UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the Matter of PUGET SOUND POWER & LIGHT COMPANY, *ET AL.* (Skag t Nuclear Power Project, Units 1 and 2)	Docket Nos. STN 50-522 STN 50-523

NRC STAFF SUPPLEMENTAL TESTIMONY ON ALTERNATIVE SITE COMPARISON

by

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TABLE OF CONTENTS

TABLE OF CONTENTS

PAGE

502 019

TABLE OF CONTENTS

502 020

This supplemental testimony presents the results of additional staff analysis of the applicant's site selection process and provides a comparison requested by the Atomic Safety and Licensing Board (ASLB), in its order dated April 10, 1979, "between sites located east of the Cascade Mountains with those west of the Cascade Mountains from the standpoint of geology, seismology, transmission problems, environmental impacts, and construction and operation costs, including those costs associated with the foregoing factors."

1 THE APPLICANT'S SITE SELECTION PROCESS

In light of an Atomic Safety and Licensing Appeal Board decision (ALAB-479) directing the NRC staff to "take a hard look" at another applicant's selection of the site for Pilgrim Nuclear Plant Unit 2 in Massachusetts, we decided to reexamine the process by which the Skagit site was selected. In Section 9.2 of the NRC Final Environmental Statement (FES) on the Skagit Project[20] and subsequent testimony before the ASLB, the staff has summarized the applicant's site screening studies, compared the final three candidate sites (Goshen, Ryderwood and Skagit), and concurred with the applicant's choice of the Skagit site. Our principal objective in reexamining the selection process was to confirm that the three candidate sites are among the best that could reasonably be found and that no sites obviously superior to the Skagit site are likely to be found within the region of interest.

1.1 THE REGION OF INTEREST

The applicant's selection of the proposed site in the Skagit River Valley, approximately 64 miles north of Seattle, was the result of an evolutionary process which began in 1966 with two studies performed for Puget Sound Power & Light Company by the Bechtel Corporation.[42, 43] In general, the geographic scope of both studies was Puget's service territory. As shown on Figure 9.1 of the FES (reproduced on the next page), Puget's service territory is adjacent to the Puget Sound and extends toward central Washington, but does not include Snohomish County, Seattle and Tacoma.

In 1970, the region of interest was expanded appreciably when the cities of Seattle and Tacoma, and Public Utility District No. 1 of Snohomish County joined with Puget in sponsoring a more comprehensive study by Bechtel to aid in the initial selection of thermal power plant site locations in the state of Washington.[24] The region surveyed was the western Washington area generally bounded by the Canadian Border, the Pacific Ocean, and the Cowlitz River, except that it also included the Hanford area in central Washington. Essentially all of the service areas of the sponsoring utilities were included in the study area.

No further changes in the region of interest occurred when different utility organizations - Portland General Electric Company (PGE), Pacific Power and Light Company (PP&L), and the Washington Water Power Company (WWP) - became participants in the Skagit Project. The reason why no further changes were made in the region of interest was probably due to the fact that the sponsoring utility (Puget Power) had found several promising site areas in western Washington and at least tentatively decided on the Skagit location. It should also be noted that construction of additional thermal power generation for the western Oregon area was being considered during the same time period and this resulted in the proposed Pebble Springs Nuclear Plant, with PGE as the sponsor. Puget, PGE and PP&L are the largest participants in both projects.

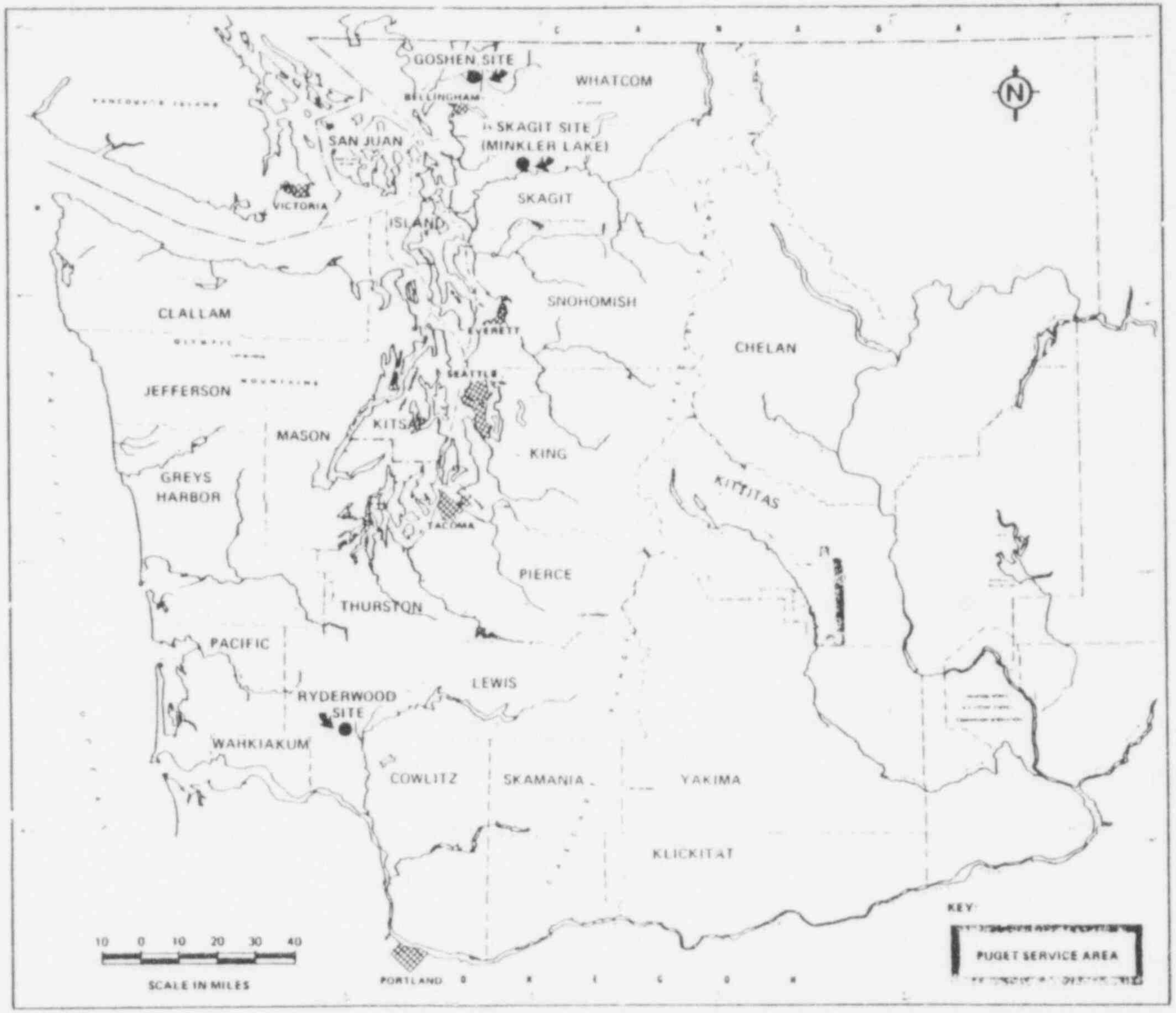

Fig. 9.1. Alternative Sites Considered by the Applicant. From ER, Fig. 9.2.1.

502 023

The staff has estimated that approximately 40% of the combined loads of the four participating utilities is west of the Cascade Mountains and 12% east of the mountains in Washington, while 42% is in western Oregon and 6% is in eastern Oregon. Thus, about 82% of the participants' load is west of the Cascades. For the entire West Group Area of the Northwest Power Pool, approximately 75% of its entire load is estimated to be west of the Cascades.[21] On the other hand, the largest share of the power generating resources is in hydroelectric facilities east of the mountains. This situation represents a substantial imbalance of resources vs. demand within the area west of the Cascades and has required the development of extensive transmission facilities to convey electricity through the mountains to the Puget Sound, Portland and Willamette Valley (Oregon) load centers.

Locating new generating plants near the load centers rather than remote areas reduces the losses incurred in transmission and reduces the amount of transmission capacity that would otherwise be needed. Reliability can also be enhanced by locating new plants near load centers.[21] For these reasons, the utilities involved in the Hydro-Thermal Program of the Pacific Northwest (FES Section 8.1.2.4) have planned to construct most of the nuclear plants near the western load centers. The locations of the Washington Public Power System Nuclear Project Units 3 and 5 near Satsop, Washington, and the Trojan Nuclear Plant near Portland, Oregon, are consistent with this objective. The Centralia coal-fired power plant is also in western Washington.

Even with the Centralia, Trojan and Satsop plants in operation, the generating capacity will be substantially less than demand in the Puget Sound load area. In his testimony before the ASLB on July 8, 1976, Mr. Knight of Puget Power presented data from the 1976 West Group Forecast (follows Tr.6018) which indicates a 1986-87 generation deficiency for this area of 6,273 Mw without the Skagit Project, or 3,697 Mw if both Skagit units are available (the staff is aware that more recent forecasts indicate a slightly reduced demand in 1986-87, but the generation deficiency would still be about 6,000 Mw without the Skagit units). Mr. Ferguson of Puget Power, in his testimony on the same date (follows Tr.6012), stated that the Skagit units are intended to help reduce the grossly unbalanced loads vs. resources condition that presently exists in the western Washington load center area, particularly in the region from Seattle north to the Canadian Border, where this situation is most critical.

Although the power transmission grid throughout the Northwest is designed to be very reliable and there is no reason to believe it will be less so in the future,[44] the western Washington area is heavily dependent upon cross-mountain transmission lines for supply of electricity. These lines are sensitive to natural and man-made disasters which can cause system outages.[45] With the plant located on the west side of the mountains, the cross-Cascade transmission lines to the area would be less heavily loaded. This would result in greater reserve transmission capacity, which would reduce the likelihood of having to trip or curtail load under outages conditions. If load tripping or curtailment are required, its magnitude would be significantly less than if the plant is located away from the load area.[44]

Considering the generation deficiency of the Puget Sound area and its dependence on cross-mountain transmission lines, the relatively low losses involved with a load-center plant location, and potential reductions in additional transmission capacity that eventually might be needed, it would be desirable from a system planning standpoint to locate the Skagit facilities in western Washington. As shown in Plate 1 of the 1970 Bechtel study,[24] this region encompasses a great variety of water and land resources which should offer an adequate number of candidate sites. The study did, in fact, identify 117 potential site areas and suggested 25 of those for further consideration. The staff therefore concludes that location of the Skagit Project in western Washington is justified from a system standpoint and that appropriate sites can be found within that region.

1.2 Identification of Potential Sites

The two 1966 Bechtel studies[42, 43] were oriented to finding sites in the Puget Power service territory which might be suitable for a large nuclear power plant. The nominal size was 2,000 MW. Sites which were suitable for once-through cooling of the turbine steam condensers were preferred because of lower costs for cooling but inland sites, which might require cooling towers, were also considered. Potential sites were identified from a map study looking for locations providing a 1/2 to 3/4-mile exclusion radius, 50 acres of flat land near water, and adequate water (minimum of 2,000 cfs for once-through cooling a 1,000 Mw unit). Scenic and recreational areas and large populations were avoided.

After screening with the above considerations and ruling out sites with "obviously" bad conditions for cooling system development costs and recirculation, 24 sites remained which were considered acceptable. These were compared primarily in terms of safety considerations and cost factors, but public acceptance was also considered. Cherry Point near Bellingham was found to be superior to the others and five were ranked second best: Drayton Harbor, Similk Beach and Turners Bay in the north part of Puget Sound and Hammersley Inlet and Percadia in the south. All six recommended sites were regarded as suitable for once-through cooling.

