrosion was judged acceptable during the CP review; however, the major source of the copper no longer will be present. The applicant now estimates copper concentration in the station discharge to average 21.5 μg/l (ER-OL, Table 3.6-1) in comparison to the 230 μg/l estimated at the CP review (FES CP, page 5-31).

Plant piping and equipment will be cleaned by flushing with water before startup (ER-OL, page 3.6-3). At the time of the CP review, a phosphate wash was anticipated (FES-CP, page 3-23). The flush water--which will contain hydrazine, metal oxides, and other debris from fabrication procedures--will be treated, if necessary, and ultimately released through the sedimentation basin.

The sanitary waste is essentially as described at the CP review. WNP-3 will continue to dispose of treated waste in the drain field that was constructed for construction phase loading.

4.2.7 Power Transmission System

The transmission facilities included in the scope of this review consist of a 500-kV above ground line and a 230-kV underground low-pressure oil-filled cable, each connecting the plant island to a Bonneville Power Amdinistration (BPA) substation on the site. The single right-of-way for these lines is approximately 1476 m (4841 feet) long, lies completely within the site, and crosses no public roads (ER-OL, RQ 290.12 and accompanying figure). The 500-kV line will be suspended from lattice steel, single-circuit delta towers about 37 m (120 feet) high and 12 m (40 feet) wide.

The system beyond the WNP-3 substation was evaluated, designed, and built by BPA. BPA documented this evaluation in an environmental impact statement entitled "Satsop Integrating Transmissions" (U.S. Department of the Interior, 1976).

4.3 Project-Related Environmental Descriptions

4.3.1 Hydrology

4.3.1.1 Hydrologic Description

4.3.1.1.1 Surface Water

The surface water descriptions in Section 2.5 of the FES-CP are still valid with the inclusion of the new information and discussions below. In addition, Section 5.3.3 of this report addresses the hydrologic effects of alterations in the floodplain in response to Executive Order 11988, Floodplain Management, and Section 5.9 contains the analysis of severe liquid pathway accidents.

The WNP-3 site is located in the hills just south of the Chehalis River, the major drainage system in Grays Harbor County and one of the major drainage basins in West Central Washington. The total drainage area of the Chehalis River basin is approximately 5440 km^2 (2100 mi^2). The stretch of the river from its mouth at Grays Harbor to the vicinity of the site (about 32 km (20 miles)) is tidal. Figure 4.6 is a map of the Chehalis River basin.

The Chehalis River flows generally eastward to the city of Chehalis where it changes course abruptly to the north. From near Grand Mound, about 16 km (10 miles) north of Chehalis, the river flows northwesterly to Elma then west to Grays Harbor at Aberdeen. The major tributaries of the Chehalis in the vicinity of the site are the Satsop and Wynoochee Rivers. The Satsop River has a drainage area of 777 km^2 (300 mi^2) and an estimate average annual flow of about 57.5 m^3/sec (2030 ft^3/sec). The Wynoochee River has a drainage area of 259 km^3 (100 mi^2) and an estimated average flow of about 34.0 m^3/sec (1200 ft^3/sec). Figure 4.7 shows the surface hydrologic features in the vicinity of the plant site.

The long-term average flow of the Chehalis River at the site just downstream of the Satsop confluence is estimated to be 193 m^3/sec (6824 ft^3/sec); the average flows in the Chehalis and Satsop Rivers above their confluence are about 133 m^3/sec (4680 ft^3/sec) and 57.5 m^3/sec (2030 ft^3/sec), respectively. The estimated average monthly flows in the Chehalis River at the site vary from 22.8 m^3/sec (806 ft^3/sec) in August to 415 m^3/sec (14,668 ft^3/sec) in January (ER-OL, Section 2.4.1); this variability reflects the seasonal rainfall distribution within the basin. The once-in-10-year, 7-day-duration low flow is estimated to be about 15.0 m^3/sec (530 ft^3/sec). The minimum and maximum historical flows at the site have been estimated by the applicant to be 12.9 m^3/sec (454 ft^3/sec) and 2750 m^3/sec (97,100 ft^3/sec), respectively.

The Chehalis River channel in the vicinity of the site is about 76.2 m (250 feet) wide and varies in depth from approximately 0.3 m (1 foot) during low flow to greater than 10 m (30 feet) during flooding conditions. The average river bed elevation ranges from about 16.8 m (55 feet) below mean sea level (msl) near the mouth to 5.8 m (19 feet) above msl about 16 km (10 miles) upstream of the site.

The velocity characteristics of the Chehalis River are quite variable. During low flow conditions (11.3^3/sec (400 ft^3/sec)), velocities of about 0.1 m/sec (0.4 fps) are experienced, whereas during flood flow conditions (850 m^3/sec

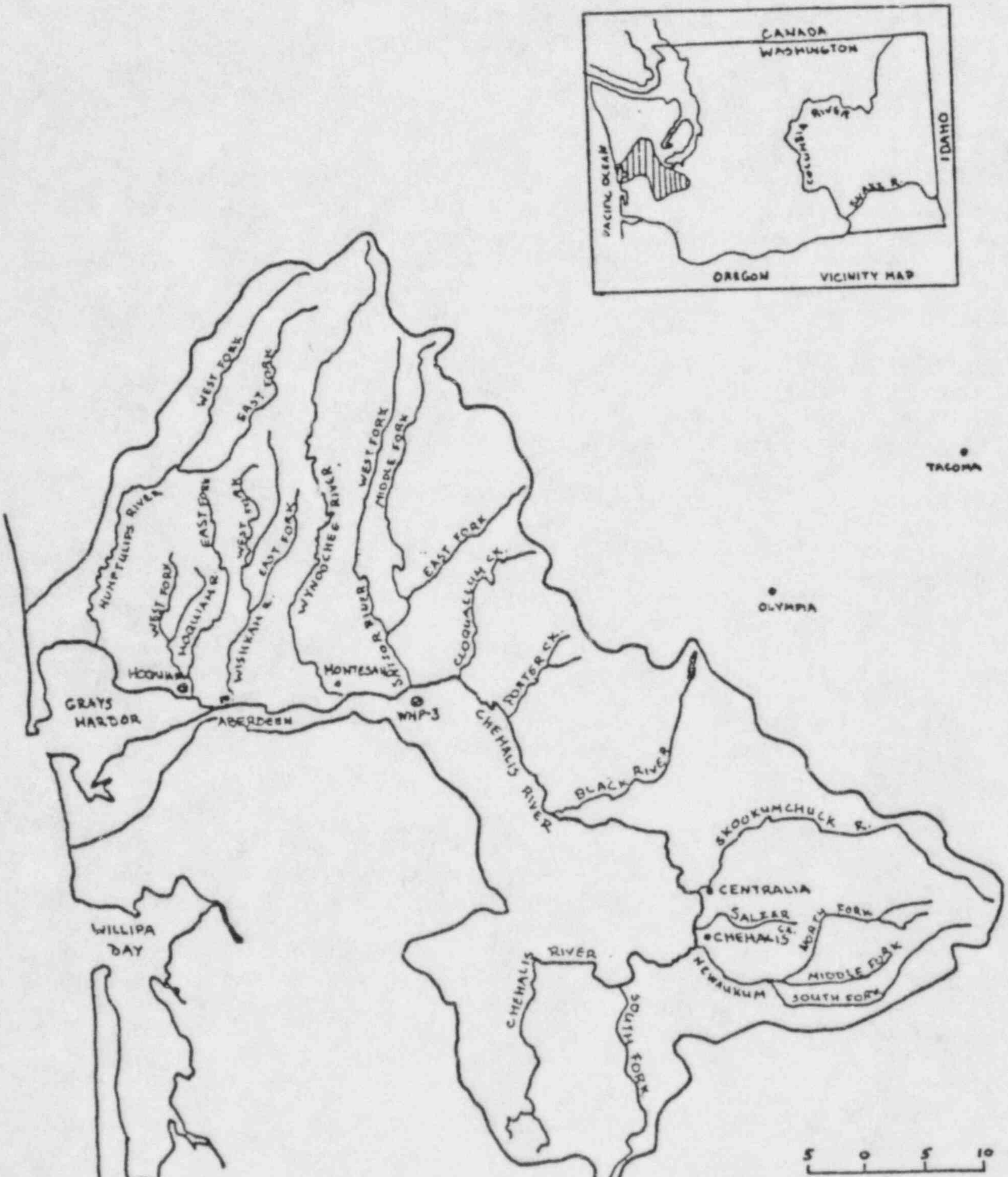

Figure 4.6 Chehalis River basin
Source: ER-OL Figure 2.4-1

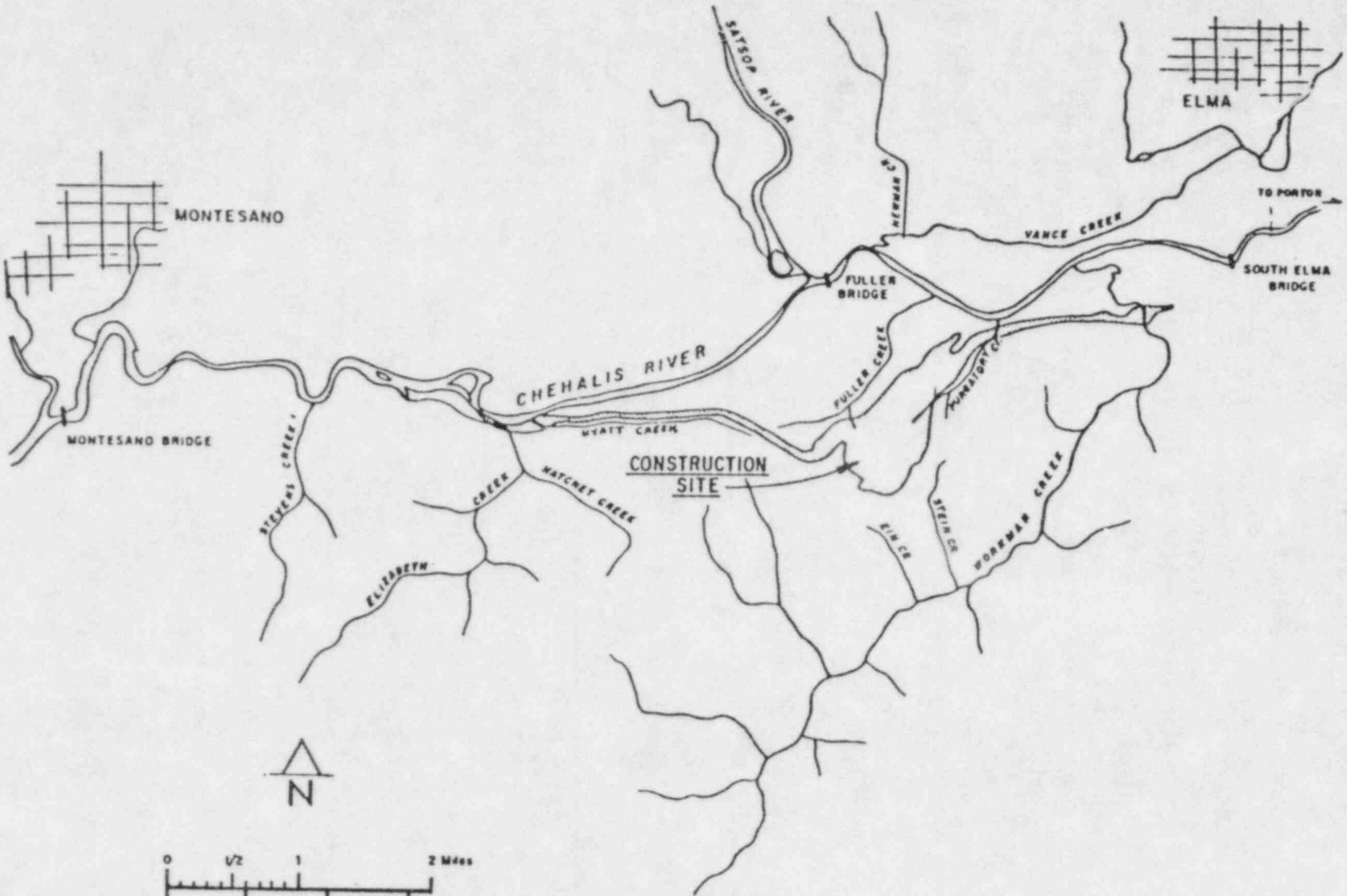

Figure 4.7 Hydrologic features near WNP-3
Source: ER-OL Figure 2.4-2

(30,000 ft^3/sec)) channel velocities reach 1.8 to 2.1 m/sec (6 to 7 fps). In addition to fresh water flow conditions, the site hydrology is influenced to some extent by ocean tides. Flow reversals of the Chehalis River are known to occur several miles upstream from Montesano over most of the range of discharge; on the other hand, salt water intrusion is known to extend only a short distance upstream from the Montesano highway bridge and only during low flow conditions.

Plant grade elevation is about 119 m (390 feet) msl, which is about 113 m (370 feet) above the normal water level of the Chehalis River. Five streams, all relatively short and intermittent, drain at least some portion of the site. These include Workman, Purgatory, Fuller, Hyatt, and Elizabeth Creeks. Purgatory and Fuller Creeks were significantly altered by site-erosion-control-runoff-treatment-measures during site construction. Hyatt Creek and Elizabeth Creek were directly influenced by plant construction. All of these creeks have also been altered by lumbering activities which have altered their watersheds.

Table 4.1 shows the characteristics of streams within the influence of the site.

Table 4.1 Characteristics of streams at WNP-3 site

Stream	Length (feet)	Total watershed area (acres)	Watershed area within plant construction (acres)	(%)	Watershed area clearcut from 1965 - 1977 (acres)	(%)
Workman	48,000	7,090	60	1.1	2,690	37.9
Stein	6,700	360	40	11.7	40	11.1
Purgatory	7,000	320	120	37.5	130	40.6
Fuller	12,300	720	230	33.3	220	30.6
Hyatt	10,000	540	60	11.1	260	48.1
Elizabeth	21,000	2,730	10	0.4	520	19.0

Source: ER-OL Table 2.4-3.

4.3.1.1.2 Groundwater

The only satisfactory source of groundwater in the vicinity of the site is in the sand and gravel aquifers in the Chehalis River valley. These coarse alluvial deposits are up to 61 m (200 feet) thick, and their yields range from 0.8 to 11.4 m^3/min (200 to 3000 gpm). Lower yield sources of groundwater occur in the Pleistocene terrace deposits north of the site. The groundwater in these unconsolidated terrace deposits occurs in pockets of permeable sands and silty sands having low yield; it is adequate only for domestic uses.

A compilation of data for wells within 3 and 32 km (2 and 20 miles) of the site is in ER-OL Tables 2.1.12 and 2.1.13. Most of these wells are north of the site because the population density is very low in other directions. The

wells are relatively shallow 30 m (100 feet), yielding a few hundred gpm; they are used for irrigation and/or domestic purposes. The only major consumer of groundwater in the area is the town of Elma 6 km (4 miles) northeast of the plant, which can withdraw up to 7.6 m^3/min (2000 gpm). The nearest well to the plant is about 8045 km (5000 feet) to the north-northwest.

Water for plant operations is produced from two Ranney well collectors located at about river mile 18. About 88% of the water collected by the Ranney wells comes from the Chehalis River via infiltration; the rest comes from groundwater in the alluvial valley fill. A single well is capable of supplying the total plant needs of about 68.1 m^3/min (18,000 gpm).

4.3.1.1.3 Supplemental Water Supply

The plant is permitted by the State of Washington to withdraw from its Ranney wells up to 196,800 m^3/day (52,000,000 gpd) on a daily basis, and 183,600 m^3/day (48,500,000 gpd) on a 30-day average basis. Withdrawal may not exceed 2.2 m^3/sec (80 ft^3/sec) instantaneously; in addition, it may not exceed the difference between the river flow and 15.6 m^3/sec (550 ft^3/sec). When Chehalis River flows are less than 15.6 m^3/sec (550 ft^3/sec), normal withdrawals must cease, except that up to 0.1 m^3/sec (2 ft^3/sec) may be withdrawn to maintain the plant in a hot standby condition. According to the applicant (see WPPSS-8 in Appendix A.) The 15.6 m^3/sec river flow limitation may be waived by the state on the basis of regional power needs. The applicant has also made provision to purchase up to 1.8 m^3/sec (62 ft^3/sec) of water from the City of Aberdeen's Wynoochee Reservoir to supplement flow in the Chehalis River below the plant during low flow periods. However, this water would not be used by the plant and would not significantly benefit the Chehalis River near the plant or upstream.

4.3.1.2 Regional Water Use

The water resources of the Chehalis River Valley include both ground and surface supplies. More than half of the water used in Grays Harbor County is for irrigation. Water use is controlled by certificate or permit issued by the Washington State Department of Ecology. Within 8 km (5 miles) of the site, surface water permits have been granted to about 78 users for a combined water use of up to 0.7 m^3/sec (23 ft^3/sec), mostly for irrigation, with the remainder for domestic, livestock watering, fish propagation, fire protection, and industrial uses. There are no known drinking water users drawing from Chehalis River surface supplies downstream from the plant.

Groundwater wells in the Chehalis River Valley are relatively shallow, usually less than 3 m (10 feet) in depth. Most of the wells are located on the floodplain deposits north of the river. There are 45 known wells within 3.2 km (2 miles) of the plant, used mostly for drinking and irrigation. Five major municipal water systems within 32 km (20 miles) of the site are served partially or totally by groundwater. Only two of these systems, Montesano and Central Park, are located on the Chehalis River downstream from the plant. These systems serve populations of 3200 and 2000, respectively.

4.3.2 Water Quality

The water in the Chehalis and Satsop Rivers has remained at a high level of quality (ER-OL, page 24-4, and Washington, 1979, page 13). The applicant conducted extensive sampling for water quality in both rivers and in onsite streams from 1978 through 1981 to document effects of construction on water quality as well as to strengthen the baseline data for later evaluation of potential impact of station operation (Envircsphere, 1978, 1980, and 1982).

Analysis of data collected during these studies showed that the procedures employed for erosion control and for preventing silt from reaching surface waters were effective. The major effects of construction have passed. During 1981, suspended solids concentrations in the onsite streams were higher during periods of high rainfall but were not uniformly greater than values measured in streams away from the influence of construction activities. Hyatt Creek showed values for suspended solids and turbidity that were higher than those at the control station on the Chehalis River. In Hyatt Creek, the average turbidity was 42.0 compared to an average of 6.4 in the Chehalis upstream. Values in Hyatt Creek ranged up to 500, and a maximum of 34 was observed in the Chehalis. Other streams receiving site drainage were comparable in turbidity to the control (Envirosphere, 1981).

Data collected on the Chehalis and Satsop Rivers subsequent to the issuance of the FES-CP improved the description of river water quality but did not alter conceptual understanding of the processes affecting water quality. Of major concern to the State of Washington during its licensing proceeding was the effect of toxic metals on the highly valued salmonids of the region. Particular concern related to copper. WNP-3 would influence copper concentration through the release of corrosion products and through the concentrating effect of evaporative cooling.

The original waste discharge permit for the project all but forbade the discharge of water from the project by limiting the concentration of copper in the discharge to a value near the ambient concentration. In 1979, a revised discharge permit gave some relief but required the utility to conduct studies of the background copper and of other heavy metal concentrations in the Chehalis River for a 52-week period (Washington, 1979). This study was conducted during the period November 1980 through October 1981 (Envirosphere, 1982a). Table 4.2 shows the average value and the range of values observed for total ion concentration for each metal during this study. Also measured but not included in the table was the dissolved fraction of the metals.

4.3.3 Meteorology

WNP-3 is situated in western Washington State where the climate is comprised of warm, dry summers and wet, mild winters. These conditions are the result of proximity to the Pacific Ocean and the presence of semipermanent high and low pressure centers off the coast, which migrate in a north-south manner (Water Info Ctr, 1974). Temperatures normally vary from an average January minimum of approximately -1°C (30°F) to an average July maximum in the middle 21°C (70°F) range (Baldwin, 1973). Temperature extremes observed at Olympia, WA, were -18°C (-8°F) and 40°C (104°F) during the 40-year period ending in 1981 (Nat'l Climatic Ctr, 1973, 1981). Precipitation usually occurs every month, although the greatest portion of the nearly 1295 mm (51 inches) of annual precipitation occurs from October through March.

Table 4.2 Total metal ion concentration values for water samples collected from the Chehalis River near the WNP-3 intake (values are in μg/l except as noted)

Metal	Mean concentration	Concentration range	No. of samples
Chromium	1.2	< 0.5 - 10.8	49
Nickel	1	< 1 - 14	50
Iron	861	80 - 7400	50
Zinc	<5	<5 - 37	50
Copper	2	<1 - 8	50
Cadmium	<0.1	<0.1 - 0.5	12
Lead	4	<1 - 36	12
Barium	10	6 - 22	10
Manganese	29	11 - 80	12
Mercury	0.4	<0.2 - 1.3	12
Selenium	<2	all <2	12
Calcium (mg/l)	6.6	4.5 - 8.4	4
Magnesium (mg/l)	1.9	1.5 - 2.4	4
Potassium (mg/l)	0.55	0.45 - 0.76	4
Sodium (mg/l)	4.4	3.2 - 5.4	4

Source: Envirosphere, 1982a.

The precipitation total includes the water equivalent of the snowfall that occurs from November through April. Thunderstorms are recorded infrequently and occur primarily in spring and summer. There is a corresponding very low frequency of tornado events, with only one tornado occurring in the one-degree square that includes the site during the period 1916 to 1979. Although the FSAR states that the tornado strike probability is approximately 1.4×10^{-7} years^{-1}, the plant has been designed to exceed the RG 1.76 Region III criteria for wind speed, pressure drop, and rate of pressure drop (107 m/sec (240 mph), 0.11 kg/cm^2 (1.5 psi), and 0.04 kg/cm^2/sec (0.6 psi/sec), respectively).

Another meteorological phenomenon of note in the area is the general cloudiness that results in less than 60 clear days per year. Similarly, in the region there is heavy fog with visibility of 402 m (0.25 mile) or less 60 to 80 days annually. These fog observations are made at airports that are situated in lower terrain areas and are subject to cool air drainage that contributes to the occurrence of ground fog. The plant site, situated on higher level terrain, is not expected to experience the large number of heavy fog days observed at the regional airports.

Prevailing winds in the area, as measured at Olympia, are from the southwest quadrant and average about 3.1 m/sec (7 mph). Onsite 10-meter wind observations shown in Figure 4.8 present the annual wind frequency distribution measured during the period October 1979 through September 1981. The maximum fastest mile wind speed observed at Olympia, was 26.8 m/sec (60 mph).

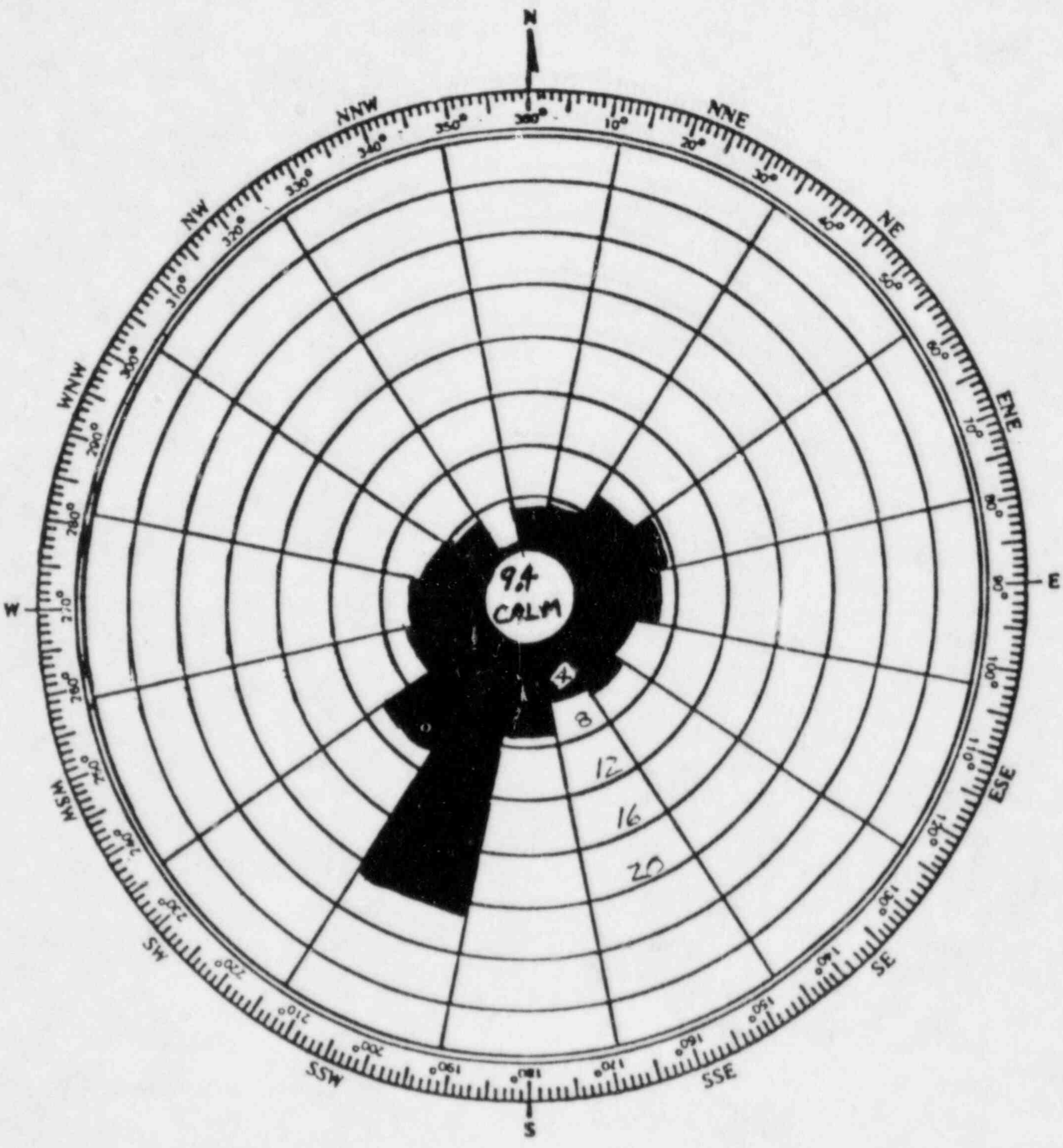

Figure 4.8 WNP-3 onsite 10-m windrose showing percentage of the time the wind blew from the direction shown, October 1979 to September 1981

4.3.4 Terrestrial and Aquatic Resources

4.3.4.1 Terrestrial Resources

The terrestrial ecology of the WNP-3 site and surrounding area is described in Section 2.7 of the FES-CP. Additional data collected from 1975 through 1980 are given in ER-OL Section 2.2.1. From 1978 through 1980, the terrestrial ecology program was concentrated within four small watersheds (ER-OL, Figure 2.2-2). These watersheds were selected to be representative of the two major habitat types surrounding the site, maturing second-growth coniferous forest and recent clearcuts. They were selected in matched pairs so that areas adjacent to the plant site could be compared with areas outside the influence of the plant.

4.3.4.2 Aquatic Resources

Biota

The aquatic resources of the Chehalis River in the vicinity of the WNP-3 site were described in the FES-CP (Section 2.7.2). Surveys of the site vicinity conducted since the FES-CP was issued are summarized in the ER-OL (Section 2.2.2). These studies included phytoplankton, periphyton, macrophytes, zooplankton, benthic macroinvertebrates, river and tributary stream fishes, and counts and distribution of anglers using the river. There appear to have been no significant changes in the biotic community of the Chehalis River system in the site vicinity since the CP stage assessments that affect or alter the previous conclusions.

As discussed above, design changes in station's cooling system have occurred since the CP stage. Reductions in the intake and blowdown volume have reduced the potential for impacts to aquatic biota. The location of the discharge diffuser has been moved from near the south river bank to a position nearly midstream in the river (see Section 4.2.4 for details). Before the location of the diffuser was finally determined, in 1976 and 1977 the applicant conducted studies on the movements of salmon and steelhead in the river (Thorne et al., 1978). Ultrasonic tracking of coho salmon and steelhead during a year of low river flow (1976) and one with more typical flows (1977) found that the preferred migration routes tended to be near the river banks just upstream of the discharge area and for a downstream distance of about 610 m (2000 feet). Coho salmon showed a strong preference for the southern half of the river while they moved through the discharge area. The southern portion of the river near the south bank was the proposed location of the blowdown diffuser at the CP stage (Figure 4.6 above and FES-CP Figure 3.7). Studies conducted during 1978 and 1979 (WPPSS, Envirosphere, 1979 and 1980 and summarized in the ER-OL) showed that several species of fishes and the young of some species (e.g., dace, shiners, largemouth bass) were collected more frequently in the shallow near-shore areas of the river (see Section 5.5.2.2).

Fisheries

Fisheries in the WNP-3 site vicinity were discussed briefly in the FES-CP (Section 2.7.2.4). The ER-OL (Section 2.1.3 and RQ 291.02, 291.04, 470.05, 470.08) provides updated discussions of fisheries resources. The discussion

below summarizes recent information and includes harvest data compiled for NRC by the State of Washington Department of Fisheries and Department of Game.

Fishery harvests of the Chehalis River and Grays Harbor are dominated overwhelmingly by salmon (chinook, coho, chum) and steelhead trout, with recent annual harvests ranging to greater than 1,000,000 lbs (Tables 4.3, 4.4, and 4.5). Annual harvests of other species include green and white sturgeon (2000 to 69,000 lbs), sockeye salmon (50 to 100 lbs), and a small amount of other fish species and crabs.

Angler surveys were conducted by the applicant from December 1977 to March 1978 along a 15 to 16 km section of the Chehalis River between the South Elma Bridge (upstream of WNP-3) and the mouth of the Smith Canal near Montesano (downstream of the site) (Envirosphere, 1978). Boat and shore anglers were counted between 9 a.m. and 12:30 p.m. on weekdays, weekends, and holidays. During 1978 to 1981, surveys were conducted in the same area from 9 a.m. to 1 p.m., but only on weekdays (Envirosphere, 1982). Thus, the surveys subsampled the actual number of anglers present throughout a given fishing day or week.

The surveys do not reflect the significant amount of fishing done in tributaries to the river. The major months of salmon fishing were August through November,

Table 4.3 Commercial fishery harvests for Grays Harbor, Chehalis River, and Humptulips River (tributary to Grays Harbor) during 1974-1982 in lb*

Year	Grays Harbor and Chehalis River**	Humptulips River***	Total
1974	1,011,636	172,081	1,183,717
1975	465,878	162,565	628,443
1976	709,518	241,846	951,364
1977	462,235	38,665	500,900
1978	402,341	25,153	427,494
1979	154,031	20,868	174,899
1980	835,787	198,325	1,034,112
1981	631,762	124,464	756,226
1982	1,295,399	188,284	1,483,683

*To convert pounds to kilograms, multiply values shown by 0.454.

**Harvest includes salmon (chinook, chum, coho, sockeye), steelhead trout, white and green sturgeon.

***Harvest includes the above species except for sockeye salmon.

Source: Washington Department of Fisheries

Table 4.4 Recreational harvest of salmon for Grays Harbor and Chehalis River during 1979 and 1980*

Species	No. of fish	Mean weight per fish (lbs)	Estimated total weight (lbs)
		1979 Harvest	
Chinook (<24 inches)	414	4.0	1,656
Coho			
Adult	2,165	9.4	20,351
Juveniles	200	3.0	600
Subtotal	2,365	-	20,951
Total	2,779	-	22,607
		1980 Harvest	
Chinook (<24 inches)	1,880	4.0	7,520
Coho			
Adults	344	9.4	3,234
Juveniles	406	3.0	1,218
Subtotal	750	-	4,452
Total	2,630	-	11,972

*Harvest in numbers and mean weight of fish supplied to C. Hickey, NRC, by W. Young, Washington State Department of Fisheries, via telephone August 16, 1983. To change pounds to kilograms, multiply the values shown by 0.454.

Table 4.5 Recreational and commercial harvest of steelhead for Grays Harbor and Chehalis River

Year	Numbers of fish*		Estimated total weight (lbs), at mean weight of 8.0 lbs per fish***
	Recreational	Indian commercial harvest**	
1977-78	882	3,581	35,704
1978-79	447	3,355	30,416
1979-80	1,105	3,790	39,160
1980-81	319	3,393	29,696
1981-82	806	2,282	24,704
5-year mean	712	3,280	31,936

*Harvest in numbers of fish supplied to NRC by Gary Fenton, Washington State Department of Game, through an Energy Facility Site Evaluation Council letter of July 7, 1983 (M. E. Mills to A. Vietti). To change pounds to kilograms, multiply values shown by 0.454.
**Quinault Tribe and Chehalis Tribe.
***Mean weight of fish supplied to C. Hickey (NRC) by W. Young, Washington State Department of Fisheries, via telephone August 16, 1983.

Table 4.6 Fish planted in three creeks near WNP-3 site

Creek	No. of fish planted		
	Coho	Rainbow	Cutthroat
Fuller Creek			
1980	7,700	3,600	1,400
1981	8,820	1,800	3,200
1982*	7,700	5,000	-
Workman Creek			
1980	46,550	6,400	4,100
1981	48,804	3,700	6,400
1982*	42,000	10,000	-
Elizabeth Creek			
1980	18,550	-	-
1981	19,600	-	-
1982*	25,500	-	-

*1982 data on coho plantings supplied by the Washington Department of Fisheries (see Appendix A, page A-16); data on steelhead plantings supplied by Gary Fenton, Washington Department of Game, in a telephone conversation with C. R. Hickey, NRC, April 13, 1984.

with peaks in October. The mean number of anglers observed (during the morning surveys) ranged from about 2 to 18 a day during 1978 to 1981. Salmon fishing primarily was by boat (58 to 78% of all anglers). Anglers fishing from shore were concentrated in the area immediately downstream of the confluence of the Satsop and Chehalis Rivers where access is provided by the Fuller Bridge and the Union Pacific Railway tracks along the south bank of the Chehalis River. In early December, and lasting through March, angler emphasis shifted to steelhead trout, which were sought primarily from shore. The mean number of anglers observed during 1978 to 1981 ranged between 2 to 26 per day; the total number ranged from near zero to about 50 per day in the 1977 to 1978 survey. Angling was concentrated in the area downstream from the confluence of the Satsop and Chehalis Rivers, and near the mouths of Hyatt and Elizabeth Creeks. The average angler success for catching salmon is reported to be 0.055 to 0.065 fish per hour. This suggests that anglers expend (on the average) 15 to 18 hours of effort to catch a salmon. Angling success for steelhead is reported to be less than for salmon (e.g., more hours of effort expended per fish caught). Fish caught range between about 1 to 15 kg (2 to 30 lbs) with mean weights of about 9.1 kg (20.1 lbs) for adult chinook, 4.3 kg (9.4 lbs) for adult coho, and 5.6 kg (12.4 lbs) for chum salmon.

The Washington Department of Fisheries conducts a fish hatchery and planting program to supplement natural fish production and to ensure adequate production of fish for the state's user groups. Salmon and steelhead are planted annually into the Chehalis River and many of its tributaries. The number of coho salmon planted into the river from 1976 to 1981 ranged between about 29,000 and 402,000 yearling fish annually. Three creeks in the immediate WNP-3 site vicinity also have been planted with coho salmon by the Washington Department of Fisheries (Mills, 1983), and with rainbow trout and cutthroat trout by the Washington Department of Game (Envirosphere, 1982), as shown in Table 4.6. The plantings were a 3-year mitigation program to replace fish losses to the creeks resulting from construction-related erosion impacts during 1977-1978 (ER-OL Section 4 and Envirosphere, 1978).

4.3.5 Endangered and Threatened Species

4.3.5.1 Terrestrial

The FES-CP (page 2-30) lists 16 bird species that might occur on and near the site and access roads that are considered to be threatened by the State of Washington or U.S. Fish and Wildlife Services.

On July 6, 1983, the NRC staff, by letter (Knighton, 1983b), notified the U.S. Fish and Wildlife Service (FWS) regional office in Portland, Oregon, of the proposed licensing of WNP-3. The letter formally requested information on any Federally listed or proposed threatened or endangered plant or animal species in the vicinity of the project. The FWS responded on August 30, 1983 (Bottorff, 1983) that "to the best of our present knowledge there are no listed or proposed species occurring within the area of the subject project."

As part of NRC's environmental review, the staff asked the applicant for updated information of any sightings of bald eagles on or in the immediate vicinity of the site (Knighton, 1983a). The applicant's response (Bouchey, 1983) states that bald eagles were sighted during February, April, May, June, July, and September 1981 along the Chehalis River from river miles 15 through 24.

In addition the Washington Department of Game has identified two active nests. One, known as the "South Elma Nest," was established in 1982; it is on the north bank of the Chehalis River, near river mile 27, about 4.5 miles east-northeast of WNP-3. The other, the "Brady Loop Nest," has been active since 1979; it is located near the WNP-3 Ranney wells in the Greenbanks Slough area, about 3.5 miles west-northwest of the plant.

The U.S. Fish and Wildlife Service and the Washington State Department of Game list the bald eagle (Haliaeetus leucocephalus) as a threatened species (Washington, 1983).

4.3.5.2 Aquatic

As noted above, in July 1983 the NRC staff asked the FWS for information on any Federally listed or proposed threatened or endangered species near WNP-3. The FWS replied that no Federally listed or proposed species occur in the Chehalis River or other surface waters within the immediate WNP-3 site vicinity (Bottorf, 1983).

The State of Washington Department of Game does not list any fishes as threatened or endangered (Washington, 1983).

4.3.6 Community Characteristics

The socioeconomic descriptions of the area including demography, land use, and community characteristics in general are in Sections 2.1, 4.4, and 5.6 of the FES-CP. The WNP-3 site, located in southeastern Grays Harbor County, Washington, is approximately 1.6 km (1 mile) south of the Chehalis River, near its confluence with the Satsop River. The largest cities within 80 km (50 miles) of the site are Olympia and Aberdeen, Washington. Olympia, the state capital, had a 1980 population of 27,450 and is 41.6 km (26 miles) east of the site; Aberdeen, with a 1980 population of 18,739, is 25.6 km (16 miles) west of the site. The closest incorporated communities with populations exceeding 1000 are Elma (population 2720), approximately 6.4 km (4 miles) northeast of the site, and Montesano (population 3247), 9.6 km (6 miles) west-northwest. The applicant developed population figures within 16.1 km (10 miles) of the plant through field surveys of housing units (ER-OL, page 2.1-1). Table 4.7 shows the applicant's data for the 16.1-km area. With the exception of 5.6 km^2 (6 square miles) of Mason County, this area is composed of Grays Harbor County, which grew by more than 11% between 1970 and 1980. For population within 16.1 km to 80 km (10 to 50 miles), the applicant used an equal area approach to allocating 1980 census data at the enumeration district, census tract, and block levels, as shown in Table 4.8. Projections prepared by the applicant for 10-year periods from 1990 to 2030 were based on a number of sources, including county population forecasts prepared by the Washington State Office of Financial Management, the Bonneville Power Administration, and the U.S. Bureau of the Census, as well as on discussions with various regional planning agencies. These data are in ER-OL Table 2.1-2.

To evaluate the applicant's population data within 80 km (50 miles), the staff relied on the applicant's survey within 16 km (10 miles) as a method that has the potential for producing relatively accurate data. For projections of population data from 16 to 80 km, the staff used a computerized allocation model and U.S. Bureau of Economic Analysis growth factors. Table 4.9 presents the staff's population projections for the year 2010. An examination of these

Table 4.7 Population distribution within 0-10 miles in 1980*

Sector	0-1	1-2	2-3	3-4	4-5	5-10	Total
N	3	14	77	174	61	210	539
NNE	0	3	280	419	38	62	802
NE	0	11	13	716	1955	1462	4157
ENE	0	0	105	100	129	375	709
E	0	0	3	20	74	562	659
ESE	0	0	0	6	46	267	319
SE	0	0	3	0	0	119	122
SSE	0	0	0	0	0	0	0
S	0	0	0	0	0	0	0
SSW	0	0	0	0	0	17	17
SW	0	0	0	0	0	0	0
WSW	0	0	0	0	0	3	3
W	0	0	0	18	35	1748	1801
WNW	0	32	28	109	356	4214	4739
NW	0	31	84	477	53	0	645
NNW	0	12	204	116	59	259	650
Total	3	103	797	2155	2806	9298	15,162

Source: ER-OL, Table 2.1-2

*To change miles to km, multiply the values shown by 1.6.

Table 4.8 Population distribution within 10-50 miles in 1980*

Sector	10-20	20-30	30-40	40-50	Total
N	410	42	18	3	473
NNE	499	1019	1577	1817	4912
NE	1902	8680	5334	15247	31163
ENE	2292	26535	13321	223901	266049
E	406	34920	34345	11299	80970
ESE	2491	6231	2760	2438	13920
SE	1789	13210	12560	6619	34178
SSE	440	638	1465	2741	5284
S	562	444	396	1111	2513
SSW	811	1919	269	1349	4348
SW	436	4128	1056	2213	7833
WSW	147	684	1596	0	2427
W	30073	3937	4075	0	38085
WNW	1107	869	2255	73	4304
NW	430	667	46	749	1892
NNW	50	145	695	548	1438
Total	43845	104068	81768	270108	499789

Source: ER-OL, Table 2.1-2

*To change miles to km, multiply the values shown by 1.6.

Table 4.9 Population distribution within 0-50 miles in 2010*

Sector	0-10	10-20	20-30	30-40	40-50	Total
N	713	0	95	162	0	257
NNE	1306	0	3227	3011	434	6672
NE	5878	2636	19466	6186	19748	48036
ENE	1006	2926	35968	13794	220884	273572
E	892	692	39900	51198	9536	101326
ESE	438	3252	15604	6755	4768	30379
SE	179	1827	12527	18292	9890	42536
SSE	0	0	1971	1493	3358	6822
S	0	0	1079	0	1852	2931
SSW	23	2550	2196	1505	1581	7832
SW	0	0	5649	1616	2319	9584
WSW	3	0	2685	0	0	2685
W	3205	43233	3609	4714	0	51556
WNW	6406	0	0	3420	0	3420
NW	851	1927	1795	101	1055	4878
NNW	872	0	162	1185	442	1789
Total	21772	59043	145933	113432	275867	594275

*To change miles to km, multiply the values shown by 1.6.

data and ER-OL Table 2.1-2 indicates that the applicant's data are conservative from the staff's perspective.

The transient population in the area around the site is associated with educational and nursing institutions, logging operations and industrial facilities, and recreational activities. There are three school districts within 11.2 km (7 miles) of WNP-3: Satsop School District 104 (62 students; 6 staff members), Elma School District 68 (1734 students, 169 staff members), and Montesano School District 66 (1478 students, 101 staff members). Four nursing homes are within 11.2 km (7 miles) of the site, the largest being the Oakhurst Convalescent Center (6.4 km (4 miles) northeast) with 180 patients and 148 staff members. The nearest hospital, the Mark E. Reed Hospital, is approximately 17.6 km (11 miles) from the site; it is licensed for 26 beds, but has an average patient population of 11 and a staff of 55. Specifics regarding these and other facilities are listed in ER-OL Table 2.1-3.

With the exception of public employment, the largest employee categories are associated with logging and wood-related industries. The applicant estimates that the 40,000 ha (100,000 acres) of commercial forest within 16 km (10 miles) of the site can support approximately 120 employees during the course of 1 year. The four largest employers within 16 km (10 miles)--Elma Plywood, Ventron Corporation, Anderson Logging Company, and Elma Cedar Products--employ an estimated 285 persons at their peak of operation. Elma Plywood (12.8 km (8 miles) northeast) is the largest employer at peak, accounting for 120 persons.

Opportunities for recreation also contribute to the generation of transient population. The applicant has estimated the peak number of big game and upland bird hunters within 16 km (10 miles) of the site. Hunting activities are primarily concentrated in areas to the south of the plant site (ER-OL, Figure 2.1-5). The applicant has also estimated the number of fishermen on the Chehalis River and its tributaries, and on the Satsop and Wynoochee Rivers (ER-OL, Table 2.1-5). Three recreational facilities within 14.4 km (9 miles) of the plant offer 98 camping sites, in addition to opportunities for boating, picnicing, swimming, hiking, and horseback riding. Camp Delezene, a year-round Boy Scout camp 4.8 km (3 miles) southeast of WNP-3, is used by an estimated 350 scouts in a 12-month period (ER-OL, pages 2.1-4 to 2.1-5).