The purpose of the 1970 Bechtel study[24] was to identify an additional 10 to 20 promising site areas in western Washington and the Hanford area for fossil-fired units in multiples of 500 Mw or nuclear units in multiples of 1000 Mw. A total of 58 areas were picked from previous siting studies, including the 24 found acceptable in 1966. Among these 58 were 4 - Cherry Point, Kiket Island, Roosevelt Beach Beach and Samish Island - which were not evaluated further since they were under consideration by various utilities for plant sites. Bechtel identified an additional 59 site areas, each consisting of about 6 square miles with the idea that within the area there would be one or more preferred locations. Selecting the site areas involved a detailed study of the topogrography of the region and a systematic screening, using overlay maps (Plates 1 through 7 of the 1970 Bechtel report[24]) for population density, transportation systems, land use, transmission networks, seismicity, water resources and surface geology. (A copy of Plate 7 is on the next page).

Areas generally excluded from consideration were national forests, parks and preserves, recreation and urban areas. Although the Skagit River was a designated study river under the National Wild and Scenic Rivers Act, several site areas along the river were selected, apparently on the basis that the proposal had not been implemented thus far. Land use and its ownership, population density, public acceptance, and seismic requirements for nuclear siting were considered to be the most important factors in initial site area selection.

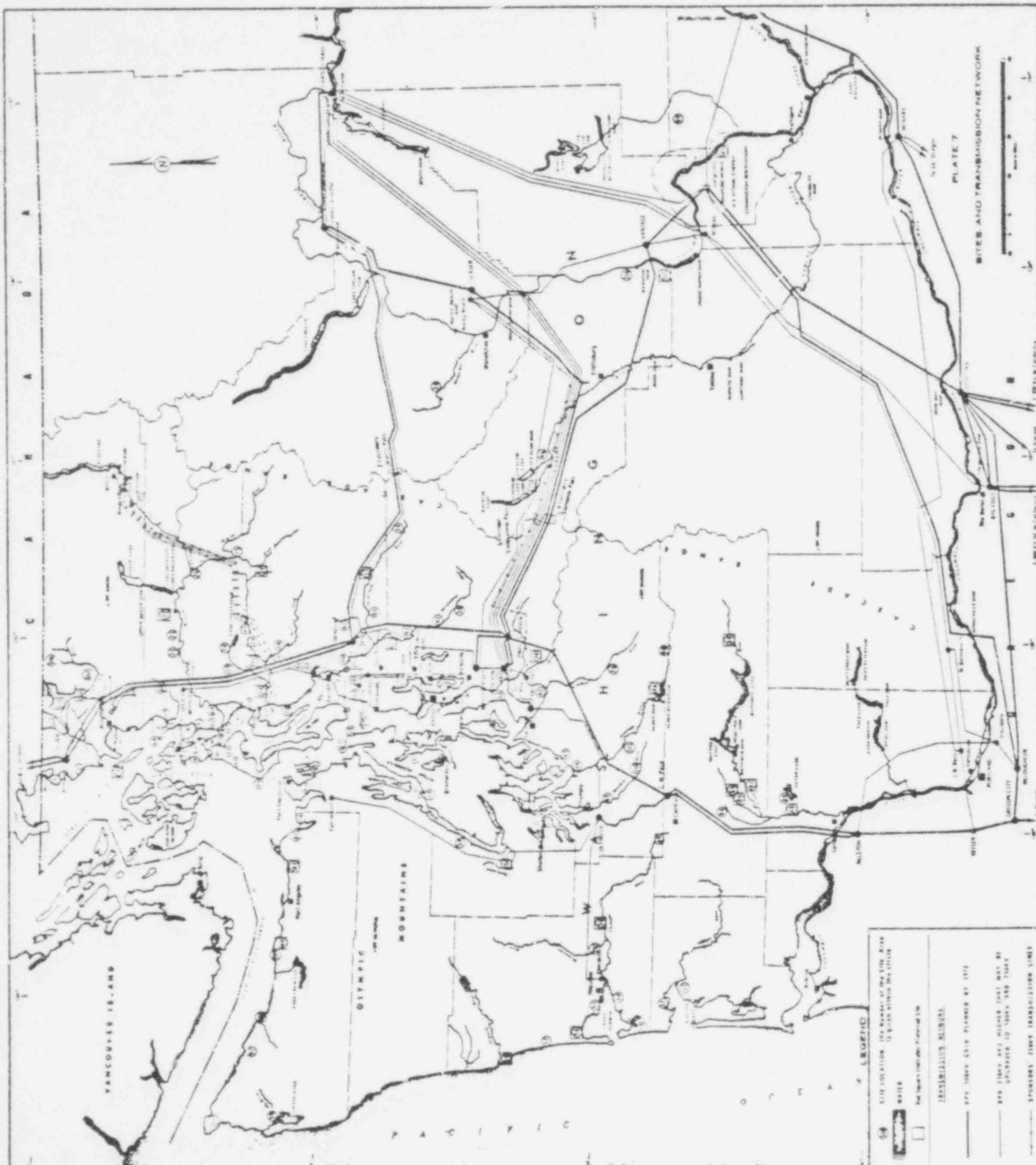
PLATE 7
SITES AND TRANSMISSION NETWORK
VANCOUVER ISLAND
OLYMPIC MOUNTAINS
PACIFIC
LEGEND

502 028

Almost of equal importance was transmission, inasmuch as its effect on the environment, its reliability, the need for public acceptance and its considerable costs, were considered major factors. Other factors such as cooling water availability, foundations, topography, access and labor availability were all considered to be of less significance for initial site area selection.

Seismology was generally assessed using a map of seismic probability; known and inferred faults and earthquakes were taken into consideration. Sites were not eliminated if within five miles of indicated faults or historical epicenters, but were indicated for detailed study of the effects on plant design. Available surficial geology information was used to generalize a map (Plate 2) indicating foundation suitability. The map includes two categories, essentially one with more bedrock and some alluvial deposits, and another with more alluvial and other deposits but some bedrock.

Cooling water was to be taken from coastal or lake waters, or streams having at least 500 cfs average annual flow (deemed sufficient for cooling towers or a cooling pond for at least one 500 MW fossil-fueled plant). State water quality standards were also taken into consideration.

In evaluating topography, the Bechtel study team looked for reasonably level land of approximately one square mile as providing area for development of a cooling pond, coal storage area or multi-unit development. Accessibility via water, highways and railroad was also evaluated. Information on land use within 25 miles of each site was assessed and potential benefits from plant development were noted, as required by state guidelines.

A table in the report summarizes the cooling system options, beneficiation potential (irrigation, recreation, etc.) and anticipated constraints for a plant at each of the 117 sites. The constraints considered were land use, population proximity, topography/meteorology, transmission, transport, site development, seismic and foundation design, labor availability and cooling water system design.

The evaluation appears to have been understandably concerned with site impacts on plant development. Ecological considerations, where mentioned, seem to have been translated into public acceptance problems. However, related factors such as effects on water quality and land use were involved in selection of the preferred areas.

The 117 site areas were classified into 16 regions which are characterized broadly in the report. One region, the Hood Canal/Skokomish River Valley, was not considered promising due to water quality, potential public opposition and unsuitable topography. Each of the 16 regions except the Hood Canal/Skokomish River Valley contributed at least one site to a total list of 25 most preferred site areas. Four of these (Duvall, White River, North Bay, Goshen) were regarded as suitable for fossil-fueled plants only but upon subsequent examination, Goshen was also regarded as suitable for nuclear. Sites east of the Cascade Mountains were considered undesirable because of the costs of transmission and problems with reliability; however, two were retained due to perceived strong public interest in siting plants at Hanford. A list of the preferred sites is on the following page. These sites are also identified on Plate 7 of the 1970 Bechtel report by a numbered circle within a red square.

TABLE 2.3-1

SITE AREAS RECOMMENDED FOR FURTHER ANALYSIS

GROUP 1 The Thirteen Most Preferred Site Areas

Site Area No.	Name	Location	Possible Suitability to be confirmed
22	Duvall	Snoqualmie R.	Fossil
23	Easton	Yakima R.	Nuclear or fossil
24	White River	White R.	Fossil
28	Florence	Stillaguamish R.	Nuclear or fossil
29	Darrington	Stillaguamish R.	Nuclear or fossil
33	Gold Bar	Skykomish R.	Nuclear or fossil
46	Alder	Nisqually R.	Nuclear or fossil
72	Concrete	Skagit R.	Nuclear or fossil
77	Trafton	Stillaguamish R.	Nuclear or fossil
87	Layton Prairie	Cowlitz R.	Nuclear or fossil
100	Manchester	Puget Sound	Fossil, single unit
104	Sumas	Nooksack R.	Fossil
113	Marrowstone	Puget Sound	Fossil, single unit

GROUP 2 The Twelve Next Most Preferred Site Areas

Site Area No.	Name	Location	Possible Suitability to be confirmed
3	Lummi Island	Strait of Georgia	Nuclear or fossil
47	Ringold Flat	Columbia R. (Hanford)	Nuclear or fossil
48	Castle Rock	Cowlitz R.	Nuclear or fossil
50	Satsop	Chehalis R.	Nuclear or fossil
56	North Bay	Grays Harbor	Fossil
58	Taholah	Pacific Coast	Nuclear or fossil
60	Freshwater Bay	Juan De Fuca	Nuclear or fossil
61	Agnew	Juan De Fuca	Nuclear or fossil
85	Lacamas Prairie	Cowlitz R.	Nuclear or fossil
89	Randle	Cowlitz R.	Nuclear or fossil
108	Goshen	Nooksack R.	Fossil
117	Hanson Creek	Columbia R.	Nuclear or fossil

502 031

1.3 Selection of Candidate Sites

The 1970 siting study led to the conclusion that the Skagit, Nooksack and Cowlitz River regions were among the most promising and that a more detailed review of selected site areas and a search for additional site areas in these regions was warranted. This conclusion was based on the judgment of Puget and Bechtel personnel.[46] As stated in the FES (p.9-4), lake sites were excluded from further consideration because the state water quality requirements now prohibit their use and coastal sites were excluded because public acceptance would be unlikely. As Puget verified that certain sites were suitable for a fossil-fired plant, but not a nuclear plant, they were also omitted. In January 1972, Bechtel completed a reevaluation of the potential sites in the three regions selected by Puget, taking into account AEC criteria on site suitability and the guidelines of Washington state authorities.[50] This study[47] identified 8 sites: Goshen on the Nooksack River; Minkler Lake (Skagit) and Lake Shannon in the Skagit River area; and 5 sites in the Cowlitz River area -- Lacamas Prairie, and Barnes Park. Minkler Lake was preferred over Lake Shannon if diversion of water from the Skagit River is feasible. The costs of rail and road access for Lake Shannon would be greater and public opposition was expected to construction of a 500 kV transmission line in the valley which would parallel and be close to State Highway 20 for several miles.

Puget concluded[47] that the Skagit site was the most promising of the 8 sites and, after a detailed geological/seismological evaluation program at the site, announced the Skagit Project in January 1973. Because of a delay in obtaining zoning approval from Skagit County, a geological reconnaissance was made in 1973[48] which identified an additional site at Ryderwood as the most promising site in the Cowlitz River area. Skagit (Minkler Lake), Goshen and Ryderwood were thus selected as the three candidate site areas which are described in the Applicant's Environmental Report.[51]

1.4 Staff's Review of the Selection Process

The staff regards the applicant's studies as sufficiently comprehensive that it seems unlikely that any potential sites in the region of interest have been overlooked which might be superior to the proposed site. We also concluded that the 25 preferred sites identified in the 1970 study present an adequate selection of the best sites that might be found, with the possible addition of the 4 additional sites that were identified as under study by various utilities.

Cherry Point, Site #2 in the 1970 study, was identified in the 1966 studies as a superior site with the feature of once-through cooling from Puget Sound. However, the railroad which owned it refused to sell the site and protracted litigation to acquire it would probably be necessary.[49] Anticipated difficulties in obtaining an exemption from regulations prohibiting once-through cooling of new thermal power plants and the existence of potential safety hazards from adjacent petroleum installations also influenced Puget to look elsewhere for a nuclear site. The staff agrees that these are good reasons not to consider Cherry Point further but we have done so in previous testimony at the ASLB's direction. Sites 25 (Kiket Island), 57 (Roosevelt Beach), and 64 (Samish Island) have not been developed either for nuclear plants. The staff therefore included these in a visit to many of the preferred site areas during the month of May 1979. These areas included: (1) the lower Chehalis River valley; (2) the Pacific Coast from north of Grays Harbor, south to the mouth of the Columbia River; (3) the northern side of the lower Columbia River; (4) the

Cowlitz River valley; (5) the Nisqually Reach of the southern part of Puget Sound and the Hood Canal; (6) the Strait of San Juan de Fuca; (7) the northern part of Puget Sound, including Admiralty Inlet, Skagit Bay, Padilla Bay, Samish Bay, Rosario Strait, and the Strait of Georgia; (8) the Nooksack River valley; (9) the Skagit River valley; (10) the Stillaguamish River valley; and (11) the Snohomish River valley.

All of the above-mentioned siting areas appear to have shortcomings, relative to Skagit, which would make the overall potential environmental impacts of construction and operation of a two-unit nuclear power plant in these areas greater than at Skagit. These shortcomings are with respect to several siting factors and include: water resources and aquatic ecology, transportation and transmission access, land use and terrestrial ecology, socioeconomic considerations, and public acceptance. Most of the sites are probably acceptable geologically, but none except for site 50 near Satsop appear to have geologic conditions which are equal to or better than Skagit.[3] Two of the sites, Duvall (#22) and Manchester (#100) have population densities above 500 per square mile.[52]

Although nuclear units are under construction at the Satsop site (WPPSS 3 and 5), land and water constraints on two more units make the site less desirable than Skagit. Both the low minimum flows of the Chehalis River and the high erosion potential of the region would exact greater environmental costs than the construction of two units at Skagit.

Other alternatives to Skagit exist in the lower Columbia River valley in Oregon,[1] but none are clearly preferrable to Skagit from an environmental point-of-view, and in some respect are less desirable than Skagit. The Trojan plant operated by P(is designed for one additional unit and space for expansion appears too limited to accommodate the Skagit units. The six other sites identified by PGE along the lower Columbia River have shortcomings with respect to aquatic ecology, terrestrial ecology, socioeconomic considerations, and foundations and flooding.

The staff concludes that Cherry Point, Skagit, Ryderwood, and Goshen adequately represent the range of environmental alternatives available and are among the best that can reasonably be found in the siting areas west of the Cascades. The staff recognizes, however, that additional alternatives may be found east of the Cascades, as discussed in Section 3 of this testimony.

1.5 Comparison of the Candidate Sites in Western Washington

Three candidate site areas -- Goshen, Ryderwood and Skagit -- were identified in the applicant's Environmental Report[51] and compared with regard to environmental, safety and site sensitive factors. The results of this comparison are summarized in Section 9.2 of the staff's Final Environmental Statement.[20] Based on its review of the applicant's analysis and information obtained during the site visit, the staff concluded that Skagit is the best choice of the three sites. That conclusion is essentially unchanged as a result of the staff's foregoing reexamination of the applicant's site selection process. We conclude that the applicant's three candidate sites are among the best that could be found in western Washington for the proposed nuclear power plant and that no obviously superior sites are likely to be available.

The Hanford area in central Washington and the Pebble Springs site near the Columbia River in central Oregon offer some advantages over Skagit in terms of potential environmental effects of constructing and operating a nuclear power plant. However, these advantages, as discussed in Section 8, would be offset by higher losses in transmission of electricity from Hanford or Pebble Springs to the load centers west of the Cascade Mountains, increased project costs due to relocation of the Skagit units, and the additional costs of replacement electrical energy during approximately 3 years of delay in bringing these generating units into commercial operation. Such a delay would be caused by the necessity for the applicant to obtain additional site specific information, make appropriate design changes, and obtain approvals from local, state, and federal authorities.

2.0 GEOLOGY, SEISMOLOGY AND GEOTECHNICAL ENGINEERING

Background and Summary

Section 2 of this testimony is an up-dated evaluation of geological features of the alternative sites and replaces that portion of the staff's testimony which was presented before the ASLB, pursuant to their request, on July 19, 1977 (following Tr. 7326).

This review addresses those geological, seismological and geotechnical engineering aspects considered by the Staff to be pertinent to the evaluation of the Skagit site and five alternate sites (Goshen, Ryderwood, Cherry Point, Pebble Springs, and the Hanford Reservation). The considered aspects include:

a) Depth to bedrock
b) Foundation material and competency
c) Extent of excavation
d) Liquefaction potential
e) Landslide potential
f) Faulting (including ability to date the faulting)
g) Volcanic hazard
h) Modified Mercalli Intensity

With the exception of Pebble Springs, which is in Oregon, all the sites are located in Washington State. The sources of the information used in this evaluation included published literature, maps, previous results of investigations for nuclear power plants, discussions with Puget Sound Power and Light Company, its consultants, and knowledgable individuals. The compilation of the Staff's siting aspects relative to each of the evaluated alternate sites is attached as Table 1. In addition to numerous visits to the Skagit site and near vicinity, the alternate sites (with the exception of Pebble Springs and the Hanford Reservation) were visited by Harold E. Lefevre during the week of January 29, 1979. The Pebble Springs and Hanford sites and vicinity were visited by another member of the Staff on several occasions during the review of those sites. Based upon presently available information, we find that there are no known geological, seismological or geotechnical reasons to preclude construction of a nuclear power plant at any of the six sites. The statements incorporated into this report relative to the Skagit site are based upon all data available to the Staff as of March, 1978. Since then, extensive geological and geophysical investigations have been conducted by the Skagit applicant (Puget Sound Power and Light Company) in the vicinity of the site. These investigations focus on the interpretation of possible nearby geological structure and the impact of the structure, if it exists, on site safety. The above information was received by the NRC on June 1, 1979. Pending completion of the Staff's review of the newly-submitted data, statements made in this report relative to the Skagit site are subject to revision.

Skagit

The Skagit site is located above the Skagit River on a bench behind Bacus Hill. Overburden thickness in the site area ranges from 0 to 50 feet in thickness. The overburden consists predominately of an assemblage of glacially-derived soils. Bedrock in the site area consists of Shuksan metamorphics (pre-Jurassic phyllites and schists) and sedimentary rocks (siltstones and sandstones with some shale and coal) of the Cretaceous-Paleocene Chuckanut formation (NRC, 1978). The reactor foundations will be in the competent Chuckanut formation. Zones of coals, shales, and shear zones 2 feet or greater in width measured horizontally on the exposed surfaces will be treated with dental concrete. To reach the required foundation depth in bedrock, moderate excavation will be required. Landslides in the plant vicinity are not expected to effect the plant Seismic Category I facilities. There is no potential for liquefaction at the site (NRC, 1977).

The Skagit site is situated on the eroded, steeply-dipping (50° or greater to the southwest) northeast limb of a syncline which plunges to the northwest. The syncline is expressed in the folded and refolded Cretaceous-Paleocene Chuckanut formation. The closest significant fault to the Skagit site is the Shuksan thrust located 2 to 3 miles southwest of the site. The fault is overlain by the Chuckanut formation which establishes the most recent movement as pre-Upper Cretaceous (Misch, 1966, Pl. 7-1). Thus, we consider this fault not capable. The Devils' Mountain Fault Zone is 13 miles southwest of the Skagit site. For the purpose of evaluating the Skagit site, we have considered this fault to be capable within the meaning of Appendix A to 10 CFR Part 100 (NRC, 1978).

Ashfall constitutes the most widely distributed volcanic hazard potentially impacting the site. The Skagit site is located 22 miles southwest of Mount Baker and 56 miles northwest of Glacier Peak. Due to the low explosive potential for Mount Baker (Crandell, 1976) the volcanic ash potential at the Skagit site was determined by superimposing the ash fall pattern from the explosive eruption of Mt. Katmai (Griggs, 1922) on Glacier Peak. Assuming this eruption at Glacier Peak an ashfall of approximately 3 inches would be expected at the Skagit site. The applicant has conservatively selected an ashfall of 6 inches and has designed the facilities for this condition (NRC, 1978).

The controlling earthquake in determining the ground motion for the Skagit site is a postulated event occurring in the subducted oceanic lithosphere at a depth of 50 km or greater, producing surface intensities of near MM VIII. Because of uncertainties in hypocentral location and in the attenuation of vertically traveling seismic energy, it is the conclusion of the NRC Staff that a reference acceleration of 0.35g used to scale Regulatory Guide 1.60 response spectra at 33 Hz will conservatively describe the ground motion from anticipated earthquake sources. Another potential source of significant, but less severe ground motion, would be an earthquake associated with the Devils' Mountain Fault Zone (Magnitude 6.0-6.5) at a distance of 13 miles (NRC, 1978).

Goshen

The Goshen site is located about four miles northeast of Bellingham on a bedrock structural high. Overburden, consisting of glacial drift, outwash, sand and gravels, and peat (Easterbrook, 1976b) is estimated to range between 0 to 20 feet in thickness. Bedrock (Huntingdon Formation) consists primarily of arkosic sandstone with shale, conglomerate, and minor coal seams of Eocene age (Miller and Misch, 1963, p. 170). The structure foundations could be founded on this rock. If so, liquefaction would not be possible. With the exception of immediately adjacent to the valley of Ten Mile Creek, slopes are stable under most natural conditions (Easterbrook, 1976a). It is likely that coal, if encountered within the foundation area, will require remedial treatment. To reach the required foundation depth in bedrock, moderate excavation (less than 30 ft) would most likely be required.

An anticlinal axis (the Goshen Anticline) passes through the site area, and trends generally N15°E (Vonheeder, 1975). The structure is asymmetrical, with dips of less than 5° on the eastern limb and dips of up to 12° on the west (Bechtel, 1973). The Boulder Creek Fault has been mapped approximately five miles east of the site, and has been inferred to extend within three miles northeast of the site (Miller and Misch, 1963, Fig. 1). According to Miller and Misch (1963, Fig. 2), the Boulder Creek Fault displaces beds of Devonian through Paleocene(?) age, but does not displace rocks of the overlying Huntingdon Formation of Eocene age thus suggesting no movement in about 37 million years. The fault displacement is apparently in excess of 5,000 feet. The fault length has not been determined (Miller and Misch, 1963, Fig. 1).

Approximately 17 miles west of the Goshen site, the offshore essentially east-west trending Northern San Juan Island Fault has been identified (PSAR, Skagit, Fig. 2G-14). The eastward projection of this fault, if coincident with the outline of the Bellingham Basin (Miller and Misch, 1963), would place the fault within four miles of the Goshen site. High resolution offshore seismic profiling has shown displacement on the Northern San Juan Island Fault in excess of hundreds of meters. The upward extent of fault displacement is not clearly defined, but apparently undisturbed sediments overlying the fault in some areas are at least 300 meters thick (NRC, 1978). Neither an age determination of the sediment overlying the fault nor the association, if any, of the Northern San Juan Island Fault with the Boulder Creek Fault or the Bellingahm Basin outline has been made by the Staff. Definition and delineation (if required) of the trace of both of these faults beneath the glacial drift onshore and offshore would be costly, time-consuming and possibly inconclusive. Absolute age determinations of the last movement on the Northern San Juan Island Fault would likewise be difficult.