Within 16 km of the plant site, land use is dominated by activities related to timber and agricultural production. From the southeast sector through the west-southwest sector out to 16 km (10 miles), virtually all land is devoted to timber production and logging. Although only a relatively small percentage of the land within 16 km contains soil that is suitable for intensive agriculture, agricultural activities are concentrated in the fertile bottom lands and floodplains of the Chehalis and Satsop Rivers. Agricultural land has been under pressure in Grays Harbor County as a result of residential subdivision activity, particularly in the eastern, unincorporated portions of the county (ER-OL, pages 2.1-5 to 2.1-6). There are no plans for new or expanded industrial activity within the site area. Programs that do exist for stimulating nonresidential activities have focused on Grays Harbor as a deep water port and the exploitation of the region's natural resources (FSAR, page 2.2-3).

4.3.7 Historic and Archeological Sites

FES-CP Sections 2.3.1 and 2.3.2, respectively, describe historic and archeological sites. Information obtained since the issuance of the FES-CP consists of new surveys and the identification and retrieval of resources. The applicant retained professional archeologists to orient construction personnel, to conduct field reconnaissances, to monitor construction activities, and to recover, evaluate, and preserve cultural resource materials. During construction, 2 prehistoric and 21 historic sites were identified and documented. Work on two sites involved with the relocation of Keyes Road and the removal of farm buildings in the area of the water intake facilities resulted in the retrieval and preservation of materials. These materials were placed in the Washington Archeological Collections Repository in Pullman, and a few materials were released to WPPSS for display. Finally, the applicant has determined that within the vicinity of WNP-3 there are no properties listed or eligible for listing on the National Register of Historic Places (ER-OL, Section 2.6).

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5 ENVIRONMENTAL CONSEQUENCES AND MITIGATING ACTIONS

5.1 Résumé

This section evaluates changes in environmental impacts that have developed since the FES-CP was issued in June 1975. Section 5.2 describes operational impacts of the plant on the plant site. Section 5.3.1 discusses changes in the volumes and concentrations of wastes in plant effluents as a result of finalization of plant design and updated environmental data. Section 5.3.2 evaluates the impact of the cancellation of WNP-5 on water use, and Section 5.3.3 addresses effects on the Chehalis River floodplain. Section 5.5 evaluates the impacts of plant operation on both terrestrial biota and aquatic biota. Section 5.8 provides socio-economic impacts.

Information in Section 5.9 on radiological impacts has been revised to reflect knowledge gained since the FES-CP was issued. The material on plant accidents now contains information that has been revised and updated, including actual experience with nuclear power plant accidents beyond design-basis accidents and the lessons learned from the accident at Three Mile Island Unit 2. Information on the environmental effects of the uranium fuel cycle (Section 5.10), decommissioning (Section 5.11), and operational monitoring programs (Section 5.14) is provided.

5.2 Land Use

5.2.1 Plant Site

According to present plans, timber will be harvested only from the 336 ha (830 acres) for which the applicant has easement rights, as deemed appropriate by good forest management practice determined by the various owners. Those portions of the 551 ha (1,360 acres) used for temporary purposes (e.g., laydown areas) and not eventually utilized for power production or transmission will be revegetated. The State of Washington has required the applicant to develop a wildlife management plan for the portions of the site not directly used for power production. The applicant has notified the State of Washington that the submittal of a wildlife management plan will be deferred pending the resumption of construction activities (Sorenson, 1983). The plan should be submitted to the NRC for comment when it is submitted to the State.

The area designated "construction water wells and game mitigation land" on ER-OL Figure 2.2-1 will be under the direct control of the Washington State Department of Game as a wildlife management area.

The main access road to the nuclear generating station will be deeded to Grays Harbor County once construction is completed (figure accompanying ER-OL RQ 290.14).

5.2.2 Transmission Lines

Land use impacts from the operation of the two 1476-m (4841-foot) transmission lines are discussed in FES-CP Sections 5.1.2 and 5.5.1.2. No significant changes are expected from the impacts discussed at the CP stage of review.

5.3 Water

5.3.1 Water Quality

The FES-CP stated that chemical discharges from the plant, including chlorine, will be diluted to concentrations below those that might adversely affect aquatic biota (FES-CP Summary and Conclusions, Item 33). In addition, that review examined the potential toxicity of copper added by corrosion of condenser tubing. The review concluded that organisms in the river drifting past the diffuser would be subjected to the higher concentrations at the discharge and that some deleterious sublethal effects might be experienced.

Changes occurring since the CP review will reduce the discharge of toxic forms of chlorine and of copper. As noted in Section 4.3.2, provision has been made for dechlorinating by adding sulfur dioxide in proportion to the concentration of residual chlorine in the discharge. Sulfur dioxide dissolved in water reacts to form sulfurous acid. In reacting with oxidative chlorine compounds, chlorine is reduced to chloride ion and the sulfur leaves in the discharge as sulfate. As a result of reaction of the combined chlorine residuals (that is, the chloramines) with sulfurous acid, ammonium sulfate is formed. Reactions are very rapid, contributing to the expectation that toxic forms of chlorine will not be discharged at toxic concentrations. At the time of the CP review, it was anticipated that there would be no discharges when chlorine concentration exceeded 0.03 mg/l. Dilution and reaction in the river was expected to reduce residual concentration below potentially toxic levels. The addition of dechlorination equipment will allow higher concentration of chlorine within the circulating water system, thereby achieving more effective biofouling control. Dechlorination will keep the discharge concentration below 0.02 mg/l. The impact will not exceed that determined at the time of the CP review.

As noted in Section 4.2.6.3, the condensers are now to be tubed with stainless steel rather than copper-nickel. With this change, the major source of copper addition by the plant is eliminated. Discharge concentrations will range from 21.5 to 61.3 μg/l instead of the 230 μg/l evaluated at the CP stage.

In 1976, the State of Washington issued an NPDES Discharge Permit for WNP-3 that, among other things, limited the concentrations of copper in the station discharge to 1.3 μg/l. Estimates of the average concentration of the copper in the Chehalis River range from 4 μg/l to 13 μg/l. Thus, discharge from the station under the terms of the 1976 permit would have been difficult. On August 18, 1978, WPPSS filed a petition with the State for a modification to that discharge permit. The State examined the issue of copper toxicity to salmonid and other fish species in the Chehalis River and concluded that the fish would be adequately protected by allowing a discharge concentration of copper at a maximum of 65 μg/l during the first 180 days of station operation and at 30 μg/l thereafter. Additionally, during the months of August, September, and

October the limit is 30 μg/l, if the startup period should include these months (State Order Number 568, October 8, 1979). These are the limits in the current NPDES Discharge Permit (see Appendix G).

The basis for the State determination that a 65-μg/l limit would provide adequate protection during startup was that a dilution of the discharge of at least 20 to 1 would occur before the effluent encountered areas or routes of biological significance. At a background concentration of 4 μg/l, a 20-to-1 dilution would provide a copper concentration that is believed to be a level that has no effect on the salmonid species. More recent studies found the background concentrations of copper to average 2 μg/l (see Table 4.2).

The State required that the applicant perform bioassay studies to determine the adequacy of the requirements for copper and for zinc. The applicant completed the studies in September 1983 and submitted the draft report (Davis et al., 1983) to the State. The Energy Facility Site Evaluation Council has reviewed and accepted the study (by resolution during March 1984) as having satisfied General Condition G.29 of the NPDES Permit for WNP-3. The study found that the long-term, no-effect levels for exposure to copper and zinc in the Chehalis River were: 18 μg/l of copper and 220 μg/l of zinc for coho salmon; and 24 μg/l of copper and 59 μg/l of zinc for steelhead trout. The no-effect level of 7 μg/l of copper noted in the DES is, therefore, conservatively low. The State-allowable discharge concentrations of 65 μg/l and 30 μg/l of copper appear to be adequate, given dilution with river flows.

5.3.2 Water Use

FES-CP Section 5.2 states that WNP-3 and WNP-5 would have some impacts on the local and regional surface water and groundwater. No adverse impacts were expected to the tidal portion of the Chehalis River. The consumptive withdrawal of approximately 1.7 m^3/sec (60 ft^3/sec) was expected to lower the river level near the plant during low flow conditions and cause some elimination of riffle flow in a shallow area known as "Green Banks." Withdrawal from the Ranney collectors was also expected to cause drawdown of Elizabeth Creek and the adjacent marsh, causing it to become dry during low flow periods.

With the cancellation of WNP-5, water use has been approximately cut in half. The above-stated impacts of water use will be appreciably smaller because of the diminished water use.

5.3.3 Other Hydrologic Impacts

Construction of the site had already begun at the time Executive Order 11988, Floodplain Management, was signed in May 1977. It is, therefore, the staff's conclusion that consideration of alternative locations for any of the structures identified as being in the floodplain is neither required or practicable. The 100-year flood discharge on the Chehalis River adjacent to the site, as determined by a study performed by the U.S. Army Corps of Engineers (COE), Seattle District, is 2209 m^3/sec (78,000 ft^3/sec). Estimated stages for this 100-year flood varied from 5.8 to 6.1 m (19 to 19.9 feet) msl for the preconstruction river geometry. The plant itself is located well above any conceivable flood on the Chehalis River. The only plant-related structures that could be affected by the 100-year flood would be the discharge structure, the Ranney well intake structures and associated bank protection, and a barge slip. These

structures are considered by the staff to be a relatively minor intrusion on the floodplain of the Chehalis River for which no alternatives are readily apparent. The only likely consequences of these plant-related features would be a small loss in habitat. The applicant calculated the maximum increase in post-construction 100-year flood levels because of these structures to be about 0.1 m (0.2 feet). The staff concurs in this evaluation.

Figure 5.1 shows the preconstruction floodplain including the various plant-related features that would be within its limits.

5.4 Air Quality

5.4.1 Fog and Ice

The impacts of the operation of the natural draft cooling tower, as described in the FES-CP (NUREG-75/009), are still applicable relative to the potential occurrence of ground fog or icing.

5.4.2 Other Emissions

Nonradioactive emissions from the plant, excluding cooling tower emissions, will include exhaust gases from the monthly testing of diesel engines. This testing, which is planned for 2 hours a month, will produce limited amounts of NO_x, S, and ash, and should not contribute significantly to regional air pollution, as described in the annual report of the Council on Environmental Quality for the year 1978 (CEQ, 1978).

5.5 Terrestrial and Aquatic Resources

5.5.1 Terrestrial Resources

The staff presently foresees no significant adverse impact of plant operation on terrestrial biota of the plant site or on lands required for access and support facilities. However, uncertainty exists as to the effects of salt drift from the cooling tower on the vegetation. The results of modeling salt drift are presented in ER-OL Figure 5.1-4. The predicted highest annual deposition (50 kg/ha or 45 lb/acre) beyond 457 m (1500 feet) from the tower occurs on forested land outside the area cleared for construction (ER-OL, RQ 290.13). Because of the importance of this area for timber and the uncertainty of the effect of drift, a monitoring program will be required (see Section 5.14.2 below).

Although not a result of plant operation, detrimental impacts to the terrestrial ecology of the site will occur from logging operations (see Section 5.2.1). As a consequence, the applicant will implement a wildlife management plan. This plan must be approved by the State of Washington and the NRC and will help minimize the detrimental impacts of logging.

5.5.2 Aquatic Resources

The impacts of WNP-3 operation on aquatic resources of the Chehalis River system were considered and assessed in the FES-CP (Sections 5.5.2, 10.1,2, and 10.2.2) and in the Atomic Safety and Licensing Board's Partial Initial Decision

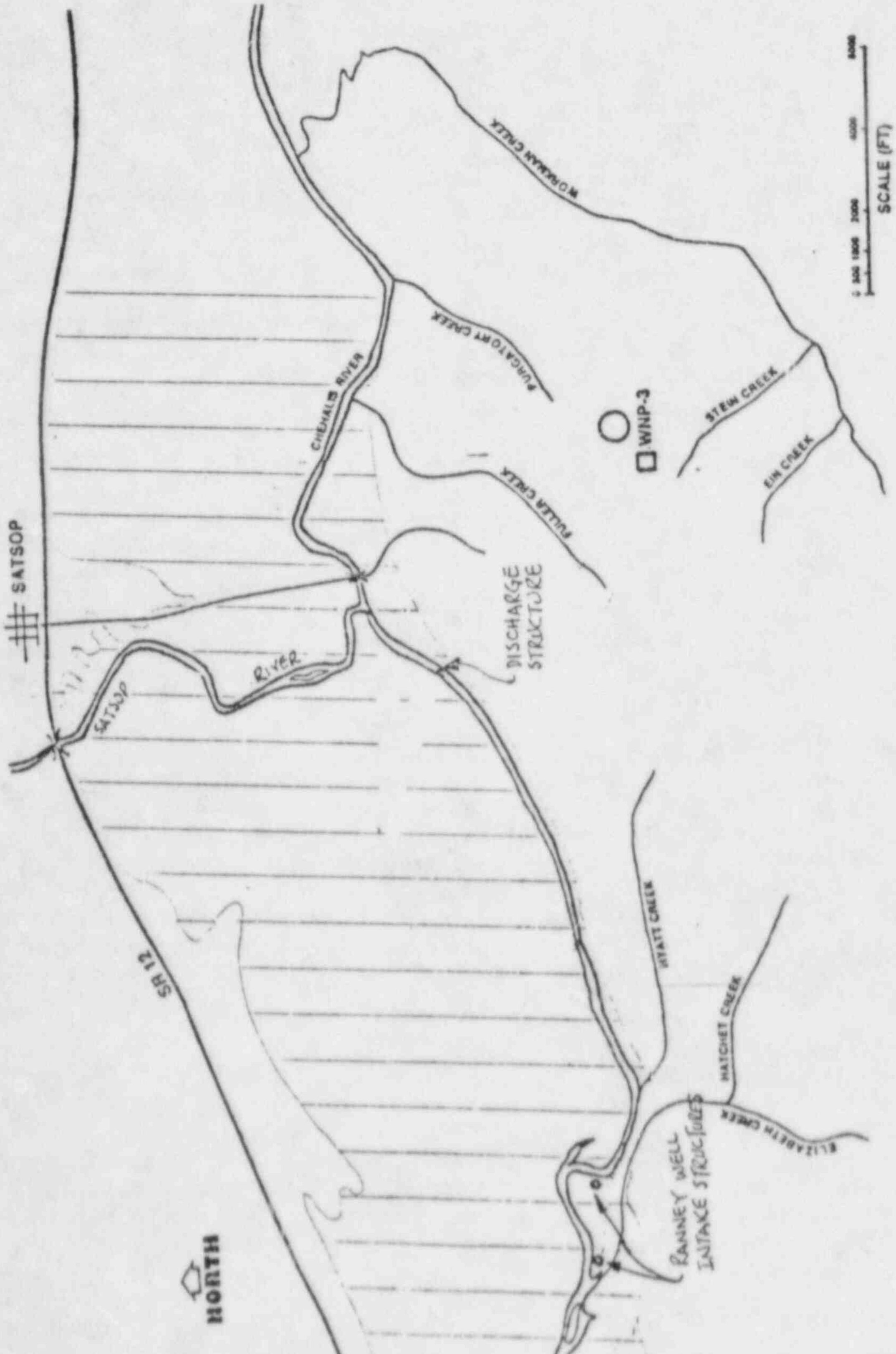

Figure 5.1 100-year floodplain

of April 8, 1977 (LBP-77-25, 5 NRC 964 (1977)). Both those assessments examined the impact potential to the Chehalis River system from operation of two units. Construction of WNP-5 has been terminated since those CP-stage reviews, thus reducing the makeup and blowdown volumes. Other design changes have been made in the location of the blowdown diffuser and its discharge ports (see Section 4.2.4 of this report). The major findings of the FES-CP and the ASLB decision are summarized in this section and updated based upon the recent design changes. Findings by the State of Washington on the impacts to the river system also are summarized below.

5.5.2.1 Intake Effects

FES-CP Section 5.5.2.1 and ASLB Finding No. 49 (5 NRC 982) state that impingement and entrainment of aquatic biota should be eliminated by use of the subsurface Ranney well system. Because no substantive changes have occurred in this regard, these conclusions and findings remain valid.

At the CP stage of review, the staff found that aquatic biota will be impacted because water withdrawal by the Ranney wells will result in a lowering of water levels in the adjacent river and in Elizabeth Creek near its confluence with the river (FES-CP Sections 5.5.2.1 and 10.1.2.1; ASLB Finding No. 47, 5 NRC 982). This drawdown that was projected could have stressed and/or killed salmonid fishes in the creek and benthic organisms in the river during natural low flow conditions. It was estimated that the salmonid loss as the result of drawdown would be a maximum of about 0.1% of the total estimated annual number of coho and chum salmon migrating past the site. This loss was considered to be small and acceptable.

However, because WNP-5 was cancelled, makeup water requirements have been reduced by about 44%. This has reduced the amount of drawdown that will occur during operation of WNP-3, with a consequent reduction in the impact potential to creek and river biota. The State of Washington has imposed limitations on the withdrawal of water in its Site Certification Agreement of October 1982 (see Section 4.3.2 of this report); the applicant has arranged for downstream release of water to mitigate consumptive losses (see Section 4.2.4). These measures should serve to minimize effects from withdrawal, especially during the more critical low flow periods. Therefore, the conclusions and findings of the FES-CP and ASLB remain valid.

5.5.2.2 Thermal Discharge Effects

FES-CP Section 5.5.2.2 and ASLB Finding No. 54 (5 NRC 984) noted that during low river flows, some disorientation and temporary blockage of fish movements upstream may occur as a result of the effluent plume. It was anticipated that the largest percentage of migrating juvenile and adult anadromous fish will pass by the discharge site adjacent to the south bank. Because the diffuser was to be placed close to the south bank, there was an increased probability of confrontation with the plume, both by fishes and organisms in drift. However, because motile fish are capable of detecting temperature changes and should be capable of avoiding the higher plume temperatures, only a small proportion of the total population was expected to experience adverse effects.

Studies conducted since the FES-CP was issued substantiate the conclusions that migrating fishes use routes near the south river bank in the vicinity of the

blowdown diffuser (see Section 4.3.4.2 of this report). Since the FES-CP was issued, the applicant has utilized this information on preferred migration routes of salmonids and moved the location of the diffuser from near the south bank into the river, to about midstream. This substantially reduces the potential for interaction between migrating fishes and thermal discharges. The FES-CP conclusions that there will be minimal effects on migrating fishes as a result of disorientation and blockage by the plume remain valid.

FES-CP Section 5.3.2.2 and ASLB Finding No. 54 (5 NRC 984) noted that during some months (especially June through September), plume temperatures would be close to or exceed the tolerance level of several organisms. Some organisms unable to escape the plume in situations in which the temperature differential is great or the absolute temperatures are high will, no doubt, be affected. In the event of plant shutdown, some fishes may be killed by thermal shock; however, it was concluded that the thermal effluent would have a minimal effect upon aquatic life because only a small portion of the river would be affected and the difference between the temperature of the discharge and ambient river temperature would be small.

For protection of the aquatic environment, since the CP-stage review the State of Washington has imposed thermal limitations and imposed mixing zone requirements on the blowdown effluent in conjunction with issuance of an NPDES Permit for WNP-3 and WNP-5 (see Section 4.2.4 above and Appendix G). To ensure that there is compliance with the State's thermal criteria, WNP-3 will use a supplemental cold-side heat exchanger on an as-needed basis. This capability should ensure that the effluent temperature is within the acceptable range for important aquatic organisms. Additionally, there will be less interaction between fishes and the effluent because of (1) a reduction in effluent volume by more than 50% (as a result of the cancellation of WNP-5) and (2) relocation of the diffuser away from fish migratory paths. This further reduces the potential and probability for impact compared to that evaluated at the CP stage. The conclusions that there will be minimal effects on aquatic biota remain valid.

5.5.2.3 Conclusions

Assessments of the impacts of station operation on aquatic biota and fisheries of the Chehalis River system during the CP review found the impacts minimal and acceptable. The termination of WNP-5 has resulted in reduced station requirements for makeup water and a lowering of blowdown volume. Design changes in the effluent diffuser location and in the supplemental cooling system have reduced further the potential for impact. The State of Washington has established limitations upon water withdrawals and discharges and defined an allowable effluent mixing zone for protection of water quality and aquatic biota. Thus, the conclusions of minimal impact of WNP-3 operation remain valid.

5.6 Endangered and Threatened Species

5.6.1 Terrestrial

The staff expects station operation to have little or no impact on the bald eagle, which is a Federal and state listed threatened species. Although the Ranney wells are located near a bald eagle's nest (Section 4.3.5), these wells protrude only about 20 feet above the floodplain. Collision with cooling towers

or other buildings is not likely because bald eagles have keen eyesight and fly mostly along the river, away from where these structures are located. The potential that bald eagles would be electrocuted because they touch two conductors at the same time is negligible because eagles have wing spans from 1.9 to 2.4 m (6 to 8 feet), while the minimum vertical spread distance between phase lines of a given structure will be 3 m (10 feet) and the horizontal spread will be 9.1 m (30 feet).

5.6.2 Aquatic

There are no threatened or endangered aquatic species in the WNP-3 site vicinity (see Section 4.3.5.2); therefore, no impacts will result from facility operation.

5.7 Historic and Archeologic Impacts

As stated in Section 4.3.7, there are no properties listed or eligible to be listed in the National Register of Historic Places in the vicinity of WNP-3. The staff therefore concludes that no known or anticipated historic or archeological resources will be adversely affected by operation and maintenance of the station. The conclusion is consistent with the opinion of the State of Washington, Office of Historic Preservation (see Appendix H).

5.8 Socioeconomic Impacts

The socioeconomic impacts of station operation are analyzed in Sections 5.6 and 10.4 of the FES-CP. Changes that have occurred since the issuance of the FES-CP include an increase in the estimated operating work force to 514 people; of this total, 470 would be WPPSS employees (including security personnel) and 44 would be employees of contractors. The work force is estimated to have a payroll of $20,560,000, assuming an initial average salary of $40,000* (ER-OL, page 8.1-1 and RQ 310.01). The applicant has projected a buildup of operating workers over a 5-year period, reaching a total of 514 (ER-OL, RQ 310.05). The applicant also expects that nearly all the operating staff will reside in communities throughout the Aberdeen to Olympia area (ER-OL, page 8.1-1). Because of the gradual buildup of staff and dispersed residential locations, the staff concludes that local public and private services and facilities will have an opportunity to adjust to increased demands and that such demands will not be significant.

The applicant will make some local purchases of fuel and other materials and services (ER-OL, page 8.1-1). The staff expects that such purchases will be small compared to the size of the local economy and will not be a significant impact.

Tax payments are considered as indirect benefits of the station's operation because they are transfer payments. Although the publicly owned portion of WNP-3 will not be subject to local real estate taxes, the investor-owned utilities that own 30% of the plany will pay an estimated $5.7 million in property

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*All dollar values for costs and benefits are escalated costs for the first full year of operation. The assumed cost escalation until the first year of operation is 8% per year.

taxes. The Elma School District, Grays Harbor County, and the City of Aberdeen will be major beneficiaries (ER, RQ 310.04). The applicant also estimates that a privilege tax on the publicly owned portion of the plant will pay approximately $1.0 million per year (in current dollars); of this, 62% would be returned to local taxing jurisdictions. Sales tax revenues on local purchases by the applicant will yield an additional $2.0 million. Finally, purchases by operating workers will result in approximately $465,000 in sales taxes, assuming a 5% sales tax and a 45% capture rate for retail sales in the state (ER-OL, page 8.1-1). The staff anticipates no other significant socioeconomic impacts from station operation.

5.9 Radiological Impacts

5.9.1 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 of 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 continuously present in an area, 2 mrems in any 1 hour 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, there are recorded in 10 CFR 50.36a license requirements 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, 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/year to the total body or 10 mrems/year to any organ from all pathways of exposure from liquid effluents; 10 mrads/year gamma radiation or 20 mrads/year beta radiation air dose from gaseous effluents near ground level--and/or 5 mrems/year to the total body or 15 mrems/year to the skin from gaseous effluents; and 15 mrems/year 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 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 20.

In addition to the impact created by facility radioactive effluents as discussed above, within the NRC policy and procedures for environmental protection described in 10 CFR 51 there are generic treatments of environmental effects of all aspects of the uranium fuel cycle. These environmental data have been summarized in Table S-3 and are discussed later in this report in Section 5.10. In the same manner the environmental impact of transportation of fuel and waste to and from an LWR is summarized in Table S-4 and presented in Section 5.9.3 of this report.

Recently an additional operational requirement for uranium fuel cycle facilities including nuclear power plants was 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 all fuel-cycle facility contributions that may impact a specific individual in the public (see Section 5.9.3.2).

5.9.2 Operational Overview

During normal operations of WNP-3, small quantities of radioactivity (fission, corrosion, and activation products) will be released to the environment. As required by NEPA, the staff has determined the estimated dose 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. Radioactive-waste management systems are incorporated into the plant and are designed to remove most of the fission-product radioactivity that is assumed to leak from the fuel, as well as most of the activation and corrosion-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 areas outside the plant boundaries are to be recorded and published semiannually in the Radioactive Effluent Release Reports for the facility.

Airborne effluents will diffuse in the atmosphere in a fashion determined by the meteorological conditions existing at the time of release and are generally dispersed and diluted by the time they reach unrestricted areas that are open to the public. Similarly, waterborne effluents will be diluted with plant waste water and then further diluted as they mix with the Chehalis 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 liquid effluent stream outside of the plant boundaries, 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% 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 satisfies 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 the WNP-3 plant, 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's 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 WNP-3.

5.9.3 Radiological Impacts from Routine Operations

5.9.3.1 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 schematically in Figure 5.2. 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 by 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 20 years after the station begins operation. (Calculation for the 20th 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 humans that are appropriate to be studied to determine the impact of routine releases from WNP-3 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 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. The only major consumers of groundwater located downstream of the plant are the municipal water systems of Montesano and Central Park. However, the wells serving these communities are located away from the Chehalis River so any potential contamination of Chehalis River water would not affect these groundwater supplies. Montesano, which is about 8 km (5 miles) from the plant on the opposite side of the Chehalis River, is served by two wells which are located northeast of the Wynoochee River about 2.4 km (1.5 miles) from the Chehalis. Central Park, which is about 8 km west of Montesano, is also served by two wells. Both of these wells are located about 1.6 km (1 mile) from the Chehalis River.

Surface water is not a pathway of concern because there are no drinking water intakes on the river downstream of the plant.

Calculations of the effects for most pathways are limited to a radius of 80 km (50 miles). This limitation is based on several facts. Experience, as demonstrated by calculations, has shown that all individual dose commitments

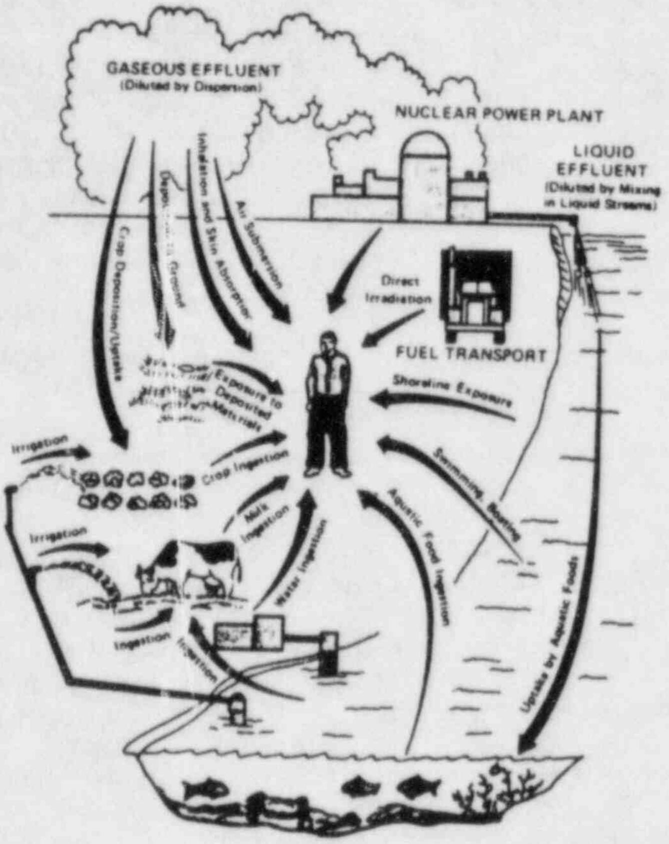

Figure 5.2 Potentially meaningful exposure pathways to individuals

(>0.1 mrem/year) 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/year, 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.

5.9.3.1.1 Occupational Radiation Exposure for Pressurized Water Reactors (PWRs)

Most of the dose to nuclear plant workers results from external exposure to radiation coming from radioactive materials outside of the body rather than from internal exposure 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 PWRs. Recently licensed 1000-MWe PWRs 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, in Chapter 12 of the NRC Standard Review Plan (NUREG-0800), and in 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 SERs. 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 270 PWR reactor years of operation is available for those plants operating between 1974 and 1981. (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 PWRs has been about 500 person-rems, although some plants have experienced annual collective doses averaging as high as about 1400 person-rems over their operating lifetime (NUREG-0713, Vol 3). These dose averages are based on widely varying yearly doses at PWRs. For example, for the period mentioned above, annual collective doses for PWRs have ranged from 18 to 3223 person-rems per reactor. However, the average annual dose per nuclear plant worker of about 0.8 rem (ibid) 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/year, or 1.25 rems/quarter if it is not.

The wide range of annual collective doses experienced at PWRs 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 on occasion be a 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 WNP-3 are based on the assumption that the facility will experience the annual average occupational dose for PWRs to date. Thus the staff has projected that the collective occupational doses at WNP-3 will be 500 person-rems, but annual collective doses could average as much as 3 times this value over the life of the plant.

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 5.1 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 Section 5.9.3.2) 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 220 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 and BEIR III. 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 4 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 there may be biological mechanisms that can repair damage caused by radiation at low dose and/or dose rates. The number of potential nonfatal cancers would be approximately the same as the number of potential fatal cancers, according to the 1980 report of the National Academy of Sciences Committee on the Biological Effects of Ionizing Radiation (BEIR III).

Values for genetic risk estimators range from 60 to 1100 potential cases of all forms of genetic disorders per million person-rems (BEIR III). The value of 220 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.

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, 1982).

The risk of potential fatal cancers in the exposed work-force population at WNP-3 is estimated as follows: multiplying the annual plant-worker-population dose (about 500 person-rems) by the somatic risk estimator, the staff estimates that about 0.06 cancer death may occur in the total exposed population. The value of 0.06 cancer death means that the probability of 1 cancer death over the lifetime of the entire work force as a result of 1 year of facility operation is about 6 chances in 100. The risk of potential genetic disorders attributable to exposure of the work force is a risk borne by the progeny of the

Table 5.1 Incidence of job-related mortalities

Occupational Group	Mortality Rates (premature deaths per 10^5 person-years)
Underground metal miners*	~1300
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

*The President's Report on Occupational Safety and Health, "Report on Occupational Safety and Health by the U.S. Department of Health, Education, and Welfare," E. L. Richardson, Secretary, May 1972.

**U.S. Bureau of Labor Statistics, "Occupational Injuries and Illness in the United States by Industry, 1975," Bulletin 1981, 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 R. Wilson and E. S. Koehl, "Occupational Risks of Ontario Hydro's Atomic Radiation Workers in Perspective," presented at Nuclear Radiation Risks, A Utility-Medical Dialog, sponsored by the Inter national Institute of Safety and Health in Washington, D.C., September 22-23, 1980. (Note that the estimate of 11 radiation-related premature cancer deaths describes a potential risk rather than an observed statistic.)

entire population and is thus properly considered as part of the risk to the general public.

5.9.3.1.2 Public Radiation Exposure.

Transportation of Radioactive Materials

The transportation of "cold" (unirradiated) nuclear fuel to the reactor, of spent irradiated fuel from the reactor to a fuel reprocessing plant, and of solid radioactive wastes from the reactor to waste burial grounds is considered in 10 CFR 51.52. 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 51.52, reproduced herein as Table 5.2. 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 PWRs

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. Direct radiation from sources within the plant is due primarily to nitrogen-16, a radionuclide produced in the reactor core. Because the primary coolant of a PWR is contained in a heavily shielded area, dose rates in the vicinity of PWRs are generally undetectable (less than 5 mrems/year).

Low-level radioactivity storage containers outside the plant are estimated to make a dose contribution at the site boundary of less than 1% of that resulting from the direct radiation from the plant.

Radioactive-Effluent Releases: Air and Water

Limited quantities of radioactive effluents will be released to the atmosphere and to the hydrosphere during normal operations. Plant-specific radioisotope-release rates were developed on the basis of estimates regarding fuel performance and descriptions of the operation of radwaste systems in the applicant's FSAR, and by using the calculative models and parameters described in NUREG-0017.

These radioactive effluents are then diluted by the air and water into which they are released before they reach areas accessible to the general public.

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 the radioactivated gas argon, do not deposit on the ground nor are they 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.

Table 5.2 (Summary Table S-4) Environmental impact of transportation of fuel and waste to and from one light-water-cooled nuclear power reactor[1]

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. I, 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 $5.45 (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.

Another group of airborne radioactive effluents--the fission product radioiodines, as well as carbon-14 and tritium--are also gaseous, but these tend to be deposited on the ground and/or inhaled into the body during breathing. For this class of effluents, estimates 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 are made. Concentrations of iodine in the thyroid and of carbon-14 in bone are of particular interest.

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 strontium 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 and corrosion products, such as nuclides of sodium, iron, and cobalt; and tritium 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 rates 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 via 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 Revision 1 of RG 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" (October 1977), 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, and 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's 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.

5.9.3.2 Radiological Impact on Humans

Although the doses calculated in Appendix D are based primarily on radioactive-waste-treatment-system capability and are below the Appendix I 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 WNP-3 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 to natural background doses (~100 mrems/year) or the dose limits (500 mrems/year - 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 WNP-3 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 staff's position, as stated in NUREG-0543, is that as long as a nuclear plant operates at a level below the relatively more conservative Appendix I dose design objectives and reporting requirements, it is operating in compliance with 40 CFR 190. Therefore, the staff concludes that under normal operations, WNP-3 is capable of operating within these EPA 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 for decades been subject 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 WNP-3 are presented below.

The risk to the maximally exposed individual (see Section 5.9.2) is estimated by multiplying the risk estimators presented in Section 5.9.3.1.1 by the annual dose-design objectives for total-body radiation in 10 CFR 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 miles) of the reactor from exposure to radioactive effluents from the reactor is much less than the risk to the maximally exposed individual. These risks are very small in comparison to total cancer incidence from causes unrelated to the operation of WNP-3.

Multiplying the annual U.S. general public population dose from exposure to radioactive effluents and transportation of fuel and waste from the operation

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*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.

of this facility (that is, 81 person-rems) by the preceding somatic risk estimator, the staff estimates that about 0.011 cancer death may occur in the exposed population. The significance of this risk can be determined by comparing it to the total incidence of cancer death 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%), about 52 million cancer deaths are expected (American Cancer Society, 1978). For purposes of evaluating the potential genetic risks, the progeny of workers are considered members of the general public. However, according to ICRP Publication 26 (1977, paragraph 80), it is assumed that only about one-third of the occupational radiation dose is received by workers who have offspring after the radiation exposure. Multiplying the sum of the U.S. population dose from exposure to radioactivity attributable to the normal annual operation of the plant (that is, 81 person-rems), and one-third the estimated dose from occupational exposure (that is one-third of 500 person-rems) by the preceding genetic risk estimator, the staff estimates that about 0.05 potential genetic disorder may occur in all future generations of the exposed population. Because BEIR III indicates that the mean persistence of the two major types of genetic disorders is about 5 generations and 10 generations, in the following analysis the risk of potential genetic disorders from the normal annual operation of the plant is conservatively compared with the risk of actual genetic ill health in the first 5 generations, rather than the first 10 generations. Multiplying the estimated population within 80 km of the plant (~760,000 persons in the year 2000) by the current incidence of actual genetic ill health in each generation (~11%), about 420,000 genetic abnormalities are expected in the first 5 generations of the 80-km population (BEIR III).

The risks to the general public from exposure to radioactive effluents and transportation of fuel and wastes from the annual operation of the facility are very small fractions of the estimated normal incidence of cancer fatalities and genetic abnormalities. On the basis of the preceding comparison, the staff concludes that the risk to the public health and safety from exposure to radioactivity associated with the normal operation of the facility will be very small.

5.9.3.3 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, 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 BEIR Report (BEIR I) concluded

that evidence to date indicated that 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.

5.9.3.4 Radiological Monitoring

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. Secondarily, 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 generically in greater detail in RG 4.1, Revision 1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," and in the Radiological Assessment Branch Technical Position, "An Acceptable Radiological Environmental Monitoring Program." Revision 1, November 1979.*

5.9.3.4.1 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 ER-CP, and it was discussed in the FES-CP. This early program has been updated and expanded; it is presented in Section 6.1.5 of the applicant's ER-OL, and the applicant's summary Table 6.1-7 is reproduced here as Table 5.3.

The applicant states that the preoperational program will have been implemented at least 2 years before initial criticality of WNP-3 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 WNP-3 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, although the staff has noted several typographical errors on the applicant's Table 6.1-7 (Table 5.3 herein).

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*Available from the radiological Assessment Branch, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555.

Table 5.3 Reproduction of applicant's preoperational radiological environmental monitoring program summary table*

Sample Media	Location	Sampling Frequency[a]	Analysis Type	Analysis Frequency
Airborne				
Radioiodine[b] Particulates[c]	Samples from 5 locations: 3 samples from offsite in 3 different sectors having highest calculated annual average groundlevel D/Q	Continuous sampling with weekly collection	Radioiodine: ^{131}I	Weekly
	1 in the vicinity of community (Elma) having highest calculated annual average groundlevel D/Q		Particulates: Gross Beta[d]	Weekly
			Gamma Isotopic [e]	Weekly Composite by location, quarterly
	1 control in Chehalis, 30 miles SE of the site			
Direct Radiation[f]	A minimum of 40 stations as follows:	Quarterly and Annually	Gamma dose	Quarterly and Annually
	An inner ring of stations in each of 16 sectors in the general vicinity of the site boundary.			
	An outer ring of 16 stations in each sector in the range of four to five miles from the site.			
	The balance of the stations (8) in areas of special interest (e.g., population centers, schools) including 2 controls. One control near Chehalis approximately 30 miles SE and one near Aberdeen approximately 17 miles west.			

*Reproduced from the ER-OL (Table 6.1-7)

Table 5.3 (Continued)

Sample Media	Location	Sampling Frequency[a]	Analysis Type	Analysis Frequency
Waterborne				
River Water[c]	Upstream and downstream of the discharge	Composite[g] for month	^{3}H	Quarterly composite
			Gamma Isotopic[e]	
Groundwater[c]	Nearby resident domestic well	Quarterly grab sample	^{3}H	Quarterly
			Gamma Isotopic	Quarterly
Sediment[f]	1-3 miles downstream from discharge	Semi-annually	Gamma Isotopic	Semi-annually
Ingestion				
Milk[h]	4 locations as follows: Samples from 3 different locations within 3 miles distance having highest calculated dose potential	Semi-monthly during grazing season; monthly at other times	Gamma Isotopic[c] ^{131}I[b]	Semi-monthly; monthly
	A control to be collected near Chehalis			
Fish[f]	2 in vicinity of discharge.	Semi-annually	Gamma Isotopic (edible portion)	Semi-annually
	1 control - Wynoochee or Wishkah River			
Fruit and Vegetables[f]	1 sample of each principal food product from areas irrigated downstream and a control in the vicinity of Chehalis	Monthly during growing season	Gamma Isotopic	Monthly

Table 5.3 (Continued)

(a)Deviation may be required if samples are unobtainable due to hazardous conditions, seasonal availability, malfunction of automatic sampling equipment, or other legitimate reasons. All deviations will be documented in the annual report.

(b)Minimum six months preoperational sampling.

(c)Minimum one year preoperational sampling.

(d)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.

(e)Gamma isotopic means identifications and quantification of gamma emitting radionuclides that may be attributable to the effluents of the facility.

(f)Minimum of two years preoperational monitoring.

(g)Composite samples will be collected with equipment which is capable of collecting an aliquot at time intervals which are short relative to the compositing period.

(h)Milk samples will be obtained from farms or individual milk animals which are located in sectors with the higher calculated annual average ground-level D/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.

(i)Fruit and vegetables will be obtained, if possible, from farms or gardens which use Chehalis River water within ten miles of the discharge for irrigation and different varieties will be obtained in season. One sample each of root food, leafy vegetables, and fruit should be collected each period.

5.9.3.4.2 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 20 and 50. It assists and provides backup support to the effluent-monitoring program recommended in RG 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 preoperational program described above, with some periodic adjustment of sampling frequencies in expected critical exposure pathways. The proposed operational program will be reviewed before plant operation. Modification will be based upon 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.

5.9.4 Environmental Impacts of Postulated Accidents

5.9.4.1 Plant Accidents

The staff has considered the potential radiological impacts on the environment of possible accidents at the WNP-3 plant site, in accordance with the June 13, 1980, Statement of Interim Policy issued by the NRC. The discussion below reflects the staff's considerations and conclusions.

Section 5.9.4.2 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 the consequences should accidents 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 societal impacts associated with actions to avoid such health effects as a result of air, water, and ground contamination from accidents 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 the WNP-3 facility 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. Also described are the results of calculations for the WNP-3 site using probabilistic methods to estimate the possible impacts and the risks associated with severe accident sequences of exceedingly low probability of occurrence.

5.9.4.2 General Characteristics of Accidents

The term "accident," as used in this section, refers to any unintentional event not addressed in Section 5.9.3 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 permissible limits for normal operation. Normal release limits are specified in the Commission's regulations in 10 CFR 20 and 10 CFR 50, Appendix I.

There are several features that combine to reduce the risk associated with accidents at nuclear power plants. Safety features in 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 for the WNP-3 plant are in the applicant's FSAR. The most important mitigative features are described in Section 5.9.4.4(1) below.

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.

(1) <u>Fission Product Characteristics</u>

By far the largest inventory of radioactive material in a nuclear power plant is produced as a byproduct of the fission process and is located in the uranium oxide fuel pellets in the reactor core in the form of fission products. During periodic refueling shutdowns, the assemblies containing these fuel pellets are transferred to a spent-fuel storage pool so that the second largest inventory of radioactive material is located in this storage area. 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. Table 5.4 lists the inventories of radionuclides that could be expected in the WNP-3 reactor core.

These radioactive materials exist in a variety of physical and chemical forms. Their potential for dispersion into the environment depends 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 degradation of the fuel cladding, the release of substantial quantities of these radioactive gases from the fuel is a virtual certainty. Such accidents are low frequency but credible events (see Section 5.9.4.3). It is for this reason that the safety analysis of each nuclear power plant incorporates a hypothetical design-basis

Table 5.4 Activity of radionuclides in WNP-3 reactor core at 4100 MWt

Group/radionuclide	Radioactive inventory in millions 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	0.179
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 5.4 Activity of radionuclides in WNP-3 reactor core at 4100 MWt (Continued)

Group/radionuclide	Radioactive inventory in millions of curies	Half-life (days)
G. RARE EARTHS, REFRACTORY OXIDES AND TRANSURANICS		
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
Lathanum-140	210	1.67
Cerium-141	190	32.3
Cerium-143	170	1.38
Cerium-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 5.6.

accident that postulates the release of the entire contained inventory of radioactive noble gases from the fuel into the containment structure. If these gases were further released to the environment 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 structure 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 they may be quite volatile. For these reasons, they have traditionally been regarded as having a relatively high potential for release from the fuel. If the radionuclides are 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, the potential for release of radioiodines 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, so 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 contain large quantities of water as a result of an accident. 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 unless the temperature of the fuel becomes very high. By the same token, such materials, if they escape by volatilization from the fuel, tend to condense quite rapidly to solid form again when they are transported to a lower temperature region and/or dissolve in water when it is present. The former mechanism can result in production of 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 deposit on surface features by gravitational settling (fallout) or by precipitation (washout or rainout), where they will become "contamination" hazards in the environment.

All of these radioactive materials exhibit the property of radioactive decay with characterisitic half-lives ranging from fractions of a second to many days or years. Many of them decay through a sequence or chain of decay processes and all eventually become stable (nonradioactive) materials. The radiation emitted during these decay processes renders the radioactive materials hazardous.

(2) Exposure Pathways

The radiation exposure (hazard) to individuals is determined by their proximity to the radioactive materials, the duration of exposure, and factors that act to shield the individual from the radiation. Pathways for radiation and the transport of 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 5.2. There are two additional possible pathways that could be significant for accident releases that are not shown in Figure 5.2. One of these is the fallout onto open bodies of water of radioactivity initially carried in the air. 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 groundwater. These pathways may lead to external exposure to radiation and to internal exposure if radioactive material is contacted, 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, which 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 upon the weather conditions existing at the time.

(3) Health Effects

The cause-and-effect relationships between radiation exposure and adverse health effects are quite complex (CONAES, p. 515-34, 1979; Land, 1980), but these relationships have been more exhaustively studied than have the cause-and-effect relationships for any other environmental contaminant.

Whole-body radiation exposure resulting in a dose greater than about 10 rems for a few persons and about 25 rems 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, also received over a relatively short period of time (hours to a few days), can be expected to cause some fatal injuries. At the severe but extremely low probability end of the accident spectrum, exposures of these magnitudes are theoretically possible for persons in the close proximity of such accidents if measures are not or cannot be taken to provide protection, such as by sheltering or evacuation.

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 2 to 15 years (latent period) from the time of exposure 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 (that is, the plateau period is 10 years). The occurrence of cancer itself is not necessarily indicative of fatality. The somatic health consequences model currently being used is based on the 1972 BEIR Report (BEIR I). Most authorities agree that a reasonable--and probably conservative--estimate of the randomly occurring number of 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-rems. The range comes from the BEIR III Report (1980), 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-rems would be projected by BEIR III over succeeding generations. This is the estimate currently used by the NRC staff. (This value was computed as the sum of the risk of specific genetic defects and risk of defects with complex etiology (causes)).

(4) 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

(such as in soil), the hazard can continue to exist for a relatively long period of time--months, years, or even decades. Thus, a possible 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.

5.9.4.3 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 early 1983, there were 76 commercial nuclear power reactor units licensed for operation in the United States at 52 sites with power-generating capacities ranging from 50 to 1180 MWe. (WNP-3 is designed for an electric power output of 1240 MWe.) The combined experience with these operating units represents approximately 650 reactor-years of operation over an elapsed time of about 22 years. Accidents have occurred at several of these facilities (Bertini, 1980; NUREG-0651; Thompson and Beckerley, 1964). Some of these accidents 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, nor any significant individual or collective public radiation exposure, nor any significant contamination of the environment. This experience does not provide a large enough base for a reliable statistical inference. It does, however, suggest that significant environmental impacts caused by 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 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 (mostly xenon-133), it has been estimated that approximately 15 curies of radioiodine were also released to the environment at TMI-2 (Rogovin, 1980). This amount represents a minute fraction of the total radioiodine inventory present 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 millirems (Rogovin, 1980; President's Commission, 1979). The total population exposure has been estimated to be in the range from about 1000 to 5000 person-rems (this range is discussed on page 2 of NUREG-0558). This exposure could produce between no 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-rems, and approximately a half-million cancers are expected to develop in this group over its lifetime (Rogovin, 1980; President's Commission, 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 nuclear power plants have also caused occupational injuries and a few fatalities but none attributed to radiation exposure. Individual worker exposures have ranged up to about 4 rems as a direct consequence of reactor accidents (although there have been higher exposures to individual workers as a result of other unusual occurrences). However, the collective worker exposure levels (person-rems) are a small fraction of the exposures experienced during normal routine operations; these exposures 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; Thompson and Beckerly, 1964). 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 one in 1966 at Enrico Fermi Atomic Power Plant Unit 1. Fermi Unit 1 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 after the accident. It operated successfully and completed its mission in 1973. The Fermi 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 (United Kingdom, 1957). 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 (characteristic of a graphite-moderated 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 518-km^2 (200-mi^2) area around the facility was impounded for up to 44 days. The United Kingdom National Radiological Protection Board (Crick and Linsley, 1982) estimated that the releases may have caused as many as 260 cases of thyroid cancer, about 13 of them fatal, and as many as 7 deaths from other cancers or hereditary diseases. This kind of accident cannot occur in a water-moderated-and-cooled reactor like WNP-3, however.

5.9.4.4 Mitigation of Accident Consequences

Pursuant to the Atomic Energy Act of 1954, the staff has conducted a safety evaluation of the WNP-3 construction permit application. Although this evaluation contains more detailed information on plant design, the principal design features are presented in the following section.

(1) <u>Design Features</u>

The WNP-3 plant contains 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. 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 in the assessments discussed in Section 5.9.4.4.

The WNP-3 design incorporates a reinforced concrete shield building surrounding a free-standing steel containment structure. The steel containment structure is a passive mitigating feature that is designed to minimize accidental radioactivity releases to the environment. The concrete shield building provides an additional means of collecting fission products that may leak from the steel containment. Safety injection systems are incorporated to provide cooling water to the reactor core during an accident to prevent or minimize fuel damage. The containment spray system is designed to spray cool water into the containment atmosphere. The operation of the spray system after a loss-of-coolant accident (LOCA) would prevent containment system overpressure by quenching the steam generated as a

result of reactor coolant flashing into the containment atmosphere. The spray water also contains an additive (sodium hydroxide) that will chemically react with any airborne radioiodine to remove it from the containment atmosphere and prevent its release to the environment. The mechanical systems mentioned above are supplied with emergency power from onsite diesel generators if normal offsite station power is interrupted.

The fuel-handling area located in the fuel building also has accident mitigating systems. The ventilation system contains both charcoal and high efficiency particulate filters. This ventilation system is also designed to keep the area around the spent-fuel pool below the prevailing barometric pressure during fuel-handling operations to prevent exfiltration through building openings. If radioactivity were to be released from the building, it would be drawn through the ventilation system and most of the radioactive iodine and particulate fission products would be removed before exhausting to the environment.

There are features of the plant that are necessary for its power-generation function that can also play a role in mitigating certain accident consequences. For example, the main condenser, although not classified as an ESF, can act to mitigate the consequences of accidents involving leakage from the primary to the secondary side of the steam generators (such as steam generator tube ruptures).

If normal offsite power is maintained, the ability of the plant to send contaminated steam to the condenser instead of releasing it through the safety valves or power-operated relief valves can significantly reduce the amount of radioactivity released to the environment. In this case, the fission-product-removal capability of the normally operating water-processing system would come into play.

Much more extensive discussions of the safety features and characteristics of the WNP-3 plant are found in the applicant's FSAR. The staff evaluation of these features will appear in the Safety Evaluation Report being prepared by the staff.

The implementation of the lessons learned from the TMI-2 accident--in the form of improvements in design, procedures, and operator training--will significantly reduce the likelihood of a degraded core accident that could result in large releases of fission products to the containment. Specifically, the applicant is expected to follow the guidance on TMI-related matters in NUREG-0737. Some credit has been taken in this evaluation for these actions and improvements in establishing the radiological risk of accidents at the WNP-3 plant.

(2) <u>Site Features</u>

The NRC's reactor site criteria, 10 CFR 100, require that the site for every power reactor have certain characteristics that tend to reduce the risk and potential impact of accidents. The discussion that follows briefly describes the WNP-3 site characteristics and how they meet these requirements.

First, the site has an exclusion area, as required by 10 CFR 100, that is a circular area with a minimum 1310-m (4300-foot) radius measured from the center of the reactor containment building. WPPSS owns approximately 551 ha (1360 acres) of the site in which the exclusion area is located. The rest of the site area is owned by private corporations or individuals, but is under the control of WPPSS through agreements with these owners. These agreements provide easements to the land. All of the mineral rights in the site area will be either owned

or controlled by WPPSS. There are no persons who live within the exclusion area. The only activities unrelated to plant operations that occur within the exclusion area are those associated with tree farming and transmission line maintenance. Approximately 30 persons and associated temporary structures and facilities may be located within the exclusion area from time to time to conduct timber farming activities. These activities are subject to approval by WPPSS. Also, personnel from the Bonneville Power Administration (BPA), by agreement with WPPSS, will be conducting maintenance in the BPA transmission corridor that falls within the exclusion area. There are no railroads, waterways, or highways traversing the exclusion area. The only vehicular traffic is on the access roads leading to the plant and the BPA corridor. In case of an emergency, arrangements have been made to limit access and to control the activity and evacuation of everyone in the exclusion area.

Second, beyond and surrounding the exclusion area is a low population zone (LPZ), also required by 10 CFR 100. The LPZ for the WNP-3 site is a circular area with a 4.8-km (3-mile) radius measured from a point centered on a line midway between Unit 3 and the previously planned Unit 5. Except for the Chehalis and Satsop Rivers, the LPZ consists mostly of wooded areas. There is some limited recreational activity on the rivers. Within the LPZ, the applicant must ensure that there is a reasonable probability that appropriate protective measures could be taken on behalf of the residents and other members of the public in the event of a serious accident. The applicant has indicated that there were about 906 persons residing in the LPZ in 1980, and projects the population will increase to 1506 by the year 2030. In case of a radiological emergency, the applicant has made arrangements to carry out protective actions, including evacuation of personnel in the vicinity of the WNP-3 nuclear plant. (See also the following section on Emergency Preparedness.)

Third, 10 CFR 100 also requires that the distance from the reactor to the nearest boundary of a densely populated area containing more than about 25,000 residents be at least one and one-third times the distance from the reactor to the outer boundary of the LPZ. Because accidents of greater potential hazards than those commonly postulated are conceivable although highly improbable, it was considered desirable to add the population center distance requirements in 10 CFR 100 to provide for protection against excessive doses to people in large centers. The cities of Aberdeen and Hoquiam, located approximately 26 km (16 miles) west of the plant, with a combined population of 35,170 in 1980, comprise the nearest population center. The distance from the site to the Aberdeen-Hoquiam area is at least one and one-third times the distance to the outer boundary of the LPZ. Olympia, the capital of Washington, is about 42 km (26 miles) east of the site and had a population of 27,447 in 1980. The largest city near the site is Tacoma, WA, located about 80 km (50 miles) northeast, with a 1980 population of 158,501. The population density within 48 km (30 miles) of the site when the plant is scheduled to go into operation (about 1986) is projected to be 66 persons per square mile, and is not expected to exceed 105 persons per square mile during the life of the plant.

The safety evaluation of the WNP-3 site has also included a review of potential man-made external hazards (activities off site that might adversely affect the operation of the nuclear plant and cause an accident). This review encompassed nearby industrial, transportation, and military facilities that might create explosive, missile, toxic gas, or similar hazards. The risk to the WNP-3 facility from such hazards has been found to be negligibly small. Compliance with

the Commission's siting criteria and both natural (e.g., earthquakes and floods) and man-made external hazards are discussed in more detail in the staff's Safety Evaluation Report.

(3) Emergency Preparedness

Emergency preparedness plans, including protective action measures for the WNP-3 facility and environs, are in an advanced but not yet fully completed stage. In accordance with the provisions of 10 CFR 50.47 and 10 CFR 50, Appendix E, effective November 3, 1980, no operating license will be issued to the applicant unless a finding is made by the NRC 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 miles) in radius and an ingestion exposure pathway EPZ of 80 km (50 miles) 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.

The NRC findings will be based (1) on a review of the Federal Emergency Management Agency (FEMA) findings and determinations as to whether state and local government emergency plans are adequate and capable of being implemented, and (2) on the NRC assessment as to whether the applicant's onsite plans are adequate and can be implemented. The NRC staff findings will be reported in the operating license SER. Although adequate and tested emergency plans cannot prevent the occurrence of an accident, it is the judgment of the staff that they can and will substantially mitigate the consequences to the public if one should occur.

5.9.4.5 Accident Risk and Impact Assessment

(1) Design-Basis Accidents

As a means of ensuring that certain features of the WNP-3 plant meet acceptable design and performance criteria, the applicant 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 the particular course taken by the accident and the conditions (including wind direction and weather) prevalent during the accident.

In the safety analysis and evaluation of the WNP-3 plant, three categories of accidents have been considered by the applicant. These categories are based upon their probability of occurrence and include (1) incidents of moderate frequency (events that can reasonably be expected to occur during any year of operation); (2) infrequent accidents (events that might occur once during the lifetime of the plant); and (3) limiting faults (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 operation that are discussed in Section 5.9.3. Initiating events postulated in the second and third categories for WNP-3 are shown in Table 5.5. These are designated design-basis accidents in that specific design and operating features, as described in Section 5.9.4.4(1), are provided to limit their potential radiological consequences. Approximate radiation doses that might be received by a person at the boundary of the plant's exclusion area during the first 2 hours of the accidents were calculated by the applicant and are shown in Table 5.5. The results shown in the table reflect the expectation that ESFs and operating features designed to mitigate the consequences of the postulated accidents would function as intended. An important implication of this expectation is that the predicted releases are dominated by noble gases and radioiodines and that any other radioactive materials (for example, radioiodine in particulate form) are not released in significant quantities. The results also use the meteorological dispersion conditions that are average values determined by actual site measurements. To contrast the results of these calculations with those using more pessimistic, or conservative, assumptions in the SER, as described below, the doses shown in Table 5.5 are sometimes referred to as "realistic" doses. These low calculated doses, in combination with the fact that these accidents are infrequently observed, indicate that the risk of incurring any adverse health effects as a consequence of these events is exceedingly small.

Table 5.5 Approximate radiation doses from "realistic" assessments of design-basis accidents*

Design-basis accident	Dose at 1310 m** (rems)	
	Thyroid	Whole body
Infrequent accidents		
Rod-ejection accident	<0.001	0.002
Steam generator tube rupture	<0.001	0.041
Fuel-handling accident	<0.001	<0.001
Limiting faults		
Main steamline break	<0.001	<0.001
Large-break LOCA	<0.001	0.02

Source: WNP-3 ER-OL Table 7.1-8
*Duration of release less than 2 hours.
**The site boundary distance.

The staff is carrying out calculations to estimate the potential upper bounds for individual exposures from the initiating accidents listed in Table 5.5 to implement the provisions of 10 CFR 100. For these calculations, much more pessimistic (conservative or worst case) assumptions are made as to the course taken by the accident and the prevailing conditions. These assumptions include much larger amounts of radioactive material released by the initiating events, additional single failures in equipment, operation of ESFs in a degraded mode,* and poor

*The containment system is assumed to prevent leakage in excess of that demonstrable by testing, as provided in 10 CFR 100.11(a).

meteorological dispersion conditions. A license to operate the plant will not be issued unless the results of these calculations show that for these events the exposures are not expected to exceed 25 rems to the whole body and 300 rems to the thyroid of any individual at the exclusion area boundary over a period of 2 hours. For calculation of the thyroid dose, it will be assumed that an individual is located at a point on the exclusion area boundary where the radioiodine concentration in the plume has its highest value and inhales at a breathing rate characteristic of a person jogging for a period of 2 hours. The health risk to an individual receiving 300 rems to the thyroid is the appearance of benign or malignant thyroid nodules in about 1 out of 10 cases and the development of a fatal thyroid cancer in about 4 out of 1000 cases. The staff will also evaluate the potential upper bounds for individual exposures at the outer edge of the LPZ using the same dose guidelines. These exposures, in general, are not limiting.

None of the calculations of the impacts of design-basis accidents described in this section take into consideration possible reductions in individual or population exposures as a result of the individual or population taking any protective actions.

(2) Probabilistic Assessment of Severe Accidents

In this and the following three sections, probabilities and consequences of accidents of greater severity than the design-basis accidents addressed in the previous section are discussed. 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 accidents, heretofore frequently called Class 9 accidents, can be distinguished from design-basis accidents in two primary respects: they involve substantial physical deterioration of the fuel in the reactor core, including overheating to the point of melting, and they involve deterioration of the capability of the containment structure to perform its intended function of limiting the release of radioactive materials to the environment.

The assessment methodology employed is that described in the RSS, which was published in 1975 (WASH-1400, now designated NUREG-75/014). A less comprehensive but more up-to-date treatment is given in NUREG/CR-2300, "PRA Procedures Handbook." Because WASH-1400 has been subject to considerable controversy, a discussion of the uncertainties surrounding it is provided in Section 5.9.4.5(7). However, the staff has selected a set of updated accident sequences, their associated probabilities, and the resultant releases that are appropriate to WNP-3. The selection of these sequences used better data and analytical techniques that have evolved since the RSS was published. The earlier technique of grouping a number of accident sequences into release categories has been refined. Also, the "smoothing technique" used in the RSS for adjusting probabilities, which was criticized in the Lewis Report (NUREG/CR-0400), was not used in this study.

WNP-3 is a Combustion Engineering-designed PWR. The present assessment for WNP-3 used plant-and site-specific information, along with more general information generated from indepth analyses of other PWRs. In particular, the Zion and the Indian Point Units 2 and 3 probabilistic risk assessments (PRAs) and the staff reviews thereof provided the framework for selecting the accident sequences, containment failure modes, and release categories used for WNP-3. The release categories and their associated probabilities are used directly to calculate the consequences and risks of potential accidents. Each release category is specific to a certain type and timing of core damage and containment failure,

but different accident sequences can lead to the same release category. The release categories are described in Appendix E. Characteristics of the release categories used (all of which involve partial to complete melting of the reactor core) are shown in Table 5.6. Sequences initiated by natural phenomena such as tornadoes, floods, or seismic events and those that could be initiated by humans, including deliberate acts of sabotage, are not included in the event sequences corresponding to the listed release categories. The only plants for which external natural events have been assessed by the staff in detail in a probabilistic sense are Zion, Indian Point, Limerick, and Millstone 3. In these cases, no estimates of risk from sabotage were made, and these estimates are considered beyond the state of the art. The staff notes, however, that the consequences of large releases caused by sabotage should not be different in kind from the releases estimated for severe internally initiated accidents. The staff analysis of externally initiated events showed that, for the plants studied, the risk of early fatalities from external events ranged from less than to 30 times as much as the risk from internal events. For other measures of risk--such as person-rems and latent cancer fatalities--the external event risk was comparable to or less than the internal event risk.

The calculated probability per reactor-year associated with each release category used is shown in Table 5.6. 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 (ibid.).

The magnitudes (curies) of radioactivity release for each release category are obtained by multiplying the release fractions shown in Table 5.6 by the amounts that would be present in the core at the time of the hypothetical accident. These are shown in Table 5.4 for WNP-3 at a core thermal power level of 4100 MWt, the power level used in the safety evaluation. Of the hundreds of radionuclides present in the core, the 54 listed in the table were selected as significant contributors to the health and the economic risks of severe accidents. The core radionuclides were selected on the basis of (1) half-life, (2) approximate relative offsite dose contribution, and (3) health effects of the radionuclides and their daughter products.

The potential radiological consequences of these releases have been calculated by the consequence model used in the RSS (see also NUREG/CR-2300), adapted and modified as described below to apply to a specific site. The essential elements are shown in schematic form in Figure 5.3. Environmental parameters specific to the WNP-3 site have been used and include the following:

- meteorological data for the site representing a full year of consecutive hourly measurements and seasonal variations

- projected population for the year 2010 extending throughout regions of 80-km (50-mile) and 563-km (350-mile) radii from the site

- the habitable land fraction within a 563-km (350-mile) radius

- land-use statistics, on a statewide 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

Table 5.6 Summary of atmospheric releases, defined by release categories, for WNP-3

Parameter	Release Categories*				
	B	C	F	H	I
Probability per reactor year	9.0×10^{-7}	2.1×10^{-5}	2.3×10^{-6}	7.6×10^{-6}	6.8×10^{-5}
Release time (hr)	1	13	3.0	72.0	2
Release duration (hr)	0.5	0.5	0.5	8.0	8.0
Release energy (Btu/hr x 10^6)**	0.5	98	180	0	0
Warning time (hr)	1	8	1	67	1
Release fraction (fractions of total core inventory)***					
Xe-Kr	1.0(0)	9.6(-1)†	8.5(-1)	7.0(-1)	5.0(-4)
I-Br	7.0(-1)	9.8(-2)	7.8(-2)	4.0(-4)	5.0(-6)
Cs-Rb	5.0(-1)	3.4(-1)	6.2(-2)	1.0(-3)	1.0(-5)
Te	1.0(-1)	3.8(-1)	4.9(-2)	1.0(-3)	1.0(-5)
Ba-Sr	6.0(-2)	3.7(-2)	7.1(-3)	1.0(-4)	1.0(-6)
Ru††	2.0(-2)	2.9(-2)	4.3(-3)	7.0(-5)	1.0(-6)
La†††	2.0(-3)	4.9(-3)	6.6(-4)	1.0(-5)	2.0(-7)

*Release categories are a description of the type of releases expected from various types of core damage and containment failure. See Appendix E for further discussion.

**cal/sec = 14.29 Btu/hr

***Background on the isotope groups and release mechanisms is presented in WASH-1400, Appendix VII, and in NUREG/CR-2300.

†9.6(-1) means 9.6×10^{-1} or 0.96; the same pattern holds for the other numbers.

††Include Ru, Rh, Co, Mo, Te.

†††Includes Y, La, Zr, Nb, Ce, Pr, Nd, Np, Pu, Am, Cm.

563-km (350-mile) region (land-use statistics for Canada were assumed to be the same as for adjacent states)

To obtain a probability distribution of consequences, the calculations are performed assuming the releases, as defined by the release categories, at each of 91 different "start" times throughout a 1-year period. Each calculation uses (1) the site-specific hourly meteorological data, (2) the population projections for the year 2010 out to a distance of 800 km (500 miles) around the WNP-3 site, and (3) 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.

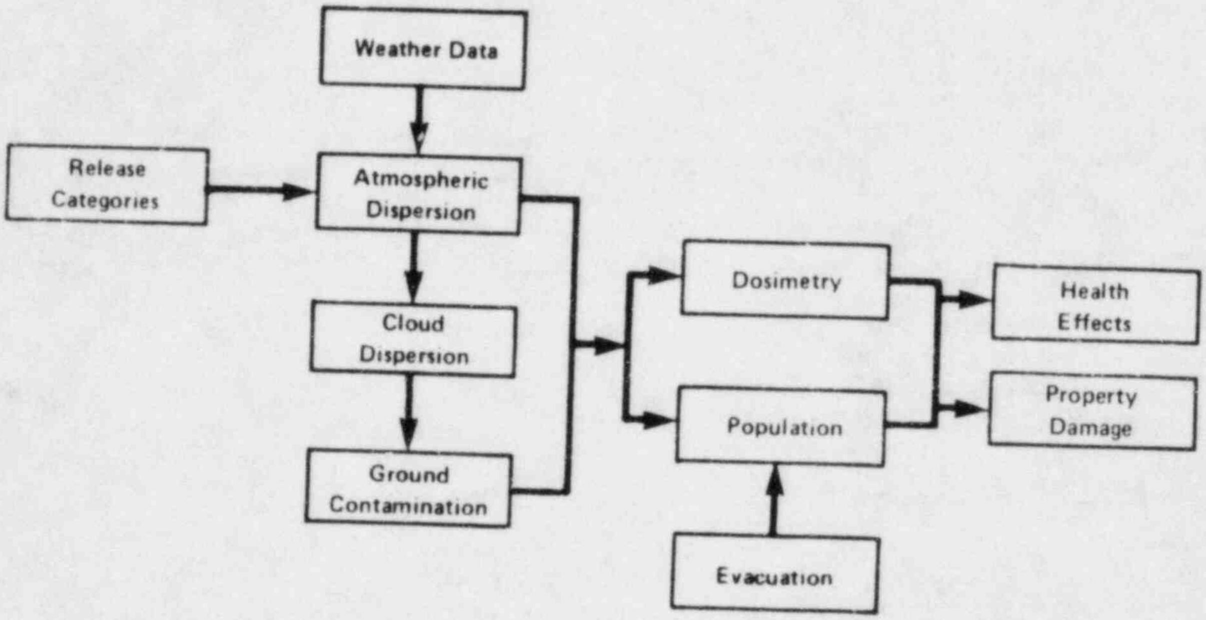

Figure 5.3 Schematic of atmospheric pathway consequence model

Early evacuation and relocation of people would considerably reduce the exposure from the radioactive cloud and 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 WNP-3 site are estimates made by the staff. There normally would be some facilities near a plant, such as schools or hospitals, where special equipment or personnel may be required to effect evacuation, and there may be some people near a site who may choose not to evacuate. Such facilities (including Beechwood Nursing Home, Oakhurst Convalescent Center, Edgewood Manor Nursing Home, Woodland Terrace Nursing Home, and Grays Harbor County Jail) have been identified near the WNP-3 site. Therefore, actual evacuation effectiveness could be greater or less than that characterized, but it would not be expected to be very much less, because special consideration will be given in emergency planning for the WNP-3 plant to any unique aspects of dealing with special facilities.

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 food stuffs such as crops and milk, (2) decontamination of a 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, and (3) denial of use (interdiction) of severely contaminated land and property for varying periods of time until the contamination levels are reduced to such values by radioactive decay and weathering 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 zone (see Appendix F) and other protective actions as mentioned above are considered as essential sequels to serious nuclear reactor accidents involving significant release of radioactivity to the atmosphere. Therefore, the results shown for WNP-3 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 5.3).

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.

(3) Dose and Health Impacts of Atmospheric Releases

The results of the calculations of dose and health impacts performed for the WNP-3 facility and site are presented in the form of probability distributions in Figures 5.4 through 5.7* and are included in the impact summary table, Table 5.7. All of the release categories shown in Table 5.6 contribute to the results, the consequences of each being weighted by its associated probability.

Figure 5.4 shows the probability distribution for the number of persons who might receive bone marrow doses equal to or greater than 200 rems, whole body doses equal to or greater than 25 rems, and thyroid doses equal to or greater

*Figure 5.4 through 5.8 and Figure F.1 are called complementary cumulative distribution functions. They are intended to show the relationship between the probability of a particular type of consequence being equalled or exceeded and the magnitude of the consequence. Probability per reactor-year (ry means reactor-year) is the chance that a given event will occur in 1 year for one reactor. Because only one operating reactor is planned at the WNP-3 site, per reactor-year just means per year. Because the different accident releases, atmospheric dispersion conditions, and chances of a health effect (for example, early fatalities) result in a wide range of calculated consequences, they are presented on a logarithmic plot in which numbers varying over a very large range can be conveniently illustrated by a grid indicated by powers of 10. For instance, 10^6 means one million or 1,000,000 (1 followed by 6 zeroes). The cumulative probabilities of equalling or exceeding a given consequence are also calculated to vary over a large range (because of the varying probabilities of accidents and atmospheric dispersion conditions), so the probabilities are also plotted logarithmically. For instance, 10^{-6} means one millionth or 0.000001.

Table 5.7 Summary of environmental impacts and probabilities

Probability of impact/ reactor-yr	Persons exposed >200 rems	Persons exposed >25 rems	Early fatalities	Population exposure, millions of person-rems, 80-km/total	Latent† cancers, 80-km/ total	Cost of offsite mitigating actions, $ millions
10^{-4}	0	0	0	0/0	0/0	4
10^{-5}	0	3000	0	0.4/1.7	50/140	210
5×10^{-6}	0	13,000	0	1.5/5.3	200/470	710
10^{-6}	1500	110,000	0	5.9/24	750/2000	2,800
10^{-7}	6900	270,000	92	10/30	1700/2800	4,300
10^{-8}	30,000	540,000	340	14/41	1800/4000	4,300
Related Figure	5.4	5.4	5.6	5.5	5.7	5.8

†Includes cancers of all organs. Genetic effects would be approximately twice the number of latent cancers.

Note: Please refer to Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates.

than 300 rems from early exposure,* all on a per-reactor-year basis. The 200-rem bone marrow dose figure corresponds approximately to a threshold value for which hospitalization would be indicated for the treatment of radiation injury. The 25-rem whole-body dose (which has been ideintified earlier as the lower limit for a clinically observable physiological effect in nearly all people) and 300-rem thyroid dose figures correspond to the Commission's guide-line values for reactor siting in 10 CFR 100.

Figure 5.4 shows in the left-hand portion that there are approximately 2 chances in 100,000 (2×10^{-5}) per reactor-year that one or more persons may receive doses equal to or greater than any of the doses specified. The fact that the three curves run almost parallel in horizontal lines initially hows 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 about 4 in 100,000,000 (4×10^{-8}) that 10,000 or more people might receive doses of 200 rems or greater. Virtually all of the exposures reflected in this figure would occur within a 80-km (50-mile) radius.

*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.

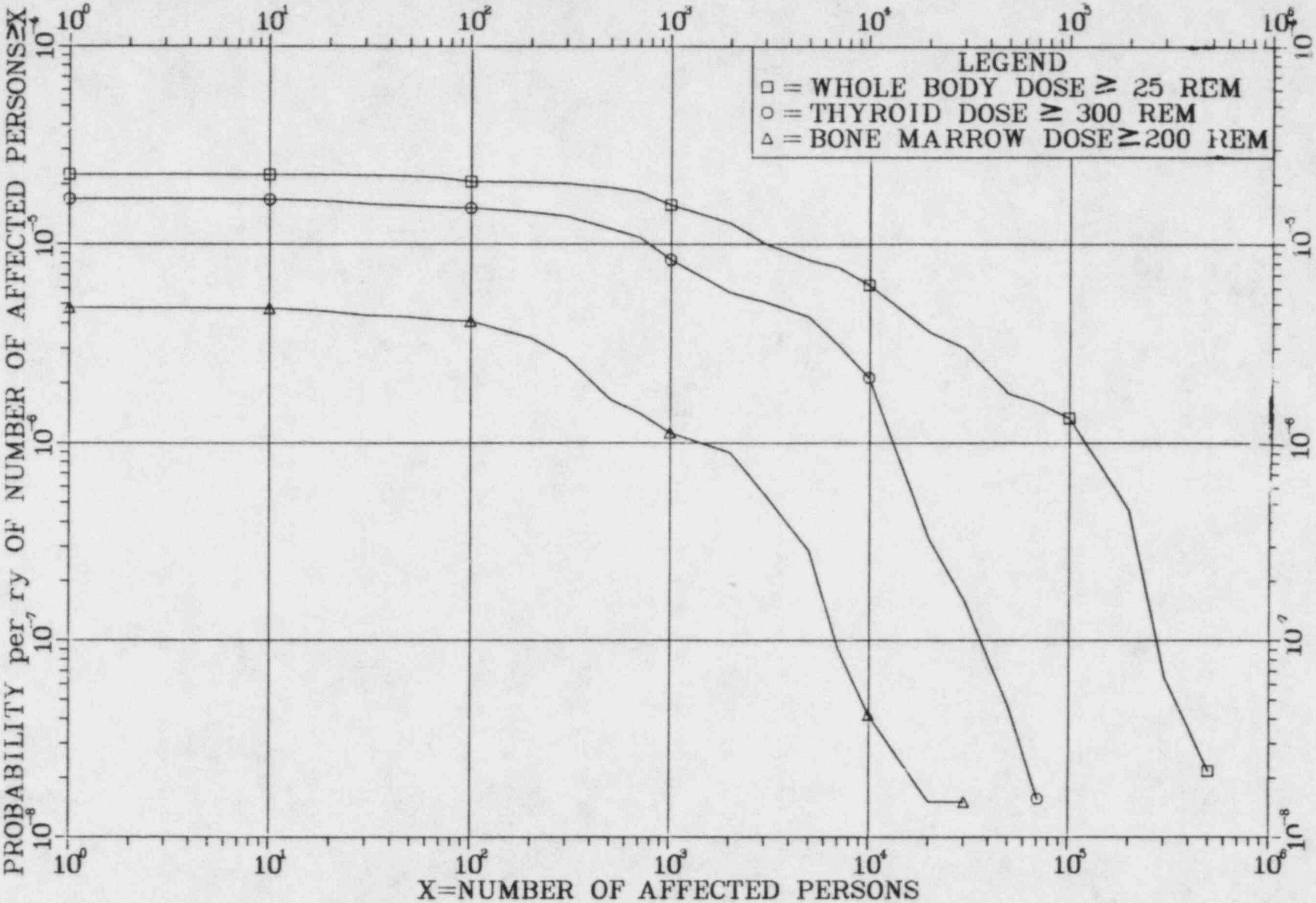

Figure 5.4 Probability distributions of individual dose impacts. See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates; also see footnote in Section 5.9.4.5(3) for help in interpreting this figure.

Figure 5.5 shows the probability distribution for the total population exposure in person-rems; that is, the probability per reactor-year that the total population exposure will equal or exceed the values given. Most of the population exposure up to 400,000 person-rems would occur within 80 km (50 miles), but the more severe releases (as in the first two release categories in Table 5.6) would result in exposure to persons beyond the 80-km range as shown.

For perspective, population doses shown in Figure 5.5 may be compared with the annual average dose to the population within 80 km of the WNP-3 site resulting from natural background radiation of 82,000 person-rems, and to the anticipated annual population dose to the general public (total U.S.) from normal plant operation of 81 person-rems (excluding plant workers) (Appendix D, Tables D-7 and D-9).

Figure 5.6 shows the probability distributions for early fatalities, representing radiation injuries that would produce fatalities within about 1 year after exposure. All of the early fatalities would be expected to occur within a 28-km (18-mile) radius and the majority within a 6.4-km (4-mile) radius. The results of the calculations shown in this figure and in Table 5.7 reflect the effect of evacuation within the 16-km (10-mile) plume exposure pathway zone. Figure F.1 shows the sensitivity of the early fatalities to the emergency response variations including (1) no evacuation and relocation after 1 day, (2) evacuation to 16 km (10 miles), and (3) evacuation to 24 km (15 miles).

Figure 5.7 represents the statistical relationship between population exposure and the induction of 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 miles) are shown separately. Further, the fatal latent cancers have been subdivided into those attributable to exposures of the thyroid and all other organs. These estimates may be compared to the cancer fatality risk per individual per year from all causes of 1.9×10^{-3} (American Cancer Society, 1981).

(4) Economic and Societal Impacts

As noted in Section 5.9.4.2, the various measures for avoidance of adverse health effects, including those resulting from residual radioactive contamination in the environment, are possible consequential impacts of severe accidents. Calculations of the probabilities and magnitudes of such impacts for the WNP-3 facility and environs have also been made. Unlike the radiation exposure and health effect 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 5.8 and are included in Table 5.7. 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

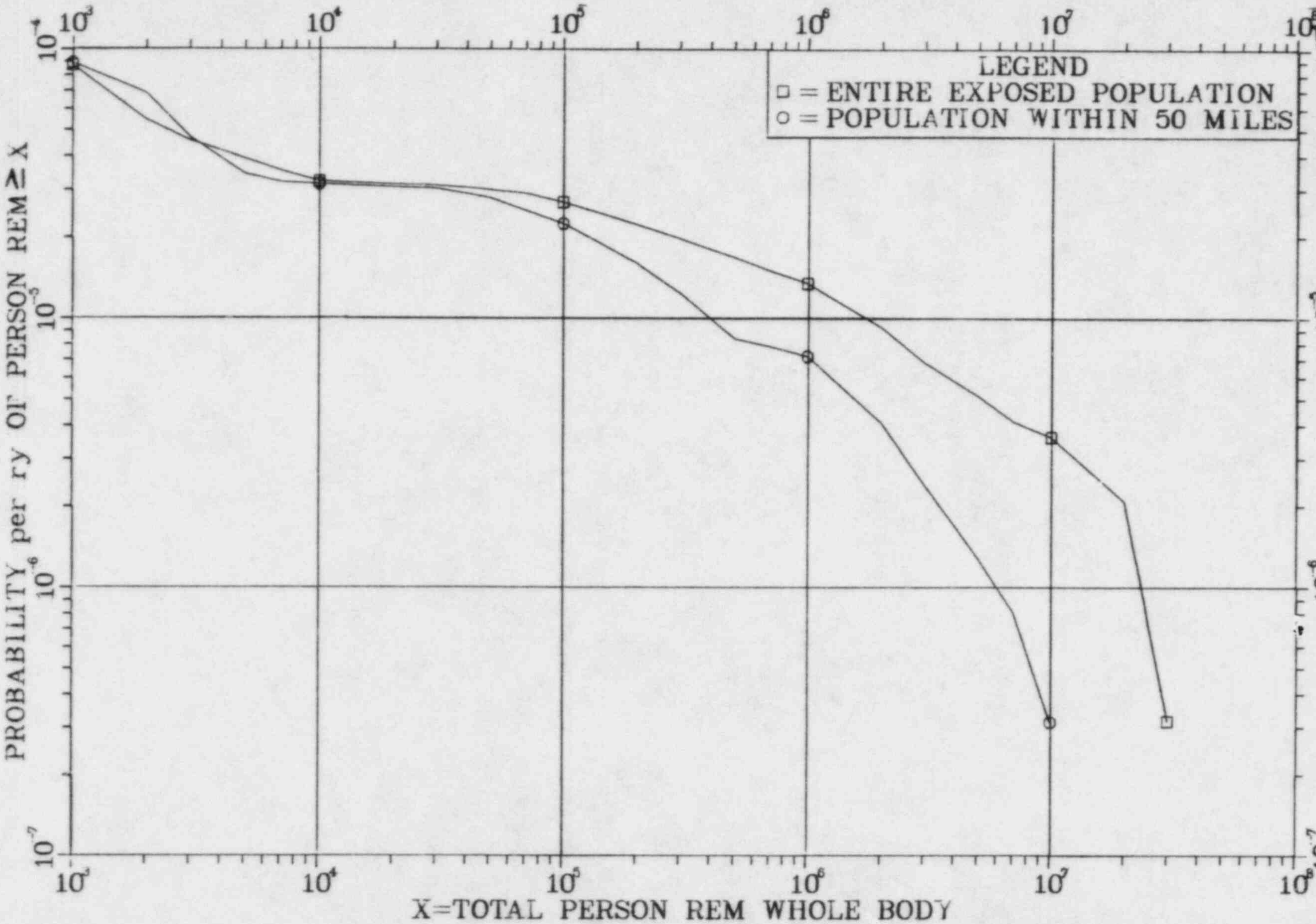

Figure 5.5 Probability distributions of population exposures. See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates; also see footnote in Section 5.9.4.5(3) for help in interpreting this figure. (50 mi = 80 km)

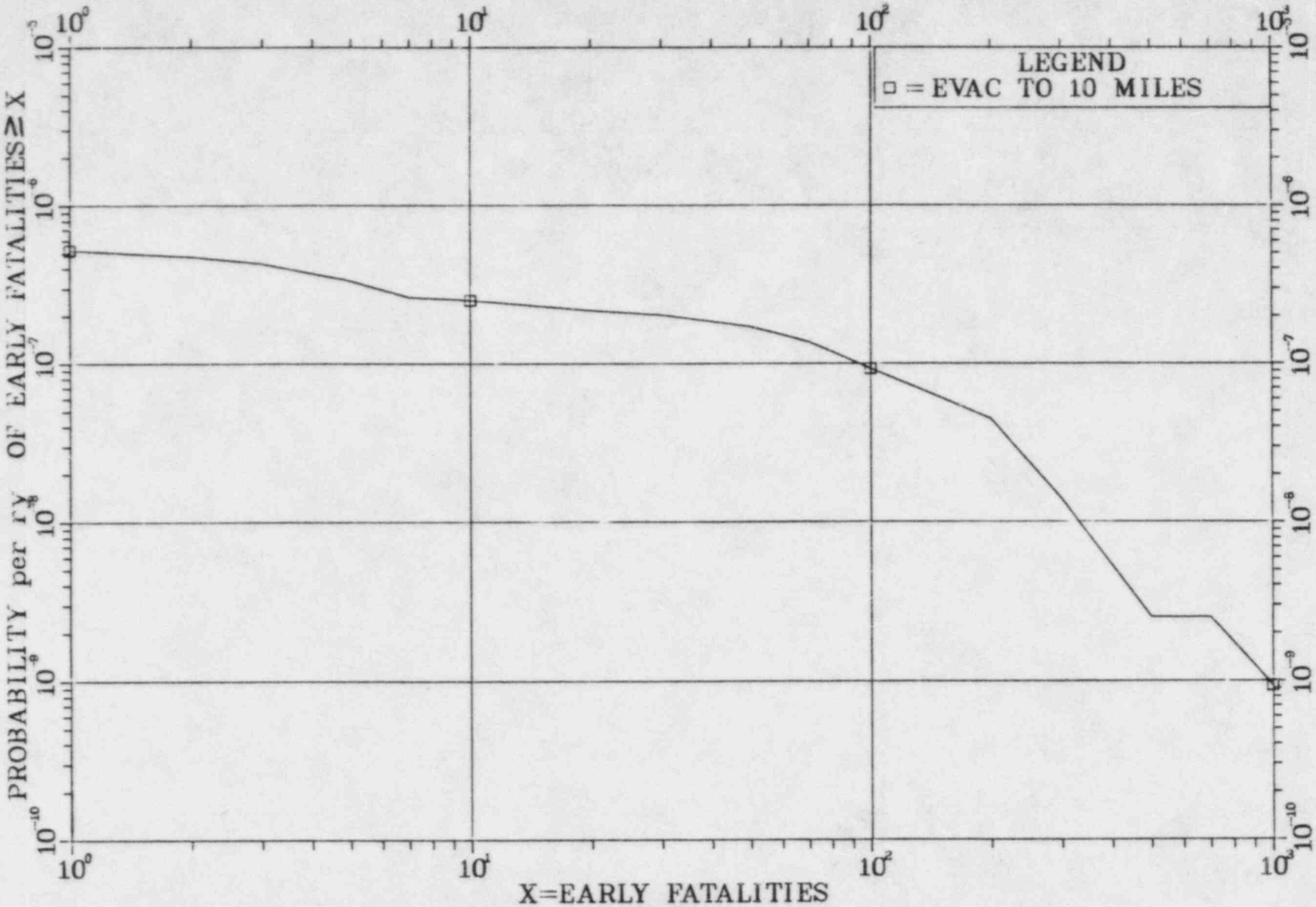

Figure 5.6 Probability distribution of early fatalities. See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates; also see footnote in Section 5.9.4.5(3) for help in interpreting this figure. (10 mi = 16 km)

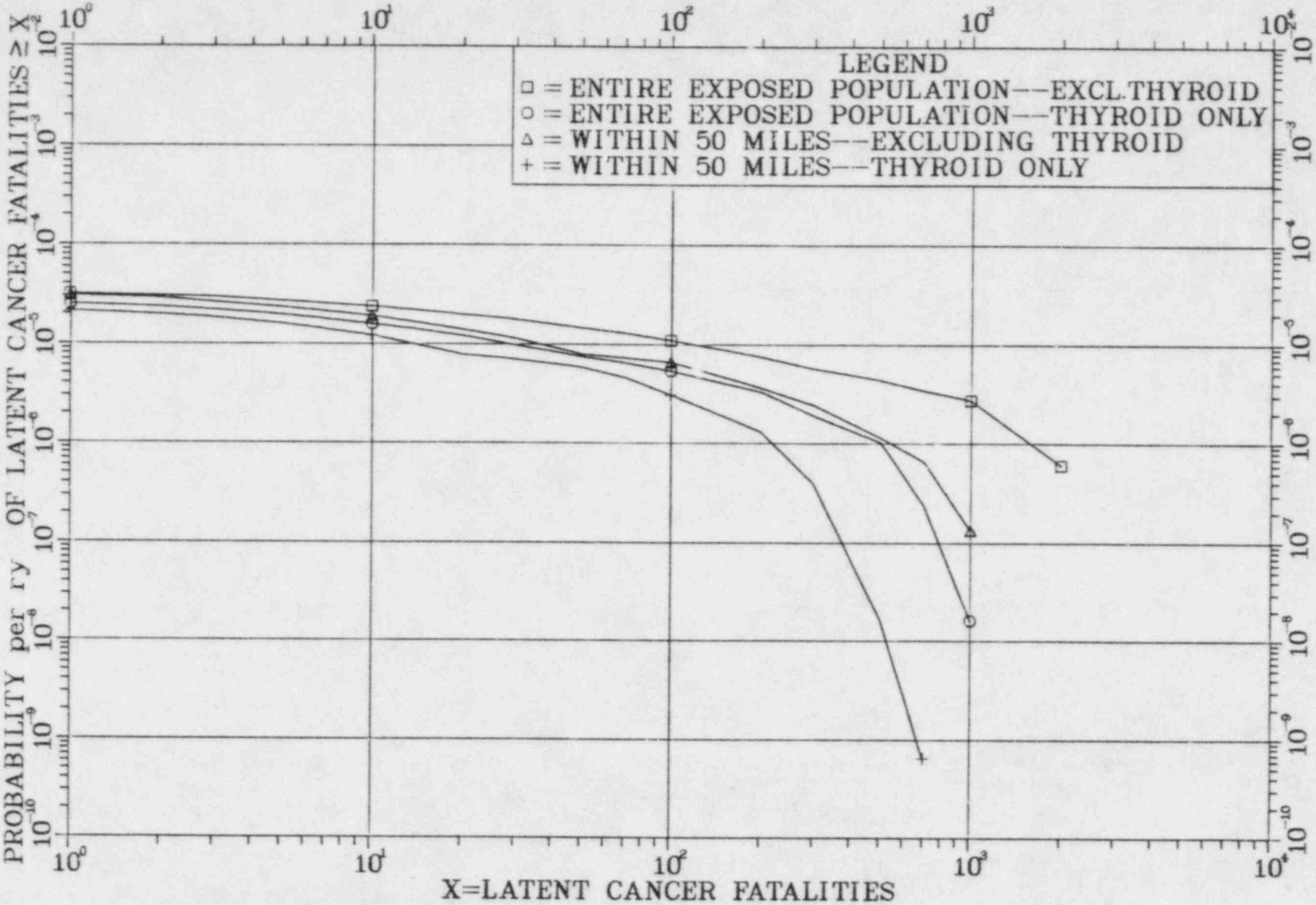

Figure 5.7 Probability distribution of cancer fatalities. See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates; also see footnote in Section 5.9.4.5(3) for help in interpreting this figure. (50 mi = 80 km)

- indirect costs attributable 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 5.8 shows that at the extreme end of the accident spectrum these costs could exceed several billion dollars but that the probability that this would occur is exceedingly small (about one chance in one million per reactor-year).