The Goshen site is 25 miles northwest of Mount Baker and 72 miles northwest of Glacier Peak. Ashfall potential at the site from a postulated eruption at Glacier Peak, modeled after the Alaskan Mt. Katami eruption (Griggs, 1922) event, would be less than one inch. Crandell (1976) considers Mt. Baker to have a low explosion potential.

The largest historical earthquakes in the Goshen site vicinity are the January 11, 1909, and January 23, 1920, Intensity VII earthquakes. These events are estimated to have occurred at a distance of approximately 15 miles from the site. The regional earthquake intensity for seismic design consideration would be MM VIII. The design ground motion for this site has not been

502 042

determined and would require consideration of the site specific geologic and seismic factors and regional tectonic structure.

Ryderwood

The Ryderwood site is located on Cougar Flat along Washington Highway 506, between Ryderwood and Vader, Lewis County. The site area is underlain by sedimentary rocks of the Stillwater Creek member of the Cowlitz formation of Upper Eocene age (Henriksen, 1956). These rocks consist primarily of soft, poorly-cemented siltstone, and silty, fine-grained sandstone, with some soft shale. Based on numerous outcrops, alluvial and residual soil cover in the area appears to be thin with rock generally expected to be within 20 feet of ground surface. Liquefaction would not constitute a potential hazard since Seismic Category I structures can be founded on bedrock. Although landsliding has occurred in the region, the site is within an area of low landslide incidence (Weigel and Foxworthy, 1958).

The primary structural features in the area are small folds related to the Willapa Hills Anticline (Henriksen, 1956). The axis of the North Branch of the Willapa Hills anticline is shown by Henriksen as passing through the site area, trending generally east-west. Minor folds are common in the area, and dips shown on Henriksen's map vary from 8° to 23° near the site. Strikes vary from north-south to nearly east-west. Field investigations by Henriksen indicate these represent minor, local flexures; the regional trend is northwest-southeast with a gentle easterly dip.

Henriksen (1956) has mapped faults in Eocene, Miocene and Oligocene bedrock in the vicinity of Ryderwood. According to Henriksen (1956, p. 100) structural features in the site area are the result of Tertiary deformation. On the other hand, Weigel and Foxworthy (1962, p. 44) indicate that faulting may have continued into the Pleistocene epoch, but can offer no evidence to support this suggestion. A northwest-southeast trending fault, about one-half mile south of the Ryderwood site area, is shown by Henriksen (1956, Plate 1) cutting both Eocene and Miocene formations. The relationship of this fault and others in the area nearby to widespread early Pleistocene deposits has not yet been demonstrated. The Crego Hills fault zone, approximately 5 miles long, is northwest of Winlock (7 miles northeast of the site area) and is described by Henriksen (p. 99) as a series of small, en echelon northwest-trending faults with a total displacement of probably less than 100 feet. If extended to the southeast, the closest approach of this zone to the site would be about 5 miles (Henriksen, Plate 1). Adequate definition and delineation of the above faults would most likely be possible, but time- consuming and costly due to paucity of rock and marker horizon exposures in the immediate site area.

The Ryderwood site area lies approximately 47 miles west of Mt. St. Helens, approximately 78 miles west of Mt. Adams, and approximately 65 miles southwest of Mt. Rainer. Of the three volcanoes in the site area, Mt. St. Helens is the closest and is regarded conservatively as high in relative explosiveness of eruptions. An eruption of Mt. St. Helens could result in an ashfall accumulation estimated to be two inches or less (Crandell, 1976).

The Ryderwood site is located approximately 50 miles from the largest historic Puget Sound earthquake (Intensity VIII). The regional earthquake intensity for seismic design consideration would be a MM VIII. The design ground motion for this site has not been determined and would include consideration of the site specific geologic and seismic factors and regional tectonic structures.

Cherry Point Site

The Cherry Point Site is located along the eastern shore of the Strait of Georgia. Glacial sediments, at least 400 feet thick, underlie the site (Hall and Othberg, 1974). The depth to bedrock is unknown. The glacial sediments are heterogeneous both laterally and vertically, and are considered less desirable as a foundation material than the bedrock foundations of the other alternate sites. The Seismic Category I structures could be founded in consolidated sediments. We believe these soils are sufficiently dense to preclude liquefaction (NRC, 1975). In order to reach the required foundation level deep excavating (approximately 60 feet) would be required. The site area slopes would be stable under most natural conditions (Easterbrook, 1976a).

The Cherry Point site is located in the Bellingham Basin (Miller and Misch, 1963, p. 171) but the thick soil cover obscures the bedrock structure underlying the proposed site. At least two major faults, the Boulder Creek Fault (Miller and Misch, 1963) and the Northern San Juan Island Fault (NRC, 1978) would require evaluation.

The Boulder Creek Fault, reportedly of Eocene age (at least 37 million years old), with greater than 5,000 feet of displacement may underlie or pass very close to the Cherry Point site. The trace of this fault is east-west where exposed approximately 20 miles directly east of the site. According to Misch (1963, p. 173) the Boulder Creek Fault displaces rock of Devonian through Paleocene (?) age (Miller and Misch, 1963, Figs. 2 and 3) but does not displace rocks of the Huntingdon Formation of late Eocene age. The westward extension of the Boulder Creek Fault is obscured by glacial debris reported to be at least 400 feet in thickness (Hall and Othberg, 1974).

The east-west trending Northern San Juan Island Fault of undefined length (PSAR, Skagit, Fig. 2G-14) has been identified north of the San Juan Islands by geophysical methods. Vertical displacement along this fault (located approximately five miles south of the Cherry Point site) is reportedly on the order of several thousand feet. The eastward projection of this fault across Lummi Bay has not been determined. No conclusive determination has been made of either the age of last movement of the fault or the age of the material directly overlying the fault. However, a mid-Tertiary age (at least 26 million years) has been suggested (PSAR, Skagit, p. 2G-12). Definition and delineation (if required) of the trace of each of these faults beneath the glacial drift onshore and offshore would be difficult, costly, time-consuming and possibly futile. Absolute age determinations of the last movement of the Northern San Juan Island Fault could likewise be difficult, perhaps inconclusive.

The Cherry Point site is 46 miles northwest of Mount Baker and 100 miles northwest of Glacier Peak. Ashfall potential at the site was conservatively estimated at less than one inch by superimposing the ashfall distribution pattern of Mt. Katmai, Alaska (Griggs, 1922) on Glacier Peak rather than Mt. Baker since Crandell (1976) considers Mt. Baker to have a low explosive potential.

The maximum historic earthquakes experienced within the Cherry Point site region were the January 11, 1909, and January 23, 1920, Intensity VII events at distances of approximately 10 miles. The regional earthquake intensity for seismic design consideration would be a MM VIII. The design ground motion for this site has not been determined and would include consideration of the site specific geologic and seismic considerations and regional tectonic structure.

Pebble Springs

The Pebble Springs site is located southeast of the town of Arlington, Oregon on a gently rolling plateau 400 feet above the Columbia River. Overburden at the site consists of 50 to 70 feet of glacio-fluvial deposits, and poorly indurated siltstone, sandstone and tuffs, underlain by 2000 to 3000 feet of Columbia River Basalts with sedimentary interbeds (NRC, 1976a). The massive or vesicular zones of the Pomona basalt flow, directly underlying the overburden, will contain the reactor foundation. Therefore, there is no liquefaction potential. Landsliding presents no hazard at the proposed plant location. In order to reach the required foundation levels, deep excavation will be required.

The nearest mapped fault to the Pebble Springs site is exposed 5 miles to the west along the south bank of the Columbia River. A projection of this fault to the south would pass 2-1/2 miles west of the site. There is no evidence that Quaternary deposits overlying the fault are offset. We do not consider the fault to be capable within the meaning of Appendix A to 10 CFR Part 100. There are no known faults in the immediate site vicinity that could cause surface displacement or localize earthquakes. The closest capable fault to the site is the active Rattlesnake-Wallula lineament at a distance of 55 miles to the northeast.

Unlike the Skagit site and several other alternate sites (Goshen, Ryderwood, and Cherry Point), Pebble Springs is located downwind, not upwind, of the Cascade volcanoes. Relevant volcanoes include Mt. Adams (78 miles to the northwest), Mt. Hood (80 miles to the west) and Mt. St. Helens (110 miles to the northwest). Accordingly, to estimate the site ashfall, an analysis was performed utilizing recent U. S. Geological Survey work regarding Mt. St. Helens coupled with the Alaskan Mt. Katmai ashfall rate. Based on the above conservative analysis, a total ashfall accumulation of 8.5 inches is predicted over a 24-hour period.

The largest historical earthquake to occur in the Pebble Springs site region was the Milton-Freewater Intensity VII earthquake of 1936. The controlling earthquakes in determining the ground motion for the Pebble Springs are (1) the maximum random earthquake in the site area region would not be greater than Intensity VIII and could result in that intensity at the site and (2) the

Rattlesnake-Wallula lineament represents the most significant seismically active structure, which has the potential of generating an Intensity VIII event, 55 miles from the site (NRC, 1976a).

Hanford Reservation (WPPSS 1, 2, and 4)

Three of Washington Public Power Supply Systems nuclear power plants (WPPSS 1, 2, and 4) are located on the Hanford Reservation approximately 3 miles west of the Columbia River. The units are approximately 12 miles north of Richland, Benton County, in southeastern central Washington. The three units are within an area identified as Ringold Flat, Site No. 47, in Bechtel, Inc.'s 1970 Thermal Power Plant Siting Study. The Bechtel study was prepared for a group of utilities in the Northwest, including Puget Sound Power and Light Company. The following Staff discussion applies only to the known conditions at Units 1, 2, and 4 and is based upon information gathered during our reviews of the WPPSS 1, 2, and 4 applications and not elsewhere within the Hanford Reservation. The site lies within the Pasco Basin, a local physiographic and structural depression in the Columbia Plateau, that comprises approximately 1600 square miles of undulating semi-arid plain with low-lying hills and dunes interrupted by intermittent streams. Overburden in the site areas consist of approximately 500 feet of glacio-fluvial deposits and the densely compacted Ringold Formation. The overburden is directly underlain by at least 5000 feet of Columbia River Basalts and sedimentary interbeds. The loose to medium dense glacio-fluvial sand (approximately 30 feet thick) overlying the Ringold formation generally cannot adequately support the reactor foundation. It must be removed and

and replaced with controlled, compacted structural backfill in order to avoid excessive settlement or liquefaction. The underlying Ringold Formation is sufficiently competent to provide support for the recompacted sand backfill and the overlying structures. The very dense and compacted nature of the foundation strata precludes liquefaction (NRC, 1975a). Due to the topography in the site area, landsliding presents no hazard at this site.

The nearest mapped fault to these sites is exposed about 10 miles northwest of the site on Gable Mountain (NRC, 1975a). Investigations of this fault by the USGS demonstrated that last movement on this fault occurred more than 40,000 years BP (Bingham et al., 1970).

Five of the six Washington-Northern Oregon Cascades volcanoes (Mt. Hood, Mt. Adams, Mt. St. Helens, Mt. Rainier, and Glacier Peak) are within 143 miles of the Hanford Reservation. The sixth volcano, Mt. Baker, is in northwestern Washington approximately 200 miles from the reservation. The nearest volcano with a high relative potential for explosiveness of eruption is Mt. St. Helens, about 138 miles west of the site (Crandell, 1976). Mt. Hood and Glacier Peak, also of high explosive potential, are 140 and 143 miles respectively from the Hanford Reservation. The distance of the site from the hazard source precludes volcanic hazards other than ash fall. Based upon Crandell's 1976 report, ash fall at the Hanford Reservation is estimated to be less than 2 inches.