Additional economic impacts that can be monetized by the RSS consequence model 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 discussion of risk considerations in Section 5.9.4.5(6) below.

(5) Releases to Groundwater

A pathway through the groundwater for radiation exposure to the public and environmental contamination that would be unique for severe reactor accidents was identified above. Consideration has been given to the potential environmental impacts of this pathway for WNP-3. The principal contributors to the risk are the core melt accidents. The penetration of the basemat of the containment building can release molten core debris to the 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. Releases of radioactivity to the groundwater underlying the site could also occur through the failed basemat through depressurization of the containment atmosphere or the release of radioactive water from the emergency core cooling system.

An analysis of the potential consequences of a liquid pathway release of radioactivity for generic sites was presented in the "Liquid Pathway Generic Study" (LPGS, NUREG-0440). The LPGS compared the risk of accidents involving the liquid pathway (drinking water, irrigation, aquatic food, swimming, and shoreline usage) for four 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 from the liquid pathway range from fractions to very small fractions of those that can arise from the airborne pathway.

The discussion in this section is a summary of an analysis performed to determine whether or not the liquid pathway consequences of a postulated accident at the WNP-3 site would be unusual when compared with the generic "small 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 small river site and the WNP-3 site. The parameters that were evaluated include the amounts and rate of release of radioactive materials to the ground, holdup in the ground, surface water transport, drinking water usage, aquatic food consumption, swimming, and shoreline usage.

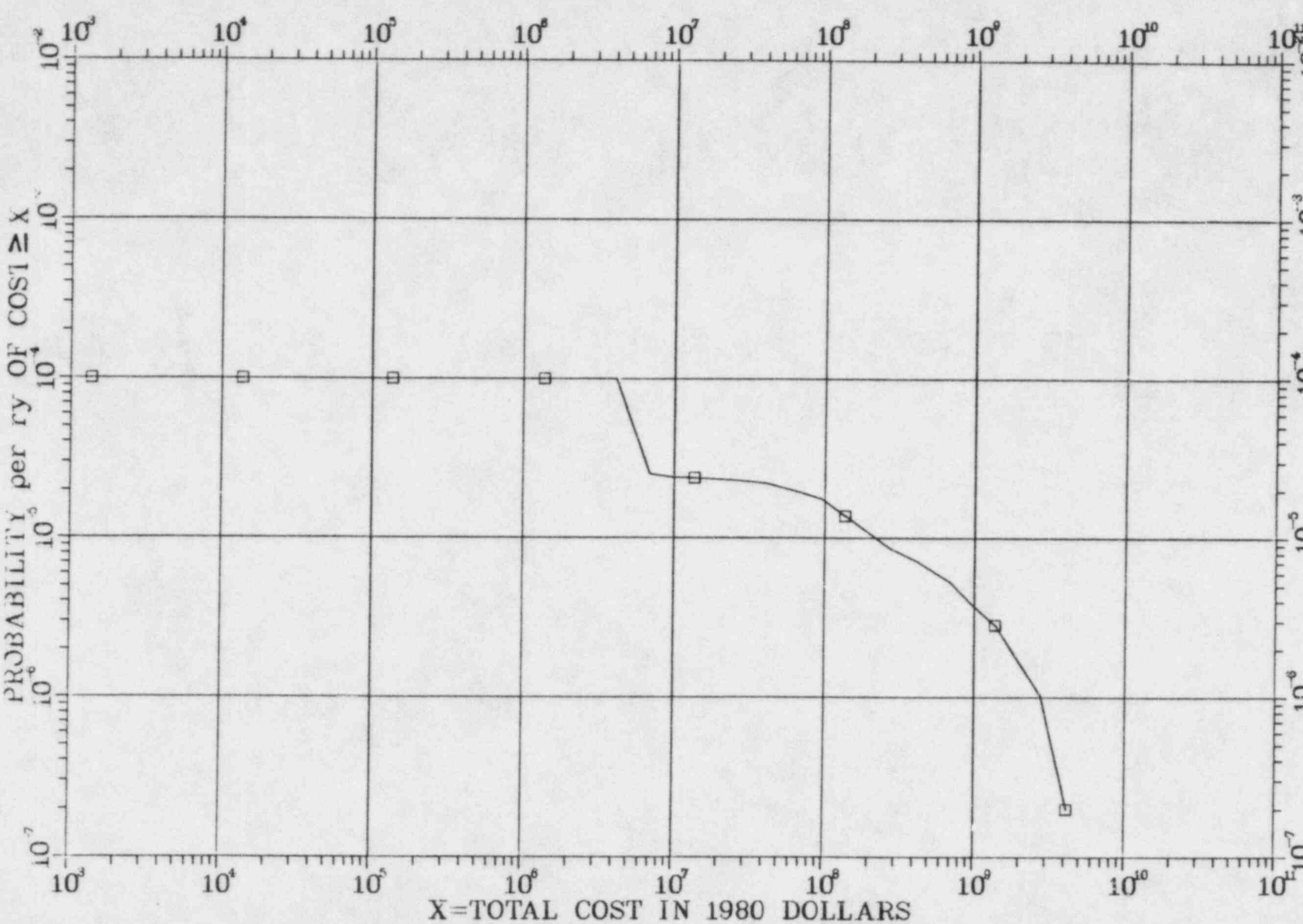

Figure 5.8 Probability distribution of mitigation measures cost. See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates; also see footnote in Section 5.9.4.5(3) for help in interpreting this figure.

Doses to individuals and populations were calculated in the LPGS without consideration of interdiction methods such as isolating the contaminated groundwater or prohibiting 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, might be restricted. The consequences would, therefore, be largely economic or social, rather than radiological.

All of the reactors considered in the LPGS were Westinghouse PWRs with ice condenser containments. Thus, there are likely to be significantly different mechanisms and probabilities of release of radioactivity for the WNP-3 reactor. However, because the WNP-3 containment is designed to contain a higher pressure than the ice condenser containment used in the LPGS (that is, WNP-3 can better delay and mitigate a release to groundwater), and because the LPGS used conservative assumptions regarding the magnitude of releases to groundwater, it is unlikely that the releases for the WNP-3 case would exceed those estimated for the LPGS. The source term for the present case, therefore, will be considered to be equivalent to the LPGS source term.

The present analysis considers only the case of a "prompt" release of highly contaminated sump water released through a failed basemat, which was the PWR-7 scenario in the LPGS. This release was chosen because, of those studied that could contribute to the groundwater pathway, this release could result in the highest prediction population dose. In this LPGS case, 24% of the Sr-90 and 100% of the Cs-134 and Cs-137 isotopes in the core inventory were considered to be released to the ground in the sump water. Even if all the Sr-90 were assumed to be released, the total estimated population dose would only be about 5% higher because the Sr-90 contributes so little to the total dose compared to the cesium isotopes. Transport in the groundwater was relatively slow because of "retardation" caused by interaction of the radionuclide with the rock or soil, so decay of many radionuclides was appreciable. Only 87% of the Sr-90 and 31% of the Cs-137 were estimated to enter the river. Dose contributions from radionuclides other than Sr-90 and Cs-137 were considered negligible.

In the WNP-3 case, however, there is a passive underdrain system beneath the reactor that is used to depress the water table below parts of the site. The underdrain system consists of porous concrete and porous pipe that collect groundwater and shunt it to a collection pipe leading to Stein Creek. Collected groundwater then flows into Workman Creek, a stream adjacent to the plant that drains to the Chehalis River. Unlike most underdrain systems in nuclear plants, the WNP-3 system relies on gravity flow alone and does not require pumping. Therefore, contaminated water entering the underdrain would, without active intervention, be transported to a surface water pathway much faster than if transport were through the normal groundwater flow pathway.

Radioactive sump water released to the underdrain would mix with groundwater collected by the underdrain and be transported to the Chehalis River via Stein and Workman Creeks. Although it is likely that there would be some holdup in the porous material of the underdrain, it is impossible to accurately quantify the extent to which this holdup would mitigate the ultimate release to Stein Creek. The transport time in Workman Creek from Stein Creek to the Chehalis River is also difficult to quantify because the creek is not gaged. Thus, it is difficult to determine what the average stream flow would be. Contaminated groundwater may either seep into the streambed of Workman Creek during low flow

conditions or be rapidly transported to the Chehalis River during high flow conditions.

Initial screening analyses indicate that for very short travel times, more than 90% of dose to affected water users would be caused by the three isotopes: Sr-90, Cs-134, and Cs-137. The present analysis is, therefore, restricted to these isotopes.

The potential exists for travel times which are short relative to the 2.2-year, 30.1-year, and 29-year half-lives of Cs-134, Cs-137, and Sr-90, respectively. Therefore, for the purposes of this analysis, the staff estimates that 100% of the sump water inventory of these three radionuclides eventually reach the Chehalis River. This compares to virtually none of the Cs-134, 31% of the Cs-137, and 87% of the Sr-90 released in the LPGS case.

Doses to the population using the Chehalis River and Grays Harbor were estimated from shoreline exposure and fish consumption only. There are no public drinking water users on the Chehalis River downstream from the plant. There are three small domestic wells for private use located between the Chehalis River and the plant. These wells probably are not supplied by water from the river because the groundwater gradient is up from the river toward the wells. Some larger central supply wells for municipal water are located along the Chehalis River. However, these wells are on the opposite side of the river at least 1.6 km (1 mile) from the river. Consequently, any contamination of Chehalis River water would not affect these municpal water supplies. Populations served are small compared to the LPGS case, so the contribution to dose from this potential pathway was not taken into consideration.

The staff used the applicant's estimate of 2.8×10^5 user-hours per year for shoreline recreational use along the Chehalis River and Grays Harbor from Chehalis River Mile 21 to the Pacific Ocean, which was based on the average data used in the LPGS. Exposure to persons swimming is only a minor pathway and is considered to be part of the shoreline exposure dose. The shoreline usage is conservative for the present site in light of the local population density and usage habits of the populace of Grays Harbor County.

Annual average commercial and recreational fish catch was estimated by the staff to be about 4.6×10^5 kilograms (1.0×10^6 pounds) per year in the Chehalis River and Grays Harbor. This figure does not include the catch in the ocean or major tributaries, but includes the river upstream from the site.

Because Grays Harbor and the lower Chehalis River are tidal, fish bioaccumulation factors (BAF) for the radionuclides would be typical of both fresh and salt water. Average BAFs of 3.5 for Sr-90 and 220 for Cs-134 and Cs-137, which are midway between the LPGS values for fresh and salt water, were used in the analysis of population dose from fish consumption.

The annual average flow rate past the site was estimated using the U.S. Geological Survey WATSTORE system to be 193.3 m^3/sec (6824 ft^3/sec), based on approximately 30 years of record on the Chehalis River at Porter, WA, and 55 years of data on the Satsop River near Satsop, WA, adjusted for drainage basin areas at the site. The "dilution" flow, which is based on a harmonic mean flow rate, is considerably smaller, estimated as 53 m^3/sec (1871 ft^3/sec), and is considered to be a representative flow rate for the river from the site to the ocean, a distance of about

33.8 km (21 miles). The latter flow rate is used in the dose calculations for this site.

Flow rate and fish catch for the LPGS site varied with distance from the site for the small river case and included a much longer stretch of major U.S. rivers (Tennessee, Ohio, and Mississippi Rivers).

Factoring dilution, fish catch, BAF, shoreline usage, and the fraction of radionuclides released from the plant indicate that the WNP-3 dose would be a factor of 190 times larger for the fish consumption pathway, and 70% as large as the LPGS shoreline exposure dose for a sump water release. Because the staff assumed that there would be no drinking water pathway in the WNP-3 case, the ratio for this factor is 0. In the corresponding LPGS case, about 7% of the total whole body dose was from the fish consumption pathway, 14% from shoreline exposure, and 79% from drinking water. Based upon these factors, the ratio of total population doses for the WNP-3 site to that for the LPGS site would be a factor of about 14.

The above dose comparison does not consider mitigative measures or probabilities that such a release could, in fact, occur. A sump water release is much less likely than other types of releases of radioactivity from the core of a nuclear reactor, and the other types of releases would have appreciably smaller consequences. Furthermore, it is highly likely that immediate measures would be taken to mitigate the liquid release to the Chehalis River. These measures might include sealing of the underdrain outflow pipes or damming Workman Creek. Contamination reaching the Chehalis River could be closely monitored, and administrative controls on fishing and other uses of the river could be placed in effect.

Although the WNP-3 liquid pathway consequences have been shown to be considerably worse than those for the LPGS site, they still pose much less of a risk than the airborne pathway. The most significant aspect of the liquid pathway at the WNP-3 site is the potentially short time in which protective action can be taken against liquid pathway releases as compared to most other sites, which do not have passive underdrains.

(6) Risk Considerations

Environmental Risks

The foregoing discussions have dealt with both the frequency (or likelihood of occurrence) of accidents and their impacts (or consequences). Because the ranges of both factors are quite broad, it is also useful to combine them to obtain average measures of environmental risk. Such averages provide a useful perspective, and 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 resultant risk is then expressed as a number of consequences expected per unit of time. Such a quantification of risk does not at all mean that there is universal agreement that the attitudes of people about risks, or what constitutes an acceptable risk, can or should be governed solely by such a measure. At best, it can be a contributing factor to a risk judgment, but not necessarily a decisive factor.

Table 5.8 shows average values of risk associated with population dose, early fatalities (with and without relocation of people between 16 and 40 km (10 and 25 miles) from the plant), latent fatalities, and costs for evacuation and other protective actions. These average values are obtained by summing the probabilities multiplied by the consequences over the entire range of the distributions. Because the probabilities are on a per-reactor-year basis, the averages shown are also on a per-reactor-year basis.

Table 5.8 Average values of environmental risks due to accidents per reactor-year

Environmental risk	Average value
Population exposure	
Person-rems within 80 km	30
Total person-rems	110
Early fatalities	
Evacuation to 16 km and relocation outside 16 km based on projected dose	3.0×10^{-5}
Latent cancer, fatalities	
All organs excluding thyroid	7.6×10^{-3}
Thyroid only	2.1×10^{-3}
Cost of protective actions and decontamination, 1980 dollars	13,000

Note: See Section 5.9.4.5(7) for discussions of uncertainties in risk estimates.

The population exposures and latent cancer fatality risks may be compared with those for normal operation shown in Appendix D. The comparison (excluding exposure to the plant personnel) shows that the accident dose risks (expressed in person-rems) to the total population are similar to the dose from normal operation, but the accident dose risks within 80 km (50 miles) are about 10 times higher than the normal operation dose within 80 km.

The latent cancer fatality risks from potential accidents can also be compared to the cancer risk from all other sources. For accidents, this risk, averaged over those within 80 km (50 miles) of the WNP-3 plant, is 5.7×10^{-9} per year per person, compared with the cancer fatality risk from all other sources of 1.9×10^{-3} per year. The average latent cancer fatality risk from accidents within 16 km (10 miles) of the plant is less than the average within 80 km, as depicted in Figure 5.11. This is because of the large risk reduction benefit from the assumption that people will evacuate within 16 km, as per the site Emergency Plan.

The staff also calculated the environmental risks using the high end of the probability estimate range for each release category (the probabilities are discussed in Appendix E). Comparing these risk results to those shown in

Table 5.8 shows the sensitivity of the calculated risks to the difference between the mean probabilities (see Table 5.6) and the high end of the probability range. With the higher probabilities, the total risk of person-rems is twice that shown in Table 5.8. The total risk of early fatalities is 40% higher; the total risk of latent cancer fatalities is less than twice as high; and the cost risk is twice as high. All these risks would be lower than those in Table 5.8 if the lower end of the probability range were used. The uncertainties resulting from probabilities are part of the whole range of uncertainties, as discussed in Section 5.9.4.5(7).

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 risk of 3×10^{-5} per reactor-year, however, the staff notes that a good approximation of the population at risk is that within about 16 km (10 miles) of the plant, about 22,000 persons in the year 2010. Accidental fatalities per year for a population of this size, based upon overall averages for the United States, are approximately 4.8 from motor vehicle accidents, 1.7 from falls, 0.67 from drowning, 0.63 from burns, and 0.26 from firearms. The average early fatality risk from reactor accidents is thus an extremely small fraction of the total risk embodied in the above combined accident modes.

Figure 5.9 shows the calculated risk expressed as whole-body dose to an individual from early exposure as a function of the downwind distance from the plant within the plume exposure pathway zone. The values are on a per-reactor-year basis, and all accident sequences and release categories in Table 5.6 contributed to the dose, weighted by their associated probabilities.

Evacuation and other protective actions can reduce the risk to an individual of early fatality or of latent cancer fatality. Figure 5.10 shows lines of constant risk per reactor-year to an individual living within the plume exposure pathway zone of the WNP-3 site, of early fatality as functions of distance resulting from potential accidents in the reactor. Figure 5.11 shows lines of constant risk of latent cancer fatality. Directional variation of these plots reflects the variation in the average fraction of the year the wind would be blowing in 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 (CONAES, page 577): automobile accident 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}.

Other Economic Risks

There are other impacts that can be monetized but that are not included in the cost calculations discussed in Section 5.9.4.5(4). These impacts, which would result from an accident to the facility, produce added costs to the public (i.e., ratepayers, taxpayers, and share holders). These costs would accrue from decontamination and repair or replacement of the facility (recovery costs) and from increased use of fossil fuels to provide replacement power during restoration of the facility. Experience with such costs is being accumulated as a result of the accident at Three Mile Island Unit 2.

If an accident occurs during the first year of operation of WNP-3 (beginning in 1986), the economic penalty to which the public would be exposed would be $1680 million (1986 dollars) for decontamination and restoration, including

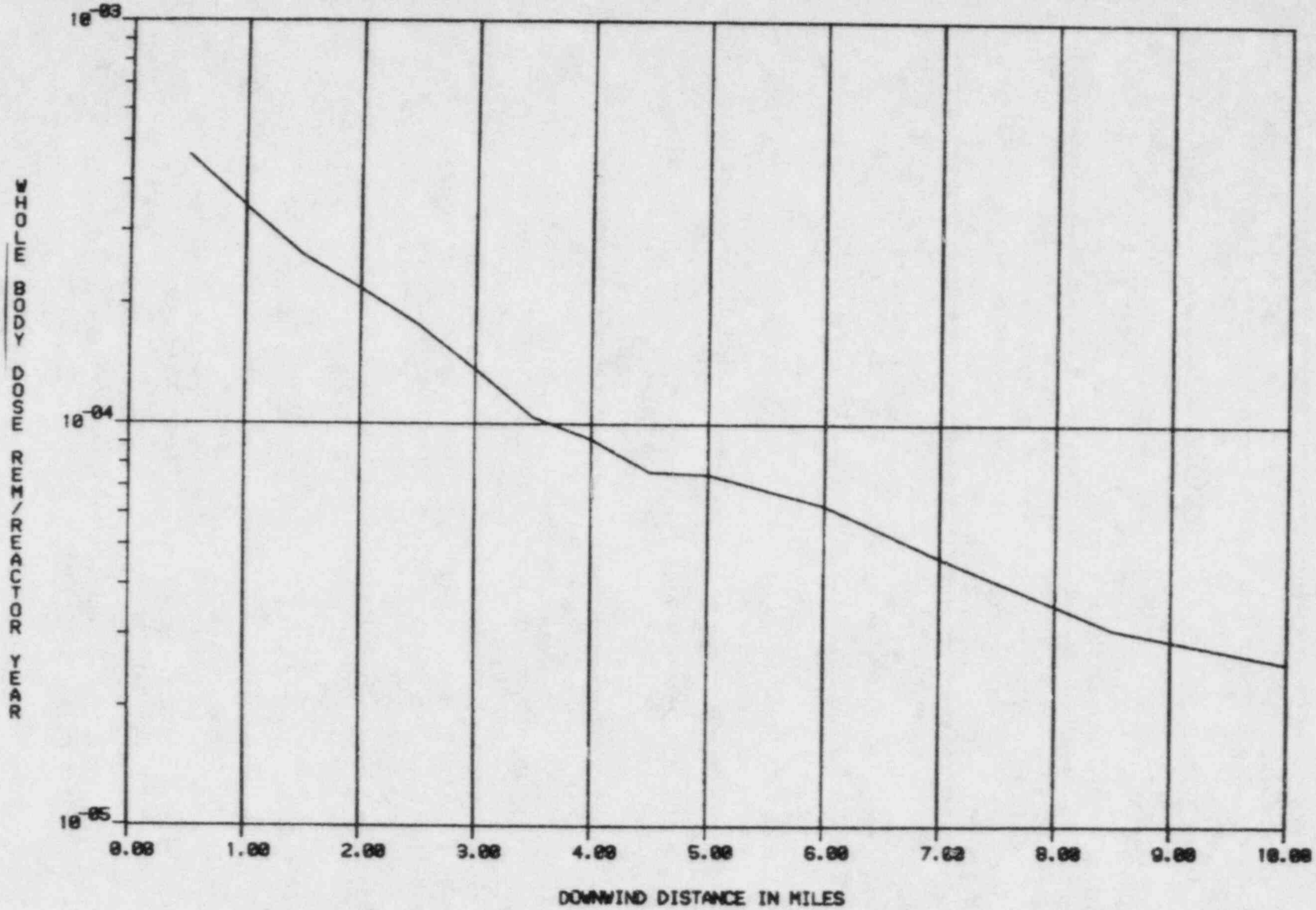

Figure 5.9 Individual risk of dose as a function of distance. See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates; also see footnote in Section 5.9.4.5(3) for help in interpreting this figure (to convert mi to km, multiply by 1.6093).

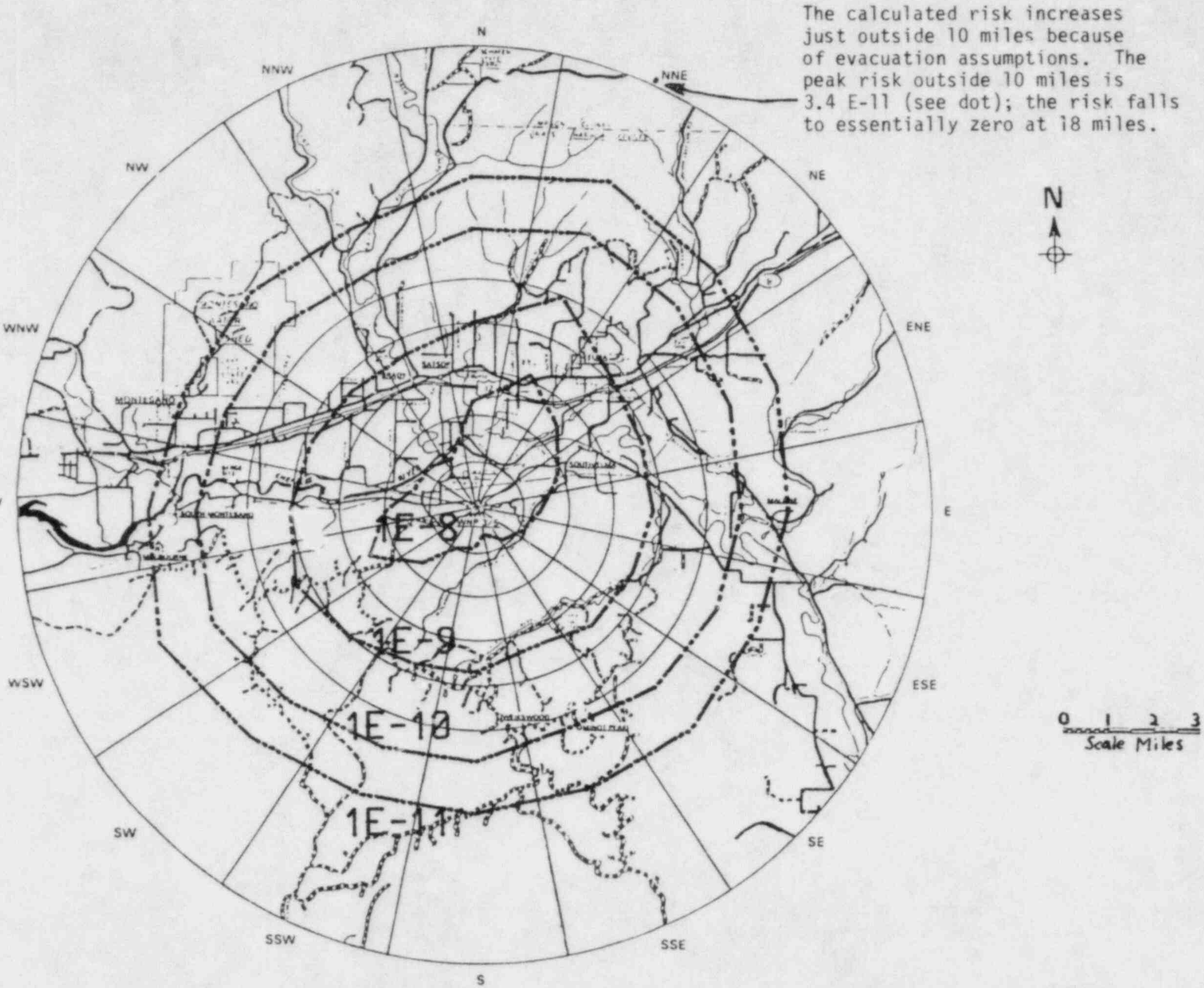

Figure 5.10 Isopleths of risk of early fatality per ry to an indivdual (10 mi = 16 km, 1E-8 = 10^{-8})

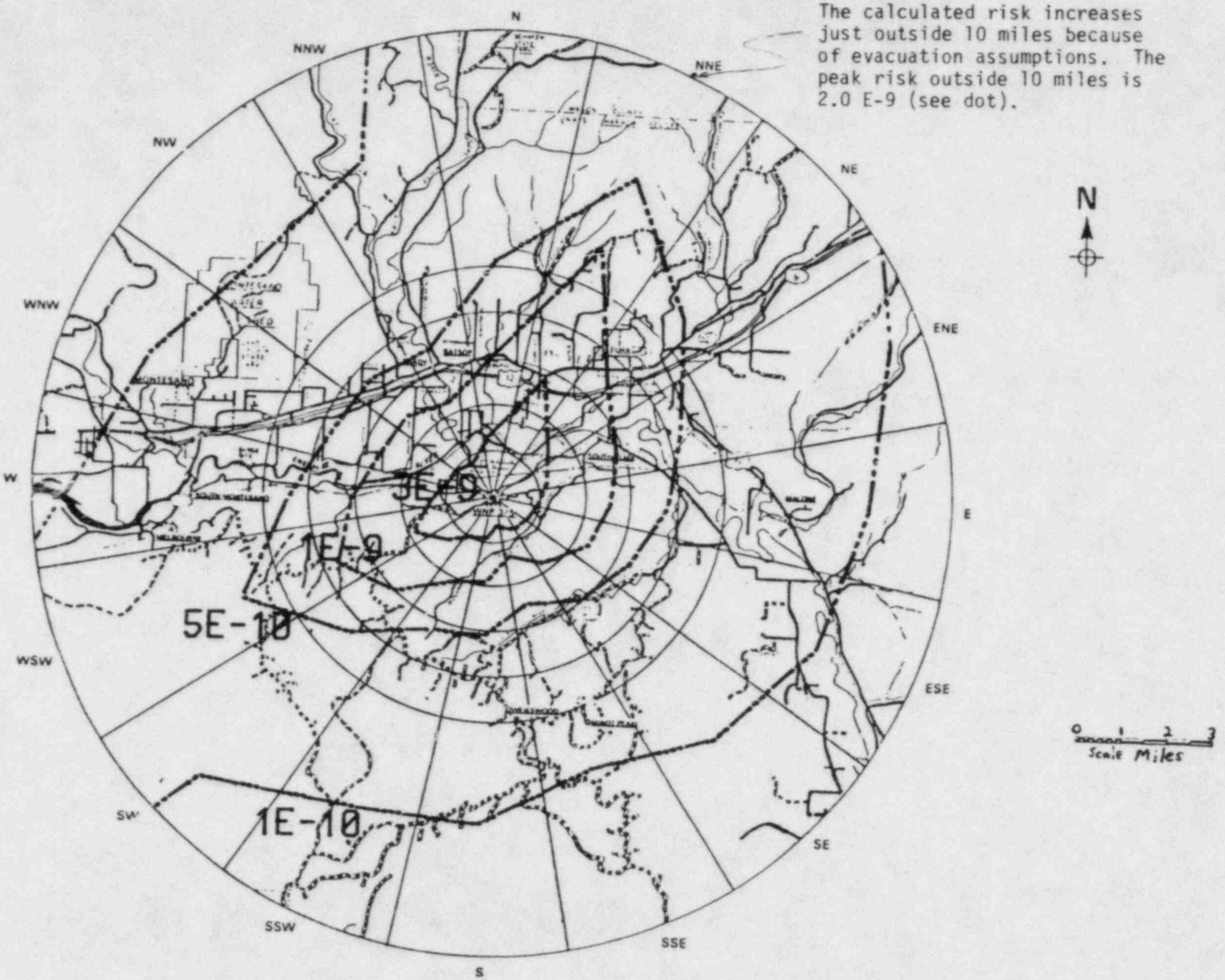

Figure 5.11 Isopleths of risk of latent cancer fatality per ry to an individual (10 mi = 16 km, 5E-10 = 5 x 10^{-10})

replacement of the damaged nuclear fuel. This estimate is based on the 10% escalation of the $950 million recovery cost (1980 dollars) estimated for Three Mile Island (EMD-81-106). Although insurance would cover $300 million or more of the $1680 million accident cost, the insurance is not credited against this cost because the arithmetic product of the insurance payment and the risk probability would theoretically balance the insurance premium.

In addition, the staff estimates that the outage time associated with an accident will total 8 years. The applicant states (in response to staff question 320.1) that, during years of favorable weather, energy that would be forthcoming from WNP-3 could be replaced by a combination of hydroelectric and coal-fueled energy at a cost comparable to that of WNP-3. However, during years of adverse weather conditions, energy would have to be purchased from oil-fueled facilities in California.

For purposes of this economic risk analysis, the staff conservatively assumes (tending toward a high cost estimate) that the accident occurs during the first year of the 4-year adverse water period. (In Federal Power Commission (FPC) Hearing Proceeding--High Ross Dam LP No. 553, 1974-1975--the FPC staff assumed a 4-year adverse water period for planning purposes.) The staff estimates that annual system fuel costs would increase by approximately $404 million (1986 dollars). This estimate assumes that the energy replaced will be equivalent to the amount of energy forthcoming from WNP-3 if it were to operate at an average annual capacity factor of 55%. This estimate further assumes that there is a reasonable possibility that 25% of this energy could be replaced by coal-fueled facilities while the remainder would have to be replaced by oil-fueled generation from California. If this annual penalty were incurred during the entire 4-year adverse period, $1616 million (1986 dollars) would have to be expended for replacement energy. For an 8-year outage, total accident cost would be approximately $3296 million dollars, the sum of the recovery costs and the replacement power costs.

The probability of a core melt or severe reactor damage is assumed to be as high as 10^{-4} per reactor-year (this type of accident probability accounts for all severe core damage accidents leading to significant economic consequences for the owner). Multiplying the previously estimated costs of $3296 million (the sum of the replacement power and recovery costs) for an accident to WNP-3 during the initial year of its operation by the above 10^{-4} probability results in an economic risk of approximately $329,600 (1986 dollars) applicable to WNP-3 during its first year of operation. This is also the approximate economic risk (1986 dollars) anticipated for the second and each subsequent year of the unit's operation. Although the economic consequences of an accident tend to lessen as the unit ages (the unit depreciates in value and may operate at a reduced capacity factor), this tendency is offset by higher future costs of decontamination and restoration.

A severe accident that requires the interdiction and/or decontamination of land areas is likely to force numerous businesses to temporarily or permanently close. These closures would have additional economic effects beyond the contaminated areas through the disruption of regional markets and sources of supplies. This section provides estimates of these impacts and risks; the estimates were made using: (1) the RSS consequence model discussed elsewhere in this section, and (2) the Regional Input-Output Modeling System (RIMS II) developed by the Bureau of Economic Analysis (BEA) (NUREG/CR-2591).

The industrial impact model developed by BEA is based on contamination levels of a physically affected area defined by the RSS consequence model. Contamination levels define an interdicted area immediately surrounding the plant, followed by an area of decontamination, an area of crop interdiction, and finally an area of milk interdiction.

Specific assumptions used in the analysis are

(1) In the interdicted area all industries would lose total production for more than a year.

(2) In the decontamination zone there would be a 3-month loss in nonagricultural output; a 1-year loss in all crop output (except there would be no loss in greenhouse, nursery, and forestry output); a 3-month loss in dairy output; and a 6-month loss in livestock and poultry output.

(3) In the crop interdicted area there would be no loss in nonagricultural output; a 1-year loss in agricultural output (except there would be no loss in greenhouse, nursery, and forestry output); no loss in livestock and poultry output; and a 2-month loss of dairy output.

(4) In the milk interdiction zone, there would be only a 2-month loss in dairy output.

The industry-specific impacts are estimated for five levels of accident severity. However, because Release Categories B and C* resulted in areas affected similarly to those determined by the RSS consequence model, they were treated as having the same impacts. The same situation holds for Release Categorics F and H, and they also are treated as having the same impacts. However, the probabilities of all these release categories differ.

The estimates of industrial impacts are made for an economic study area that consists of a physically affected area and a physically unaffected area. An accident that causes an adverse impact in the physically affected area (for example, the loss of agricultural output) could also adversely affect output in the physically unaffected area (for example, food processing). In addition to the direct impacts in the physically affected area, the following additional impacts could occur in the physically unaffected area:

(1) decreased demand (in the physically affected area) for output produced in the physically unaffected area

(2) decreased availability of production inputs purchased from the physically affected area

Only the impacts that occur during the first year following an accident are considered. The longer term consequences are not considered because they will vary widely depending on the level and nature of efforts to mitigate the accident consequences and to decontaminate the physically affected areas.

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*See Table 5.6.

The estimates assume no compensating effects such as (1) the use of unused capacity in the physically unaffected area to offset the initial lost production in the physically affected area or (2) income payments to individuals displaced from their jobs that would enable them to maintain their spending habits. These compensating effects would reduce the industrial impacts. Realistically, these compensating effects would occur over a lengthy period. The estimates considering no compensating effects are the best measures of first year economic impacts.

The output loss risk can be estimated by multiplying the probabilities of the five release categories (Table 5.6) by the probability of the wind blowing in that direction and the associated consequences. The overall risk associated with these five categories is then estimated as the sum of the individual products. The risk calculations use consequences with none of the compensating effects discussed earlier because of the time that would elapse before the compensating effects could occur. Table 5.9 presents the regional economic output and employment impacts and corresponding expected risks associated with the five different release categories. The estimated overall risk values using output losses as the measure of accident consequences, expressed on a per-reactor-year basis, is $25,990 per reactor-year. This number is composed of estimated direct impact losses of $20,166 in the nonagricultural sector and $2,979 in the agricultural sector. The indirect impacts of decreased exports and supply constraints are estimated to be a loss of $2,845 per reactor-year. The corresponding estimated employment loss per reactor-year is 1.5 jobs.

It should be noted that more than 60% of the expected losses per reactor-year are the result of one category of release travelling in a particular direction: a Category C release going toward the northeast, which has an expected risk of $16,052 and 1 job loss per reactor-year. These losses relate to the total losses of more than $8 billion and 274,000 jobs for the accident occurrence described. Alternatively, the minimal impacts for each release category result in expected losses of from $0 to $11 on a per-reactor-year basis. No offsite regional economic impacts are included for Release Category I, which has no containment failure, because none was large enough to have been reported by the simulation model.

The total estimated economic risk per year from WNP-3 from reactor decontamination and restoration, replacement fuel costs, and the first post-accident year's regional economic impacts is $212,000 (1980 dollars). This includes the replacement power and recovery costs discussed above (but expressed in 1980 dollars) and the "expected losses per reactor year [25,990]," in Table 5.9. Not included in the $212,000 total are the costs of offsite decontamination, evacuation, and relocation. The costs of offsite decontamination, evacuation, and relocation are about half of the costs ($13,000 (1980 dollars) per reactor-year) shown in Table 5.9. The other half includes costs also accounted for in the estimation of regional economic impacts. Therefore, the total of the economic risks considered in this study is about $245,000 (1980 dollars). The staff has also considered the health care costs resulting from hypothetical accidents in a generic model developed by the Pacific Northwest Laboratory (Nieves, 1983). Based upon this generic model, the staff concludes that such costs may be a fraction of the offsite costs evaluated herein, but that the model is not sufficiently constituted for application to a specific reactor site.

Table 5.9 Estimated regional output and employment impacts and expected risk, by release categories

Release category	Wind direction	Economic Impact, millons of 1980 $ — Direct — Non-agricultural	Direct agricultural	Indirect	Total	Loss in employment, annualized jobs	Loss in output/reactor-yr, 1980 $
MAXIMUM LOSSES							
B	NE	7140	93	890	8123	274000	688
C	NE	7140	93	890	8123	274000	16052
F	ENE	1218	43	155	1416	55000	212
H	ENE	1218	43	155	1416	55000	700
I	---	0	0	0	0	0	0
MINIMUM LOSSES							
B	NNW	11	0	1	12	<1000	0
C	NNW	11	0	1	12	<1000	11
F	NNW	2	0	0	2	<1000	1
H	NNW	2	0	0	2	<1000	1
I	---	0	0	0	0	0	0
TOTAL EXPECTED LOSSES, per reactor-year, 1980 $							
B	All	766	96	106	968	<1	*
C	All	17910	2238	2477	22625	1	*
F	All	347	150	61	558	<1	*
H	All	1143	495	201	1839	<1	*
I	All	0	0	0	0	0	*
All release categories	All	20166	2979	2845	25990	1.5	*

*Not applicable, as the expected loss is already expressed in the "Total" column for this portion of the table.

Source: Bureau of Economic Analysis, U.S. Department of Commerce, with assumptions supplied by the NRC staff.

(7) Uncertainties

The probabilistic and risk assessment discussion above has been based on the methodology presented in the RSS (WASH-1400).

In the consequence calculations, uncertainties arise from an over-simplified analysis of the magnitude and timing of the fission product release, from

uncertainties in calculated energy release, from radionuclide transport from the core to the receptor, from lack of precise dosimetry, and from statistical variations of health effects. Recent investigations of accident source terms, for example, have shown 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 reducing the quantity of fission products predicted to be released from the containment for some accident sequences. Such reductions in source terms would result in correspondingly lower estimates of health effects, particularly the estimates of early fatalities.

One area given considerable recent thought with respect to uncertainty is atmospheric dispersion. Although recent developments in the area of atmospheric dispersion modeling used in CRAC (the computer code developed in the 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. The 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 the cross-wind spread of the plume is another parameter of considerable uncertainty. Warning time before evacuation also has considerable impact on the 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.

Another area of uncertainty is the risks from externally caused accidents (such as earthquakes, floods, and man-caused events, including sabotage). No evaluations of such risks have been made for WNP-3. Where some of these types of risks have been evaluated for (among others) the Indian Point reactors in New York and for the Zion reactors in Illinois, however, such risks were found within a factor of less than 100 times greater than similar risks from internal accident initiators. Such experiences in plant-specific probabilistic risk assessments cannot be extended directly to WNP-3 because of site and plant design characteristics. However, the staff judges such risks to be within the uncertainty bounds discussed below.

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 herein, there are large uncertainties associated with the results shown. It is the judgment of the staff that the uncertainty bounds could be well over a factor of 10, but are not likely to be as large as a factor of 100.

Moreover, considerations of the likelihood of severe reactor accidents indicate that good quantification of severe accident risk is unlikely to influence the cost/benefit balance with respect to the licensing of this plant.

5.9.4.6 Conclusions

The foregoing sections consider the potential environmental impacts from accidents at the WNP-3 facility. 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 core melt.

The environmental impacts that have been considered include potential releases of radioactivity to the environment with resulting 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, (2) that, in order to obtain a license to operate the WNP-3 facility, the applicant must comply with the applicable Commission regulations and requirements, and (3) a probabilistic assessment of the risk based upon the methodology developed in the RSS. The overall assessment of environmental risk of accidents, assuming protective action, shows that it is on the same order as the risk from normal operation, although accidents have a potential for early fatalities and economic costs that cannot arise from normal operations. The risks of early fatality from potential accidents at the site are small in comparison with risks of accidental deaths from other human activities in a comparably sized population.

The staff has concluded that with respect to releases from severe accidents via the atmosphere, there are no special or unique circumstances about the WNP-3 site and environs that would warrant special mitigation features or operating procedures for the WNP-3 plant. On the other hand, potential releases from severe accidents via the groundwater pathway are much larger for WNP-3 than for typical U.S. power reactors. However, even for WNP-3, the total risk from this pathway is judged to be small compared to the atmospheric pathway. Further, as for the atmospheric pathway, doses from these releases can be reduced if mitigative measures are taken soon after a postulated accident.

5.10 Impacts from the Uranium Fuel Cycle

The Uranium Fuel Cycle Rule, 10 CFR 51.51 (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 in 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 terms 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. A proposed 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 5.10 herein.* 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 WNP-3 facility. The environmental impacts are based on the values given 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.

5.11 Decommissioning

The purposes of decommissioning are (1) to safely remove nuclear facilities from service and (2) to remove or isolate the associated radioactivity from the environment so that the part of the facility site that is not permanently committed can be released for other uses. Alternative methods of accomplishing these purposes and the environmental impacts of each method are discussed in NUREG-0586.

Since 1960, 68 nuclear reactors--including 5 licensed reactors that had been used for the generation of electricity--have been or are in the process of being decommissioned. Although, to date, no large commercial reactor has undergone decommissioning, the broad base of experience gained from smaller facilities is generally relevant to the decommissioning of any type of nuclear facility.

Radiation doses to the public as a result of end-of-life decommissioning activities should be small; they will come primarily from the transportation of waste to appropriate repositories. Radiation doses to decommissioning workers should be well within the occupational exposure limits imposed by regulatory requirements. The NRC is currently conducting rulemaking proceedings that will develop a more explicit overall policy for decommissioning commercial nuclear facilities. Specific licensing requirements are being considered that include the development of decommissioning plans and financial arrangements for decommissioning nuclear facilities.

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*The Supreme Court has upheld the validity of the S-3 rule in Baltimore Gas & Electric Co., et al. v. Natural Resources Defense Council, Inc., No. 82-524, issued June 6, 1983, 51 U.S. Law Week 4678.

Table 5.10 (Summary Table S-3) Uranium-fuel-cycle environmental data[1]

[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.

Table 5.10 (Continued)

[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
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	
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.

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.

Estimated effluents based upon combustion of equivalent coal for power generation.

1.2 percent from natural gas use and process.

5.12 Noise

Because of the distance from the noise sources to sensitive land uses, the staff does not expect noise to be a significant impact.

Principal noise sources during station operation will be the natural draft cooling tower and outside transformers. The nearest residence is about 1.6 km (1 mile) from the site; the nearest population center is the town of Satsop about 4.8 km (3 miles) from the site.

5.13 Emergency Planning Impacts

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 Requirements for Nuclear Power Plants."

In response to NUREG-0685, the applicant is in the process of building the Primary Emergency Operations Facility. This facility is located 1.4 km (0.85 mile) northwest of the WNP-3 reactor building just outside the exclusion zone, but on WNP-3 property. The Primary Emergency Operations Facility is a 1,208-m^2 (13,000-ft^2) shielded area in the lower level of a training facility used to support normal plant operations (WNP-3 Emergency Preparedness Plan Section 10.3). The floor plan for this facility is given in FSAR Figure 10-4. The training facility containing the Primary Emergency Operations facility, including the parking space, occupies 0.5 ha (1.3 acres). There is nothing unique about this facility that would result in environmental impacts different from those associated with construction and occupancy of a small office building.

The applicant has proposed that the Backup Emergency Operations Facility use the Washington State Emergency Operations Facility in Olympia, Washington, 48 km (30 miles) from the plant site. This proposal has been evaluated and approved by the NRC Commissioners. Because this is an existing facility, any environmental impact associated with its proposed usage would be negligible.

The staff believes the only noteworthy potential source of impacts to the public from emergency planning would be associated with the testing of the early notification system. The test requirements and noise levels will be consistent with those used for existing alert systems; therefore, the NRC staff concludes that the noise impacts from the system will be infrequent and insignificant.

5.14 Environmental Monitoring

5.14.1 Terrestrial Monitoring

The staff has concluded (Section 5.5.1) that the potential for damage to the surrounding ecosystem caused by drift from WNP-3 cooling towers will be small. Nevertheless, the staff believes it is prudent to undertake a limited-term inspection program because a margin of uncertainty still exists. An acceptable monitoring program could rely on infrared aerial photography with accompanying ground verification. A program to accomplish this will be specified in an environmental protection plan (EPP) that will be included as Appendix B of the operating license. This EPP will include requirements for prompt reporting by the

licensee of any important or unusual event that potentially could result in significant environmental impact causally related to plant operation. Examples of such events are excessive bird destruction as a result of collision with plant facilities, onsite plant or animal disease outbreaks, and mortality of any species protected by the Endangered Species Act of 1973, as amended.

5.14.2 Aquatic Monitoring

The certification and permits required under the Clean Water Act provide the mechanisms for protection of water quality and aquatic biota in the vicinity of operating power plants. Operational monitoring of effluents from WNP-3 will be required by the NPDES Permit issued by the State of Washington. Additionally, temperatures and river flow will be monitored to ensure that discharges do not violate limitations on thermal effluents and the dilution zone. The State of Washington NPDES Permit WA-002496-1 is included as Appendix G of this report. The "General Conditions" section of the permit (pages G-11 to G-19) contains provisions for monitoring and special studies related to biota of the river. The Energy Facility Site Evaluation Council's 1982 Site Certification Agreement between the State and the applicant imposes limitations on water withdrawal by the Ranney wells. The agreement also contains requirements for aquatic biological and fisheries monitoring of the Chehalis River during preoperational and operational periods. The applicant has submitted to the State a proposed ecological monitoring program. Following receipt and resolution of comments from the State, a revised program will be produced. The program will be finalized and implemented 30 months before the anticipated fuel load date. The NRC will rely on the decisions made by the State of Washington, under the authority of the Clean Water Act, for any aquatic monitoring or power plant design modification, should that become necessary.

As noted above, an EPP that will be included as Appendix B of the NRC operating license for WNP-3 will contain requirements for prompt reporting by the licensee of any important or unusual events that potentially could result in significant environmental impact causally related to station operation. Examples of such events include fish kills; mortality of any species protected by the Endangered Species Act, as amended; increase in nuisance organisms or conditions; any unanticipated or emergency discharge of waste water or chemical substances.

Violations of requirements imposed under the NPDES Permit (should they occur) also could result in environmental impact. Because this is a facility reviewed and licensed by NRC, to keep the NRC abreast of all potential environmental impacts the EPP will require the licensee to report to the NRC all violations of the NPDES Permit. A copy of the notice provided to the State of Washington will satisfy this EPP reporting requirement.

5.14.3 Atmospheric Monitoring

A pre-operational meteorological monitoring program was begun in 1973 and continued through February 1975. A second monitoring program was begun in September 1979 and continued through September 1981. (These programs are discussed in the FSAR.)

The measurements were made on a 60-m tower and include wind speed and wind direction at the 10- and 60-m levels, ambient air temperature at 10 m, dew point temperature at 60 m, and vertical temperature difference between the

10- and 60-m levels. Relative humidity is also measured at 10 m, while precipitation is measured at ground level near the tower.

This tower, located approximately 1130 m north-northwest of the plant, will provide operational data on meteorological conditions to the control room.

In addition, a 10-m tower will be installed as a backup for use in emergency preparedness to provide wind speed and wind direction, as well as the standard deviation of the wind direction (sigma theta) to indicate atmospheric stability.

5.15 References

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---, RG 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," Revision 1, June 1974.

---, RG 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," Revision 1, October 1977.

---, RG 4.1, "Programs for Monitoring Radioactivity in the Environs of Nuclear Power Plants," Revision 1, April 1975.

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6 EVALUATION OF THE PROPOSED ACTION

6.1 Unavoidable Adverse Impacts

The staff has reassessed the physical, social, biological, and economic impacts that can be attributed to the operation of WNP-3. These impacts are summarized in Table 6.1.

The applicant is required to adhere to the following conditions for the protection of the environment:

(1) Before engaging in any additional construction or operational activities that may result in any significant adverse environmental impact that was not evaluated or that is significantly greater than that evaluated in this statement, the applicant will provide written notification of such activities to the Director of the Office of Nuclear Reactor Regulation and will receive written approval from that office before proceeding with such activities.

(2) The applicant will carry out the environmental monitoring programs outlined in Section 5 of this statement as modified and approved by the staff and implemented in the Environmental Protection Plan and Technical Specifications that will be incorporated in the operating license.

(3) If an adverse environmental effect or evidence of irreversible environmental damage is detected during the operating life of the plant, the applicant will provide the staff with an analysis of the problem and a proposed course of action to alleviate it.

6.2 Irreversible and Irretrievable Commitments of Resources

There has been no change in the staff's assessment of this impact since the earlier review except that the continuing escalation of costs has increased the dollar values of the materials used for constructing and fueling the plant.

6.3 Relationship Between Short-Term Use and Long-Term Productivity

There have been no significant changes in the staff's evaluation for WNP-3 since the construction permit stage environmental review.

6.4 Benefit-Cost Summary

6.4.1 Summary

Sections below describe the environmental and socioeconomic benefits and costs that are associated with the operation of WNP-3.

Table 6.1 Benefit-cost summary

Primary impact and effect on population or resources	Quantity* (Section)	Impacts**
BENEFITS		
Direct		
Electrical energy	6 billion kWh/yr	Large
Additional capacity	1240 MWe (Section 6.4.2)	Large
COSTS		
Environmental		
Damage suffered by other water users		
Surface water consumption	0.7 m^3/sec ($25 ft^3$/sec)	Small
Surface water contamination	(Section 5.3.2)	Small
Groundwater consumption	0.1 m^3/sec ($3 ft^3$/sec)	Small
Groundwater contamination	(Section 4.3.2)	None
Damage to aquatic resources		
Impingement and entrainment	(Section 5.5.2)	None
Thermal effects	(Section 5.5.2)	Small
Chemical discharge	(Section 5.3.2)	Small
Damage to terrestrial resources		
Station operations		
Cooling tower emissions	(Section 5.5.1)	Small
Transmission line maintenance	(Section 5.5.1)	Small
Adverse nonradiological health effects		
Water quality changes	(Section 5.3.2)	None
Air quality changes	(Section 5.4)	
Adverse radiological health effects		
Routine operation	(Section 5.9.3)	Small
Postulated accidents	(Section 5.9.4)	Small
Uranium fuel cycle	(Section 5.10)	Small
Adverse socioeconomic effects		
Effect on historic and archeological resources	(Section 5.7)	None
Traffic	(Section 5.8)	Small
Demands on public facilities and services	(Section 5.8)	Small

*See footnotes at end of table.

Table 6.1 (continued)

Primary impact and effect on population or resources	Quantity* (Section)	Impacts**
Demands on private facilities and services	(Section 5.8)	Small
Noise	(Section 5.12)	Small

*Where a particular unit of measure for a benefit/cost category has not been specified in this statement or where an estimate of the magnitude of the benefit/cost under consideration has not been made, the reader is directed to the appropriate section of this report for further information.

**Subjective measure of costs and benefits is 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' judgements 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.

6.4.2 Benefits

A major benefit to be derived from the operation of the WNP-3 unit is the approximately 6 billion kWh of baseload electrical energy that will be produced annually. (This projection conservatively (low) assumes that the unit will operate at an annual average capacity factor of 55%.) The addition of the plant will also improve the ability of WPPSS to supply system load requirements by contributing 1240 MW of generating capacity to the northwest region of the United States.

6.4.3 Socioeconomic Costs

No significant socioeconomic costs are expected from the normal operation of the WNP-3 station or from the number of station personnel and their families living in the area. The socioeconomic impacts of a severe accident could be large; however, the probability of such an accident is small.

6.5 Conclusion

As a result of its analysis and review of potential environmental, technical, and social impacts, the staff has prepared an updated forecast of the effects of operation of the WNP-3 station. The staff has determined that WNP-3 can be operated with minimal environmental impact. No new information has been obtained that alters the overall favorable balancing of the benefits of station

operation versus the environmental costs that resulted from evaluations made at the construction permit stage.

6.6 Reference

U.S. Nuclear Regulatory Commission, NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning Nuclear Facilities," January 1981.

7 CONTRIBUTORS

The following personnel of the U.S. Nuclear Regulatory Commission, Washington, DC, participated in the preparation of the Final Environmental Statement:

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Clarence Hickey	Senior Fishery Biologist; MS (Marine Science), 1971; marine/fisheries science, 13 years experience; AFS Certified Fisheries Scientist.
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Alvin Brauner	Site Analyst; BS (Electrical Engineering), 1950; 33 years nuclear experience.

8 AGENCIES, ORGANIZATIONS, AND INDIVIDUALS TO WHOM COPIES OF THE DRAFT ENVIRONMENTAL STATEMENT WERE SENT

Advisory Council on Historic Preservation
Federal Emergency Management Agency
U.S. Department of Agriculture
U.S. Department of the Army, Corps of Engineers
U.S. Department of Commerce
U.S. Department of Energy
U.S. Department of Health and Human Services
U.S. Department of Housing and Urban Development
U.S. Department of the Interior
U.S. Department of Transportation
U.S. Environmental Protection Agency
Chairman, Energy Facility Site Evaluation Council (Washington)
Washington State Office of the Governor
Washington State Office of Financial Management
Chairman, Board of County Commissioners of Grays Harbor County (Washington)
Chairman, Board of County Commissioners of Mason County (Washington)
Chairman, Board of County Commissioners of Thurston County (Washington)
Mayor, City of Aberdeen (Washington)
Mayor, City of Elma (Washington)
Mayor, City of Montesano (Washington)
Mayor, City of Olympia (Washington)
Mayor, City of McCleary (Washington)

9 STAFF RESPONSES TO COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

Pursuant to 10 CFR 51, the "Draft Environmental Statement Related to the Operation of WPPSS Nuclear Project No. 3" (DES) was transmitted, with a request for comments, to the agencies and organizations listed in Section 8. In addition, the NRC requested comments on the DES from interested persons by a notice published in the Federal Register on January 27, 1984.

The organizations and individuals who responded to the requests for comments are listed below chronologically in order of the dates of their letters. The letters are reproduced in Appendix A. In parentheses after the name of each commenter are the initials used to identify the commenter later in this section and the page in Appendix A on which the comment letter begins.

The commenters were

U.S. Department of Agriculture, Economic Research Service (USDA, 1)

John F. Doherty (JFD, 2)

Washington Public Power Supply System (WPPSS, 4)

U.S. Environmental Protection Agency Region X (EPA, 9)

State of Washington

- Department of Ecology (ECOL, 10)
- Energy Facility Site Evaluation Council (EFSEC, 12)
- Office of Archaeology and Historic Preservation (AHP, 14)
- Department of Fisheries (DOF, 15)

Department of the Army, Seattle District, Corps of Engineers (COE, 16)

William R. Freudenburg (WRF, 18)

Sebastian Degens (SD, 20)

U.S. Department of the Interior (DOI, 29)

U.S. Department of Energy, Bonneville Power Administration (BPA, 30)

The letters from USDA and EPA Region X do not require a response. USDA stated it had no comments. EPA Region X rated the DES as LO-1 (lack of objections, adequate level of information) in accordance with its responsibilities under Section 309 of the Clean Air Act; however, EPA made note of the NRC commitment to supplement or otherwise revise the environmental statement should significant project changes occur. The other letters did require a staff response.

The staff's consideration of these comments and its disposition of the issues involved are reflected in part by revised text in the pertinent sections of

this FES (and indicated by lines in the margin next to the revised lines) and in part by discussion in the following section. The discussion is generally keyed to the body of the statement. For example, FES Section 9.5.9.1 contains the staff's response to comments on DES Section 5.9.1. The comments are referenced by the use of the abbreviations indicated above and by the individual comment numbers noted in the margins of the comment letters in Appendix A. Comments on appendices are in Section 9.7, and references cited are given in Section 9.8.

Table 9.1 is a cross-reference list of comments and the section(s) of this report in which they are addressed.

9.1 Abstract, Summary and Conclusions, and Introduction

9.1.2 Administrative History

SD-15

SD comments that if the DES-OL is a supplement to the FES-CP, the DES should review all altered environmental circumstances. However, he says, if the DES-OL is specifically concerned with the OL stage, the environmental review should be done when "basic conditions are known."

- Staff Response

The NRC licensing process involves two stages, the Construction Permit (CP) stage and the Operating Licensing (OL) stage. At the OL stage, the NRC's environmental evaluation considers matters that differ from or that reflect new information in addition to those matters discussed in the FES-CP (10 CFR 51.95).

9.1.3 Permits and Licenses

COE-1

COE states that this section should note that a Department of the Army permit will be required for any work in navigable water of the U.S.

- Staff Response

The staff acknowledges that Department of the Army permits are required by the applicant for performance of work in navigable waters of the United States. Section 12 of the ER-OL lists the Section 10 and Section 404 permits issued by the Corps of Engineers to the applicant during the period 1977 through 1981. Future work of a similar type will require submittal of the appropriate applications to the Corps of Engineers before new projects on the waters surrounding the site are initiated.

9.2 Purpose of and Need for Action

COE-2

COE comments that "although nuclear plants cost less to operate, they are much more expensive to construct than most fossil-fueled plants." COE suggests that the section be expanded to more fully support the conclusion.

Table 9.1 Cross-reference list of comments and section(s) of this report where the comment is addressed

Comment	Section	Comment	Section	Comment	Section
AHP	No response	JFD-3	9.5.9.3	WPPSS-14	9.4.3.4.2
	required	4	9.5.9.4.4(1)	15	9.5.2.1,
					9.5.5.1
BPA	9.4.2.7	SD-1	9.3	16	9.4.3.6
		2	9.3	17	9.5.9.3
COE-1	9.1.3	3	9.5.3.1	18	9.5.9.3
2	9.2	4	9.5.3.1	19	9.5.9.3
3	9.5.3.1,	5	9.4.2.5	20	9.5.9.3
	9.5.9.3	6	9.5.9.3	21	9.5.9.4.5(2)
4	9.5.3.1	7	9.5.9.4.5(6)	22	9.5.9.4.5(5)
5	9.5.3.1	8	9.5.3.2	23	9.5.9.4.5(5)
6	9.5.3.1	9	9.7.5	24	9.5.9.4.5(5)
7	9.5.9.3	10	9.5.9.3	25	9.5.9.4.5(5),
		11	9.5.10		9.5.9.4.5(6)
DOF-1	9.4.3.4.2	12	9.6.4	26	9.5.9.4.5(5)
2	9.5.3.1	13	9.3	27	9.6
		14	9.5.10	28	9.6
DOI-1	9.5.9.4.5(5)	15	9.1	29	9.6.1
2	9.5.9.4.5(5)			30	9.4.2.2
3	9.5.9.4.5(5)	WRF-1	9.5.8	31	9.4.2.4
		2	9.6.1	32	9.4.2.6.2
ECOL-1	9.4.2			33	9.4.3.1.1.1
2	9.5.4.2	WPPSS-1	9.4.2.1	34	9.4.3.4.2
3	9.6	2	9.4.2.1	35	9.5.3.1
4	9.5.9	3	9.4.2.2	36	9.5.3.2
	to 9.5.14	4	9.4.2.6.2	37	9.5.4.1,
EFEC-1	9.4.1	5	9.4.2.6.2		9.5.5.1,
2	9.4.2	6	9.4.2.6.2		9.5.15
3	9.5.3.1	7	9.4.2.6.3	38	9.5.9.4.5(6)
		8	9.4.3.1.1,	39	9.5.9.4.5(3)
EPA	No response		9.4.3.1.1.3	40	9.5.9.4.5(6),
	required	9	9.4.3.1.1.3		9.5.15
		10	9.5.3.1	41	9.5.13
JFD-1	9.5.10	11	9.5.3.1	42	9.7.6
2	9.5.10	12	9.4.3.3		
		13	9.4.3.4.2	USDA	No required
					response

- Staff Response

Issues related to the cost of construction were considered at the CP stage of the licensing review. At the OL stage, the substantial capital costs associated with the construction of the facility have already been incurred and will be borne whether or not the unit operates. The only economic factors that are relevant at this point are those related to the operation of the plant. Therefore, the staff views it inappropriate to "expand...the information" in the DES to include a discussion of a subject that is no longer relevant to a decision as to whether the unit should be allowed to operate.

9.3 Alternatives to the Proposed Action

SD-1

SD comments that the NRC's environmental review process "eliminates a broad range of alternatives during the OL stage," and notes that no alternatives are presented in the DES.

- Staff Response

In accordance with the NRC's responsibilities under NEPA, the alternatives of siting the nuclear power plant elsewhere and alternative energy sources are resolved at the CP stage of the licensing process. At the CP stage, the staff prepared a detailed environmental statement that evaluated the environmental conditions of the proposed action that could significantly affect the quality of the human environment. That statement considered the environmental impact of alternatives to the proposed action.

SD-2

SD comments that alternative plans of operation should have been addressed, including, for example, alternative monitoring programs.

- Staff Response

The CP stage environmental review considers both construction and operating impacts. Furthermore, at the CP stage, alternatives such as those identified by SD are considered. At the OL stage, the review focuses on new information and on issues not recognized at the earlier review. In the absence of the identification of significant new environmental impacts, the alternatives to previously reviewed practices are not reexamined.

SD-13

SD states that the DES "does not provide the type of comparative evaluation NEPA encourages."

- Staff Response

A comparison of alterntives to WNP-3 was considered at the CP stage when a complete evaluation of environmental conditions was conducted.

9.4 Project Description and Affected Environment

9.4.1 Résumé

EFEC-1

EFEC agrees that the major change affecting WNP-3 since the CP stage review is the cancellation of WNP-5, and comments that with only one unit now planned for operation, the potential for impact has lessened.

- Staff Response

The staff agrees with this comment. No text change is necessary.

9.4.2 Facility Description

EFEC-2

EFEC comments that the DES accurately describes the state's requirements for water withdrawal and thermal discharges, and design changes made in the discharge diffuser and cooling system since the CP stage.

- Staff Response

The staff agrees with this comment. No text change is necessary.

9.4.2.1 External Appearance and Plant Layout

WPPSS-1

WPPSS* notes that Figure 4.1 (ER-OL Figure 2.1-1) is to be amended.

- Staff Response

A revised version of the figure is included in the FES (see Figure 4.1).

WPPSS-2

WPPSS comments that reduction of the base diameter of the cooling tower by 90 feet is not an exception to conclusions regarding the significance of changes in the arrangement of site structures.

- Staff Response

Section 4.2.1 has been revised accordingly.

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*WPPSS is the WNP-3 applicant.

9.4.2.2 Land Use

ECOL-1

ECOL notes that the site layout (Figure 4.1) shows the Keyes Road Extension on the east of the plant and into the exclusion zone. A significant section of this road is not shown--the portion that extends from near the No. 3 cooling tower, past the turbine generator, and connecting with the main Keyes Road terminus at the top of Fuller Hill. ECOL says this road is significant as an alternative access to the site and/or evacuation corridor, and that there has been some discussion of eliminating use of this road in favor of diverting any required cross traffic to the plant connecting road. ECOL notes that use of either or both could have impacts on plant security and emergency response plans, and should be discussed in the FES.

- Staff Response

The applicant intends to abandon the segment of Keyes Road extension within the site and control access to the exclusion zone easement area via Keyes Road; therefore, omission of the on-site segment of Keyes Road from Figure 4.1 is appropriate. A full review of emergency response plans is provided for by 10 CFR 50.47 and 10 CFR 50, Appendix E, and the staff findings will be reported in the SER.

WPPSS-3

WPPSS states that the construction laydown area should be added to the land use areas listed.

- Staff Response

Section 4.2.2 has been revised accordingly, and a reference to FSAR Figure 1.2-1, which shows this area, has been added.

WPPSS-30

WPPSS pointed out that the question number cited should be 290.14 and the exclusion area boundary distance is 1310 meters.

- Staff Response

The text has been changed to reflect these comments.

9.4.2.4 Cooling System

WPPSS-31

WPPSS notes that limitations contained in the Site Certification Agreement are described in Section 4.3.1.1, not Section 4.3.2.

- Staff Response

The text has been changed to reflect this comment.

9.4.2.5 Radioactive Waste Management System

SD-5

SD comments that "a multiple reference" to the staff's Safety Evaluation Report (SER) (scheduled for publication after the closure date for comments on the DES) was "troublesome."

• Staff Response

The DES and FES address the environmental aspects of an issue, while the SER addresses safety aspects. The cross-references to the SER are provided for reader convenience only.

9.4.2.6 Nonradioactive Waste Management Systems

9.4.2.6.2 Corrosion, Scale, and Biofouling Control Chemcials

WPPSS-4

WPPSS notes that potassium chromate will be added to the closed component cooling water system for corrosion control.

• Staff Response

The text has been modified to reflect this change.

WPPSS-5

WPPSS notes that sodium hypochlorite will be the source of free chlorine residuals.

• Staff Response

The text has been modified to reflect this comment.

WPPSS-6

WPPSS notes that although the chlorine residual in the discharge is to be at or below 0.02 mg/L, the NPDES permit considers 0.05 mg/L to be the detectable limit.

• Staff Response

The comment has been noted.

WPPSS-32

WPPSS notes that the source for current estimate of average daily use of acid is ER-OL Table 3.6.2. WPPSS also commented on the "wordiness" of the last part of paragraph 3 of Section 4.2.6.2.

• Staff Response

The cross-reference has been changed.

9.4.2.6.3 Other Chemical Discharges

WPPSS-7

WPPSS points out that it will continue to dispose of treated wastes in the urain field that was sized for construction phase loading.

• Staff Response

This information has been added to the text in Section 4.2.6.3.

9.4.2.7 Power Transmission System

BPA-1

BPA points out that the evaluation of the power transmission system beyond the WNP-3 substation was done by BPA and is documented in an environmental impact statement entitled "Satsop Integrating Transmission" (Department of the Interior, FES 76-31). BPA suggested that the FES cross-reference this statement.

• Staff Response

The reference has been added.

9.4.3 Project-Related Environmental Descriptions

9.4.3.1 Hydrology

9.4.3.1.1 Hydrologic Description

9.4.3.1.1.1 Surface Water

WPPSS-8

WPPSS notes that historical flow data for the Chehalis Rive are summarized in the fourth paragraph of Section 4.3.1.1.1. The average Chehalis River flow at the site is given (without reference) as 6824 ft^3/sec, while the ER-OL and FSAR suggest it to be about 6630 ft^3/sec. WPPSS states that the average monthly flows cited for August and January should be given as 806 and 14,668 ft^3/sec, respectively (see FSAR page 2.4-2; ER-OL page 2.4-1 and ER-OL Table 2.4-1 are to be amended accordingly). The minimum historical flow is now estimated to be 454 ft^3/sec (FSAR page 2.4-51) rather than 397 ft^3/sec as cited in the DES.

• Staff Response

The average river flow given in the FSAR (6630 ft^3/sec) was estimated by using stream flow data available through 1981. The staff used data available through

1983. Using the U.S. Geological Survey WATSTORE computer system, the staff determined average flows for the Chehalis River at Porter and for the Satsop River near Satsop. The average flow value of the Chehalis River at Porter was then adjusted to a flow value for the Chehalis River just upstream of the confluence of the Satsop River. This was done by using drainage area ratios. The next step consisted of adding the average flow value from the Satsop River to the adjusted average flow value for the Chehalis River to obtain a flow value for the Chehalis River just downstream of the confluence of the Satsop River. This flow value was then adjusted to the site by again using drainage area ratios. This procedure resulted in an estimated average flow in the Chehalis River at the site of 6824 ft^3/sec.

Average monthly flows cited in Section 4.3.1.1.1 of the DES as 730 ft^3/sec and 14,900 ft^3/sec, respectively, have been revised to 806 ft^3/sec and 14,668 ft^3/sec in the FES, as suggested by this comment. Also, the minimum historical low flow has been revised from 397 ft^3/sec in the DES to 454 ft^3/sec in the FES, as suggested in the comment.

WPPSS-33

WPPSS notes that in Section 4.3.1.1.1, third paragraph, the units of flow should be m^3/sec, not m^2/sec.

- Staff Response

The units of flow have been changed.

9.4.3.1.1.3 Supplemental Water Supply

WPPSS-8

WPPSS notes that the third sentence of Section 4.3.1.1.3 should make clear that the 550-ft^3/sec river flow limitation could be waived by the state on the basis of regional power needs.

- Staff Response

This possible waiver has been noted in the FES.

9.4.3.3 Meteorology

WPPSS-12

WPPSS suggests a clarification that although fog observations are from valley stations, the plant site is one ridge above the heavy fog.

- Staff Response

This change has been made.

9.4.3.4 Terrestrial and Aquatic Resources

9.4.3.4.2 Aquatic Resources

DOF-1

DOF suggests that Table 4.6 and Section 4.3.4.2 be updated to include fish planted from 1980 to 1982.

- Staff Response

The table and text have been revised to reflect this information, as provided to the NRC by the State of Washington.

WPPSS-13

WPPSS notes that the final paragraph of DES Section 4.3.4.2 is conclusionary and hence is not appropriate to the section, which is to contain descriptive material.

- Staff Response

This conclusionary material has been deleted from Section 4.3.4.2. The conclusions regarding the relocation of the diffuser discharge and the impact to fishes are in Section 5.5.2.2.

WPPSS-14

WPPSS requests clarification of data on fisheries in the WNP-3 site vicinity.

- Staff Response

Angler surveys conducted by the applicant during the period 1978 through 1981 are summarized in the "1981 Environmental Monitoring Program" report prepared by Envirosphere Company in 1982 (see Section 4.4 of this statement for list of references). The mean number of anglers observed per weekday (by month) during the four survey years is shown in Figure 5-2 of the Envirosphere report. That figure shows a range of about 0.2 to 26.4 anglers per day (as per applicant's comment). For the months of major salmon fishing activity (August through November), Figure 5-2 shows the mean number of anglers per weekday ranged from about 2 to 18. During the period of major steelhead fishing (December through March), the mean number of anglers ranged from about 2 to 26 per day. The angler surveys conducted during December 1977 through March 1978 (Envirosphere, 1978, Figure 3-9), showed that the total number of anglers counted in the study area ranged from near zero to a high of about 50. The majority of those anglers were fishing for steelhead. Section 4.3.4.2 has been revised to reflect these numbers.

WPPSS-34

WPPSS notes that the source for numbers of fish harvested cited in Table 4.5 should be the Energy Facility Site Evaluation Council.

• Staff Response

The change has been made.

9.4.3.6 Community Characteristics

WPPSS-16

In response to Q311.05, the applicant noted minor errors in the distribution of near-plant residents. Thus, WPPSS states that ER-OL Table 2.1-2 and FSAR Table 2.1-3 will be amended to provided corrections. For instance, the 1980 population within 1 mile of WNP-3 is now estimated to be 3 versus the 15 noted in DES Table 4.7.

• Staff Response

Table 4.7 has been revised to show the changes provided by the applicant.

9.5 Environmental Consequences and Mitigating Actions

9.5.2 Land Use

9.5.2.1 Plant Site

WPPSS-15

WPPSS notes that submittal of wildlife management plan to the Energy Facility Site Evaluation Council (EFSEC) is not specifically required, but stems from conditions of the Site Certification Agreement between the applicant and the State of Washington. When the plan is submitted to EFSEC, WPPSS will provide a copy to the NRC.

• Staff Response

The comment has been noted; no text change is necessary.

9.5.3 Water

9.5.3.1 Water Quality

COE-3, -4

In both comments, COE expresses concern about the impact of chemical discharges on river sediment and bioaccumulation. COE-3 specifically mentions chlorinated organics as being of concern.

• Staff Response

There are no extensive data available on bioaccumulation of chlorinated organics or on accumulation in sediment. Anderson et al. studied long-term exposure of trout to chlorine and found no evidence of an increased amount of chloroform or other chlorination by-products. Anderson and Lusty (NUREG/CR-0893) reported

that "accumulation of chloroform was less than one order of magnitude above water concentrations for all species." Bean (NUREG/CR-3408) reported from studies at eight nuclear power units at seven locations in the U.S. as follows: "Analysis of sediment samples for organohalogen material suggests that certain chlorination products may accumulate in sediments, although no tissue bioaccumulation could be demonstrated from analysis of a limited number of samples."

COE-5

COE suggests that waterborne contaminants in sediments be monitored as well as in the receiving water below the effluents.

- Staff Response

The final determination of the content of the monitoring program is in the purview of the State of Washington under the NPDES program. However, in light of the response to COE-3 and -4, and in recognition of the high cost of measuring concentrations of these trace substances, it is not likely that monitoring of chlorinated hydrocarbons will be justifiable

COE-6

COE proposes that baseline data on sediment chemistry be collected so that monitoring and effluent limits can be established.

- Staff Response

The responsibility for final determination of nonradiological aquatic monitoring requirements and effluent limits rests with the State of Washington. However, based on the results of NRC-sponsored research (NUREG/CR-0892, -0893, and -3408), baseline (pre-operational) sediment chemistry data are not of value for establishing monitoring and effluent limits for chlorinated organics.

DOF-2

DOF comments that the results of the bioassay study are now available.

- Staff Response

See the response to WPPSS-11 below.

EFSEC-3

EFSEC also notes that the results of the bioassy study are now available.

- Staff Response

See the response to WPPSS-11 below.

SD-3

SD suggests that refueling be synchronized with river flow.

- Staff Response

The responsibility for establishing limitations for the protection of surface waters rests with the State of Washington. The state has imposed certain conditions addressing operation during low river flow. The staff has found impact to the Chehalis River to be of such magnitude that no further assessment of impact was deemed necessary.

SD-4

SD questions using the earlier two-unit review as a basis for assessing the significance of one-unit operation. SD asks specifically about the discharge of sulfuric acid.

- Staff Response

The sulphate ion concentration increase in the river will be about 2.5 mg/l at low river flow. The staff found a higher sulphate discharge to be acceptable at the earlier (two-unit) review. In the absence of significant new information regarding the effects of the sulphate ion, the staff has no justification for re-examining the one-unit discharge, which produces a lower concentration.

WPPSS-10

WPPSS notes that the ambient Chehalis River copper concentrations given in Section 5.3.1 are based on older data and suggests that a reference be made to Table 4.2 of the statement for more recent data.

- Staff Response

The reference has been added.

WPPSS-11

WPPSS notes that the bioassy studies mentioned on the last paragraph of Section 5.3.1 have been provided to the staff. The results suggest a long-term no-effect level of 18 μg/L for coho salmon versus the 7 μg/L cited in the DES.

- Staff Response

Section 5.3.1 has been revised to incorporate the bioassay studies conducted by the applicant to satisfy General Condition G.29 of the NPDES Permit.

WPPSS-35

WPPSS notes that the cross-reference for the discussion on condenser tubing should be Section 4.2.6.3. A typographical error (a value repeated) was also noted.

- Staff Response

These changes have been made.

9.5.3.2 Water Use

SD-8

SD questions the explicitness of the evaluation of cumulative inputs on regional water use, and comments that regarding endangered species, the theorization that because of an eagle's keen eyesight, collision with a cooling tower seemed unlikely, seemed less important than some field data on the effects of construction noises on the habitat as a proxy for the anticipated noise from the pumping station.

· Staff Response

As described in Section 4.3.1.1.2, water for plant operation will be produced from two Ranney wells. About 88% of this water will come from the Chehalis River via infiltration and 12% will come from the alluvial valley fill. The station is expected to consumptively use about 0.8 m^3/sec (28 ft^3/sec). Of this, 88% (0.7 m^3/sec (25 ft^3/sec)) will be surface water from the Chehalis River and 12% (0.1 m^3/sec (3 ft^3/sec)) will be groundwater.

The average flow in the Chehalis River is about 193 m^3/sec (6824 ft^3/sec), and the 7-day 10-year low flow is about 15 m^3/sec (530 ft^3/sec). Comparing these flows with the station consumptive water use shows that WNP-3 will use less than 5% of the 7-day 10-year low flow and less than 0.4% of the average flow in the Chehalis River. Because the amount of surface water to be used by the station is but a small amount of the flow in the Chehalis River, the staff concludes that operation of WNP-3 will not adversely affect other surface water users.

The amount of groundwater to be consumptively used is only about 0.1 m^3/sec (3 ft^3/sec). As discussed in Section 5.3.2, during the CP stage, withdrawal of groundwater was expected to lower the water levels in the Chehalis River, Elizabeth Creek, and the adjacent marsh. This assessment assumed that the plant would consumptively use about 1.7 m^3/sec (60 ft^3/sec). Because WNP-5 has been cancelled, water use will be only about 0.8 m^3/sec (28 ft^3/sec), so the impacts of pumping from the Ranney wells will be appreciably less than they were at the CP stage because of the diminished water use.

In regard to the second part of the comment, noise created by the Ranney wells is not expected to affect eagles. The Ranney well pumps are located within a cinder block structure. There will be very little noise emanating from this structure. In the vicinity of the Ranney wells the Chehalis River flows swiftly, creating a constant low level noise that will mask the small amount of noise coming through the block walls.

Eagles forage over several square miles so that even if the noise from the Ranney wells disturbed them, their survival would not be threatened. The eagles have not abandoned their nest along the Chehalis River during the construction of WNP-3, which caused relatively greater disturbance and noise. Therefore, the small amount of noise that will be produced by the Ranney wells is not expected to cause the eagles to abandon their foraging along the river.

WPPSS-36

WPPSS notes that units of flow should be m^3/sec, not μg/sec.

- Staff Response

The units of flow have been changed.

9.5.4 Air Quality

9.5.4.1 Fog and Ice

WPPSS-37

WPPSS suggests that the correct reference is the FES-CP.

- Staff Response

The suggested change has been made.

9.5.4.2 Other Emissions

ECOL-2

ECOL comments that its certification, as amended in March 1982, called for the applicant to use low sulfur fuel oil (5% sulfur) in the backup emergency diesel engines.

- Staff Response

The staff agrees with this understanding. No text changes are needed.

9.5.5 Ecology

9.5.5.1 Terrestrial Ecology

WPPSS-15

See comment and staff response in Section 9.5.2.1 above.

WPPSS-37

WPPSS notes that the ER-OL figure referenced is 5.1-4, and the DES (FES) section referenced is 5.14.2.

- Staff Response

The suggested changes have been made.

9.5.8 Socioeconomic Impacts

WRF-1

WRF comments that the abstract "asserts without documentation" that "the net socioeconomic effects of the projects will be beneficial," and page 5-8, after a brief description of some economic considerations, notes that "the staff anticipates no other significant socioeconomic impacts from station operation." WRF says that these statements (particularly the latter) demonstrate either an unacceptably low level of relevant expertise among the study team "or a refusal to consider relevant research findings on the social impacts of WNP-3."

WRF states that the local social environment has changed greatly, and the social impacts of the licensing and operation of the plant are likely to be dramatically different from those that were envisioned in the FES-CP. He cites an analysis by Rodney Baxter and himself that has shown that attitudes toward local nuclear facilities have declined dramatically in nuclear "host communities" across the entire nation. He adds that a report prepared by Roger L. Wisniewski and himself (copies of which were given to the applicant) states: "There is greater local opposition to the WPPSS nuclear plants than to the nuclear facilities of any of the other 'normal' host community in the history of surveys in the U.S." WRF says the level of opposition near the Satsop facility, in fact, is matched only by a survey done at the Three Mile Island Plant itself, only 4 months after the accident. He concludes that these reports and others have noted further that the social consequences of permitting operation of a facility over such intense objections could be grave indeed.

- Staff Response

The comment would extend the scope of socioeconomic analysis within the environmental statement beyond the intent of NEPA and CEQ procedural provisions in 40 CFR 1500-1508. To be treated in an environmental statement, a socioeconomic phenomenon should be causally linked to effects of the project on the natural and physical environment. Public opposition to or support of a project per se and the resulting political phenomena are not within the appropriate scope of an environmental statement.

9.5.9 Radiological Impacts

ECOL-4

ECOL states that although DES Sections 5.9 through 5.14 "contain some very useful information," there is "a large amount of academic verbiage that tends to dilute the real conclusions or comparisons useful to public understanding... The information should be...put into layman's language."

- Staff Response

The staff has attempted to minimize the amount of academic verbiage, and to present conclusions and comparisons that are relevant. The staff does not think it would be useful to separate the topics into generic and site-specific--this would render the discussion less cohesive. The staff has tried

to make the text clear, but does not want to give up meaning for the sake of simplicity. At several times in the past, when specific public comments indicated that a given portion of an environmental statement was unclear, that portion was revised and clarified.

9.5.9.3 Radiological Impact from Routine Operations

COE-3, -7

COE states that impacts of "radiological contaminants in the effluent discharge are not fully evaluated" because the effects of bioaccumulation of radionuclides and the accumulation of radionuclides in sediments have not been described.

- Staff Response

The principal pathways of exposure of humans to radioactive liquid effluents are described in Section 5.9.3 and quantified in Appendix D. The models used to estimate doses take into account the bioaccumulation of radionuclides in the environment (Regulatory Guide 1.109, Appendix A). Based on the estimates of releases of radioactive effluents and doses to humans, no significant buildup of radionuclides in sediments is expected. Nonetheless, sediment samples will be taken downstream of the plant discharge 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 specifics of the required monitoring program will be incorporated in the OL Radiological Technical Specifications.

JFD-3

JFD states that references should be provided to support the statement on page 5-14 of the DES that "the lower limit of the range would be zero because there may be biological mechanisms that can require damage caused by radiation at low doses and/or dose rates."

- Staff Response

See the response to JFD-1 and -2 in Section 9.5.10 below. In addition, see (1) "Influence of Dose and Its Distribution in Time on Dose-Response Relationships for LOW-LET Radiations," Report No. 64, of the National Council on Radiation Protection and Measurements, 1980, and (2) "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation," BEIR III, National Academy of Sciences/National Research Council, July 1980.

SD-6

SD states that the capability of the proposed radwaste system to accommodate the solid wastes expected during normal operations was not evaluated or summarized, and comments that this seems to be a "significant" omission.

- Staff Response

This information will be supplied in the staff SER. This information is included in the SER rather than the FES because the information is part of the review of the design adequacy of the solid radwaste system.

SD-10

SD comments that an evaluation of the cumulative impact of the regional nuclear program was not included in the DES.

- Staff Response

The DES did not contain an explicit evaluation of cumulative radiological impacts from routine operation of WNP-3 and other nuclear power plants in the region because the radiological impact from several reactors is not greatly different than the impact from one reactor when the reactors are more than a few miles apart. If several reactors are at the same site, then the cumulative radiological impacts are limited by 10 CFR 20, and in some cases, by Rulemaking 50-2.

WPPSS-17, -18

WPPSS comments that "the fish consumption pathway dose" is based on excessively conservative dilution factors.

- Staff Response

The footnotes to Table D-5 in Appendix D state that the dilution factors were assumed for purposes of an upper limit estimate. The rationale for using conservative dilution factors is described more fully in Chapter 4 of "Preparation of Radiological Effluent Technical Specifications for Nuclear Power Plants," NUREG-0133, 1978.

WPPSS-19

WPPSS states that it would be useful to remind the reader "in Section 5.9.3.1.2 (p. 5-20)" that this individual considered is "hypothetical."

- Staff Response

From the comment, the staff assumes that WPPSS meant Section 5.9.3.2, which is on page 5-20 of the DES, and the FES cross references Section 5.9.3.2 with Section 5.9.2.

WPPSS-20

WPPSS states that typos in Table 6.1-7 of the ER-OL will be corrected.

- Staff Response

Table 5.3 has been revised to reflect these changes.

9.5.9.4 Environmental Impacts of Postulated Accidents

9.5.9.4.4 Mitigation of Accident Consequences

(1) Design Features

JFD-4

JFD requests that the FES include a quantitative statement regarding how much credit is taken in staff analyses for post-TMI changes and improvements in establishing the estimated radiological risks at the WNP-3 site.

- Staff Response

The "pre-TMI analysis" would have been the analysis of an example (Surry) pressurized water reactor (PWR) in WASH-1400 (NUREG-075/14), later revised (commonly referred to as the rebaselined Surry analysis). Accident release categories and probabilities from this analysis were used by the staff for several PWR environmental statements. Later, other probabilistic risk assessments (PRAs) for PWRs were reviewed by the staff during and after the implementation of the TMI Action Plan. For WNP-3, the staff decided that results and insights from these PRAs (particularly Indian Point and Zion) were more relevant to the WNP-3 design than was the rebaselined Surry analysis. Therefore, some of the release categories defined in the staff's Indian Point study were used for WNP-3, with modified probabilities per reactor-year. In turn, the calculated results for Indian Point reflected some of the required changes described in NUREG-0737 ("Clarification of TMI Action Plan Requirements"). The net effect of the NUREG-0737 changes on the calculated results for WNP-3 is small and obscured because of the level of detail in the fault tree analysis at which the effect of the changes is introduced.

9.5.9.4.5 Accident Risk and Impact Assessment

(2) Probabilistic Assessment of Severe Accidents

WPPSS-21

WPPSS-21 finds the estimated effective evacuation speed given in DES Section 5.9.4.5(5) and in Appendix F "overly conservative" compared to the values given in Table 12-5 of the WNP-3 Emergency Preparedness Plan.

- Staff Response

The source from which the staff derived the effective evacuation speeds was the D. L. Renberger (WPPSS) leter to D. G. Eisenhut (NRC), dated July 24, 1980, regarding emergency evacuation times. The WNP-3 Emergency Preparedness Plan does indicate generally shorter times to evacuate. If the shorter times are more valid, the staff's calculated early fatality risk (and, to a lesser extent, other risk measures) is likely to be an overestimate.

(3) Dose and Health Impacts of Atmospheric Releases

WPPSS-39

WPPSS notes that the figure references given in Table 5.7 are not correct, and that the radius cited in the discussion on Figure 5.6 should be 28-km. WPPSS also states that, to be consistent with Appendix D, the annual average population dose within 80 km of WNP-3 from natural background radiation should be 82,000 person-rems.

- Staff Response

The suggested changes have been made.