The most significant major structure to be considered in determining the SSE is the Rattlesnake-Wallula Lineament. This topographic lineament trends northwest-southeast and is about 80 miles long. The lineament is a belt of en echelon, doubly-plunging anticlines comprising the Rattlesnake Hills anticline to the west and the Wallula Gap fault zone to the east. Faulting is associated with the Rattlesnake-Wallula Lineament, at Wallula Gap, in the Walla Walla Basin, and probably on the northeast flank of Rattlesnake Mountain. However, this structure does not appear to be continuously faulted along its entire length (NRC, 1975a).

The largest historical earthquake to occur in the region was the Milton-Freewater Intensity VII earthquake of 1936. The controlling earthquakes in determining the ground motion for the Hanford Reservation Sites WPPSS 1, 2, and 4 are (1) the maximum random earthquake in the site region which would not be greater than Intensity VIII and could result in that intensity at the site and (2) the Rattlesnake-Wallula lineament which represents the most significant seismically active structure, and has the potential of generating an Intensity VIII event (NRC, 1975a).

Conclusions

Each of the topics considered by the Staff to be relevant to the alternate site evaluation process from a geosciences standpoint has been discussed in the previous paragraphs. Based upon the Staff assessment of these topics, the following conclusions have been reached:

1) The Goshen, Cherry Point, and Ryderwood sites are considered less desirable than Skagit for the following reasons:

(a) The proximity of these sites to known or postulated faulting and

(b) possible or expected difficulty in dating the faults.

The definition and delineation of the trace of the Northern San Juan Island Fault in the Cherry Point and Goshen site regions would be costly and time-consuming due to the depth of overburden on land, the paucity of bedrock exposures, and the present offshore location of the detectable portion of the fault. With regard to delineation and definition of faulting within the Ryderwood site region, the costs would be considerable but probably less than at Cherry Point and Goshen primarily because of shallow bedrock and numerous rock exposures. The presence of widespread Early Quaternary deposits in the vicinity of Ryderwood should facilitate the age bracketing and definition of the extent of faulting. In the Goshen and Cherry Point regions, absolute age determinations of the last movement of the faults would likewise be difficult, perhaps inconclusive.

2) The competency of the proposed foundation material at the Ryderwood and Cherry Point sites is less desirable than the material at the Pebble Springs, Goshen, and Skagit sites.

3) The Skagit, Pebble Springs, and Hanford Reservation sites are considered essentially equal with the exception of the volcanic ash potential and the design ground motion as determined through extensive application reviews. With regard to the amount of volcanic ash to be considered in design, the Skagit site is considered to have an advantage over Pebble Springs. With respect to the design ground motion, the Pebble Springs and Hanford Reservation sites are considered to have an advantage over the Skagit site.

TABLE 1

Siting Factor	Skagit	Goshen	Ryderwood
Geology, Seismology & Geotechnical Engineering*			
Depth to Bedrock	10-50 ft.	6-30 ft.	0-20 ft.[b]
Foundation material and competency[a]	Sandstone, siltstone, conglomerate, coal seams: 3	Sandstone, conglomerate, siltstone, coal seams: 2	Siltstone, sandstone and shale: 4
Excavation	Moderate	Moderate	Shallow
Liquefaction Potential	None	None	None
Landslide Potential	Stable	Predominantly stable	Moderate
Faults	2-3 miles SW of site (noncapable)	3 miles to nearest fault (assumed noncapable). Another fault may project into the site area from the west.	Minor faulting zone 5 mi. from site; small fault within 0.5 mi; other faults possibly nearby.
Ease in dating the faults[c]	III	IV	II
Volcanic Ash Fall potential	3 inches	1 inch	2 inches
Earthquake Intensity Historic[d]	VII, 40 miles	VII, 15 miles	VIII, 50 miles
Regional Seismic Design Intensity	VIII, at site	VIII, at site	VIII, at site

[a] 1=Best, 6=Poorest
[b] Not able to verify
[c] I= Least difficult, V=Most difficult
[d] Epicentral distance from site

*Based on reconnaissance level data. Site specific information (with exception of Skagit, Pebble Springs, and Hanford Reservation) is not available and may change analysis.

TABLE 1 (Continued)

Siting Factor	Cherry Point	Pebble Springs	Hanford Reservation (Ringold Flat)
Geology, Seismology & Geotechnical Engineering*			
Depth to Bedrock	In excess of 400 ft.	50-70 ft.	Approximately 500 ft.
Foundation material and competency[a]	At least 60 feet of unconsolidated soil overlying consolidated dated soil at least 30 feet deep: 6	Basalt: 1	Ringold fm., gravels and compacted backfill: 5
Excavation	Deep	Deep	Deep
Liquefaction Potential	Little potential	None	None
Landslide Potential	Stable	None	None
Faults	Beyond five miles to nearest fault (assumed noncapable). Fault may project into site area from the west.	Exposed at 5 miles; projected to pass within 2-1/2 miles of the site (noncapable).	Gable Mt. fault; approx. 10 miles from site
Ease in dating the faults[c]	V	I	I
Volcanic Ash Fall potential	1 inch	8.5 inches	2 inches (approx.)
Earthquake Intensity Historic[d]	VII, 10 miles	VII, 42 miles	VII, varies depending upon site location on Hanford.
Regional Seismic Design Intensity	VIII, at site	VIII, at site	VIII, at site

[a] 1=Best, 6=Poorest
[b] Not able to verify
[c] I=Least difficult, V=Most difficult
[d] Epicentral distance from site

*Based on reconnaissance level data. Site specific information (with exception of Skagit, Pebble Springs, and Hanford Reservation) is not available and may change analysis.

502 055

SKAGIT NUCLEAR POWER PROJECT EVALUATION

OF ALTERNATE SITES

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3.0 ALTERNATIVES EAST OF THE CASCADES

The staff has chosen two sites in eastern Oregon and Washington as alternatives for comparison to the proposed Skagit nuclear plants. Potential nuclear sites identified by the applicant's studies and by studies conducted for other project participants are located along the mid and upper Columbia River, the upper Yakima River, and the Wenatchee River. Three of the sites, Easton and South Cle Elum on the Yakima River and Icicle Creek on the Wenatchee River, are on streams of low average annual flow (less than 70 m^3/s or 2500 cfs)[2] compared to other sites offered as alternatives in both eastern and western Washington. In addition, Easton may be seismically unacceptable.[3] Because impacts of plant operation on aquatic ecology and water use may be in part a function of the proportion of river flow modified by plant activities and because water storage facilities exact both aquatic and terrestrial environmental costs, the staff does not consider Easton, South Cle Elum, or Icicle Creek among the best sites the region has to offer, and thus they are not considered further as alternatives to Skagit.

Other eastern Washington sites identified by Bechtel Corporation for Puget Sound Power & Light Company (PSP&L) and the eastern Washington and Oregon sites identified by siting studies for PGE[1] share many regional similarities. All would withdraw water from the Columbia River, and all are located on the basalt plateaus and scablands. In the absence of reconnaissance-level site-specific information on some of these sites, the staff has no basis for concluding that they are preferable to sites within the Hanford Reservation and sites along the mid Columbia below McNary Dam which have been described in some detail by the sponsoring utilities and the staff.[4-6] Therefore, the

WPPSS 1, 2, and 4 sites have been chosen to represent Hanford sites along the upper Columbia River near Richland, Washington; and Pebble Springs has been chosen to represent the mid Columbia region below McNary Dam. The Boardman site is excluded from the analysis because the nearby naval bombing range precludes nuclear development of this site at this time. The staff concludes that the Hanford and Pebble Springs sites are among the best that could reasonably be found in the mid and upper Columbia.

3.1 SITING SCENARIOS FOR COMPARISONS OF EASTERN ALTERNATIVES TO SKAGIT

To compare Skagit with Hanford and Pebble Springs, it is necessary to analyze three scenarios based on different assumptions regarding the number of existing nuclear units at Hanford and Pebble Springs (Table 1). One scenario assumes that the development of the currently proposed two units at Pebble Springs would proceed as planned, and that the addition of Skagit's two units would bring the total at Pebble Springs to four units. Since, based on staff analysis, the Pebble Springs cooling lake could not accommodate the addition of two more units, it is assumed that mechanical-draft cooling towers using cooling lake water would be built for the two Skagit units. The second scenario assumes that Pebble Springs would proceed as planned with only two units, and that the Skagit units would be added to the existing three units at Hanford, bringing the total at Hanford to five units. The new units would use the same basic intake/discharge and mechanical-draft cooling-tower design as the existing three units. The third scenario, based on the present Oregon regulatory climate which may prohibit additional nuclear units in Oregon, assumes that for various reasons the Pebble Springs unit would be cited at Hanford. Thus, with the addition of the Skagit units, the total at Hanford would become seven units.

Table 1. Alternative Siting Scenarios

Site	Base Case (proposed by utilities)	Number of Units per Alternative Scenario		
		1	2	3
Hanford	3 existing units	3	3 + 2	5 + 2
Pebble Springs	2 new units	2 + 2	2	0
Skagit	2 new units	0	0	0

Additional transmission line construction necessary for the three alternative scenarios has been predicted by the Bonneville Power Administration (BPA) (see Appendix B). Facilities will be necessary to interconnect the plant with the BPA transmission grid at each of the three locations, but additional cross-Cascade lines will probably not be needed when these units are scheduled to begin operation. Location of the Skagit units at either Hanford or Pebble Springs is expected to accelerate the need for an additional cross-Cascade transmission line from about 1991 to 1989. The line would be about 200 miles in length, probably from the Hanford area to either the Puget Sound or the Portland area.[53.]

4.0 ENVIRONMENTAL DESCRIPTIONS OF EASTERN ALTERNATIVE SITES

4.1 HANFORD SITE

For the purposes of this review, the Hanford site is an area adjacent to the WPPSS 1, 2, and 4 sites on the west bank of the Columbia River near River Mile (RM) 353 within the Hanford Reservation near Richland, Benton County, Washington. The environmental characteristics of the site are assumed to be similar to the characteristics of the WPPSS sites which have been described in detail both by the sponsoring utility in the WPPSS 1 and 2 ERs[8-10] and by the NRC staff in the construction permit FES's for WPPSS 1, 2, and 4.[5,6]

4.1.1 Aquatic Description

Water use in the Hanford Reach* includes irrigation, industrial withdrawals, municipal water supplies, fish production, and recreation. The Hanford Reach has been proposed for inclusion under the Wild and Scenic Rivers Act, in large part because it represents the last unimpounded section of the Columbia River remaining above Bonneville Dam. Average annual discharge at Priest Rapids Dam is 3420 m^3/s (120,800 cfs), and minimum discharges are regulated to 1020 m^3/s. Surface withdrawals were estimated as 29.6 m^3/s (1044 cfs) in 1974. Operation of WPPSS 1, 2, and 4 might result in approximately 9.0 m^3/s (320 cfs) additional water withdrawal. Water quality in the Hanford Reach is regulated under a Class A-Excellent classification by the State of Washington which specifies standards for both chemical and thermal conditions in the river. Water temper-

*A reach is a section of river. The Hanford Reach is the section of the Columbia River between Priest Rapids Dam and Richland.