(5) Releases to Groundwater

DOI-1

DOI comments that, as noted on page 5-51, the accident analysis shows that the plant's passive underdrain system could deliver radioactive sump water to Workman Creek in the event of a core-melt accident, pointing out that the effects on Workman Creek, Chehalis River, and Grays Harbor, only briefly suggested, could be severe. DOI states that although the DES mentions a possible mitigation measure (the sealing of the underdrain, apparently after an accident), it is not clear that sealing the drain after an accident before a major radioactive release can be ensured. DOI asks why the underdrain system does not include provisions to shut off or divert to safe storage any contaminated flow from the reactor, and suggests that it would be simpler to provide for these measures before an accident has occurred than afterward.

- Staff Response

The staff believes that there are measures that could be taken to mitigate the liquid release of a core-melt accident to the Chehalis River. The more feasible measures appear to be sealing the three 10-inch underdrain outflow pipes with concrete or damming of Workman Creek. However, because the staff cannot prove conclusively that these mitigative measures would be undertaken after a core-melt accident, the staff performed a conservative analysis to determine the effects of the liquid pathway of a core-melt accident.

Conservative assumptions made by the staff in this analysis were as follows:

(1) It was assumed that no effort would be made to interdict the contaminated groundwater.

(2) The underdrain system was assumed to remain intact and fully operational. In reality, it is likely that at least part of the system would be destroyed in the melt-through of the 15-foot reinforced concrete containment basemat.

(3) It was assumed that there would be no holdup or dilution in Workman Creek.

(4) It was assumed that 100% of the core inventory of Cs-137, the main contributor to risk, would reach the Chehalis River immediately.

The staff's conservative analysis showed that although releases via the groundwater pathway would be much larger for WNP-3 than for typical U.S. power reactors, the total risk from this pathway would be small when compared to the atmospheric pathway.

The staff does not require that the underdrain system include provisions to shut off or divert to safe storage any contaminated flow from the reactor, because the postulated occurrence of a core-melt accident that would result in a liquid release would involve a sequence of successive failures more severe than those required to be considered in the design bases for protection systems and engineered safety features. The staff agrees that the effects of such an accident could be severe; however, the probability of its occurrence is so small that its environmental risk is extremely low.

DOI-2

DOI expresses concern that the proposed sealing of the underdrain outflow would retain the highly radioactive water. DOI suggests that the FES should discuss the long-term adequacy of the storage capacity of the underdrain system and should evaluate the long-term integrity of the system if it is used to retain the contaminated sump water. This evaluation should consider the potential for groundwater impacts if a loss of integrity of the underdrain system should release contaminated water to the groundwater environment, and should also explain how the passive underdrain system below and in the vicinity of the reactor would be protected against damage if the basemat failed.

- Staff Response

The staff stated that the underdrain system could be sealed following a core-melt accident. However, in analyzing the impact of a basemat melt-through, the staff assumed a worse case scenario in which the underdrain system would not be sealed and the contaminated groundwater would reach the Chehalis River immediately. If the underdrain system were sealed, the contaminated groundwater would move much more slowly in a northward direction toward the Chehalis River. In this case, the travel times via the groundwater pathway would be much greater than those that characterize the small river site in the liquid pathway generic study (LPGS). This would allow time for engineering measures such as slurry walls or wellpoint dewatering to isolate the radioactive contamination near the surface.

DOI-3

DOI points out that the Reactor Safety Study (WASH-1400, NUREG-074/14) includes an analysis of possible depth of penetration of a core-soil mass; heat transfer calculations indicated that this mass would be about 50 feet high. Thus, the Class 9 accident analysis for WNP-3 should assess the integrity of the underdrain system if 50 feet of penetration should occur. A sketch of the underdrain system should be provided in the FES.

- Staff Response

As described above, the staff assumed that a melt-through would not affect the function or operability of the underdrain system. This is a conservative

assumption that results in a worst-case situation for assessing the impacts on the Chehalis River. In reality, however, it is likely that the core-soil mass would damage or destroy the underdrain system. If this were to occur, the travel time for contaminated groundwater to reach the river would be much greater. Likewise, the population dose would be less than for the scenario assumed.

Drawings of the underdrain system are in FSAR Figures 3.4.1-1 to 3.4.1-5.

WPPSS-22

WPPSS states that the DES finds that the WNP-3 liquid pathway yields doses substantially greater than the LPGS doses and still poses much less risk than the gaseous pathway.* WPPSS notes that both the DES analysis and that of the applicant begin with the very conservative assumption that 100% of the core inventory of cesium, the major contributor to dose, reaches the river immediately, whereas a value of 10% would be more realistic. Thus, given the conservative source term, the large population dose for WNP-3 relative to the LPGS is derived from conservative assumptions regarding shoreline usage, fish catch/consumption, and river dilution.

- Staff Response to Comment WPPSS-22

The staff agrees that not all of the cesium in the core inventory would be released to the Chehalis River and that its assumption that 100% of the cesium will reach the river is conservative. However, attempting to accurately quantify the amount of cesium that would be released to the surface by the sump water via the underdrain system is difficult and is subject to large uncertainties. Thus, the staff decided to use the upper limit of 100% rather than redefine the analysis.

In the LPGS small river site, which was used for comparison with the WNP-3 site, it was assumed that 100% of the cesium in the core inventory would be in the sump water, but because of radioactive decay, only 31% would eventually reach surface waters. This radioactive decay would occur during the estimated 51-year interval that it would take cesium, which is retarded by its interaction with the soil, to travel through the ground.

For WNP-3, the same assumption (that 100% of the core-inventory of cesium would be in the sump water) was made. The staff agrees that it is a conservative assumption, but does not necessarily agree that 10% is a more realistic estimate.

WPPSS states that, "given the conservative source term, the large population dose for WNP-3, relative to the LPGS, is derived from conservative assumptions regarding shoreline usage, fish catch/consumption, and river dilution." The staff does not believe that these assumptions for WNP-3 are any more conservative than those used in the LPGS. Therefore, the main reason that the WNP-3 liquid pathway consequences are more severe than those for the LPGS site is because of the passive underdrain system, which would release contaminants to the surface much more rapidly than was determined in the LPGS.

---

*The DES estimates also are much greater than the applicant's estimates (Response to Staff Question RQ240.14).

WPPSS-23

WPPSS suggests that the staff would be more "realistic" if it assessed the liquid pathway in terms of economics rather than "fictitious" health effects.

- Staff Response

The staff does say, in the DES, that the health effects can be reduced through interdiction and also that, "The consequences would, therefore, be largely economic or social, rather than radiological." Past studies of the cost of interdiction after a postulated release through the groundwater pathway showed that the interdiction costs were small compared to the interdiction costs after releases via other pathways.

WPPSS-24

WPPSS comments that the DES analysis uses the harmonic mean flow, which is about one-fourth of the annual mean flow of the Chehalis River, and assumes it conservatively neglects the contribution of tributaries downstream. WPPSS states that because a large fraction of the one million pounds of fish are caught in Grays Harbor, with its associated flushing and dilution, yet another conservatism is inherent in the analysis, and that the analysis also neglects any sediment partitioning that would reduce concentrations.

- Staff Response

Harmonic mean flow (HMF) was used not to neglect the contribution of tributaries downstream as assumed by the applicant but to calculate a conservative dilution value. The annual mean flow (AMF) was not used to calculate dilution because it is disproportionately weighted by high flows. Consequently, using the AMF to calculate dilution may indicate higher dilutions than could be expected. For example, suppose there is an annual stream flow record consisting of 10 months when the flow was 100 cfs and 2 months when it was 10,000 cfs. The AMF would thus be ((100)(10) + (10,000)(2) ÷ 12) = 1750 cfs. Using this flow value would result in a dilution value that is too large because for 10 of 12 months the average flow was only 100 cfs. Using an HMF to compute dilution minimizes the disproportionate effect of high flows. The HMF is determined by computing the reciprocal average flow for each month. These are then summed and divided into the number of months in the period of record. In the above example, where the period of record consists of 10 months of 100 cfs flows and 2 months of 10,000 cfs flows, the sum of the reciprocal average flows is $\left(\frac{1}{100} \times 10\right) + \left(\frac{1}{10,000} \times 2\right) = 0.1002$. Dividing this value into 12 months results in an HMF of 120 cfs = (12 ÷ 0.1002). Using 120 cfs to compute dilution is thus more reasonable because it is much closer to the 100-cfs 10-month average.

For the Chehalis River at the site, the AMF computed by the staff is 6824 cfs. The HMF is 1871 cfs. Using the HMF to compute dilution results in higher population doses and is thus more conservative.

WPPSS-25

WPPSS states that the seventh and ninth paragraphs of Section 9.5.9.4.5(5) should note that the plant underdrains discharge to a Workman Creek tributary that is

referred to as Stein Creek (see Figure 5.1). Workman Creek is not an ephemeral stream. WPPSS also suggests that the eighth paragraph is out of place.

· Staff Response

The suggested changes have been made. The order of paragraphs also has been changed so the eighth paragraph now follows the ninth.

WPPSS-26

In summarizing its comments on accidents, WPPSS suggests that neither the staff nor WPPSS has "shown" WNP-3 to have "considerably worse" consequences than the LPGS. Thus, WPPSS states, given the conservatisms of the analysis, a more qualified judgment seems appropriate for the last paragraph of Section 5.9.4.5(5).

· Staff Response

Because of the many uncertainties concerning core-melt accidents, throughout its analysis the staff used conservative values and assumptions. Thus, the staff's analysis is conservative and the results can be considered to be the upper bounds of the actual values that could be expected.

The objective of the staff's analysis was not to quantify the population dose that would result from a core-melt accident and subsequent melt-through of the concrete containment floor. Rather, it was to determine whether the consequences at WNP-3 could be substantially different, qualitatively, than those associated with a typical land-based nuclear power plant. The staff analysis did show that at WNP-3 there is a potential for a significant amount of radioactivity to enter the surface rather rapidly, a situation that is not typical of the large majority of land-based nuclear plants. The staff recognizes that its analysis depicts an upper bound condition. Further, the staff states that although the liquid pathway consequences would be worse for WNP-3 than for the typical LPGS small river site, they still pose much less of a risk than the airborne pathway.

(6) Risk Considerations

Environmental Risks

SD-7

SD discussed direct, indirect, and cumulative impacts and commented: "It was not clear whether these writers entertained such impacts and excluded them, or whether they had been ignored."

· Staff Response

It is not clear to the staff which impacts SD means. With respect to the nonradiological impacts of postulated accidents, the "direct" impacts are generally of a different nature than "indirect" impacts, so a "cumulative" impact would not be meaningful. With respect to the radiological impacts of accidents, the impacts summarized in Table 5.8 include dose risks from both early exposures and long-term exposures. Some of the latter are "indirect" in that the doses are

from the food chain pathway. The radiological impacts shown in Table 5.8 are, therefore, cumulative. Those impacts that were not discussed were judged to be of less importance than the impacts discussed.

WPPSS-25

WPPSS notes that the last paragraph of this subsection seems misplaced and perhaps belongs to the discussion of uncertainties in (7) Uncertainties.

- Staff Response

The suggested change has been made.

WPPSS-38

WPPSS notes that the figure referenced in the discussion on latent cancer fatality risk should be Figure 5.11.

- Staff Response

This change has been made.

WPPSS-40

WPPSS states that the date for the Nieves reference in the last paragraph of the section should be November 1983.

- Staff Response

This change has been made.

9.5.10 Impacts from the Uranium Fuel Cycle

JFD-1, -2

JFD states that the environmental statement should contain estimates of the number of nonfatal cancers and nonfatal birth defects induced by radon releases from the fuel cycle over the licensing period of 40 years.

- Staff Response

These comments reflect some misunderstanding regarding the potential effects of exposure to low levels of ionizing radiation. JFD states that "the number of non-fatal cancer injuries induced by fuel cycle radon-222" should be included in the FES.

The staff is not aware of any studies that have established that there is no safe level of radiation. However, as a conservative and prudent assumption, it has been assumed in the DES (FES) that no amount of radiation is safe. As noted on page 5-16 of the DES, the staff's estimates of potential health effects are based on health risk estimators that are consistent with the values recommended by the major radiation protection organizations. The health risk estimators used by the staff are based on health risk estimators for a population composed of all age groups.

Impacts from the uranium fuel cycle (including radon-222) were addressed in a qualitative fashion in DES Section 5.10 and quantified in Appendix C (page C-6). Impacts are based on the radioactive effluent release values in Table 5.10 (Table S-3 of 10 CFR 51). Because the releases in Table S-3 are listed on an annual fuel requirement basis, the impacts estimated in Appendix C are also estimated on an annual fuel requirement basis. The cumulative radiological impacts as a result of 40 years of operation would be approximately 40 times the values presented in Appendix C. To incorporate JFD's suggestion, the staff has included the following statement on cancer incidence in the FES (Section 5.9.3.1.1, Paragraph 7): "The number of potential nonfatal cancers would be approximately the same as 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)." The number of potential nonfatal birth defects is estimated to be very small compared with the number of potential cancer fatalities.

Since the DES was published, the staff has revised Appendix C to more clearly describe and reference the models that were used in estimating doses. Although a few of the dose estimates have changed, the basic conclusion of Appendix C has not changed. That is: "The staff concludes that both the dose commitments and health 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" (DES page C-7).

SD-11

SD comments that a presentation of actual experience in storage, reprocessing, and waste management would have been very useful.

- Staff Response

Impacts from the uranium fuel cycle necessary to support WNP-3 were addressed in a generic fashion in Section 5.10 and Appendix C of the DES. A listing of the actual experience in storage, reprocessing, and waste management is beyond the scope of the DES or FES. The reader is referred to the references in Section 5.10 and Appendix C for more detailed information.

SD-14

SD states that there is no national consensus on the management of high-level radioactive wastes.

- Staff Response

Impacts from the uranium fuel cycle, including waste management, are described in Section 5.10 and Appendix C of the DES.

9.5.13 Emergency Planning Impacts

WPPSS-41

WPPSS notes that the reference cited in the second paragraph should be WNP-3 Emergency Preparedness Plan Section 10.3.

- Staff Response

The suggested change has been made.

9.5.15 References

WPPSS-37

WPPSS suggests that the FES, not the DES, should be listed as the title of NUREG-75/009.

- Staff Response

The suggested change has been made.

WPPSS-40

WPPSS states that the date for Nieves should be 1983.

- Staff Response

The change has been made.

9.6 Evaluation of the Proposed Action

ECOL-3

ECOL noted that the third footnote to Table 6.1 did not seem applicable.

- Staff Response

The staff agrees; the footnote has been deleted.

WPPSS-27

WPPSS comments that in Table 6.1, groundwater consumption is listed as "none," and suggests that, to be consistent with Sections 4.2.4 and 4.3.1.1.2, this should probably be "small."

- Staff Response

The staff agrees with this comment, and the suggested change has been made.

WPPSS-28

WPPSS states that Section 5.5.2 rather than 5.3.2 should be given as a reference in regard to thermal effects in Table 6.1. In addition, the table incorrectly lists "cooling lake drawdown" as an impact.

- Staff Response

The staff agrees, and the suggested changes have been made.

9.6.1 Unavoidable Adverse Impacts

WRF-2

WRF states that the Regulations for Implementing Procedural Provisions of the National Environmental Policy Act make it explicit that worst case assump `ons should be utilized in situations such as these where the absence of an adequate quantitative data base makes it difficult to predict specific impacts. WRF also comments that, as noted in a forthcoming article in The Harvard Environmental Law Review, the recent Supreme Court decision in the Nuclear Regulatory Commission vs. People Against Nuclear Energy (PANE) would not be relevant here, because that case had to do with PANE's contention that an environmental impact statement was required even though no (non-psychological) physical environmental impacts were alleged. WRF says that in the case of WNP-3 the NRC has clearly decided that an environmental statement is required, and is merely failing (in clear violation of the Council on Environmental Quality guidelines) to make best or even "token" use of available scientific expertise on the likely social impacts of issuing an operating license for WNP-3.

- Staff Response

The issue is outside of the scope of the DES, as explained in Section 9.5.8 in response to WRF-1.

WPPSS-29

WPPSS comments that, on the basis of the information in Section 5.7 concerning the effects of plant operation on historic/archeological resources, "none" seems more appropriate than "small" in Table 6.1.

- Staff Response

Table 6.1 has been revised accordingly.

9.6.4 Benefit-Cost Summary

9.6.4.3 Socioeconomic Costs

SD-12

SD comments that the socioeconomic impacts of WNP-3 should have been expanded to include a discussion of the regional waste management costs and decommissioning impacts.

- Staff Response

The NEPA effects of waste management, which were treated in the Uranium Fuel Cycle Rule (as explained in Section 5.10, Impacts from the Uranium Fuel Cycle), are not treated in detail in individual environmental statements. Socioeconomic impacts of decontamination are treated generically in NUREG-0586, "Draft Generic Environmental Impact Statement on Decommissioning of Nuclear Facilities" (referred to in Section 5.11). The related socioeconomic effects of decommissioning will be reviewed for specific facilities at the end of the operating life of each facility.

9.7 Appendices

9.7.5 Appendix D

SD-9

SD complimented the staff on its thorough and clear presentation of the radiological impacts of normal plant operation and agreed with the staff's conclusions. However, SD did not seem to be familiar with the difference between the estimated radionuclide releases ("radiation emissions," to use SD's terminology) from normal plant operations, which are presented in curies/yr in Tables D-1 and D-4, and the estimated doses to the maximally exposed individual and to the members of the general public, which are presented in units of millirems (one-one thousandth of a rem), in Tables D-6 through D-9. SD also expressed some confusion about the doses presented in Tables D-7 and D-9 and levels of background radiation.

- Staff Response

Tables D-1 and D-4 present the estimated amount of radioactivity released by the plant, and Tables D-6 through D-9 describe the amount of radioactivity or energy imparted to various organs and to the total body of the maximally exposed individual and the average member of the general public as a result of the radioactivity released by the plant.

The staff assumes that SD meant doses due to natural background radiation emissions when he stated "the base levels of background radiation." The staff does not feel it necessary to present or compare the dose to the average individual from background radiation emission to the dose to the maximally exposed individual for the following reasons: The estimated doses to the maximally exposed individual are compared to and found to be less than the 10 CFR 50, Appendix I dose design objectives, which range from 3 to 15 mrems per year. These estimated doses are much less than the average background radiation dose of about 100 to 108 mrems per year to an average individual member of the public and are clearly within the standard deviation of the average background radiation dose.

9.7.6 Appendix F

WPPSS-42

WPPSS notes that the metric evacuation rate for all evacuees (footnote on page F-2) is 3.2 km.

- Staff Response

This change has been made.

9.8 References

U.S. Nuclear Regulatory Commission, NUREG/CR-0892, "Chronic Effects of Chlorination Byproducts on Rainbow Trout, salmo gairdneri," D. R. Anderson, R. M. Bean, and R. E. Schermer, November 1980.

---, NUREG/CR-0893, "Acute Toxicity and Bioaccumulation of Chloroform to Four Species of Freshwater Fish," D. R. Anderson and E. B. Lusty, August 1980.

---, NUREG/CR-3408, "Organohalogen Products from Chlorination of Cooling Water at Nuclear Power Station," R. M. Bean, October 1983.

APPENDIX A

COMMENTS ON THE DRAFT ENVIRONMENTAL STATEMENT

United States
Department of
Agriculture

Economic
Research
Service

Washington, D.C.
20250

January 27, 1984

Mr. George W. Knighton
Chief, Licensing Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Knighton:

Thank you for forwarding the Draft Environmental Statement concerning the issuance of an operating license to the Washington Public Power Supply System for the operation of WPPSS Nuclear Project No. 3 located in southeastern Grays Harbor County, Washington.

We have reviewed Docket No. 50-508 and have no comments.

Sincerely,

VELMAR W. DAVIS
Acting Director
Natural Resource Economics Division

JFD

February 19, 1984

'84 FEB 24 A10:48

318 Summit Ave.
Suite 3
Brighton, Mass. 02135

Ms. Annette Vietti
Project Manager - WPPSS - III
Division of Licensing
Nuclear Regulatory Commission
Washington D. C. 20555

RE: Draft Environmental Statement related to the operation of WPPSS - III (Washington Public Power Supply System) NUREG-1033

Please enter the below comment on the above Statement. The statement does not indicate to whom Comments are to be mailed.

COMMENT-I

In Appendix C, the following statement (p. C-6) occurs:

> To illustrate: A single model 1000-MWe LWR operating at an 80% 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.

My concern is that the DES has not completely described the fuel cycle impact in Appendix C, not the impact of operation of the plant to the general public. Specifically the DES should contain a statement of:

JFD-1 1) The range of number of non-fatal cancer injuries induced by fuel cycle radon-222 for the WPPSS Nuclear Project No. 3 for its projected capacity factor (80%) and licensing period (40 years);

JFD-2 2) The range of number of non-fatal birth defects induced by fuel cycle radon-222 for providing fuel for the WPPSS Nuclear Project No. 3 for its projected capacity factor (80%) and licesning period (40 years).

COMMENT -II

JFD-3 On Page 5-14 of the statement it states, "The lower limit limit of the range would be zero because there may be biological mechanisms that can repair damage caused by radiation at low dose and/or does rates." The statement is unsupported by reference, or documentation. The DES should be altered to include

whatever staff feels backs this position. It stands now vague and whimsical.

<u>COMMENT - III</u>

On page 5-33 of the statement it says, "Some credit has been taken in this evluation for these actions (referring to <u>Three Mile Island</u> accident induced changes) and improvements in establishing the radiological risk of accidents at the WNP-3 plant". Without some quantitization, the statement is simply too vague. It implies there was a pre-TMI analysis, and that it was changed to reflect changes such as those in NURE-0737. The DES should contain mention of just how much credit Staff has taken for this. Since there is a quantitative base, a quantitative statement should be possible. JFD-4

Thank you for this opportunity to comment.

John F. Doherty

John F. Doherty

WPPSS

Washington Public Power Supply System
Box 1223 Elma, Washington 98541 (206) 482-4428

Docket No. 50-508

March 5, 1984
G03-84-131

Director of Nuclear Reactor Regulation
Attention: Mr. G.W. Knighton, Chief
Licensing Branch No. 3
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Knighton:

Subject: SUPPLY SYSTEM NUCLEAR PROJECT NO. 3
DRAFT ENVIRONMENTAL STATEMENT (NUREG-1033)

Reference: Letter, G.W. Knighton, NRC, to D.W. Mazur, Supply System same subject, dated January 13, 1984.

Thank you for the opportunity to review the subject document. We offer the attached comments which you may wish to consider in the preparation of a Final Environmental Statement.

Very truly yours,

G.C. Sorensen, Manager
Regulatory Programs

JPC/mam

Attachment: As stated

cc: D. Smithpeter (BPA)
A. Vietti (NRC)
J. Adams (NESCO)
N.S. Reynolds (Bishop, Liberman, Cook, Purcell & Reynolds)
J. Porrovecchio (Ebasco - NYO)
WNP-3 Files
F. Swearingen (BPA)

SUPPLY SYSTEM COMMENTS
ON
WNP-3 DRAFT ENVIRONMENTAL STATEMENT (NUREG-1033)

Facility Description (Sections 4.2.1 and 4.2.2) WPPSS-1

Figure 4.1 is taken from ER-OL Figure 2.1-1 which will be amended consistent with the response to Q290.14 and the acreages cited in DES-OL Section 4.2.2. FSAR Figure 2.1-1 has already been amended (December 1983). Also note in Section 4.2.1 that reduction of the base diameter of the cooling tower by 90 feet is not an exception to conclusions regarding the significance of changes in the arrangement of site structures. Construction laydown area should be added to the list at the bottom of p. 4-1. WPPSS-2 WPPSS-3

Nonradioactive Wastes (Secion 4.2.6)

With reference to the second paragraph in Section 4.2.6.2, it is now planned that potassium chromate will be added to the closed component cooling water system for corrosion control. As described in the DES, leakages will be processed in the SHP system with residual chromate removal by ion exchange. Water drained from the component cooling water system during maintenance operations will be captured and reused in the system. WPPSS-4

In the fifth paragraph of Section 4.2.6.2 (bottom of p. 4-11) it should be noted that sodium hypochlorite will be the source of free chlorine residuals. With reference to the last paragraph of Section 4.2.6.2 (p. 4-12) and the second paragraph of Section 5.3.1 (p. 5-2), we note that although we expect the chlorine residual in the discharge to be at or below 0.02 mg/l, the NPDES Permit considers 0.05 mg/l to be the detectable limit (p. G-4). WPPSS-5 WPPSS-6

Sanitary waste disposal is mentioned in Section 4.2.6.3. It should be noted that WNP-3 will continue to dispose of treated wastes in the drain field which was sized for construction phase loading (see ER-OL Sections 3.7.1 and 5.4). WPPSS-7

Hydrology (Section 4.3.1)

Historical flow data for the Chehalis River are summarized in the fourth paragraph of Section 4.3.1.1.1. The average Chehelis River flow at the site is given (without reference) as 6824 ft^3/sec while the ER-OL and FSAR suggest about 6630 ft^3/sec. The average monthly flows cited for August and January should be given as 806 and 14,668 ft^3/sec, respectively (see FSAR p. 2.4-2; ER-OL p. 2.4-1 and T. 2.4-1 to be amended, accordingly). The minimum historical flow is now estimated to be 454 ft^3/sec (FSAR p.2.4-51) rather than 397 ft^3/sec as cited in the DES. WPPSS-8

In the third sentence of Section 4.3.1.1.3 it should be noted that the 550-ft^3 /sec river flow limitation could be waived by the State based on regional power needs. WPPSS-9

Water Quality (Sections 4.3.3 and 5.3.1) WPPSS-10

The ambient Chehalis River copper concentrations given in the fourth paragraph of Section 5.3.1 are based on older data. Reference should be made to Table 4.2.

WPPSS-11 The Supply System bioassay studies are mentioned in the last paragraph of Section 5.3.1. Contrary to as cited therein, the draft report summarizing the results of these studies was provided to the NRC by letter dated October 21, 1983. The results suggest a long-term, no-effect level of 18 ug/l for coho salmon versus the 7 ug/l cited on p. 5-3.

Meterology (Section 4.3.3)

WPPSS-12 It should be noted in the third paragraph of Section 4.3.3 that observations of "heavy fog" are from valley stations where fog and stagnant air collects. WNP-3 is located on a ridge above the heavy fog.

Aquatic Resources (Sections 4.3.4.2 and 5.5.2)

WPPSS-13 The last two sentences of the second paragraph of Section 4.3.4.2 seem somewhat confusing and unnecessary in view of discussion provided in Sections 4.2.4 and 5.5.2. This latter section (p. 5-6) notes that the diffuser was relocated to minimize potential impact to migrating salmonids.

WPPSS-14 Angler survey data are provided on p. 4-22 and 4-25. We have difficulty relating the numbers to the referenced sources. Does the range 4 to 17 anglers per day refer to all anglers or only salmon fishermen? Does the range 10 to 26 per day and maximum of 50 mean steelhead fishermen? Our reading of the data suggests that the annual average ranged from 6 to 12 anglers per day for 1978 - 1981. Monthly averages for the survey period ranged from 0.2 to 26.4 anglers per day.

Terrestrial Resources (Sections 5.2.1 and 5.5.1)

WPPSS-15 The DES notes that a wildlife management plan is to be submitted to the Energy Facility Site Certification Council (EFSEC). The plan is not specifically required, but stems from conditions of the Site Certification Agreement between the Supply System and the State of Washington. It is subject to approval by EFSEC; a copy will be provided to the NRC at the time of its submittal.

Community Characteristics (Section 4.3.6)

WPPSS-16 In response to Q311.05 we noted minor errors in the distribution of near-plant residents. ER-OL Table 2.1-2 and FSAR Table 2.1-3 will be amended to provide corrections. For instance the 1980 population within one mile of WNP-3 is now estimated to be 3 versus the 15 noted in DES Table 4.7.

Radiological Impacts, Routine Operation (Section 5.9.3)

WPPSS-17 The estimated doses from routine operation are provided in DES Appendix D. We only note that the Staff's calculated dispersion factors and resultant doses are roughly twice the Supply System estimates in the ER-OL.

WPPSS-18 The fish consumption liquid pathway dose, although very small, seems to be based on an excessively conservative dilution factor for an anadromous fishery.

WPPSS-19 The "maximally exposed" individual is explained in Section 5.9.2 (bottom of p. 5-10). It would be useful to remind the reader in Section 5.9.3.1.2 (p. 5-20) that this individual is hypothetical and that the doses from various pathways are calculated and summed very conservatively.

The peoperational monitoring program is discussed in Section 5.9.3.4.1. The Supply System plans minor changes to the program described by Table 5.3 to assure consistency with Regulatory Guide 4.8 and its Branch Technical Position. Table 6.1-7 of the ER-OL will be amended to reflect the changes and correct the typos. WPPSS-20

Radiological Impacts, Accidents (Section 5.9.4)

The evacuation model is referenced on p. 5-41 and discussed in Appendix F. The DES (p. F-3) "conservatively" estimates an effective evacuation speed of 2 mph. Given all the conservatisms of the accident analysis, we find this estimate overly conservative by comparison with evacuation times estimated in Table 12-5 of the WNP-3 Emergency Preparedness Plan. WPPSS-21

The DES finds that the WNP-3 liquid pathway (p. 5-50 to 5-53) yields doses substantially greater than the LPGS doses and still poses much less risk than the gaseous pathway. We note that the DES estimates are also much greater than Supply System estimates (RQ240.14). Both the DES analysis and that of the Supply System begin with the very conservative assumption that 100 percent of the core inventory of cesium, the major contributor to dose, reaches the river immediately, whereas 10 percent would be more realistic. Given the conservative source term, the large population dose for WNP-3, relative to the LPGS, is derived from conservative assumptions regarding shoreline usage, fish catch/consumption, and river dilution. WPPSS-22

The fish consumption pathway provides the most significant contribution for comparison with the LPGS. Besides using an overly conservative catch of one million pounds (see DES Table 4.3 and RQ240.14), the analysis must assume (as did the LPGS) that all fish caught are fully exposed and consumed. If the containment were breached such that the Chehalis River was severly contaminated, as postulated in the DES, among the immediate impacts would be the loss of recreational opportunities and disruption of the fishery markets. The NRC would be more realistic if it assessed the liquid pathway in terms of economics rather than fictitious health effects. WPPSS-23

The DES analysis (p. 5-52) uses the harmonic mean flow which is about one-fourth of the annual mean flow of the Chehalis River. We assume it conservatively neglects the contribution of tributaries downstream. Because a large fraction of the one million pounds of fish are caught in Grays Harbor, with its associated flushing and dilution, yet another conservatism is inherent in the analysis. The analysis also neglects any sediment partitioning which would reduce concentrations. WPPSS-24

In the second and fourth paragraphs on p. 5-51 (the third seems out of place), it should be noted that the plant underdrains discharge to a Workman Creek tributary which is referred to as Stein Creek (see Figure 5.1). Workman Creek is not an ephemeral stream. Also, we note that the third paragraph on p. 5-56 seems misplaced and perhaps belongs to the discussion of uncertainties on p. 5-63. WPPSS-25

In summary of our comments on accidents, we suggest that neither the Staff nor the Supply System has "shown" WNP-3 to have "considerably worse" consequences than the LPGS. Given the conservatisms of the analysis, a more qualified judgement seems appropriate for the last paragraph of Section 5.9.4.5(5). WPPSS-26

Benefit-Cost Summary (Table 6.1)

WPPSS-27
In Table 6.1 groundwater consumption impact is listed as "none." Consistent with Sections 4.2.4 and 4.3.1.1.2 this should probably be "small." WPPSS-28 Section 5.5.2, rather than 5.3.2, should be given as a reference for thermal effects. "Cooling lake drawdown" is incorrectly listed as an impact in Table 6.1. WPPSS-29 Based on the information given in Section 5.7 concerning the effect of plant operation on historic/archeological resources, "none" seems more appropriate than "small."

Minor Editorial Comments

WPPSS-30
On p. 4-1 (Section 4.2.2) the question number is 290.14, not 29.14. On the same page, the exclusion area boundary is at 1310 meters, not 13,611 meters.

WPPSS-31
On p. 4-6 the correct reference for withdrawal limitations is Section 4.3.1.1.3, not 4.3.2.

WPPSS-32
On p. 4-11 in the third paragraph of Section 4.2.6.2, the second reference to ER-CP should be ER-OL Table 3.6.2. The last three sentences of this paragraph seem excessively wordy.

WPPSS-33
On p. 4-13 units of flow are m^3/sec, not m^2/sec.

WPPSS-34
On p. 4-24 "...Emergency..." should be "...Energy..."

WPPSS-35
On p. 5-2 "...61.3 ug/l..." is repeated. In the same paragraph reference to Section 4.3.2 should be to 4.2.6.3.

WPPSS-36
On p. 5-3 units of flow are m^3/sec, not ug/sec.

WPPSS-37
On p. 5-5 and 5-71, it seems the FES, rather than DES, should be referenced. Also on p. 5-5 (Section 5.5.1) the correct ER-OL figure reference is 5.1-4 (not 5.1.4) and the DES section reference is 5.14.2 (not 5.11.2).

WPSS-38
On p. 5-53, at the bottom, Figure 5.9 should be Figure 5.11.

On p. 5-43 incorrect figure references are given in Table 5.7. In the second WPPSS-39 paragraph on this page the background radiation dose should be 82,000 person-rems consistent with p. D-9. Also, at the bottom of the page "28-m" should be "28-km."

WPPSS-40
On p. 5-61 and 5-70, the date given for the Nieves reference should be November 1983.

WPPSS-41
On p. 5-68, FSAR Section 10.3 should be WNP-3 Emergency Preparedness Plan Section 10.3.

WPPSS-42
On p. F-2, at the bottom, "0.89 km" should be "3.2 km."

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION X
1200 SIXTH AVENUE
SEATTLE, WASHINGTON 98101

REPLY TO ATTN OF: M/S 443

MAR 7 1984

Director, Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Gentlemen:

The Environmental Protection Agency has reviewed the Draft EIS for the operation of WPPSS Nuclear Project No. 3, Docket No. 50-508.

Within EPA's area of jurisdiction, we find the coverage of the DEIS adequate and have no objections to the proposed action. We have therefore rated this DEIS LO-1 (LO = lack of objections; 1 = adequate level of information) in accordance with EPA's responsibilities under Section 309 of the Clean Air Act to review all proposed major Federal actions. We note the Commission's commitment to supplement or otherwise revise this document if necessary in the future, should significant project changes occur during the potential long lead time until start-up.

The opportunity to comment has been appreciated.

Sincerely,

Robert S. Burd

Robert S. Burd
Director, Water Division

ECOL

JOHN SPELLMAN
Governor

DONALD W. MOOS
Director

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
Mail Stop PV-11 • Olympia, Washington 98504 • (206) 459-6000

March 8, 1984

Mr. George Knighton
Chief, Licensing Branch No. 3
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Knighton:

Thank you for the opportunity to comment on the draft environmental impact statement (DEIS) for the operation of WPPSS Nuclear Project No. 3 (Docket No. 50-508). The Department of Ecology has been designated as the state coordinator for review of NEPA documents. We have coordinated the review of this DEIS with other state agencies and received comment letters from the Energy Facility Site Evaluation Council and the Office of Archaeology and Historic Preservation. Their letters, along with comments from the Department of Ecology, are attached.

If you have any questions, please call Mr. Greg Sorlie at (206) 459-6237.

Sincerely,

Dennis Lundblad
Acting Assistant Director
Office of Operations and Enforcement

DL:GS:pk

Attachments

cc: Greg Sorlie
State Agencies

Comments on WPPSS #3 from the Department of Ecology

While this facility will produce large, calculable quantities of spent fuel, by the earliest time it can be in operation some progress will have been made toward developing one or more national high-level nuclear waste (HLW) repositories. Because of currently anticipated delays and the inherently long development time associated with the first repository, it should be noted that HLW will need to be stored on-site for at least 10 years, barring some unusual change in operating procedures.

Figure 4.1 (page 4-2): The site layout map indicates the Keyes Road extension to the east of the plant and into the exclusion zone. A significant section of this road is not shown--the portion that extends from near the No. 3 cooling tower, past the turbine generator, and connecting with the main Keyes Road terminus at the top of Fuller Hill. It is significant as an alternative access to the site and/or evacuation corridor. There has been some discussion of eliminating use of this road in the future in favor of diverting any required cross traffic to the plant connecting road. Use of either or both could have impacts on plant security and emergency response plans, and should be discussed in the DEIS. ECOL-1

Sec. 5.4.2: The Energy Facility Site Evaluation Council recognized the necessity of maintaining and testing back-up diesel engines for emergency use. The certification agreement, as amended in March 1982, waived air quality standards for these stationary sources with respect to NO_x, SO_x, and particulate, but called for the utility to use low sulfur fuel oil (0.5% sulfur). With this requirement, all practical means of providing rapid start up and load acceptance without unnecessary adverse air quality impacts are accomplished. Given this understanding, the conclusion appears valid. ECOL-2

Footnote "***", end of Table 6.1 (page 6-3), does not appear applicable to the table. ECOL-3

Sections 5.9 through 5.14 contain some very useful information, particularly when taken in conjunction with Appendices D, E, and F. There is, however, a large amount of academic verbage that tends to dilute the real conclusions or comparisons useful to public understanding of risks and consequences. The information should be segregated into generic/site specific topics and put into laymans language if it is an essential part of the format required for a DEIS. Otherwise, some of it probably should be dropped in favor of taking selected portions of Appendices D, E, and F, and inserting them where appropriate. ECOL-4

EFEC

JOHN SPELLMAN
Governor

NICHOLAS D. LEWIS
Chairman

STATE OF WASHINGTON
ENERGY FACILITY SITE EVALUATION COUNCIL
Mail Stop PY-11 • Olympia, Washington 98504 • (206) 459-6490 • (SCAN) 585-6490

March 6, 1984

Director, Division of Licensing
U. S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Draft Environmental Statement - Washington Nuclear Project No. 3

Gentlemen:

Thank you for the opportunity to comment on the Draft Environmental Statement (DES) prepared by the U. S Nuclear Regulatory Commission (NRC) related to the operation of Washington Public Power Supply System Nuclear Project No. 3 (WNP-3) (NRC Docket No. 50-508).

The DES presents NRC's assessment of the various environmental, economic and technical impacts, both beneficial and adverse, associated with the issuance of an operating license for WNP-3. Because of NRC's unique requirements for environmental statements at both the construction and operating stages, this DES examines any changes or new information that have occurred since the construction permit stage environmental statement was issued in June 1975.

On October 27, 1976, the state of Washington issued a Site Certification Agreement to the Washington Public Power Supply System (Supply System) to construct and operate WNP-3. The Site Certification Agreement sets forth the license conditions under which WNP-3 is to be safely constructed and operated while minimizing adverse impacts to the greatest extent possible. The Energy Facility Site Evaluation Council (EFSEC) administers the certification agreement through a comprehensive monitoring program that ensures compliance with the environmental regulations, public health and safety standards and the other terms of the license. In view of the shared federal-state licensing responsibilities for nuclear facilities, the Council is very much interested in NRC's updated assessment of the impacts associated with an operating project and their relationship to our already existing license and permit conditions.

The Council has reviewed the information presented in the DES and finds that the document accurately describes project conditions and impacts as they existed in the original licensing considerations, as they have evolved over the initial construction period, and as they are forecast during operation of the facility. The statement provides a thorough explanation of the potential environmental, technical and social impacts of the project and we concur with the determination "that WNP-3 can be operated with minimal environmental impact." The following comments are provided on specific sections of the DES.

Director, Division of Licensing
Page 2
March 6, 1984

Section 4.1 Project Description Resume - We would agree that the major change since the CP stage is the cancellation of WNP-5. While the requirements for WNP-3 remain essentially the same from the earlier review, many of the license conditions were based on the two units operating at the site. With only one unit now planned for operation, many of the projections for usage, design capacities, effluent amounts, etc., have been reduced significantly and have lessened the potential for impact. EFEC-1

Section 4.2 Water Use and Treatment - The statement accurately describes the state's requirements for water withdrawal, thermal discharges and design changes made in the discharge diffuser and cooling system since the CP stage. EFEC-2

Section 5.3.1 Water Quality - Under the state's National Pollutant Discharge Elimination System (NPDES) Permit, the Supply System was required to conduct site specific, flow-through bioassays on local salmonids to assess the toxic levels of copper and zinc, both singly and in combination, during different times of the year and with different life stages. The results of the bioassay studies are now available and should be included in the final statement. EFEC-3

We appreciate the opportunity to comment on the DES and look forward to working with the NRC as you proceed with license proceedings for WNP-3.

Sincerely,

William L. Fitch
Executive Secretary

WLF:kc

AHP

JOHN SPELLMAN
Governor

JACOB THOMAS
Director

STATE OF WASHINGTON

OFFICE OF ARCHAEOLOGY AND HISTORIC PRESERVATION

111 West Twenty-First Avenue, KL-11 • Olympia, Washington 98504 • (206) 753-4011

February 22, 1984

RECEIVED
FEB 24 1984
DEPARTMENT OF ECOLOGY
ENVIRONMENTAL REVIEW

Ms. Barbara Ritchie
NEPA Coordinator
Dept. of Ecology
Mail Stop PV-11
Olympia, WA 98504

Log Reference: 449-F-NRC-01

Re: WPPSS No. 3 Draft EIS

Dear Ms. Ritchie:

A staff review has been completed of the above referenced draft environmental impact statement. The document adequately considers known and anticipated cultural resources and the potential for impact to these.

Thank you for this opportunity to comment.

Sincerely,

Robert G. Whitlam, Ph.D.
State Archaeologist

dw

DEPARTMENT OF FISHERIES

March 7, 1984

Ms. Barbara Ritchie,
NEPA Coordinator
Department of Ecology
St. Martin's Campus
Olympia, Washington 98504

Dear Ms. Ritchie:

WPPSS Number 3 Draft Environmental Impact Statement

We have reviewed the referenced report and find it thorough and complete as far as the aquatic resources are concerned. There are two additions that should be included in the final report, however. They are described below.

Table 4.6, on page 4-24, should include the 1982 coho plants as follows: DOF-1

Fuller Creek	7,700
Workman Creek	42,000
Elizabeth Creek	25,500

The Department of Game should also be contacted to obtain any trout planting data also.

Under Section 5.3.1, the report dealing with toxic material studies is now available. It is entitled Toxicity of Copper, Zinc and Their Chemical Forms to Coho Salmon and Steelhead Trout in the Chehalis River, Washington. DOF-2

Thank you for the opportunity to comment on the referenced document. We hope these comments will assist the Nuclear Regulatory Commission in completion of their report.

Sincerely,

Robert J. Gerke /for

William R. Wilkerson
Director

cc: Fenton, WDG

COE

DEPARTMENT OF THE ARMY
SEATTLE DISTRICT, CORPS OF ENGINEERS
P.O. BOX C-3755
SEATTLE, WASHINGTON 98124

Planning Branch

MAR 9 1984

George W. Knighton, Chief
Licensing Branch No. 3
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Mr. Knighton:

We have reviewed the draft environmental impact statement for Washington Nuclear Project No. 3 (WNP-3), Grays Harbor County, Washington, with respect to the U.S. Army Corps of Engineers' areas of responsibility for flood control, navigation, and regulatory functions. Our comments are attached.

Thank you for the opportunity to review this statement. If you have any questions, please contact Dr. Steven F. Dice, telephone (206) 764-3624, of my staff.

Sincerely,

George W. Ploudre, P.E.
Assistant Chief, Engineering Division

Enclosure

NPSEN-PL-ER 8 March 1984

COMMENTS: Draft Environmental Impact Statement, Washington Nuclear Project No. 3 (WNP-3), Grays Harbor County, Washington

1. Section 1.3, Permits and License, page 1-2. This section should state that a Department of the Army permit under Section 10 of the River and Harbor Act of 1899 would be required for the performance of any work in navigable water of the United States, which includes the Chehalis River. Also, a Department of the Army permit would be required under Section 404 of the Clean Water Act for the discharge of any dredged or fill material into any waters of the United States or on their adjacent wetlands. COE-1

2. Section 2, Purpose of and Need for Action, page 2-1. The first sentence in the third paragraph states that "... nuclear plants cost less to operate ...". Although this is true, nuclear plants are much more expensive to construct than most fossil-fueled plants of which there are very few in this region. You may wish to expand upon the information in this section in order to more fully support the conclusion. COE-2

3. General comment. Impacts of the chemical and radiological contaminants in the effluent discharge are not fully evaluated. In addition to water quality, the statement should include an evaluation of impacts on river sediments in the area of the discharge, in Grays Harbor estuary, and of the effects of bioaccumulation. COE-3

4. Section 5.3.1., Water Quality, page 5-2.

a. Using chlorine as a bifouling agent may result in the chlorination of hydrocarbons present in the water supply system. The applicant should describe the provisions that would be made to avoid accumulation of potentially carcinogenic chlorinated hydrocarbons in the water and sediments of the Chehalis River. COE-4

b. Waterborne contaminants should be monitored in sediments as well as in the receiving water below the effluent. COE-5

c. Baseline data on sediment chemistry should be included so that monitoring and effluent limits can be established. COE-6

5. Section 5.9.3.4, Radiological Monitoring, page 5-21. The EIS should discuss the potential for accumulation of radioactive wastes in sediments in the river and estuary. COE-7

WRF

WASHINGTON STATE UNIVERSITY
PULLMAN, WASHINGTON 99164

DEPARTMENT OF SOCIOLOGY/DEPARTMENT OF RURAL SOCIOLOGY
Room 23, Wilson Hall

March 12, 1984

Ms. Annette Vietti
Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Subject: Assessment of Social and Economic Impacts in Draft Environmental Statement Related to the Operation of WPPSS Nuclear Project #3, Docket 50-508, Washington Public Power Supply System.

Dear Ms. Vietti:

After several attempts, I have just received a copy of the Draft Environmental Statement (dEIS) noted above (NUREG-1033). Partly because the document itself does not make it entirely clear what day would be the actual deadline for receiving comments on the Draft EIS, and partly because an omission noted below is so serious that I am certain that your study team would want to consider it in the interest of producing an adequate impact statement (regardless of the actual date of the deadline), I am writing to call your attention to a serious problem/error in the draft statement.

WRF-1 Specifically, the abstract of the dEIS asserts without documentation that "the net socio-economic effects of the projects will be beneficial," and page 5-8, after a brief description of some economic considerations, notes that "the staff anticipates no other significant socio-economic impacts from station operation." These statements (particularly the latter one) demonstrate either an unacceptablely low level of relevant expertise among the study team or else a refusal to consider relevant research findings on the social impacts of WNP-3.

The local social environment has changed greatly, and the social impacts of the licensing and operation of the plant are likely to be dramatically different from those that were envisioned in the original EIS on the construction permit phase of plant. An analysis by Rodney Baxter and myself has shown that attitudes toward local nuclear facilities have declined dramatically in nuclear "host communities" across the entire nation (Freudenburg and Baxter, 1983), for example, and even more pointedly, as noted in a report prepared by Robert L. Wisniewski and myself (copies of which were shared with the Washington Public Power Supply System), "there is greater local opposition to the WPPSS nuclear plants than to the nuclear facilities of any of the other "normal" host community in the history of surveys in the U.S." The level of opposition near the Satsop facility, in fact, is matched only by a survey done

at Three Mile Island itself, only four months after the infamous accident (Wisniewski and Freudenburg, 1981:38). These reports and others have noted further that the social consequences of permitting operation of a facility over such intense objections could be grave indeed.

I further call to your attention to the fact that the Regulations for Implementing Procedural Provisions of the National Environmental Policy Act make it explicit that "worst-case" assumptions should be utilized in situations such as these where the absence of an adequate quantitative data base makes it difficult to predict with any precision just what specific impacts are likely to occur. I also call to your attention the fact that, as noted in a forthcoming article in The Harvard Environmental Law Review, the recent Supreme Court decision in the Nuclear Regulatory Commission vs. People Against Nuclear Energy (PANE) would not be relevant here, since that case had to do with PANE's contention that an environmental impact statement was required even though no (non-psychological) physical environmental impacts were alleged. In the current case the Nuclear Regulatory Commission has clearly decided that an EIS is required, and is merely failing (in clear violation of the Council on Environmental Quality guidelines for EISs) to make best or even "token" use of the available scientific expertise on the likely social impacts of issuing an operating license for WNP-3. WRF-2

If I may provide you with any assistance in responding to the substance of these comments and/or in identifying scientists with the relevant expertise for responding to the comments, please do not hesitate to contact me at the address on the letterhead above.

Sincerely,

Wm R. Freudenburg

William R. Freudenburg
Associate Professor

WRF:gm

SD

Sebastian Degens
4515 SE Madision
Portland, Oregeon
97215

Portland March 13, 1984

US Nuclear Regulatory Commission
Matomic Building
1717 H Street NW
Washington, D.C. 20555

Dear Commission Members,

Enclosed is a lengthy comment on EIS No. 840014, concerning the operating licence of WPPSS No. 3 in Grays Harbor County in Washington. I realize my comment is a few days over the deadline, but I had difficulties finding out where to send it. The paper was submitted for a class offered in the winter term at Portland State University. The class was 'Environmental Impact Assessment' and in the enclosed critique, I point to some of the strengths and weaknesses of this particular EIS, based upon a reading of assessment itself, NEPA regulations, as well as class discussions.

Please send this on to the appropriate reviewer. Also, I would like to be on a list of people to recieve the FEA when it comes out on this project.

Thank You,

Sebastian Degens

CRITIQUE OF AN EIS PREPARED BY THE NRC

" DRAFT ENVIRONMENTAL STATEMENT RELATED TO THE OPERATION OF WPSS NUCLEAR PROJECT NO.3 "

PREPARED BY THE U.S. NUCLEAR REGULATORY COMMISSION

Sebastian Degens
4515 SE Madison
Portland, OR 97215
Geog 523 Winter 1984

SD

The proposed action which required the Draft ES Related to the Operation of the WPPSS Nuclear Project No.3 (DES-OL) is the issuance of an operating license to the Washington Public Power Supply System (WPPSS) for start-up and operation of its nuclear project no. 3 (WPN-3), located in Grays Harbor County, WA. The project consists of a two-loop pressurised water reactor (PWR) with a projected electrical output of 1240MW. A cooling tower and pumping station to draw water from an aquifer below the Chehalis River are included on the 2570 acre site.

The U.S. Nuclear Regulatory Commission (NRC), and its staff in the Office of Nuclear Reactor Regulation, prepared the document in response to an application for an operating license for this facility from the NRC. The projected water withdrawals as well as the radioactive emissions by the facility clearly make this a Federal action significantly affecting the quality of the human environment (§ 1502.3). The statutory requirements for an EIS are met.

WPN-3 was 75% complete at the time of application for the operating license. Construction delays since that time have pushed the anticipated fuel-loading date into 1987-1989. The staff noted that this DES could therefore be issued up to six years prior to the fuel loading date. This constitutes an unusually early issuance. It was the staff's judgement that the facility's operational characteristics were sufficiently known to allow the present assessment. (WNP-3 DES, 1-2).

The DES is dated December 1983. The Notice of Availability

(NOA) was published by the Environmental Protection Agency in the Federal Register on Friday, January 27,1984 (FR; Vol 49. No 19). A 45 day comment period was scheduled ending on March 12. A copy of this critique has been submitted.

NRC licensing procedures for nuclear power plants are separated into distinct phases. The NRC has tiered their environmental statements to correspond with the construction and operating stages. This enables "... focus on the actual issues ripe for decision at each level of environmental review." (§1502.20)

The purpose of the DES-OL is to center on issues specifically related to the operational system of the nuclear plant. An additional purpose emerges in the text. The DES-OL evaluates design changes in the project which have occured since the time of the Final Environmental Statement on the construction permit (FES-CP). The bulk of the design and environmental impact information is contained in the FES-CP written in 1975. This information is summarized in the DES text and encorporated by reference.

Tiering has a number of important implications for the DES. First, it is physically shortened by the ability to reference the document in the previous stage in the process. More importantly, the range of issues covered is also reduced. The NRC has interpreted tiering to obviate evaluations of the need-for -power issues during the operation-license phase. Discussion of the need-for-power issue has occured during the construction permit stage and is considered resolved.

The NRC has assumed that nuclear power plants cost less to

operate than fossil fueled plants. The NRC concludes that nuclear power would be a preferred energy source, even were a reduction in demand to eliminate the need for any additional generation. (WPN-3 DES, 2-1) Need for the proposed action is eliminated as an issue and barring special circumstances, the operating license is not subject to a test of need.

SD-1 The logic of the environmentla review process, as conducted by the NRC in the licensing of nuclear power plants, thus eliminates a broad range of alternatives during the OL stage. Both alternative energy sources as well as alternative sites are no longer relevant. Committed resources and the advanced stage in the process have left no feasible alternatives and none are presented in this DES.

Alternative plans of operation were not considered, though I feel they would have been appropriate for comparison. Examples
SD-2 could have been alternative monitoring programs for the surrounding earth, water, and air resources. Also, in addition to mitigative responses to water removal at times of low stream flow, an op-
SD-3 perational plan which synchronized refueling with all or part of the seasonal dry periods could have been presented.

The existing environment was described adequately in the DES. Unchanged portions of the project were summarized from previous documents and referenced. A comparative evaluation of the impacts of alternatives could not be undertaken in the absence of alternatives. However, design changes since the FES-CP had altered many impacts. These new impacts were discussed in a comparative manner with the initially anticipated ones.

The major change was the cancellation of a second unit,

WPPSS No. 5, which had been planned for that site as well. In many respects this change afforded the DES quite a bit of leeway in the discussion of impacts. For example, WPPSS increased its estimate for the sulfuric acid requirement to control scale in the circulating water system. There will be an acknowledged effluent impact of sulfates on the Chehalis River. This increase in the concentration of sulfates was swept away in the text with the recolection that the planned second unit had now been scrapped and the resulting ambient concentrations for one plant were lower than had previously been projected for two.

I feel this type of analysis is more round-about than direct. SD-4
While it is important to know that the sum of the impacts is less than those previously planned, if the design changes represent significant alterations, they should be described absolutely (ie. How much effluent results from one unit with an increased requirement of sulfuric acid?).

A troublesome feature in the DES was a multiple reference to SD-5
a Safety Evaluation Report (SER) which is scheduled for release six months after the closure date for comments on the DES. In appendix form, the water and air effluents were summarized in anticipation of this report. The capability of the proposed radwaste system to accomodate the solid wastes expected during normal operations was not evaluated nor summarized. This seems to me a SD-6
significant omission..

The DES covered an extensive set of impacts both analytically and in concise and understandable language. The methodologies

were explained clearly and included in the text and appendix. I did not feel the impact discussions were each of the same quality. Direct impacts were evaluated in each of the environmental areas.
SD-7 Indirect impacts were addressed in certain of these. Cummulative impacts were not evaluated by each of the DES contributors. It was not clear whether these writers entertained such impacts and excluded them, or whether they had been ignored.

Cummulative impacts on regional water use should be more explicitly evaluated, for one. In the area of endangered species, the theorization that because of an eagle's keen eyesight, collision
SD-8 with a cooling tower seemed unlikely, seemed less important than some field data on the effects of construction noises on the habitat as a proxy for the anticipated noise from the pumping station.

Radiological impacts were described very well. The conclusions seemed reasonable, and areas of uncertainty and issues of public
SD-9 debate were outlined. Tables of radiation emissions were confusing upon occaision when the units of measurement did not compare (curies/rems) or when the base levels of background radiation were presented for comparison in some tables and not in others.
SD-10 An evaluation of the cummulative impact of the regional nuclear program was not included.

Mitigation measures were developed for a range of expected environmental impacts. The majority of these were required in the design of the facility itself and operated through avoidance and minimization of environmental impacts. Future mitigative measures will be developed based on monitoring programs to detect unanticipated

impacts. The preparers did a very thorough job in matching mitigation measures to potential impacts.

Two potential environmental impact areas which deviated from this generally factual, analytical discussion of impacts, were those of the uranium fuel cycle as well as the decommissioning of the plant once its operating life is over.

Discussion of the impacts of the fuel cycle centered around SD-11 theoretical design criteria incorporated by reference to optomistic NRC rules and research documents. A presentation of Actual experience in storage, reprocessing, and waste management would have been very useful.

Socio-economic impacts of WNP-3 should have been expanded to include discussion of the regional waste management costs, decom- SD-12 missioning impacts.

Finally, scenarios of three types of accidents (frequent and infrequent events, and a much less probable limiting fault) were very interesting and well explained. The methodology for conducting the Worst Case analysis seemed very accurate and scientifically reliable. Mitigation measures were proposed to rectify and compensate the impacts of even the low probability/ high risk events.

In conclusion, I would like to argue that the WNP-3 DES is SD-13 adequate but not really necessary as a decision-making tool. An alternative to going ahead with the operation of the facitlity was never presented. It does not provide the type of comparative evaluation NEPA encourages. Also, the licensing procedures require more stringent evaluations than were contained in the DES, (ex. Safty Evaluation Report). The document does not seem relevant to the agency decision. In many respects, the Environmental Statement

comes to late in the game to matter and simply becomes a procedural hoop.

There is a procedural contradiction with the NRC in their implementation of NEPA which limits the usefulness of this doc-
SD-14 ument. This stems from the dual role played by the DES. Firstly, it reviews the operational stage of project development. But at the time of the review, the plant was not complete, the radwaste system was not fully evaluated, the financial state and ownership of the plant were even in question, and there is no national concensus on the management of high-level radioactive wastes. This leads me to feel the operational review is premature.

The second purpose of this DES is to identify and evaluate changes in the project since the construction stage of review in 1975. It acts as a supplemental EIS, but unlike a supplemental EIS, the NRC procedures have eliminated the re-evaluation of fundamental circumstances, as in this case, a determination of the need for a project.

If the DES is to act as a supplement, then all altered
SD-15 environmental circumstances should be open for review. If it is specifically concerned with the operating license stage of the program, environmental review should be conducted at a time when basic conditions are known

40 CFR Parts 1500-1508 NEPA Regulations

Draft Environmental Statement Related to the Operation of WPPSS Nuclear Project No.3, NUREG-1033, U.S.NRC:December, 1983

Federal Register, Vol 49. No 19:January 27, 1984

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

ER 84/95

MAR 15 1984

Director, Division of Licensing
U.S. Nuclear Regulatory Commission
Washington, D.C. 20555

Dear Sir:

The Department of the Interior has reviewed the draft environmental impact statement related to the operation of WPPSS Nuclear Project No. 3, Grays Harbor County, Washington and has the following comments.

As noted on page 5-51, the accident analysis shows that the plant's passive underdrain system could deliver radioactive sump water to Workman Creek in the event of a core-melt accident. The effects on Workman Creek, Chehalis River, and Grays Harbor, only briefly suggested, could be severe. The statement mentions a possible mitigation measure—the sealing of the underdrain, apparently after an accident on page 5-52. However, it is not clear that the sealing of the drain after the accident can be assured before a major radioactive release has occurred. The question arises why the underdrain system does not include provisions to shut off or divert to safe storage any contaminated flow from the reactor. It would be simpler to provide for these measures before an accident has occurred than afterward. DOI-1

The proposed sealing of the underdrain outflow would retain the highly radioactive water. The statement should discuss the long-term adequacy of the storage capacity of the underdrain system and should evaluate the system's long-term integrity, if it is used to retain the contaminated sump water. This evaluation should consider the potential for ground-water impacts if a loss of the underdrain system's integrity should release the contaminated water to the ground-water environment. The statement should also explain how the passive underdrain system below and in the vicinity of the reactor would be protected against damage if the basemat failed. DOI-2

The Reactor Safety Study (WASH-1400) includes an analysis of possible depth of penetration of a core-soil mass; heat transfer calculations indicated that this mass would be about 50 feet high. Thus, the Class-9 accident analysis for WPPSS No. 3 should assess the integrity of the underdrain system if 50 feet of penetration should occur. A sketch of the underdrain system should be provided in the final statement. DOI-3

We hope these comments will be helpful to you.

Sincerely,

Bruce Blanchard, Director
Environmental Project Review

BPA

Department of Energy

Bonneville Power Administration
P.O. Box 3621
Portland, Oregon 97208

In reply refer to: SJ   March 16, 1984

Ms. Annette Vietti
Division of Licensing
Nuclear Regulatory Commission
Washington, DC 20555

Dear Ms. Vietti:

Bonneville Power Administration (BPA) staff have reviewed your Draft Environmental Impact Statement (NUREG-1033) on the operation of Washington Public Power Supply System Nuclear Project No. 3.

Section 4.2.7 of the statement correctly states, "The (power transmission) system beyond the WNP-3 substation was evaluated, designed, and built by BPA, the lead Federal agency for the transmission lines." BPA documented this evaluation in an environmental impact statement entitled "Satsop Integrating Transmission" (Department of the Interior, FES 76-31). A copy of this EIS is enclosed here; please cross-reference this EIS in your final statement.

Thank you for the opportunity to comment.

Sincerely,

Anthony R. Morrell
Environmental Manager

Enclosure

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 WNP-3 facility, employing the same dose calculation models used for individual doses (RG 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 that are 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 RG 1.111, Revision 1, is used in conjunction with the dose models in RG 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 WNP-3 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 RG 1.111, Revision 1, and the dose models described in RG 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 U.S. toward the northeastern corner of the U.S. 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.

(a) 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 U.S.

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 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.

(b) World-Wide Dispersion

For estimating the dose commitment to the U.S. population after the first-pass, 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 20-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, carbon-14 is gradually removed to the world's oceans). The total-body population-dose commitment from the noble gases is due mainly to 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 20 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 is due mainly to 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 RG 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.

4. References

U.S. Nuclear Regulatory Commission, NUREG-0597, K. F. Eckerman, et al., "User's Guide to GASPAR Code," June 1980.

---, RG 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," Revision 1, October 1977.

---, RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water-Reactors," Revision 1, July 1977.

APPENDIX C

IMPACTS OF THE URANIUM FUEL CYCLE

APPENDIX C

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 of Title 10 of the Code of Federal Regulations, Part 50 (10 CFR 50) (see Section 5.10 of the main body of this report) and the NRC staff's estimates of radon-222 and technetium-99 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%. In the following review and evaluation of the environmental impacts of the LWR-supporting 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 WNP-3 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% of those from the model 1000-MWe LWR using once-through cooling. The

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*The LWR-supporting fuel cycle consists of all cycle steps other than reactor operation: mining and milling of uranium, uranium hexafluoride conversion, isotopic enrichment, uranium oxide fuel fabrication, fuel reprocessing and transportation, irradiated fuel storage, and waste management.

**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.

consumptive water use of 0.6×10^6 m^3 per year is about 2% 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 cycle used cooling towers) would be about 6% 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% 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% 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. 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 U.S.; that is, about 0.02% 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. Additionally, all liquid discharges into the navigable waters of the U.S. from plants associated with the fuel-cycle operations will be subject to requirements and limitations set forth in the 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 (Table S-3).

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 environmental dose commitment* to the U.S. population from the LWR-supporting fuel cycle. Dose commitments are provided in this section for exposure to four categories of radioactive releases: (1) airborne effluents that are quantified in Table S-3 (that is, all radionuclides except radon-222 and technetium-99), (2) liquid effluents that are quantified in Table S-3 (that is, all radionuclides except technetium-99); (3) the staff's estimates of radon-222 releases; and (4) the staff's estimate of technetium-99 releases. Dose commitments from the first two categories are also described in a proposed explanatory narrative for Table S-3, which was published in the Federal Register on March 4, 1981 (46 FR 15154-15175).

Airborne Effluents

Population dose estimates for exposure to airborne effluents are based on the annual releases listed in Table S-3, using an environmental dose commitment (EDC) time of 100 years.* The computational code used for these estimates is the RABGAD code originally developed for use in the "Generic Environmental Impact Statement on the Use of Mixed Oxide Fuel in Light-Water-Cooled Nuclear Power Plants," GESMO (NUREG-0002, Chapter IV, Section J, Appendix A). Two generic sites are postulated for the points of release of the airborne effluents: (1) a site in the midwestern United States for releases from a fuel reprocessing plant and other facilities, and (2) a site in the western United States for releases from milling and a geological repository.

The following environmental pathways were considered in estimating doses: (1) inhalation and submersion in the plume during its initial passage; (2) ingestion of food; (3) external exposure from radionuclides deposited on soil; and (4) atmospheric resuspension of radionuclides deposited on soil. Radionuclides released to the atmosphere from the midwestern site are assumed to be transported with a mean wind speed of 2 m/sec over a 2413-km (1500-mile)** pathway from the midwestern United States to the northeast corner of the United States, and deposited on vegetation (deposition velocity of 1.0 cm/sec) with subsequent uptake by milk- and meat-producing animals. No removal mechanisms are assumed during the first 100 years, except normal weathering from crops to soil (weathering half-life of 13 days). Doses from exposure to carbon-14 were estimated using the GESMO model to estimate the dose to U.S. population from the initial passage of carbon-14 before it mixed in the world's carbon pool. The model developed by Killough (1977) was used to estimate doses from exposure to carbon-14 after it mixed in the world's carbon pool.

In a similar manner, radionuclides released from the western site were assumed to be transported over a 3218-km (2000-mile) pathway to the northeast corner of the United States. The agricultural characteristics that were used in computing doses from exposure to airborne effluents from the two generic sites

*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.

**Here and elsewhere in this narrative, insignificant digits are retained for purposes of internal consistency in the model.

are described in GESMO (NUREG-0002, page IV J(A)-19). To allow for an increase in population, the population densities used in this analysis were 50% greater than the values used in GESMO (NUREG-0002, page IV J(A)-19).

Liquid Effluents

Population dose estimates for exposure to liquid effluents are based on the annual releases listed in Table S-3 and the hydrological model described in GESMO (NUREG-0002, pages IV J(A)-20, -21, and -22). The following environmental pathways were considered in estimating doses: (1) ingestion of water and fish; (2) ingestion of food (vegetation, milk, and beef) that had been produced through irrigation; and (3) exposure from shoreline, swimming, and boating activities.

It is estimated from these calculations that the overall total-body dose commitment to the U.S. population from exposure to gaseous releases from the fuel cycle (excluding reactor releases and the dose commitment due to radon-222 and technetium-99) would be approximately 450 person-rems to the total body for each year of operation of the model 1000-MWe LWR (reference reactor year, or RRY). Based on Table S-3 values, the additional 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 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 550 person-rems to the total body (whole body) per RRY.

Because there are higher dose commitments to certain organs (for example, lung, bone, and thyroid) than to the total body, the total risk of radiogenic cancer is not addressed by the total body dose commitment alone. Using risk estimators of 135, 6.9, 22, and 13.4 cancer deaths per million person-rems for total-body, bone, lung, and thyroid exposures, respectively, it is possible to estimate the total body risk equivalent dose for certain organs (NUREG-0002, Chapter IV, Section J, Appendix B). The sum of the total body risk equivalent dose from those organs was estimated to be about 100 person-rems. When added to the above value, the total 100-year environmental dose commitment would be about 650 person-rems (total body risk equivalent dose) per RRY (Section 5.9.3.1.1 describes the health effects models in more detail).

Radon-222

At this time the quantitites of radon-222 and technetium-99 releases are not listed 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.

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

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 3 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.

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, 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% underground and 34% open pit (Department of Energy, 1978), the staff has further assumed that uranium to fuel LWRs will be produced by conventional mining methods 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.

Table C-2 Estimated 100-year environmental dose commitment per year of operation of the model 1000-MWe LWR

		Environmental dose commitments			
Radon source	Radon-222 releases (Ci)	Total body (person-rems)	Bone (person-rems)	Lung (bronchial epithelium) (person-rems)	Total body risk equivalent dose (person-rems)
Mining	4100	110	2800	2300	630
Milling and active tailings	1100	29	750	620	170
Total	5200	140	3600	2900	800

Based on a value of 37 Ci per year per RRY for long-term releases from unreclaimed open-pit mines, 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 environmental dose commitments for a 100- to 1000-year period would be as shown in Table C-3.

Table C-3 Estimated 100-year environmental dose commitments from unreclaimed open-pit mines for each year of operation of the model 1000-MWe LWR

		Environmental dose commitments			
Time span (years)	Radon-222 releases (Ci)	Total body (person-rems)	Bone (person-rems)	Lung (bronchial epithelium) (person-rems)	Total body risk equivalent dose (person-rems)
100	3,700	96	2,500	2,000	550
500	19,000	480	13,000	11,000	3,000
1,000	37,000	960	25,000	20,000	5,500

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 Estimated 100-year environmental dose commitments from stabilized-tailings piles for each year of operation of the model 1000-MWe LWR

		Environmental dose commitments			
Time span (year)	Radon-222 releases (Ci)	Total body (person-rems)	Bone (person-rems)	Lung (bronchial epithelium) (person-rems)	Total body risk equivalent dose (person-rems)
100	100	2.6	68	56	15
500	4,090	110	2,800	2,300	630
1,000	53,800	1,400	37,000	30,000	8,200

Using risk estimators of 135, 6.9, and 22 cancer deaths per million person-rems for total-body, bone, and lung exposures, respectively (NUREG-0002, Chapter IV, Section J, Appendix B) the estimated risk of cancer mortality resulting from mining, milling, and active-tailings emissions of radon-222 (that is, Table C-2) is about 0.11 cancer fatality per RRY. When the risks from radon-222 emissions from stabilized tailings and from reclaimed and unreclaimed open-pit mines are added to the value of 0.11 cancer fatality, the overall risks of radon-induced cancer fatalities per RRY are as follows:

0.19 fatality for a 100-year period
2.0 fatalities for a 1000-year period

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.

Current NRC regulations (10 CFR 40, Appendix A) require that an earth cover not less than 3 meters in depth be placed over tailings to reduce the Rn-222 emanation from the disposed tailings to less than 2 pCi/m^2-sec, on a calculated basis above background. In October 1983, the U.S. Environmental Protection Agency (EPA) published environmental standards for the disposal of uranium and thorium mill tailings at licensed commercial processing sites (EPA 1983). The EPA regulations (40 CFR 192) require that disposal be designed to limit Rn-222 emanation to less than 20 pCi/m^2-sec, averaged over the surface of the disposed tailings. The NRC Office of Nuclear Material Safety and Safeguards is reviewing its regulations for tailings disposal to ensure that they conform with the EPA regulations. Although a few of the dose estimates in this appendix would change if NRC adopts EPA's higher Rn-222 flux limit for disposal of tailings, the basic conclusion of this appendix should still be valid. That conclusion is: "The staff concludes that both the dose commitments and health 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."

Technetium-99

The staff has calculated the potential 100-year environmental dose commitment to the U.S. population from the release of technetium-99. 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) and are described in more detail in the staff's testimony at the operating license hearing for the Susquehanna Station (Branagan and Struckmeyer, 1981). The gastrointestinal tract and the kidney are the body organs that receive the highest doses from exposure to technetium-99. The total body dose is estimated at less than 1 person-rem per RRY and the total body risk equivalent dose is estimated at less than 10 person-rems per RRY.

Summary of Impacts

The potential radiological impacts of the supporting fuel cycle are summarized in Table C-5 for an environmental dose commitment time of 100 years. For an environmental dose commitment time of 100 years, the total body dose to the U.S. population is about 790 person-rems per RRY, and the corresponding total body risk equivalent dose is about 2000 person-rems per RRY. In a similar manner, the total body dose to the U.S. population is about 3000 person-rems per RRY, and the corresponding total body risk equivalent dose is about 15,000 person-rems per RRY using a 1000-year environmental dose commitment time.

Multiplying the total body risk equivalent dose of 2000 person-rems per RRY by the preceding risk estimator of 135 potential cancer deaths per million person-rems (NUREG-0002, Chapter IV, Section J, Appendix B), the staff estimates that about 0.27 cancer death per RRY may occur in the U.S. population as a result of exposure to effluents from the fuel cycle. Multiplying the total body dose of 790 person-rems per RRY by the genetic risk estimator of 220 potential cases of all forms of genetic disorders per million person-rems (ibid), the staff estimates that about 0.17 potential genetic disorder per RRY may occur in all future generations of the population exposed during the 100-year environmental dose commitment time. In a similar manner, the staff estimates that about 2 potential cancer deaths per RRY and about 0.7 potential genetic disorder per RRY may occur using a 1000-year environmental dose commitment time.

Some perspective can be gained by comparing the preceding estimates 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 and about 770,000 and 7,700,000 genetic disorders, during the same time periods. From the above analysis, the staff concludes that both the dose commitments and health 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.

Table C-5 Summary of 100-year environmental dose commitments per year of operation of the model 1000-MWe light-water reactor

Source	Total body (person-rems)	Total body risk equivalent (person-rems)
All nuclides in Table S-3 except radon-222 and technetium-99	550	650
Radon-222		
Mining, milling, and active tailings, 5200 Ci	140	800
Unreclaimed open-pit mines, 3700 Ci	96	550
Stabilized tailings, 100 Ci	3	15
Technetium-99, 1.3 Ci*	<1	<10
Total	790	2000

*Dose commitments are based on the "prompt" release of 1.3 Ci/RRY. Additional releases of technetium-99 are estimated to occur at a rate of 0.0039 Ci/yr/RRY after 2000 years of placing wastes in a high-level-waste repository.

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 waste values in Table S-3 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 that support the model 1000-MWe LWR is about 200 person-rems (NUREG-0216, Appendix I). 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 LWR-supporting 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 LWR-supporting fuel cycle are not affected by the specific fuel cycle selected.

10. References

Branagan, E., and R. Struckmeyer, testimony from "In the Matter of Pennsylvania Power & Light Company, Allegheny Electric Cooperatives, Inc. (Susquehanna Steam Electric Station, Units 1 and 2)," U.S. Nuclear Regulatory Commission, Docket Nos. 50-387 and 50-388, presented on October 14, 1981, in the transcript following page 1894.

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., testimony from "In the Matter of Duke Power Company (Perkins Nuclear Station)," U.S. Nuclear Regulatory Commission, Docket No. 50-488, filed April 17, 1978.

Killough, G. G., "A Diffusion-Type Model of the Global Carbon Cycle for the Estimation of Dose to the World Population from Releases of Carbon-14 to the Atmosphere," ORNL-5269, May 1977.

National Council on Radiation Protection and Measurements, NCRP, "Natural Background Radiation in the United States," NCRP Report No. 45, November 1975.

U.S. Environmental Protection Agency, "Environmental Standards for Uranium and Thorium Mill Tailings at Licensed Commercial Processing Sites (40 CFR 192), "Federal Register, Vol 48, No. 196, pp. 45926-45947, October 7, 1983.

U.S. Department of Energy, "Statistical Data of the Uranium Industry," GJO-100(8-78), January 1978.

U.S. Nuclear Regulatory Commission, NUREG-0002, "Final Generic Environmental Statement on the Use of Recycled Plutonium in Mixed Oxide Fuel in Light-Water-Cooled Reactors," August 1976.

---, NUREG-0116, "Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle" (Supplement 1 to WASH-1248), October 1976.

---, NUREG-0216, "Public Comments and Task Force Responses Regarding the Environmental Survey of the Reprocessing and Waste Management Portions of the LWR Fuel Cycle (Supplement 2 to WASH-1248)," Appendix I, March 1977.

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 WNP-3 facility are estimated on the basis of the description of the design and operation of the radwaste systems as contained in the applicant's FSAR and by using the calculative models and parameters described in NUREG-0017. These estimated effluent release values for normal operation, including anticipated operational occurrences, along with the applicant's site and environmental data in the 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 RG 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 is described in Appendix B of this statement.

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 20 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 on site from October 1979 to September 1981. The long-term atmospheric dispersion estimates were made using the procedure described in RG 1.111, Revision 1. The data were comprised of wind speed and wind direction measured at 10 meters, along with vertical temperature difference between 10 and 60 meters, which were combined in a joint frequency distribution. These data were used in a straight line gaussian plume model corrected using the standard default factors for effluent recirculation in areas of uncomplicated terrain, as described in NUREG/CR-2919.

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.

(a) 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 well 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 RG 1.109.

(b) Cumulative Dose Commitments to the General Population

Annual radiation dose commitments from airborne and waterborne radioactive releases from the WNP-3 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, NUREG-0017, "Calculation of Releases of Radioactive Materials in Gaseous and Liquid Effluents from Pressurized Water Reactors (PWR-GALE Code)," April 1976.

---, RG 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," Revision 1, October 1977.

---, RG 1.111, "Methods for Estimating Atmospheric Transport and Dispersion of Gaseous Effluents in Routine Releases from Light-Water Reactors," Revision 1, 1977.

---, NUREG/CR-2919, J. F. Sagendorf, S. T. Goll, and W. F. Sandusky, "XOQDOQ: Computer Program for the Meteorological Evaluation of Routine Effluent Releases at Nuclear Power Stations," Pacific Northwest Laboratory, Battelle Memorial Institute, September 1982 (also issued as PNL-4380).

Table D-1 Calculated releases of radioactive materials in gaseous effluents from WNP-3 (Ci/yr)

Nuclides	Releases*
Ar-41	25
Kr-83m	2
Kr-85m	17
Kr-85	263
Kr-87	4
Kr-88	26
Kr-89	a
Xe-131m	4
Xe-133m	25
Xe-133	1262
Xe-135m	a
Xe-135	66
Xe-137	a
Xe-138	a
Total Noble Gases	1694
Mn-54	0.0004
Fe-59	0.00015
Co-58	0.0015
Co-60	0.00067
Sr-89	0.000055
Sr-90	0.0000059
Cs-134	0.00044
Cs-137	0.00075
Total Particulates	0.004
I-131	0.029
I-133	0.03
H-3	1400
C-14	8

*Releases are all ground level, so releases from reactor building, auxiliary building, turbine bulding, and air ejector exhaust have been combined.

Note: a = less than 1.0 Ci/yr for noble gases.

Table D-2 Summary of atmospheric dispersion factors (χ/Q) and relative deposition values for maximum site boundary and receptor locations near the WNP-3 nuclear facility*

Location**	Source***	χ/Q (sec/m^3)	Relative Deposition (m^{-2})
Nearest effluent-control boundary (1.7 km NNE of plant)	A	1.1×10^{-5}	3.5×10^{-8}
	B	1.1×10^{-5}	3.5×10^{-8}
	C	1.1×10^{-5}	3.5×10^{-8}
	D	1.1×10^{-5}	3.5×10^{-8}
Nearest residence and garden (1.6 km N of plant)	A	6.9×10^{-6}	1.5×10^{-8}
	B	6.9×10^{-6}	1.5×10^{-8}
	C	6.9×10^{-6}	1.5×10^{-8}
	D	6.9×10^{-6}	1.5×10^{-8}
Nearest milk cow (2.4 km NNE of plant)	A	5.2×10^{-6}	1.4×10^{-8}
	B	5.2×10^{-6}	1.4×10^{-8}
	C	5.2×10^{-6}	1.4×10^{-8}
	D	5.2×10^{-6}	1.4×10^{-8}
Nearest milk goat (2.7 km NE of plant)	A	2.2×10^{-6}	5.2×10^{-9}
	B	2.2×10^{-6}	5.2×10^{-9}
	C	2.2×10^{-6}	5.2×10^{-9}
	D	2.2×10^{-6}	5.2×10^{-9}
Nearest meat animal (2.6 km NNE of plant)	A	4.6×10^{-6}	1.2×10^{-8}
	B	4.6×10^{-6}	1.2×10^{-8}
	C	4.6×10^{-6}	1.2×10^{-8}
	D	4.6×10^{-6}	1.2×10^{-8}

*The values presented in this table are calculated in accordance with RG 1.111, Revision 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 stack, intermittent release, 24 releases per year, 2 hours each release.
B - Auxiliary building exhaust stack, continuous release.
C - Auxiliary building exhaust stack, intermittent release, 15 releases per year, 8 hours each release.
D - Turbine building-ventilation exhaust and main-condenser air-ejector exhaust, continuous release.

Table D-3 Nearest pathway locations used for maximally exposed individual dose commitments for the WNP-3 nuclear facility

Location	Sector	Distance (km)
Nearest effluent-control boundary*	NNE	1.7
Residence and garden**	N	1.6
Milk cow	NNE	2.4
Milk goat	NE	2.7
Meat animal	NNE	2.6

*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 consumption as well.

Table D-4 Calculated release of radioactive materials in liquid effluents from the WNP-3 nuclear facility

Nuclide	Ci/yr*	Nuclide	Ci/yr
Corrosion and Activation Products		Fission Products (continued)	
Cr-51	0.00022	Te-127	0.00007
Mn-54	0.00005	Te-129m	0.00015
Fe-55	0.0002	Te-129	0.00015
Fe-59	0.00015	I-130	0.00009
Co-58	0.002	Te-131m	0.00024
Co-60	0.00022	Te-131	0.00005
Np-239	0.00014	I-131	0.022
		Te-132	0.0024
		I-132	0.0037
Fission Products		I-133	0.019
Br-83	0.00013	I-134	0.00075
Br-84	0.00003	Cs-134	0.032
Rb-86	0.00011	I-135	0.0075
Rb-88	0.018	Cs-136	0.017
Sr-89	0.00005	Cs-137	0.023
Sr-91	0.00005	Ba-137m	0.0027
Y-91m	0.00003	Ba-140	0.00003
Mo-99	0.0096	La-140	0.00002
Tc-99m	0.0074		
Te-127m	0.00003	All Others	0.00007
		Total (except H-3)	0.17
		H-3	140.

*Nuclides whose release rates are less than 10^{-5} Ci/yr are not listed individually but are included in "all others."

Table D-5 Summary of hydrologic transport and dispersion for liquid releases from the WNP-3 nuclear facility*

Location	Transit Time (hours)	Dilution Factor
Nearest drinking-water intake**	1	1100
Nearest sport-fishing location (discharge area)***	0	160
Nearest shoreline (bank of Chehalis River near discharge area)	0	160

*See RG 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; no public water systems downstream of WNP-3 withdraw drinking water from the Chehalis River and no such withdrawals are planned.

***Assumed for purposes of an upper limit estimate; detailed information not available.

Table D-6 Annual dose commitments to a maximally exposed individual near the WNP-3 nuclear station

Location	Pathway	Doses (mrems/yr, except as noted)			
		Noble Gases in Gaseous Effluents			
		Total Body	Skin	Gamma Air Dose (mrads/yr)	Beta Air Dose (mrads/yr)
Nearest* site boundary (1.6 km NNE)	Direct radiation from plume	0.3	0.7	0.4	0.8

Location	Pathway	Doses (mrems/yr, except as noted)			
		Iodine and Particulates in Gaseous Effluents**			
		Total Body		Organ	
Nearest*** site boundary (1.6 km NNE)	Ground deposition	a	(T)	a	(T) (thyroid)
	Inhalation	0.6	(T)	0.8	(T) (thyroid)
Nearest residence and garden (1.6 km N)	Ground deposition	a	(C)	a	(C) (bone)
	Inhalation	0.4	(C)	a	(C) (bone)
	Vegetable consumption	2.8	(C)	6.0	(C) (bone)
Nearest milk cow (2.4 km NNE)	Ground deposition	a	(I)	a	(I) (thyroid)
	Inhalation	0.2	(I)	0.2	(I) (thyroid)
	Cow milk consumption	1.6	(I)	7.8	(I) (thyroid)
Nearest milk goat (2.7 km NE)	Ground deposition	a	(I)	a	(I) (thyroid)
	Inhalation	a	(I)	a	(I) (thyroid)
	Goat milk consumption	1.0	(I)	3.8	(I) (thyroid)
Nearest meat animal (2.6 km NNE)	Meat consumption	0.2	(C)	0.6	(C) (bone)

Location	Pathway	Doses (mrems/yr, except as noted)			
		Liquid Effluents**			
		Total Body		Organ	
Nearest drinking water†	Water ingestion	a	(I)	a	(I) (thyroid)
Nearest fish at plant-discharge area	Fish consumption	0.3	(A)	0.4	(A) (liver)
Nearest shore access near plant-discharge area	Shoreline recreation	a	(A)	a	(A) (liver)

[a]Less than 0.1 mrem/year.

*"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.

†Assumed for purposes of an upper limit estimate; no public water systems downstream of WNP-3 withdraw drinking water from the Chehalis River and no such withdrawals are planned.

Table D-7 Calculated Appendix I dose commitments to a maximally exposed individual and to the population from operation of WNP-3

	Annual Dose	
	Individual	
	Appendix I Design Objectives*	Calculated Doses**
Liquid effluents		
Dose to total body from all pathways	3 mrems	0.3 mrems
Dose to any organ from all pathways	10 mrems	0.4 mrems
Noble-gas effluents (at site boundary)		
Gamma dose in air	10 mrads	0.4 mrads
Beta dose in air	20 mrads	0.8 mrads
Dose to total body of an individual	5 mrems	0.3 mrems
Dose to skin of an individual	15 mrems	0.7 mrems
Radioiodines and particulates* **		
Dose to any organ from all pathways	15 mrems	8.0 mrems (thyroid)
	Population Dose Within 80 km, person-rems	
	Total Body	Thyroid
Natural-background radiation†	82,000	-
Liquid effluents	0.1	0.1
Noble-gas effluents	0.1	0.1
Radioiodine and particulates	2.6	3.7

*Design objectives from Sections II.A, II.B, II.C, and II.D of Appendix I, 10 CFR 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 756,000.

Table D-8 Calculated RM-50-2 dose commitments to a maximally exposed individual from operation of the WNP-3 nuclear facility*

	Annual Dose per Site	
	RM-50-2 Design Objectives**	Calculated Doses
Liquid effluents		
Dose to total body or any organ from all pathways	5 mrems	0.4 mrem
Activity-release estimate, excluding tritium (Ci)	10	0.17
Noble-gas effluents (at site boundary)		
Gamma dose in air	10 mrads	0.4 mrad
Beta dose in air	20 mrads	0.8 mrad
Dose to total body of an individual	5 mrems	0.3 mrem
Dose to skin of an individual	15 mrems	0.7 mrem
Radioiodines and particulates***		
Dose to any organ from all pathways	15 mrems	8.0 mrems (thyroid)
I-131 activity release (Ci)	2	0.029

*An optional method of demonstrating compliance with the cost-benefit Section (II.D) of Appendix I to 10 CFR Part 50.

**Annex to Appendix I to 10 CFR Part 50.

***Carbon-14 and tritium have been added to this category.

Table D-9 Annual total-body population dose commitments, year 2000

Category	U.S. Population Dose Commitment, person-rems/yr
Natural background radiation*	26,000,000*
WNP-3 nuclear station	
Plant workers	500
General public:	
Liquid effluents**	0.1
Gaseous effluents	78
Transportation of fuel and waste	3

*Using the average U.S. background dose (100 mrems/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.

**80-km (50-mile) population dose

APPENDIX E

RELEASE CATEGORIES AND PROBABILITIES FOR WNP-3

APPENDIX E

RELEASE CATEGORIES AND PROBABILITIES FOR WNP-3

The NRC staff, licensees, applicants, and contractors have used the methodology of the Reactor Safety Study (RSS) (NUREG-75/014, originally published by the U.S. Atomic Energy Commission as WASH-1400) to study potential severe accidents for several different reactors. For the current study, the staff examined the features of WNP-3 most salient to severe accidents, together with results developed during the Zion and Indian Point studies (NUREG-0850), to derive release sequence descriptions and probabilities specific to the WNP-3 plant and site.

The new information and results available for this study reflect use of advanced modeling of the processes involved in meltdown accidents, i.e., the MARCH computer code modeling for transient- and loss-of-cooling accident (LOCA)-initiated sequences and the CORRAL code used for calculating magnitudes of releases accompanying various accident sequences. These codes* have led to a better capability to predict the transient- and small LOCA-initiated sequences than was used in WASH-1400. The improved accident process models (MARCH and CORRAL) produced some changes in staff estimates of the release magnitudes (expressed as a fraction of the total core inventory for various groups of elements) from various accident sequences in WASH-1400. In general, a decrease in iodine and bromine radioisotopes was predicted for many of the dominant accident sequences, and there were some predicted increases in the release magnitudes for cesium and tellurium isotopes.

The staff recently identified nine release categories that would encompass the range of expected releases from accidents in large, dry containments (U.S. PWRs without ice containments, of which WNP-3 is one). For WNP-3, dominant accident sequences and containment failure modes were identified that would lead to five of these release categories. The staff believes that these categories are more valid than the synthetic release categories defined in WASH-1400 because of the more mechanistic treatment of the fission product behavior and release. The present study also eliminates the "smoothing technique" that the Risk Assessment Review Group criticized in the Lewis Report (NUREG/CR-0400).