502 064

atures range from a winter low of 4°C (39°F) to an average of 18.7°C (66°F) in August. Temperatures are above the Class A limit (18°C or 64°F) and above the upper preferred temperature for salmonid species during short periods in the late summer. The thermal characteristics of fishes in the Columbia River have been extensively studied and are referenced in the ERs and FES's. Chemical characteristics of the river are also presented in both documents.

Important aquatic groups in the Hanford Reach include the periphyton, benthos, and fishes. Periphyton production supports a diverse, abundant community of aquatic insects dominated by caddisfly larvae and midge larvae. These benthic insects, in particular the caddisflies, are the major dietary items of young chinook salmon. The fish community is composed of both native and introduced species. Since the Hanford Reach is the only unimpounded section of the Columbia between Bonneville Dam and the U.S.-Canadian Border, it is one of the few remaining natural spawning habitats on the Columbia River for chinook salmon and steelhead trout. The fall chinook spawnings below Priest Rapids Dam and downstream near the Hanford site represent the Columbia's premier natural salmon run. Hatcheries at Priest Rapids Dam produce coho salmon, chinook slamon, and steelhead trout.

4.1.2 Terrestrial Ecology

The terrestrial ecology of the Hanford area has been described in numerous publications, including the ERs and construction permit FES's for WPPSS 1, 2, and 4; the applicant's response to NRC questions for the WPPSS 2 operating license EIS (8 December 1978, Q 6.15 and Q 6.19); Battelle Northwest Laboratories' progress reports on terrestrial ecology studies;[11,12] technical reports on the natural terrestrial communities;[13,14] and numerous reports and professional papers by scientists at Battelle Northwest. Following is a brief summary of the history and current status of the terrestrial ecology.

The sites are located on a flat plain in the lower Columbia basin in the rainshadow east of the Cascade Mountains. Due to the low elevation (140 m MSL), the climate is mild continental, with an average summer temperature of 23°C and an average winter temperature of 0°C. Precipitation averages only 16 cm/yr. The growing season of the natural vegetation begins with the onset of winter rains in October, and plant productivity reaches its maximum in the spring. In summer, the warm dry winds and variation in available soil moisture place a great moisture stress on vegetation, leading to a large difference in vegetative productivity from year to year.

Soils are formed from the Pasco glacial-fluvial gravels and associated sediments of late Pleistocene age; they are sandy loams with essentially no pedogenic horizons. Clay-sized particles are scarce, and thus moisture-holding capacity and cation exchange are low. Soluble salts, organic matter, and nitrogen are also low. When disturbed, these soils are subject to serious wind erosion.

The original dominant natural vegetation has been characterized as a sagebrush/bluebunch-wheatgrass steppe, which supported a diversity of plants and animals. The vegetation was four-layered: an upper open layer, about 1 m tall, of sagebrush and other shrubs; a second layer of perennial bunch grasses; a third layer of mostly annual grasses and forbs; and a fourth layer consisting of a thin fragile crust of lichens, mosses, and liverworts. There was virtually no bare ground.

However, in the late 1800s and early 1900s, domestic cattle and sheep severely overgrazed the range. The perennial bunchgrasses could not withstand grazing, and an invading exotic* annual grass, cheatgrass, assumed dominance along with sagebrush (which is unpalatable to livestock). Since 1943, grazing has been prohibited on the Hanford Reservation and the cheatgrass has re[illegible]ted reinvasion by native plants. Most of the area near the Columbia River is now characterized as a sagebrush-bitterbrush/cheatgrass vegetation type.

In 1970, a very hot wildfire burned all the vegetation and litter off the area immediately surrounding the reactor sites. The conspicuous plants are now cheatgrass (which provides much of the herbaceous ground cover and vegetative productivity), Russian thistle (another exotic plant), rabbitbrush, bursage, jagged chickweed (an exotic), and Sandberg bluegrass (an exotic). Ground cover is very sparse. Without the protective cover of shrubs, the sandy soils are being eroded by the wind. Sagebrush and bitterbrush will likely not reinvade for several decades.

The Great Basin pocket mouse is the most abundant mammal near the site, especially in the shrub areas that were not burned. Although observations of fecal pellets indicate that mule deer do not use the area to any great extent, numerous horse hoofprints were noted near the intake area during a staff site visit in 1977. Apparently these animals are grazing on the Hanford Reservation. Side-blotched lizards and gopher snakes are the most abundant reptiles, and horned larks and meadowlarks the most abundant resident birds near the site.

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*An exotic plant is one whose native habitat is in another country.

Occasional predators--such as coyotes, badgers, and owls--probably feed in the vicinity of the site.

In 1967, 120 square miles of the western part of the Hanford Reservation in the Rattlesnake Hills area was set aside as the Arid Lands Ecology (ALE) Reserve. (The nuclear developments are mostly on the east and northeast parts of the Reservation.) Also, the bulk of the Reservation (570 square miles, including the ALE) has recently been designated as a National Environmental Research Park. Because the federal government has controlled the land since 1943, and because in that period similar land in the region was severely overgrazed and is now being turned into dryland wheat farming and irrigation at a very fast rate, "today, the only sizeable acreage of Washington steppe land in a nearly pristine condition exists on the Hanford Reservation."[15]

4.1.3 Socioeconomic Description

4.1.3.1 Population

The Hanford Reservation has not been open to the public since 1943. The information noted here is derived from the WPPSS 2 project.[5]

The demography (1970) of the area is dominated by the tri-cities of Richland (26,290), Kennewick (15,212), and Pasco (13,920). North Richland is within 10 miles of the site and accounts for about 70 percent of the 5,860 people who live within 10 miles of WPPSS 2. The tri-cities are located within the 10-30 mile airline distance from the site. No other urban concentration affects the population concentration, commuting patterns, or land use. The estimated 1976 total population of Richland, West Richland, Kennewick, and Pasco was 67,489. These cities have been growing rapidly in the 1970s. Overall growth in Benton County was 26 percent from 1970 to 1977.

4.1.3.2 Land Use

Energy-related industry and agriculture dominate both the economy and the land use of the tri-cities area. Irrigation with Columbia River water has been an important element in the expansion of agriculture. Total farm income increased tremendously in the 1970-1974 period, and much of this is attributable to a 28% increase in land under irrigation. The presence of Hanford and irrigated agricultural land limits the direction of urban growth.

The tri-cities area has been growing rapidly; contract construction has grown at an annual rate of 23%, mainly due to the Hanford Reservation. To meet the demands of growth, housing stock increased from 10,879 units to 40,850 units between 1970 and 1977. Due to this housing growth surge, the vacancy rate in 1977 was actually greater (5.2%) than in 1971 (1.7%).

4.1.3.3 Traffic Congestion, Transmission Lines, and Site Access

Traffic congestion has become a problem in parts of the tri-cities area because of limited access to the Reservation. Commuters to the Reservation from Kennewick and Pasco must pass through Richland or take the bypass route.

NEXT PAGE IS 51

Highways are affected by the one-way surge of traffic from Hanford in the evening and to the Reservation in the morning.

New 500-kV lines about 1 to 2 miles long would have to be constructed to the Ashe Substation on the Hanford Reservation. Also, the BPA grid would need reinforcement by constructing a second 500-kV line from the Ashe Substation northwest across the Hanford Reservation to the Hanford Substation. This new line would cross 18 miles of fairly flat land on the Columbia River plateau, along an existing corridor.

All railroad and road construction to provide access for construction equipment and fuel shipments would take place within the confines of the Reservation. Road improvements to relieve congestion would require some study of traffic engineering and may already be a part of the State of Washington's highway improvement plans. Access to the site for the reactor vessel would be expected to be accomplished by barge up the Columbia River to the Hanford Reservation near North Richland. The barge unloading facility is at Port Benton, Washington.

4.1.3.4 Labor Supply

The labor supply in the Hanford area has historically been drawn from other areas of Washington and from other states. Certain of the craft skills on a nuclear project require labor in quantities greater than other construction projects. Depending on the timing of projects, the Hanford area may or may not retain skilled personnel who are employed to construct WPPSS 1, 2, and 4.

4.1.3.5 Cultural Resources

Information available in the National Register indicates that there are six archaeological districts located on the Hanford property. Ethnographic settlements of the Wanapan are reported to have persisted in the area of the Hanford Atomic Works until 1943. "Historically, the main village of the Wanapan was located at Priest Rapids, approximately 43 miles upstream from the WNP-2 area. There is archaeological evidence, however, that other village sites closer to the project [WNP-2] were important in prehistoric times, such as the extensive village at Wahluke, located 24 miles upstream from the project area, which was excavated in 1926-1927 by the U.S. Museum."[9] Regarding present Native American communities, the WPPSS-2 ER concluded that based on Relander (Drummers and Dreamers), "remaining descendents of the Wanapan people live at Priest Rapids and on the Yakima Indian Reservation."

The staff understands that an intensive cultural resource survey for all the Hanford property has not been made. According to the WPPSS-2 ER, archaeological resources within the Hanford area are considerable and warrant further investigation and preservation.[9]

4.1.3.5 Aesthetics

The eastern portion of the Hanford Reservation is extremely flat. When completed, the WPPSS 1, 2, and 4 cooling towers will be the principal landmarks in the area. These 200-foot high mechanical-draft tower units will be 8 miles within the Reservation and will not be noticeable from the city of Richland. However, they will be visible from public and private lands on the east bank

502 072

of the river--most readily seen from the river about 2 miles away from the site. Any new units would be expected tc be located further from Richland and at least as far from the river.

4.2 PEBBLE SPRINGS SITE

The Pebble Springs site has been proposed by Portland General Electric Company (PGE) as the location of two nuclear power plants of 2622-MWe combined capacity. The plants would be located southeast of Arlington on a plateau above the Columbia River, Gilliam County, Oregon. Environmental characteristics of this site have been summarized in the Pebble Springs construction permit FES[4] and the sponsoring utility's ER.[16]

4.2.1 Aquatic Description

The Pebble Springs site is located 3 miles from the Columbia River; water would be withdrawn from the river for a cooling reservoir. The Columbia River near Arlington is impounded by John Day Dam, a hydroelectric project, and this stretch of the river is called John Day Pool. Uses of the river besides hydroelectric power generation include industrial withdrawals, navigation, irrigation, recreation, and refuges for migrating waterfowl. The average annual flow rate in the Columbia at McNary Dam is 5245 m^3/s (185,000 cfs). Pool elevations vary as much as 11 feet during a year. In the area of the proposed intakes, the shore of John Day Pool is steep and heavily riprapped.

Thirty-five feet of water are found within 100 feet of shore at normal pool elevations. John Day Pool is classified Class A-Excellent by the Washington State Department of Ecology.

The design of the two units proposed by PGE for the Pebble Springs site specifies that water would be withdrawn from the John Day Pool and piped to Pebble Springs Reservoir, a 60,000 acre-feet single-purpose cooling lake formed by earthen dams on either end of a dry streambed. Water from the reservoir would not be discharged to the Columbia River during normal operations, although up to 2800 acre-feet/year might be provided for irrigated agriculture in the vicinity of the site.

No permanent aquatic habitats occur onsite; thus impacts of construction and operation on aquatic ecosystems are confined to the Columbia River. Descriptions of aquatic habitats for the Pebble Springs nuclear plants are based on studies of Willow Creek Slough,[16] an area the staff believes may not be representative of the area proposed for intake construction. The steep, contoured, heavily riprapped banks of the river at the intake location may have much less abundant fish populations than the slough. Major fishery resources in the John Day Pool include chinook salmon, sockeye salmon, coho salmon, and steelhead trout, all of which migrate through the river past the Pebble Springs site. In addition, the John Day Pool supports a sports fishery for steelhead, chinook salmon, bass, catfish, perch, and crappie.

The staff predicts that because the proposed Pebble Springs Reservoir would be used for cooling and because its surface temperature would be greater than 32°C (90°F), fauna and flora would include only a few species of thermally tolerant organisms. These would probably include a variety of algae, fly larvae, oligochaete worms, and introduced warm-water fishes such as carp, sunfishes, and catfish. The staff expects no endangered, threatened, or rare aquatic species to colonize the cooling reservoir. Organisms may colonize the reservoir by becoming entrained in the intakes, but the staff concludes that native fishes adapted to the relatively cold waters of the Columbia River are unlikely to become established.

4.2.2 Terrestrial Ecology

The terrestrial ecology of the Pebble Springs site has been described in the Pebble Springs ER,[16] the construction permit FES,[4] and Reference 17. Like Hanford, the site is within the semiarid shrub-steppe region of eastern Oregon and Washington. It is also located on the relatively flat plain next to the Columbia River, although the elevation is slightly higher (250 m MSL). Average summer and winter temperatures are identical (23°C and 0°C, respectively), but precipitation is slightly higher (23 cm/yr). Soils are similar and are derived from glaciofluvial and aeolian materials.

Also like Hanford, the site has been severely overgrazed in the past and has been invaded by exotic plants. Unlike Hanford, the grazing continues and there has not been a recent severe fire. The most common plants on the Pebble Springs site today are cheatgrass, sandberg bluegrass, rabbitbrush, snakeweed, and Russian thistle. Bunch grasses are scattered and infrequent, and sagebrush is generally found only in small stands.

502 075

The most abundant small mammals are pocket mice and deer mice, and the most abundant medium-sized mammal is the black-tailed jackrabbit. Mule deer, coyote, and bobcat also use the site. The most abundant birds are horned larks and western meadowlarks.

The present use of the site is for sheep grazing. The land surrounding the site is used for dryland wheat farming and for grazing cattle and sheep.

4.2.3 Socioeconomic Description

4.2.3.1 Population

The principal demographic feature of Pebble Springs is the lack of large nearby towns; there were only 69,250 people within 50 miles of the site in 1970. The closest town, Arlington (394; 1974), is 3 miles away. There is no population center (city of 25,000 people or more) within 50 miles. The nearest large urban concentration of Richland, Pasco, and Kennewick is 88 miles by road. The largest towns within commuting distance are The Dalles (10,423), about 57 miles, and Hermiston (5,865; 1974), about 66 miles away. A smaller community is Goldendale, Washington (2,484), which is approximately 47 miles by road. Closer communities in Oregon include Heppner (1,500; 1974), about 50 miles, and Condon (910; 1974), about 40 miles. Other communities in Washington more than 50 miles away by local roads (which are paved most of the distance between the town and site) include Prosser, Grandview, and Sunnyside, the largest of which is Sunnyside (6,751). Only Hermiston, Goldendale, and The Dalles are located on I-80.

4.2.3.2 Land Use

The major land use in the area is dryland farming; the most important cash crops are wheat and alfalfa. The area of the site is under single ownership and presently used for forage for cattle and sheep. There are farms with irrigated cropland within 30 miles of the site.

Industrial development of the area includes a waste-disposal and burial site near Arlington (operated by Chem-Nuclear Services, Inc.) and a coal-fired power plant constructed by PGE near Boardman, 30 miles to the east. The U.S. Navy Weapons System Training Facility lies 20 miles to the east. The Arlington Airport is an uncontrolled strip 2 miles from the plant and has no scheduled service.

4.2.3.3 Traffic Congestion, Transmission Lines, and Site Access

Traffic in the Pebble Springs area is free-flowing and congestion is not a problem. Interstate 80 is the principal east-west route, paralleled on the north side of the Columbia River by State Route 14. North-south access is relatively undeveloped. Considerable road capacity exists in the area and no traffic impacts are foreseen in the future.

The transmission system for Pebble Springs is well developed. For example, the first two units designed for Pebble Springs required less than 1 mile of new 500-kV line and 4.5 miles of 230-kV line. The Pebble Springs site is traversed by two BPA 500-kV lines and one 230-kV line.

Materials transported by barge would be delivered at Arlington on the Columbia River. The main line of the Union Pacific Railroad runs along the south bank of the Columbia, and branch lines run north-south along Highways 19 and 74; access by railroad from Route 74 would require 1.5 miles of construction.

4.2.3.4 Labor Supply

The Pebble Springs area does not have an adequate labor supply for a nuclear power project. Many of the workers would be drawn from the Hanford area. Depending on the construction schedules at Hanford, the Pebble Springs area would have to draw some proportion of its work force from Portland, Western Washington, or other areas.

Of those workers from the Hanford area, nearly all would be expected to move closer to Pebble Springs. Some workers would commute only on weekends. All other workers not from the area would be expected to move to communities within commuting distance of Pebble Springs. It is likely that only laborers would be successfully drawn from the area and that skilled craft trades would be almost entirely newcomers.

4.2.3.5 Cultural Resources

From a human settlement perspective, interest in the Pebble Springs area is for the most part archaeological rather than historical or ethnographic. The only eligible National Register resource in the area is the Oregon Trail, approximately 5 miles from the site. The Umatilla National Wildlife Refuge is 20 miles east near Boardman (Ref. 15, p. 4.1-3).

The primary source for archaeological study is the survey and test pit investigations performed by the University of Oregon Museum of Natural History in 1977.[18] In the abstract of the report, it was noted that "one archaeological site and twenty-three paleontological localities were recorded." The conclusion regarding the archaeological site was that it is badly weathered and little, if any, archaeological data remains.

4.2.3.6 Aesthetics

The Pebble Springs site lies 3 miles from the Columbia River and closer to I-80, the two main views of interest. The first two Pebble Springs units were designed with a cooling reservoir, and consequently no cooling towers would be present. The staff assumes that the two additional units would be built with mechanical-draft cooling towers which, if built similar to the Hanford units, would be approximately 200 feet high. However, the cooling towers would not be visible from either highway I-80 or from the Columbia River because the elevation of the site is approximately 720 to 900 feet MSL, whereas the Columbia River is approximately 265 feet MSL, and most of the rise in elevation takes place immediately from the river.

5.0 ENVIRONMENTAL COMPARISON OF EASTERN ALTERNATIVES TO THE SKAGIT SITE

The staff has gathered information on the environmental characteristics of the alternative sites from the sponsoring utilities' ERs, previous NRC testimony and EIS's, scientific reports, consultation with state agencies, and visits to the sites. Each alternative site is briefly described for three technical areas (aquatic ecology and resources, terrestrial ecology, and socioeconomic characteristics), whereas descriptions of the proposed site are found in the FES. The staff has evaluated the environmental characteristics of each alternative relative to characteristics of the Skagit site. In addition, the staff has compared expected impacts of nuclear power plant construction and operation at the alternative sites, relative to those expected at the Skagit site, based on reconnaissance-level descriptive information and previous staff testimony. Methodologies used by the staff to evaluate alternative sites differed for each technical discipline and included siting characteristics and expected impacts commonly addressed in preparation of an EIS, as well as issues developing from site-specific characteristics of both the proposed site and the alternatives.

Each alternative site was rated in comparison to the Skagit site for both site characteristics and expected impacts: these ratings are subjective and based on the data available to the staff at the time of the review as well as the staff's professional experience. The rating system had three categories:

1. If, for a given characteristic, an alternative was perceived by the staff to have a clear siting advantage due either to relative siting value of resources or site characteristics or to relative magnitude of expected

impacts, the site was rated "preferable".

2. If an alternative was perceived to have a clear siting disadvantage due either to relative siting value of resources or site characteristics or to relative magnitude of expected impacts, the site was rated "less desirable".

3. If the alternative and proposed sites were similar or the differences were equivocal, the site was rated "comparable".

Following a discussion of the ratings for each characteristic, a staff judgement was made about the overall environmental preferability of each alternative based on the ratings and staff perception of the relative environmental significance of the ratings.

5.1 AQUATIC ECOLOGY AND RESOURCES

5.1.2 Water Supply

Determination of water supply was based on the proportion of low flows used in plant operations under worst-case conditions. The water supplies of all alternatives contain sufficient flows, even at recorded low flows, to support nuclear power generation of the magnitude analyzed here, without supplementary storage capacity. In addition, sufficient flows are maintained in the rivers by natural hydrological processes and/or by dam operation even under recorded low-flow conditions to ensure that plant water requirements would not measurably affect variations in water surface elevations. Thus, the Pebble Springs scenario (four units) and the Hanford scenarios (five and seven units) are judged to be comparable to Skagit.

5.1.3 Water Use

Waters from both the Columbia and Skagit rivers are used for recreation, agriculture, industrial processes, and municipal water supplies. Consumptive water use rates from both rivers are not a large proportion of discharges and are not expected to impact other water users. Both the Columbia and Skagit rivers are intensively used for recreation, the majority of which is based on fishing. Since all four scenarios are expected to produce negligible impacts on the salmonid populations of the rivers, the staff concludes that the sites are comparable based on impacts to fishery-based recreational use of the rivers. Therefore, the staff concludes that the alternatives are comparable to Skagit with regard to their impacts on water use.

5.1.4 Water Quality

The staff concludes that the alternatives are comparable to Skagit on the basis of water quality impacts with the following qualifications. Although the Skagit site is adjacent to Class AA waters, the discharge area is Class A, a designation comparable to Pebble Springs and Hanford. Since summer temperatures are above the Class A limits at Hanford, coalescing discharge plumes from any of the five or seven units in the alternative Hanford scenarios could raise river temperatures above state limits, unless discharges are carefully located. A comparable rating for Hanford is given only with the expectation that discharges and plumes would be well separated.

502 082

5.1.5 Fishery Resources

Both alternative sites are located on the Northwest's largest salmon producing stream, the Columbia River. At Pebble Springs, salmon use the river primarily for migration. The area upstream of the Hanford site is the Columbia's most important natural spawning habitat; newly emerged, naturally spawned salmon and steelhead juveniles, as well as hatchery-reared salmonid juveniles, are prevalent in the Hanford area. Thus, Hanford is judged to be comparable to the Skagit River based on the presence of this important fishery resource. The Pebble Springs site is judged to be preferable to Skagit because no important salmonid habitat other than migration routes occur near the proposed intakes at Pebble Springs.

5.1.6 Loss of Habitat

Few differences exist between the alternative and proposed sites in the amount of aquatic habitat lost in the immediate vicinity of the proposed plants due to construction. At Pebble Springs, no natural water bodies are found and no streams would be crossed by new or improved access roads or rail lines. At this site loss of habitat along the Columbia River would be limited to the area of the intakes (approximately 200 yrds), an area already disturbed by contouring and riprapping. At Hanford, no natural water bodies are found in the immediate vicinity of the site, nor would any be crossed by new or improved access roads. Loss of habitat on the Columbia River would be limited to the immediate area of the intakes and discharge lines. Loss of aquatic habitat has not been considered an important environmental issue in previous discussion by the staff at either site, and preemption of aquatic habitat by four units at Pebble Springs and five or seven units at Hanford is proportionately very small compared to the total area with similar habitats near the site. At Skagit, habitat loss would be confined to the area of the discharge structure in the Skagit River and to a short section of Black Creek rerouted around the plant. Disturbances to creeks along the sewer line, makeup water line, blowdown line, and access road would be temporary and would not result in permanent loss of habitat. Thus the staff concludes that the alternatives are comparable to Skagit based on loss of habitat, since no clear differences exist in the total amount of aquatic habitat permanently lost by nuclear plant construction at any of the sites.