Since WASH-1400 was published, the staff has reduced its estimate of the likelihood of an accident sequence leading to the occurrence of a steam explosion (α) in the reactor vessel of enough energy to breach the reactor vessel and containment to reflect both experimental and calculative indications that explosions of such energy are unlikely in those sequences involving small LOCAs and transients. Also, the staff has considerably reduced its estimate of the likelihood of an accident sequence leading to containment failure by a steam-spike overpressurization--which happens (if it happens at all) shortly after vessel failure.

For this study, site- and plant-specific accident sequence probabilities were determined by a review of the WNP-3 plant features that affect the probability

*The MARCH code was used on a number of scenarios in connection with the recovery efforts and the investigations for the Three Mile Island 2 accident, as well as more recent studies of Zion, Indian Point, and other reactors.

of a core melt, and by incorporating the loss-of-offsite-power frequency observed for the WNP-3 region (Thadani, June 30, 1983). The conditional probability of various failure modes, given a certain accident sequence, was estimated by comparing the WNP-3 containment design to designs for which the staff and contractors performed extensive analyses (Sheron, August 1983). The containment failure mode and the amount of radionuclides available for release during and after containment failure determine the release category, which is simply a definition of the release time, release duration, amount of energy released with the material, the warning time, and the release fractions for each of seven groups of elements (each element of interest will have one or more radioactive isotopes). The grouping of the elements is shown in Table 5.6 of the main body of this report. Each group consists of elements whose physical and chemical properties, as they relate to release from the core and containment, are similar. The staff determined that the release categories could be represented by five of the release categories described in the testimony supporting the Indian Point 2 and 3 study (Meyer and Pratt, 1983). The staff did not identify new release categories explicitly for WNP-3 because an in-depth probabilistic risk assessment (PRA) would be necessary for this, and a PRA is not required for licensing of the plant. Further, the staff concluded that the basic containment and reactor design are sufficiently similar to Indian Point 2 and 3 that the use of the same release categories is valid. The phenomena controlling fission product release and transport in the two designs are predicted to be similar, so the methodology for the treatment of one should be valid for the other.

Four of the release categories defined in the Indian Point study were not used because either they represented a very small fraction of the total risk or the accident sequence leading to them was not analyzed. For instance, the probability, for WNP-3, that a hydrogen burn would occur without the sprays being available was determined to be so small (because pumps in two different systems would have to fail) that the two release categories resulting from that sequence would contribute very little to the risk and could be dropped from further analysis. On the other hand, no accident-initiating external events were considered for WNP-3, except a loss of offsite power that could lead to a core melt. Had external events like earthquakes been considered, another release category involving early containment collapse might have been added.

The five release categories presented in Table 5.6 and used in the calculations for this study are designated B, C, F, H, and I. They are each described below. The release category nomenclature is that of the Indian Point study (Meyer and Pratt, 1983); the PWR accident sequence symbols (see Table E.1) are the same as in WASH-1400. The numerical description of the release categories is presented in Table 5.6.

<u>Release Category B</u>

During the RSS (WASH-1400), a potentially large risk contributor was identified by examining the configuration of the multiple check valves used to separate the high pressure reactor coolant system from the low pressure portions of the emergency core cooling system (ECCS) (i.e., the low pressure injection system, (LPIS)). If these valves were to fail in various modes (such as a leak in one and rupture of the other, or rupture of both) and suddenly expose the LPIS to high pressure and dynamic loads, the WASH-1400 authors concluded that an LPIS

Table E.1 Key to PWR accident sequence symbols

Symbol	Accident
A	Intermediate to large LOCA.
D	Failure of the emergency core cooling injection system.
H	Failure of the emergency core cooling recirculation system. (Not the same as release Category H described in text.)
K	Failure of the reactor protection system.
L	Failure of the secondary system steam relief valves and the auxiliary feedwater system.
M	Failure of the secondary system steam relief valves and the power conversion system.
Q	Failure of the primary system safety relief valves to reclose after opening.
S_1	A small LOCA with an equivalent diameter of about 2 to 6 inches.
S_2	A small LOCA with an equivalent diameter of about 1/2 to 2 inches.
T	Transient event.
V	LPIS check valve failure.
α	Containment rupture due to a reactor vessel steam explosion.
β	Containment failure resulting from inadequate isolation of containment openings and penetrations.
γ	Containment failure due to hydrogen burning.
δ	Containment failure due to overpressure.
ε	Containment vessel melt-through.

rupture would be highly probable. Because most of the LPIS is located outside the containment, an LPIS rupture would likely provide a pathway for the leaking reactor coolant to bypass containment and the mitigating features inside containment, like containment spray. This scenario is called Event V in WASH-1400, and all accident sequences starting with Event V are predicted to lead to release Category B. The WASH-1400 authors assumed that if the LPIS rupture did not entirely fail the LPIS makeup function (which would ultimately be needed to prevent core damage), the flooding and steam caused by the LOCA would. Past release magnitude and consequence calculations for Event V have indicated

that this sequence represents one of the largest risk contributors for PWRs. The NRC has recognized this finding and has taken steps to reduce the probability of Event V scenarios in both existing and future LWR designs by requiring periodic surveillance testing of the interfacing check valves to ensure that they are properly functioning as pressure boundary isolation barriers during plant operations. The WNP-3 design reflects the concerns about Event V. At WNP-3, the low pressure system is called the shutdown cooling system (SCS). The SCS suction valves are two motor-operated valves per line, designed for full reactor coolant pressure, and equipped with independent interlocks preventing their opening at high pressure. The SCS discharge lines each have two check valves and a closed motor-operated valve. The check valve design permits leak testing, which is judged to reduce the probability of Event V below that originally predicted. The probability of Event V, as it contributes to release Category B for this study, was taken to be the midpoint of probabilities calculated for plants with systems similar to WNP-3.

Another sequence assigned to release Category B is a core melt caused by loss of ac power, followed by a steam spike shortly after vessel failure, which fails containment. The staff assumes a steam spike could occur about 0.5% of the time that the core melts after a loss of ac power.

Release Category C

For WNP-3, the only containment failure mode in Category C is overpressure of containment from steam and noncondensible gas buildup. The accident sequence leading to this is the loss of offsite power (which scrams the reactor and initiates the accident), failure of onsite diesel generators, failure of the ac-power-independent auxiliary feedwater pump, and failure to restore offsite power in time to provide core and containment cooling and prevent containment overpressure.

Associated with this could be a reactor coolant pump seal LOCA, because pump seal cooling would be lost due to the loss of component cooling water (which requires ac power). Assuming that a seal failure occurs within 30 minutes of loss of seal flow, this small LOCA would cause a core melt, beginning about 2 hours after loss of ac power. Regional data were used to estimate the probability of loss and nonrestoration of offsite power for WNP-3; the unavailability of onsite electric power was taken to be 2×10^{-3} per demand (specific to a plant with two diesel generators, from NUREG/CR-2497). For this release category, the probability consistent with nonrestoration of ac power for 8 hours was used.

Release Category F

Category F includes those containment failures resulting from an early hydrogen burn with containment sprays still available. About 3% of a variety of core melt scenarios for which sprays are still available and for which containment is not already breached or bypassed are estimated to result in an early hydrogen burn of enough energy to fail containment. The probability of the WNP-3 sprays being available is high, because they are in a separate system from the core cooling system postulated to fail and lead to the core melt. (The primary possibility for common-cause failure of the two systems, loss of ac power, is

accounted for in release Category C.) The containment sprays will reduce the amount of airborne fission products available for release when the burn occurs, so the radionuclide release fractions are less than for release Categories B and C.

Release Category H

Category H includes those accident sequences that lead to basemat melt-through. A variety of core melt accidents may lead to containment penetration through basemat failure: for example, S_2D-ε, S_1D-ε, S_2H-ε, S_1H-ε, AD-ε, AH-ε, TML-ε, and TKQ-ε. Except for the last two, all the listed sequences involve the potential failure of the ECCS following a LOCA with the containment engineered safety features continuing to operate as designed until the basemat is penetrated. Containment sprays would reduce the containment temperature and pressure as well as the amount of airborne radioactivity. The only containment penetration would be the basemat melt-through, which would release radionuclides into the ground with some leakage to the atmosphere occurring upward through the ground. Release is postulated to occur after about 3 days. The combination of removal by containment spray and retention in the soil greatly reduces the released fraction of all types of radionuclides except noble gases. Decay prior to release would further lessen the effects of short-lived radionuclides.

About 10% of all core melt accident sequences not accounted for by release Categories B, C, and F are assumed to result in release Category H.

Release Category I

All core melt sequences that result in no containment failure are assigned to Category I. The containment is assumed to leak at 1% per day. Containment sprays are assumed available to reduce the airborne concentration of all nuclides except noble gases. The probability was taken to be the probability of all core melts less those accounted for in release Categories B, C, F, and H.

For WNP-3, no specific calculation of the probability of all core melts was made. The design and construction of WNP-3 benefited from considerations of severe accidents and from the information generated from the TMI-2 accident investigations. The probability of all core melts for WNP-3 was assumed to be in the lower end of the range of probabilities determined for internal events in reactors for which PRAs were performed. This range is 10^{-3} to 10^{-5} per reactor-year; a mid-range value of 10^{-4} per reactor-year was used for the WNP-3 consequence calculations.

References

Meyer, James F. and W. Trevor Pratt, Indian Point 2 and 3 Hearing Testimony before the Atomic Safety and Licensing Board, Section III.B, Direct Testimony, Concerning Commission Question 1, 1983.

Sheron, Brian, NRC, memorandum to L. G. Hulman, August 1983.

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---, NUREG/CR-0400, "Risk Assessment Review Group Report to the U.S. Nuclear Regulatory Commission," September 1978.

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APPENDIX F

CONSEQUENCE MODELING CONSIDERATIONS

APPENDIX F

CONSEQUENCE MODELING CONSIDERATIONS

F.1 Evacuation Model

"Evacuation," used in the context of offsite emergency response in the event of a substantial amount 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 post-accident response to reduce exposure from long-term ground contamination after plume passage. The Reactor Safety Study (RSS) (NUREG-75/014, originally 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 F.2) and acute radiation sickness which would require hospitalization. The evacuation model originally used in the RSS consequence model is described in WASH-1400 as well as in NUREG-0340 and NUREG/CR-2300. The evacuation model which has been used herein is a modified version of the RSS model (Sandia, 1978) and is, to a certain extent, site emergency planning oriented. The modified version is briefly outlined below.

The model utilizes a circular area with a specified radius (the 16-km (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 one 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 downwind direction as its median--that is, those people who would potentially be under the radioactive cloud that would develop following the release--would leave their residences after 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 sums of: the time required by the reactor operators to notify the responsible authorities; the time required by the authorities to interpret the data, decide to evacuate, and direct the people to evacuate; and the time required for the people to mobilize and get under way.

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*Assumed to be a constant value, 1 hour, that would be the same for all evacuees.

The model assumes that each evacuee would move radially outward* away from the reactor with an average effective speed** (obtained by dividing the zone radius by the average time taken to clear the zone after the delay time) over a fixed distance** from the evacuee's starting point. This distance is selected to be 24 km (15 miles) (which is 8 km (5 miles) more than the 16-km (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 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; that is, 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 would 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/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 one-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 exposures from airborne radioactivity and ground contamination have been used.

Results shown in Section 5.9.4.5 of the main body of this environmental statement for accidents involving significant release of radioactivity to the atmosphere were based upon the assumption that all people within the 16-km (10-mile) plume exposure pathway EPZ would evacuate according to the evacuation scenario described above. Because sheltering can be a mitigative feature, it is not expected that detailed inclusion of any facility (see Section 5.9.4.5(2))

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*In the RSS consequence model, the radioactive cloud is assumed to travel radially outward only, spreading out as it moves away.

**Assumed to be a constant value, 3.2 km (2 miles) per hour, that would be the same for all evacuees.

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 such a value appropriately reflects the Commission's emergency planning requirements. The applicant has provided estimates of the time required to clear the 16-km (10-mile) zone.

From these estimates, the staff has conservatively estimated the effective evacuation speed to be 0.893 meter per second (2.0 mph). It is realistic to expect that the authorities would aid and encourage evacuation at distances from the site where exposures above the threshold for causing early fatalities could be reached regardless of the EPZ distance. The sensitivity of the early fatalities to evacuation distance was calculated by assuming the longer evacuation distance of 24 km (15 miles) from WNP-3. As an additional emergency measure for the WNP-3 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. A modification of the RSS consequence model was used, which incorporates the assumption that 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 plume passage, and people from these regions would be relocated immediately. For this situation the model 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 dose.

Figure F.1 shows the early fatalities for (1) evacuation distances of 24 km (15 miles) followed by relocation as described above, (2) 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, (3) a case of evacuation to 16 km (10 miles) followed by relocation of those outside 16 km as described above.

The model has the same provision for calculation of the economic cost associated with implementation of evacuation as the original RSS model. For this purpose, the model assumes that for atmospheric releases of durations of 3 hours or less, all people living within a circular area of 8-km (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 will be evacuated and temporarily relocated. However, if the duration of release were to exceed 3 hours, the cost of evacuation is based on the assumption that all people within the entire plume exposure pathway EPZ would be evacuated and temporarily relocated. For either of these situations, the cost of evacuation and relocation is assumed to be $225 (1980 dollars) per person, which includes cost of food and temporary sheltering for a period of 1 week.

F.2 Early Health Effects Model

The medical advisors to the RSS (WASH-1400, Appendix IV, Section 9.2.2, and Appendix F) 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"; they are more fully described in NUREG-0340. There is uncertainty associated

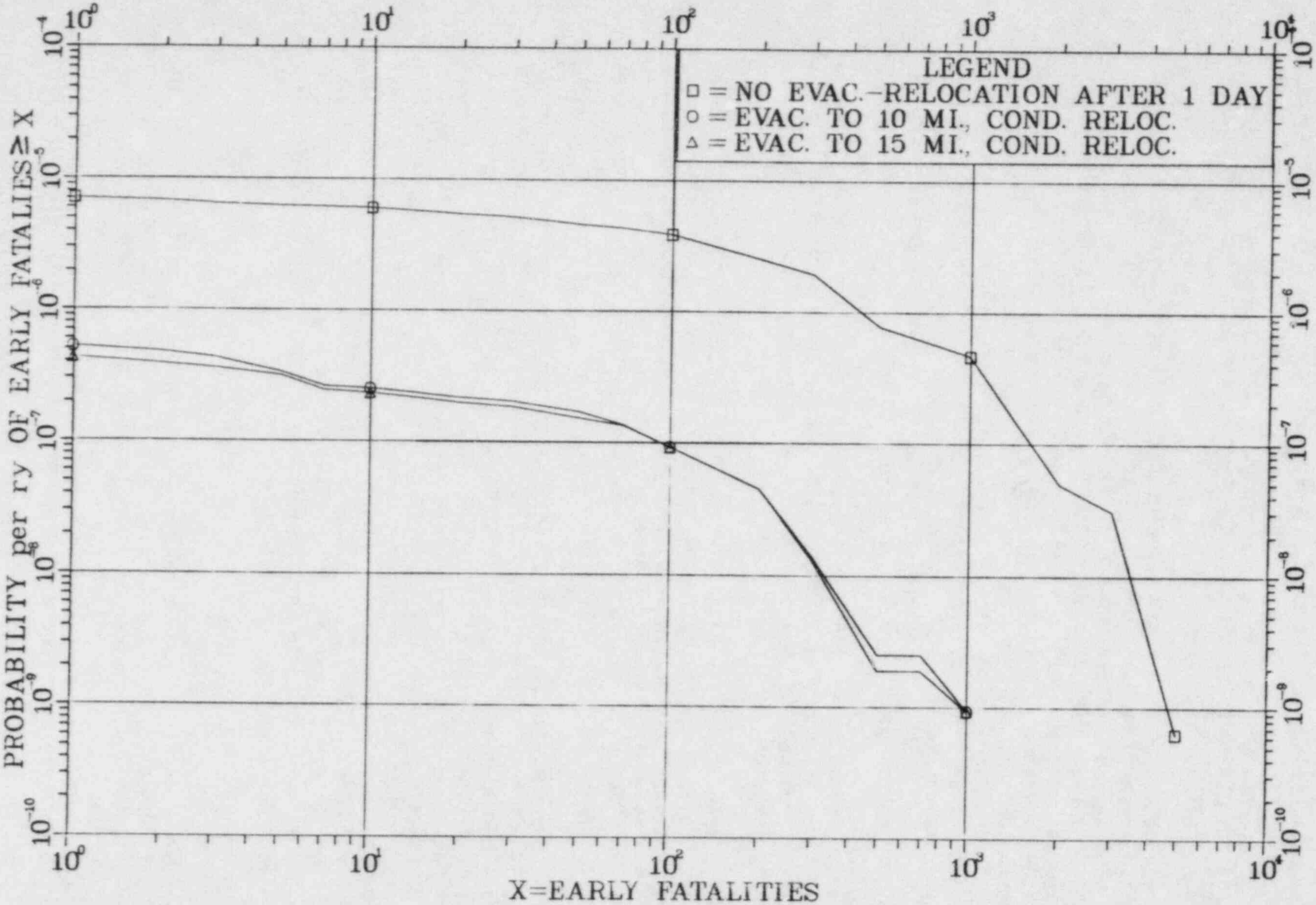

Figure F.1 Sensitivity of early fatalities to evacuation characteristics. See Section 5.9.4.5(7) for a discussion of uncertainties in risk estimates; also see footnote to Section 5.9.4.5(3) for help in interpreting this figure. (To convert miles to km, multiply by 1.6093.)

with the mortality relationships (NUREG/CR-3185) and the availability and effectiveness of different classes of medical treatment (Elliot, 1982).

The calculative estimates of the early fatality risks presented in the text of Section 5.9.4.5(3) of the main body of this report and in Section F.1 of this appendix used the dose-mortality relationship that is based upon the supportive treatment alternative. This implies the availability of medical care facilities and services that are designed for radiation victims, for those exposed in excess of 170 rems, the approximate level above which the medical advisors to the RSS recommended more than minimum medical care to reduce early fatality risks. 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 that provide the best such services, in which case the number of early fatalities might have been underestimated. To gain perspective on this element of uncertainty, the staff has also performed calculations using the most pessimistic dose-mortality relationship based upon the RSS medical experts' estimated dose-mortality relationship for minimal medical treatment and using identical assumptions regarding early evacuation and early relocation as made in Section 5.9.4.5(3). This shows an overall 10-fold increase in annual risk of early fatalities (see Table 5.8). The major fraction of the increased risk of early fatality in the absence of supportive medical treatment would occur within 48 km (30 miles), and virtually all would be within 80 km (50 miles) of the WNP-3 site. However, the hospitals now in the U.S. are likely to be able to supply considerably better care to radiation victims than the medical care on which the minimal medical treatment relationship is based. Further, a major reactor accident at WNP-3 would certainly cause a mobilization of such medical services with a high national priority to save the lives of radiation victims. Therefore, the staff expects that the mortality risks would be less than those indicated by the RSS description of minimal treatment (and much less, of course, for those who will be given the type of treatment defined as "supportive"). For these reasons, the staff has concluded that the early fatality risk estimates are bounded by the range of uncertainties discussed in Section 5.9.4.5(7).

F.3 References

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---, NUREG-0340, "Overview of the Reactor Safety Study Consequences Model," October 1977.

---, NUREG/CR-3185, "Critical Review of the Reactor Safety Study Radiological Health Effects Model," March 1983.

APPENDIX G

STATE OF WASHINGTON NPDES PERMIT

Permit No. WA-002496-1
Issuance Date: 9/14/81
Expiration Date: 9/14/86

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

WASHINGTON PUBLIC POWER SUPPLY SYSTEM
3000 George Washington Way
Richland, Washington 99352

Plant Location:	Section 17 T 17N, R 6W W.M. South of Satsop Grays Harbor County, Washington	Receiving Water: Chehalis River Discharge Location: Outfall 001 Lat. 46° 58'26"N Lo. 123° 29'19"W Outfall 002 Lat. 46° 58'30"N Lo. 123° 27'15"W
Industry Type:	Nuclear Steam Electric Generating Plant (WPPSS Nos. 3&5)	Waterway Segment Number: 10-22-12

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is authorized to discharge in accordance with the special and general conditions which follow.

Nicholas D. Lewis, Chairman
Energy Facility Site
Evaluation Council

SPECIAL CONDITIONS

S.1 DILUTION ZONE BOUNDARIES, EFFLUENT LIMITATIONS, AND MONITORING REQUIREMENTS FOR OUTFALL DISCHARGE SERIAL NUMBER 001

The dilution zone for Outfall 001 shall have the following boundaries:

a. The vertical boundaries shall be the surface and the bottom of the river.

b. The longitudinal boundaries shall be 50 feet upstream from the diffuser and 100 feet downstream from the diffuser.

c. The lateral boundaries shall be 25 feet, respectively, from the midpoint of the diffuser.

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 001 subject to the following limitations and monitoring requirements:

A. LOW VOLUME WASTE SOURCES PORTION OF DISCHARGE SERIAL NUMBER 001 PER UNIT[1]

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS (2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Total Suspended Solids				
(lb/day)	70	12.5	3 times per week	Grab
(mg/l)	100			
pH	Between 6.0 and 8.5 at all times		3 times per week	Grab
Oil and Grease				
(lb/day)	10.5	6.3	Weekly	Grab
(mg/l)	15			
Flow (GPD)	8.4×10^4	$5. \times 10^4$	Continuous while discharging	N/A

Note (1) Permittee shall mix effluent from this source with cooling water blowdown when either cooling tower is operational. When neither cooling tower is operational, low volume wastes must be retained or a minimum dilution flow of 2000 gpm must be provided from the recirculated cooling water inventory or plant makeup water supply. Alternatively, during metal cleaning operations, the associated low volume wastes flows may be discharged into the equalizing reservoir.

Note (2) Permittee shall monitor the low volume wastes prior to mixing the effluent with cooling tower blowdown or other in-plant streams.

B. RECIRCULATED COOLING WATER BLOWDOWN PORTION OF DIFFUSER DISCHARGE SERIAL NUMBER 001 PER UNIT (1)

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS (2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Temperature	Note (3)		Continuous	Instantaneous
Total Residual Chlorine (mg/l)	No detectable amount		Continuous (4)	Instantaneous
pH	Between 6.0 and 8.5 at all times		Continuous (4)	Instantaneous
Flow (GPD) (CFS)	4.18×10^6 6.47	4.12×10^6 6.38	Continuous	Instantaneous
Copper (mg/l)	0.030 See Note (5)		Weekly (6)	Grab
Chromium (mg/l	0.1		Weekly (6)	Grab
Zinc (mg/l)	0.075		Weekly (6)	Grab
Iron (mg/l	1.0		Weekly (6)	Grab
Nickel (mg/l)	0.065		Weekly (6)	Grab

Special Chlorine Limitation

Permittee shall be deemed to have satisfied the "no-detectable chlorine limitation" if chlorine is continuously monitored by mechanical amperometric analysis with no concentration above .05 mg/l being shown by the monitor (if monitoring equipment malfunctions, grab samples every four hours shall be substituted). A grab sample shall be taken and analyzed under laboratory controls using standard amperometric titration techniques at least weekly to demonstrate continuous monitor performance. Dechlorination facilities shall be started at the same time chlorination begins, and the dechlorination facilities shall be operated for 15 minutes after the dechlorinator influent is monitored at .05 mg/l or less of total residual chlorine.

RECIRCULATED COOLING WATER BLOWDOWN PORTION OF DIFFUSER DISCHARGE SERIAL NUMBER 001 PER UNIT (Cont.)

Note (1) No discharge is permitted from this source at any time when instantaneous river velocities are slower than 0.3 feet per second at the diffuser, in a downstream direction.

Note (2) Permittee shall monitor the blowdown prior to mixing with other in-plant streams.

Note (3) The discharge temperature shall be such that the applicable Water Quality Standards for temperature will be complied with at the edge of the dilution zone described at page 2. The temperature of the blowdown for recirculated cooling water systems shall not exceed at any time the lowest temperature of the recirculated cooling water prior to addition of the makeup water. Additionally, when ambient river temperatures are $20^{\circ}C$ or less, the temperature of the effluent at the point of discharge shall be $20^{\circ}C$ or less and shall not exceed the ambient river temperature by more than $15^{\circ}C$; and when ambient river temperatures are greater than $20^{\circ}C$, the temperature of the effluent at the point of discharge shall be equal to or less than the ambient river temperature.

Note (4) Permittee shall include alarm systems for pH control and for total residual chlorine to provide indication of any variance from established limits.

Note (5) Permittee is authorized to discharge total copper up to a daily maximum of 0.065 mg/l for 180 days after initial startup of a unit and for 30 days after a unit is shut down for maintenance, exept in the period from August 1 to November 1. During the three months of August, September and October, the maximum allowed daily discharge of copper is 0.030 mg/l.

Note (6) Monitoring for copper, chromium, zinc, iron and nickel may be discontinued or the frequency reduced, subject to the concurrence of the Council, upon demonstration of compliance with the effluent limitations for a period of one year.

C. METAL CLEANING WASTES PORTION OF DISCHARGE SERIAL NUMBER 001 PER UNIT(1)

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENTS(2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Total Iron (lb/day) (mg/l)	0.42 1.0	0.17	Each discharge	Grab
Total Copper (lb/day) (mg/l)	0.03 0.065(3)	0.01	Each discharge	Grab
Nickel (mg/l)	0.065		Each discharge	Grab
Chromium (mg/l)	0.1		Each discharge	Grab
Total Suspended Solids (lb/day) (mg/l)	42 100	5	Each discharge	Grab
pH	Between 6.0 and 8.5 at all times		Each discharge	Grab
Oil and Grease (lb/day) (mg/l)	6.3 15	2.5	Each discharge	Grab
Flow (GPD)	5×10^4	2×10^4	Each discharge	Calculated Total Volume

METAL CLEANING WASTES PORTION OF DISCHARGE SERIAL NUMBER 001 PER UNIT (1) (Cont.)

Note (1) The metal cleaning wastes may be discharged from outfall 001 to the river only at times when river flow at the outfall exceeds 6600 cfs. Metal cleaning wastes flows may be discharged into the equalizing reservoir; discharge of metal cleaning wastes from Outfall 002 shall occur only when there is a dilution factor of at least 10 to 1 available from site runoff.

Note (2) Permittee shall monitor the metal clenaing wastes prior to mixing with other in-plant streams.

Note (3) Under no circumstances will more than a daily maximum of .030 mg/l of copper be discharged during the period from August 1 to November 1 in any year.

D. SANITARY SERVICE PORTION OF DISCHARGE SERIAL NUMBER 001[1]

PARAMETER	EFFLUENT LIMITATIONS		MONITORING REQUIREMENT (2)	
	Daily Maximum	Daily Average	Minimum Frequency	Sample Type
Biochemical Oxygen Demand (5 day) (lb/day)	7.5	5.0	Weekly	Composite
(mg/l)	45	30		
Total Suspended Solids (lb/day)	7.5	5.0	Weekly	Composite
(mg/l)	45	30		
Fecal Coliform Bacteria	400 per 100 ml	100 per 100 ml	Weekly	Day shift grab
pH	Betwen 6.0 and 8.5 at all times		3 Times weekly	Day shift grab
Flow (GPD)	2×10^4	2×10^4	Continuous	Instantaneous
Total Residual Chlorine (mg/l)	0.5 mg/l maximum prior to mixing with cooling tower blowdown		3 times weekly	Grab

Note (1) Permittee shall mix effluent from this source with cooling water blowdown when either cooling tower is operational. When neither cooling tower is operational, sanitary wastes must be retained or a minimum dilution flow of 2000 gpm must be provided from the recirculated cooling water inventory or plant makeup water supply.

Note (2) Permittee shall monitor the effluent prior to mixing with other in-plant streams.

S.2 DILUTION ZONE BOUNDARIES, EFFLUENT LIMITATIONS, AND MONITORING REQUIREMENTS FOR OUTFALL DISCHARGE SERIAL NUMBER 002

The dilution zone for Outfall 002 shall have the following boundaries:

a. The vertical boundaries shall be the surface and bottom of the river

b. The longitudinal boundaries shall be 10 feet upstream from the discharge and 75 feet downstream from the discharge.

c. The lateral boundaries shall be the south bank of the river and 25 feet from the south bank toward the center of the river.

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 002 subject to the following limitations and monitoring requirements:

A. COLLECTED STORM RUN-OFF DRAINAGE OF DISCHARGE SERIAL NUMBER 002

PARAMETER	EFFLUENT LIMITATIONS (1)	MONITORING REQUIREMENTS	
		Minimum Frequency	Sample Type
Total Suspended Solids (mg/l)	50	Once per ½ day when there is discharge from the storm collector basins	Grab 2 hours after discharge begins
Settleable Solids (ml/l)	0.1		
pH	Between 6.0 and 8.5 at all times	Once per ½ day when there is discharge from the storm collector basins	Grab 2 hours after discharge begins

Note (1) Any untreated overflow from facilities designed, constructed and operated to treat the volume of material storage runoff and construction runoff which results from a 10-year 24-hour rainfall event (5.5 inches per 24 hours) shall not be subject to the limitations above for total suspended solids, settleable solids, and pH.

GENERAL CONDITIONS

General Discharge Limitations

G1. No discharge of polychlorinated biphenyl compounds such as transformer fluid is permitted. There shall be no discharge of water treatment chemicals which contain the priority pollutants listed in 40 CFR, Part 122, Appendix D, Tables II, III, and V. The discharge of water treatment additives which were 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 untreated water supply, (2) entrained from the atmosphere, or (3) quantitatively identified in the permit application; except as modified or limited by the special or general conditions of this permit. However, the effluent concentrations in the permittee's waste water shall be determined on a gross basis and the effluent limitations in this permit mean gross concentrations and not net additions 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. Permittee shall notify the Council no later than 120 days before the date of anticipated first discharge from Outfall 001 under this permit.

G4. Notwithstanding any other condition of this permit, the permittee shall not discharge any effluent which shall cause a violation of State of Washington Water Quality Standards, as they exist now or hereafter are amended, at the edge of the applicable dilution zone.

G5. Notwithstanding any other condition of this permit, permittee shall handle and dispose of all solid waste material from plant operations including settled silts, sludges and any other source in such a manner as to prevent any pollution of ground or surface water. Prior to the production of nonradioactive solid wastes, the permittee shall obtain Council

approval of the proposed method of handling and disposing of solid wastes. The disposal of radioactive solid wastes shall be in accordance with the facility operating license issued by the NRC.

Operation/Maintenance Provisions

G6. The permittee shall provide an adequate staff which is qualified and shall carry out the operation, maintenance, testing and reporting activities required to ensure compliance with the conditions of this permit. The permittee shall at all times properly operate and maintain all treatment and control facilities or systems which are installed or used to achieve compliance with the conditions of this permit.

G7. The permittee shall, upon failure of the treatment or control facilities, control production or reduce discharges or, alternatively, employ back-up or auxiliary facilities as necessary to comply with the conditions of this permit.

G8. The intentional diversion of any discharge or bypass of any facilities utilized by the permittee to comply with the conditions of this permit is prohibited except:

(a) When the bypass does not cause effluent limitations to be exceeded and it is necessary to perform essential maintenance to assure efficient operation;

(b) Where the bypass was unavoidable to prevent loss of life or severe property damage; or

(c) Where excessive storm runoff (see Special Condition 2(A), Note (1)) would clearly damage any facilities necessary for compliance with the conditions of this permit.

Anticipated bypasses, other than those in (a) above, shall be reported to the Council as far in advance as possible for the Council's approval. Unanticipated bypasses shall be reported to the Council in accordance with the procedure specified in General Condition G9.

G9. If for any reason the permittee does not comply with, or will not be able to comply with, any effluent limitations specified in this permit, the permittee shall:

(a) Immediately take appropriate action to stop, contain and clean up the unauthorized discharge and correct the problem;

(b) Notify the Council within 24 hours of becoming aware of any noncompliance which may endanger health or the environment;

(c) Provide the Council with a written report of any noncompliance within five days of becoming aware of its occurrence. This submission shall contain a description of the noncompliance and its cause; the period of noncompliance, including dates and times, and if not corrected, the anticipated time the noncompliance is expected to continue; and steps being taken to reduce, eliminate, and prevent recurrence of the noncompliance.

Monitoring

G10. The results of monitoring required by Special Conditions S.1 and S.2 shall be summarized by month and reported quarterly on a Discharge Monitoring Report Form (EPA 3320-1), postmarked no later than the 28th day of the month following the end of the quarter. Duplicate signed copies of these and all other reports required herein shall be submitted to the Council, EPA and DOE at the following addresses:

U.S. EPA Region X
1200 6th Avenue
Seattle, WA 98101
Attn: Permits Branch
M/S 521

Dept. of Ecology
Attn: Industrial Waste Section
M/S PV-11
Olympia, WA 98504

EFSEC
Attn: Executive Secretary
Mail Stop PY-11
Olympia, WA 98504

G11. The permittee shall retain for a minimum of three years all records of monitoring activities and results, including all reports of recordings from continuous monitoring instrumentations, records of analyses performed, and calibration and maintenance of instrumentation. This period of retention shall be extended during the course of any unresolved litigation regarding the discharge of pollutants by the permittee or when requested by the Council.

G12. All samples and measurements required by Special Conditions S.1 and S.2 shall be representative of the monitored discharge and all analytical test procedures shall be approved under 40 CFR Part 136, unless other procedures are specified in this permit.

G13. The permittee shall record for such measurements of samples taken pursuant to the requirements of this permit the following information: (1) the date, place and time of sampling; (2) the dates the analyses were performed; (3) who performed the analyses; (4) the analytical techniques or methods used; and (5) the results of the analyses.

G14. As used in this permit, the following terms are as defined herein:

(a) The "daily maximum" discharge means the total pollutant discharge by weight during any calendar day and where specified, the maximum permissible pollutant concentration.

(b) The "daily average" discharge means the total discharge by weight, and where specified the average pollutant concentration, during a calendar month divided by the number of days in the month that the 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 collecting day.

(d) "Grab sample" is an individual sample collected in a time span of less than 15 minutes.

G15. Prior to the commencement of discharges from Outfall 001, the permittee shall initiate a program to monitor river flow and velocity and water quality. This program shall be submitted to the Council for review and approval sufficiently in advance of the commencement of discharges. Modifications to the program shall be subject to the Council's approval.

Administrative Requirements and Other Provisions

G16. Whenever a facility expansion, associated construction operation, production increase, or process modification is anticipated which will result in a new or increased discharge or which will cause any of the conditions of this permit to be

exceeded, appropriate notification must be submitted to the Council with reports and engineering plans for the proposed changes. The Council may, in addition, require submittal of an updated permit application. No such change shall be made until plans have been approved and a new permit or permit modification has been issued. If such changes will not violate the effluent limitations specified in this permit, permittee shall notify the Council of such changes prior to such facility expansion, production increase, or process modification.

G17. If a toxic effluent standard or prohibition (including any schedule of compliance specified in such effluent standard or prohibition) is established under state law or under Section 307(a) of the Federal Act for a toxic pollutant which is present in the permittee's discharge and such standard or prohibition is more stringent than any limitation upon such pollutant in this permit, this permit shall be revised or modified in accordance with the toxic effluent standard or prohibition and the permittee shall be so notified.

G18. Except for data determined confidential under Section 308 of the Federal Act, all reports prepared in accordance with the terms of this permit shall be available for public inspection at the office of the Council and the Regional Administrator. As required by the Federal Act, effluent data shall not be considered confidential. Knowingly making a false statement on any such report may result in the imposition of criminal penalties as provided in Section 309 of the Federal Act.

G19. After notice and opportunity for a hearing, this permit may be modified, suspended, or revoked in whole or in part duirng its term for cause, including, but not limited to, the following:

(a) Violation of any terms or conditions of this permit;

(b) Obtaining this permit by misrepresentation or failure to disclose fully all relevant facts;

(c) A change in conditions of the receiving waters that requires either a temporary or permanent reduction or elimination of the authorized discharge;

(d) If any provision of this permit is declared invalid by the courts.

G20. The permittee shall, at all reasonable times, allow authorized representatives of the Council upon the presentation of credentials:

(a) To enter upon the permittee's premises for the purposes of inspecting and investigating conditions relating to the pollution of, or possible pollution of, any of the waters of the State, or for the purpose of investigating compliance with any of the terms of this permit;

(b) To have access to and copy any records required to be kept under the terms and conditions of this permit;

(c) To inspect any monitoring equipment or monitoring method required by this permit; or

(d) To sample any discharge of pollutants.

G21. Nothing in this permit shall be construed as excusing the permittee from compliance with any applicable Federal, State, or local statutes, ordinances, or regulations.

G22. 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 the subject.

G23. In addition to the conditions of this permit, the Council may require adherence to appropriate standards of practice and performance committed to by the permittee in the course of hearings on this matter.

G24. Prior to the on-site storage of oil and hazardous waste materials, the permittee shall obtain Council approval of a spill prevention containment and counter-measure plan which shall include:

(a) A description of the reporting system which will be used to alert responsible facility management and appropriate legal authorities;

(b) A description of preventive facilities (including overall facility plot) which prevent, contain, or treat spills and unplanned discharges and a compliance schedule to install any necessary facilities in accordance with the approved plan;

(c) A list of all hazardous materials used, processed, or stored at the facility which may be spilled directly or indirectly into state waters.

Submittal of this plan in accordance with this requirement does not relieve the permittee from compliance with, nor ensure compliance with, the Federal spill prevention requirement

contained in 40 CFR Part 112. Oil Spill Prevention Containment and Counter-Measure Plans prepared in accordance with the above federal requirement may be used in partial fulfillment of this permit requirement.

G25. The permittee shall notify and afford the Council reasonable opportunity to review and comment on completed design drawings, specifications, and operational procedures for facilities including, but no limited to, the following:

(a) Liquid radioactive waste discharge prevention;

(b) Sanitary sewage treatment;

(c) Low volume waste treatment, including frequency of discharges;

(d) Construction run-off ponds;

(e) Outfalls and diffusers;

(f) River flow measuring stations and tidal effect measuring stations;

(g) Metal cleaning waste discharges;

(h) Water composition and condition stations.

The Council reserves the right to reject any drawing or procedural manuals for failure to conform to conditions stated in this permit. The Council further reserves the right to require amendments to any drawings or procedural manuals to produce conformance with conditions stated in this permit. Nothing contained herein shall be construed to relieve permittee from any liability arising from deficiencies or omissions in drawings, specifications, or operating procedures.

G26. The permittee shall initiate actions and implement measures necessary to eliminate surface runoff problems threatening to cause discharge of pollutants in quantities or concentrations greater than those authorized by this permit. Prior to the commencement of activities which could result in the discharge of suspended solids the permittee shall submit sedimentation and erosion control plans to the Council for review and approval. The Council will assure that best management practices are being applied and may impose discharge limitations as appropriate. Permittee must promptly notify the Council of problems in erosion control.

Special Studies

G27. Within 14 months after the startup of each unit, permittee shall conduct special studies directed toward determining the temperature and levels and forms of copper and zinc in the receiving water both inside and outside the dilution zone during critical low flow periods as may be approved by the Council.

G28. Studies shall be commenced as soon as practicable and as may be approved by the Council to determine the background levels of heavy metals in the Chehalis River.

Matters to be considered should include, but may not be limited to, the following: sampling should occur once a week for fifty-two weeks, commencing from the taking of first samples. Sampling should occur at least in the following areas: the diffuser site, upstream immediately above the confluence of the Satsop River, and downstream in the intake area. Analysis should be by heated graphite tube method of atomic absorption. No concentration of samples will occur and analysis in each instance shall be direct. Sampling should occur for each constituent metal limited by this permit.

G29. Thorough bioassays, as may be approved by the Council, shall be commenced as soon as practicable to determine sensitivities of resident salmonids to potential toxicants in the effluent, specifically, copper and zinc. Matters to be considerd should include, but may not be limited to, the following:

The bioassays should conform as closely as possible to the procedures set out in Standard Methods for the Examination of Water and Wastewater. Specifically, the bioassays should use nonaerated continuous flow sampling of sensitive resident salmonids, using measured amounts of toxicants with strict laboratory controls. The bioassays should be performed on-site and use Chehalis River water as the test medium. A complete record of water quality, particularly pH, hardness, and alkalinity, should be kept for each replicate. A 96-hour LC50 should be reported for each species tested. The incipient lethal threshold should be established for each species tested. Long-term exposures, at least 60 days, should be tested. Sublethal effects should be studied and assessed. An in-stream "no effect" level should be estimated for each species tested. Species chosen should be within the meaning of "sensitive resident species" as that term is used in the EPA Redbook. Wherever possible, strains and families for the Chehalis System should be used for test purposes. There should be assessment of additive and synergistic effects of

toxicants at varying seasonal river temperatures . Various life stages should be studied, if practical, and some effort to assess the sublethal effects of the toxicants on migrating adult salmon should be attempted. The toxicants to be tested should be zinc and copper.

APPENDIX H

LETTER FROM STATE OFFICE OF
ARCHAEOLOGY AND HISTORIC PRESERVATION

JOHN SPELLMAN
Governor

JACOB THOMAS
Director

STATE OF WASHINGTON
OFFICE OF ARCHAEOLOGY AND HISTORIC PRESERVATION
111 West Twenty-First Avenue, KL-11 • Olympia, Washington 98504 • (206) 753-4011

September 29, 1983

Mr. George W. Knighton, Chief
Licensing Branch #3
Division of Licensing
Office of Nuclear Reactor Regulation
Nuclear Regulatory Commission
Washington, D.C. 20555

Log Reference: 449-F-NRC-01

Re: Washington Public Power Supply System Nuclear Project 3 (WNP-3)

Dear Mr. Knighton:

We have reviewed the materials forwarded to us for the above referenced project. Based on the information provided for our review, in our opinion the proposed project will have no effect on known cultural resources included in or eligible for inclusion in the National Register of Historic Places.

Please feel free to contact us if we can be of any further assistance.

Sincerely,

Robert G. Whitlam, Ph.D.
Archaeologist

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*U.S. GOVERNMENT PRINTING OFFICE: 1985-461-721:20101

NRC FORM 335 (2-84) NRCM 1102, 3201, 3202 — U.S. NUCLEAR REGULATORY COMMISSION — **BIBLIOGRAPHIC DATA SHEET** — SEE INSTRUCTIONS ON THE REVERSE	1. REPORT NUMBER (Assigned by TIDC, add Vol. No., if any): NUREG-1033 FES
2. TITLE AND SUBTITLE: Final Environmental Statement related to the operation of WPPSS Nuclear Project No. 3	3. LEAVE BLANK
	4. DATE REPORT COMPLETED — MONTH: May — YEAR: 1985
5. AUTHOR(S)	6. DATE REPORT ISSUED — MONTH: May — YEAR: 1985
7. PERFORMING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code): Division of Licensing, Office of Nuclear Reactor Regulation, U.S. Nuclear Regulatory Commission, Washington, D.C. 20555	8. PROJECT/TASK/WORK UNIT NUMBER
	9. FIN OR GRANT NUMBER
10. SPONSORING ORGANIZATION NAME AND MAILING ADDRESS (Include Zip Code): Same as 7. above	11a. TYPE OF REPORT: Final Environmental Statement
	b. PERIOD COVERED (Inclusive dates)
12. SUPPLEMENTARY NOTES: Docket No. 50-508	

13. ABSTRACT (200 words or less)

The Final Environmental Statement related to the operation of Washington Nuclear Project No. 3 by Washington Public Power Supply System, et al (Docket No. 50-508), located in Grays Harbor County, Washington, has been prepared by the Office of Nuclear Reactor Regulation of the U.S. Nuclear Regulatory Commission. This statement reports on the staff's review of the impact of operation of the plant. Also included are comments of state and federal governments, local agencies and members of the public on the Draft Environmental Statement for this project and staff responses to these comments. The NRC staff has concluded, based on a weighing of environmental, technical and other factors, that an operating license could be granted.

14. DOCUMENT ANALYSIS – a. KEYWORDS/DESCRIPTORS	15. AVAILABILITY STATEMENT: Unlimited
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