5.1.7 Turbidity and Sedimentation Impacts

The turbidity and sedimentation impacts to the Columbia River from nuclear plant construction at Hanford and Pebble Springs are expected to be minimal according to previous staff analysis. No other water bodies at these sites would be impacted. Previous staff testimony has concluded that sedimentation impacts from sewer line and access road construction are expected to be minimal. Sedimentation impacts to streams crossed by water transport lines and sedimentation impacts from site clearing and rerouting of Black Creek are expected to be insignificant. Sediment transport from construction activities is expected to be much less than from regional land use practices, including farming and lumbering. Therefore the staff concludes that the Hanford and Pebble Springs scenarios are comparable to Skagit on the basis of turbidity and sedimentation impacts.

5.1.8 Impingement and Entrainment

Both Hanford and Skagit are near salmonid spawning areas; thus small juveniles can be expected in the vicinity of the plant intakes during some seasons of the year. Both intake designs, however, are expected to have very small potential for impingement and entrainment. The Ranney collectors proposed for Skagit and the perforated-pipe intake proposed for Hanford are reported to be the best available technology. Although loss of fish from operation of plant intakes at Hanford is expected to be low, losses would be additive to those from other units at the site and might result in impingement and entrainment effects becoming large enough to be measured. Thus, the staff considers Hanford to be somewhat less desirable than Skagit which would use a design expected to have virtually no impingement or entrainment. Likewise, the staff concludes that although the sidewall collectors proposed at Pebble Springs would have very low impingement and entrainment rates due both to intake design and lack of preferred fish habitat in the vicinity of the intakes, the Pebble Springs site is less desirable than Skagit.

5.1.9 Effluent Discharge Impacts

No routine discharges would be released from nuclear plants at Pebble Springs into any natural water body. Discharges of cooling-tower blowdown would occur at Skagit. Therefore, although the effluent impacts at Skagit have been found by the staff to be acceptable, the absence of any impact at Pebble Springs leads the staff to conclude that Pebble Springs is preferable. Hanford would also release blowdown to the Columbia River. At Skagit, cooling-tower blowdown would be mixed with about 0.6 m^3/s (20 cfs) of untreated river water, a threefold dilution, to reduce the heat and chemical content of the blowdown. At Hanford, blowdown woud be disposed of directly into the river through a slotted-pipe discharge. Additive environmental effects of two units with either three or five units in operation at Hanford depend in large part on the placement of the discharges and the probabilities that plumes would overlap. Additional discharge plumes in the Columbia at Hanford would also increase the probability that migrating salmonids would suffer single and multiple exposure to effluent plumes. Therefore, the staff concludes that Hanford is less desirable than Skagit.

5.1.10 Transmission Impacts

Aquatic impacts associated with transmission facilities would include turbidity and stream disturbance during construction, increased turbidity from erosion throughout the life of the transmission line, increased stream temperature from deforestation of the corridor, and effluents from herbicide or other vegetation management practices. The relative magnitude of these impacts would depend in part upon the type of vegetation cover maintained on the corridors, the climate, and the location of the corridor crossing--e.g. near the headwaters or the mouth of the stream.

At Skagit, the 8 miles of new 500-kV lines to be constructed would cross Coal and Wiseman creeks as well as at least five smaller watercourses. During construction, temporary sedimentation impacts could be expected and a short section of the streams would be disturbed. However, the damp climate should promote a growth of dense herbaceous cover, minimizing erosion and stream sedimentation during operation. Since the streams within the corridor are small, the staff expects herbaceous and shrubby vegetation to adequately shade the stream. Since the watersheds of these streams are operated as tree farms, the staff concludes that the impacts from the Skagit transmission lines on aquatic communities would be negligible compared to the impacts of lumber operations.

Construction of the Skagit alternatives at Hanford in either the five- or seven-unit scenario would require the construction of 18 miles of 500-kV single-circuit lines adjacent to existing corridors. This line would not cross any existing aquatic habitats; therefore the staff concludes there would be no aquatic impacts and the Hanford site is preferable to Skagit.

Construction of the Skagit alternative at Pebble Springs would result in the construction of 30 miles of 500-kV single-circuit line adjacent to an existing corridor. The region is arid and most of the stream channels that would be crossed contain water only intermittently and probably already carry moderate to heavy sediment during periods of high runoff. Although the only major stream crossed by the corridor would be the lower John Day River, it contains regionally important fish habitat, and the Pacific Northwest River Basins Commission[19] has concluded that the aquatic habitats of the lower John Day River should be preserved in their natural condition. The John Day River above RM 10 and below RM 157 has been proposed for addition to the National Wild and Scenic River System, and the State of Oregon has designated parts of the John Day River as "natural" and "scenic".

However, since the proposed line would probably parallel existing transmission corridors, the staff expects little additional impacts to the John Day River from another transmission line. In addition, the sediment load of the John Day River is normally high during periods of heavy discharge when erosion of soils from the corridor could occur. The staff expects impacts of transmission line construction to be negligible for the Pebble Springs alternative. Therefore, the staff judges Pebble Springs comparable to Skagit for impacts of transmission line construction and operation on aquatic ecosystems.

5.1.11 Summary

In conclusion, the staff finds neither alternative site clearly preferable to the Skagit site for either aquatic ecology or impacts to aquatic resources. Although Hanford is preferable on the basis of transmission corridor impacts (Table 2), the less preferable ratings assigned this site on the basis of impingement and entrainment and effluent discharges outweigh the preferable rating. Therefore, the staff concludes that Hanford, with either the five-unit or seven-unit scenario, is slightly less desirable than Skagit, but not clearly so because of the difficulty of assigning impacts to multiple units. Because the differences between Hanford and Skagit are somewhat equivocal, the staff assigns Hanford a comparable rating.

The Pebble Springs scenario is preferable to Skagit regarding the importance of nearby fishery resources and the impacts of effluent discharge and less desirable regarding impingement and entrainment (Table 2). Therefore, the staff concludes that the only basis for preferring the Pebble Springs site is the absence of salmon spawning in the vicinity of the intakes. Since no significant impacts are expected to salmonids spawning at Skagit, the staff concludes that the Pebble Springs site is only marginally better than the Skagit site and since these differences are somewhat equivocal due to difficulties in precise prediction of very small impacts, the staff gives Pebble Springs a comparable rating.

Table 2. Summary of Comparisons of Alternative Sites with the Skagit Site, Based on Aquatic Ecology and Resources

	Hanford		Pebble Springs
Characteristic	Five Units	Seven Units	Four Units
Water supply	Comparable	Comparable	Comparable
Water use	Comparable	Comparable	Comparable
Water quality	Comparable	Comparable	Comparable
Fishery resources	Comparable	Comparable	Preferable
Loss of aquatic habitat	Comparable	Comparable	Comparable
Turbidity and sedimentation impacts	Comparable	Comparable	Comparable
Impingement and Entrainment	Less desirable	Less desirable	Less desirable
Effluent discharge	Less desirable	Less desirable	Preferable
Transmission corridor impacts	Preferable	Preferable	Comparable
OVERALL	Comparable	Comparable	Comparable

5.2 TERRESTRIAL ECOLOGY

5.2.1 Habitat Disturbance and Land Use On and Near the Site

Neither Pebble Springs nor Hanford is clearly preferable to Skagit in terms of potential impacts on the terrestrial environment at the site proper. As noted in the site descriptions, Hanford and Pebble Springs have similar terrestrial ecosystems--both are sagebrush steppe dominated by the exotic annual cheatgrass which replaced the former perennial bunch grasses after severe overgrazing by livestock. Both sites are degraded relative to the original natural ecosystem, and both sites are representative of similar habitat in the region. Hanford is designated as a National Environmental Research Park[15] and is the only sizeable acreage of steppe left in relatively good condition. The immediate area around the existing reactors, however, has been recently severely burned. The surrounding land is used for grazing, dry-land wheat farming, and irrigation.

Skagit, on the other hand, was originally in coniferous forest which was logged in the late 1800s and early 1900s. Since the 1940s, part of the site has been managed for timber and paper pulp production by clearcut logging/replanting, and part of the site has been in pasture for cattle grazing. Relative to other managed forests in western Washington, the site is mediocre because of the thinner, poorer soils. Relative to other pasture land on the coastal plain or even in the Skagit valley floor, the site is mediocre. The surrounding land is used for pasture and tree farming.

Construction and operation of (1) two more units at Pebble Springs, (2) two more units at Hanford, assuming three existing units, or (3) two more units at Hanford, assuming five existing units, would not have a significant adverse impact on the terrestrial environment. Whatever minor impacts might occur (e.g., replacement of a couple hundred acres of steppe with parking lots and buildings; disturbance of nearby wildlife because of the increased presence of humans; soil erosion; or theoretical vegetation damage by cooling-tower drift), they would be comparable to the impacts projected for the Skagit site. There is no more inherent ecological value in the steppe at Pebble Springs and Hanford than in the pastures and periodically clearcut forests at Skagit. Both ecosystems are highly modified and artificial compared to the original ecosystems, and both are representative of similar ecosystems in their respective regions. Both ecosystems occasionally have a very diverse flora and fauna as well as an aesthetic appearance (e.g., the steppe after an unusual season of favorable temperatures and high rain, or the tree farm after 40 years of growth just prior to clearcutting). Both Pebble Springs and Hanford are comparable to Skagit on the basis of habitat disturbance and land use.

5.2.2 Regional Land Use

Potential impacts in the site regions would be comparable for all three sites. The further industrialization of the Pebble Springs or Hanford sites should not affect surrounding terrestrial ecosystems and land uses any more or less than industrialization of the Skagit site. In the former case, grazing land and dryland wheat farms would be replaced by buildings and roads to accommodate nuclear plant workers; in the latter case, cropland, pasture, and tree farms would be replaced.

5.2.3 Habitat Disturbance and Land Use Along Transmission Lines

Neither Hanford nor Pebble Springs is clearly preferable to Skagit in terms of potential impacts on the terrestrial environment along the transmission lines.

For Skagit, only 4.3 miles of new right-of-way (2.7 miles with two double-circuit 500-kV lines in a 325-foot common corridor, plus 1.6 miles with one double-circuit 500-kV line in a 165-foot corridor) would be necessary to connect with the existing BPA grid (Ref. 20, Sec. 3.8). Apparently, no other BPA grid development can be clearly attributed to Skagit.[7,21] There would also be a 4.1-mile, 230-kV line constructed within an existing 100-foot corridor (replacing two existing 115-kV lines) to PSP&L's existing Sedro Woolley substation (Ref. 20, Sec. 3.8). The major terrestrial habitat disturbance would be along the 4.3 miles of new 500-kV lines. About 145 acres of fir-alder forest, now managed for lumber production, would be cut down and never allowed to regrow as long as the land were used for transmission purposes. Since the transmission line would be constructed along the edge of the valley on lower, more gently sloping land and since vegetation cutting would be selective for tall-growing species (leaving low-growing vegetation and the soils intact), soil erosion both during construction and in the long term should not be a major problem. Soil erosion along the access road would depend on maintenance procedures. There would be a continuous long-term impact due to use of herbicides to control vegetation growth on the right-of-way. Construction of the new 230-kV towers and lines adjacent to the existing corridor and removal of the old 115-kV towers and lines should cause only temporary disturbance of the cropland and other cleared land on the flat valley floor.

If the two Skagit units were moved to the Pebble Springs site, bringing the total number of units at Pebble Springs to four, there would probably be new construction of two 500-kV lines on new right-of-way about 1-mile long to connect the existing BPA grid (Ref. 4, Sec. 3.8). The local area of the BPA grid would also need to be reinforced with a 30-mile 500-kV line between the Slatt and John Day substations.[7] Although this line would likely parallel an existing BPA line, right-of-way widening would be necessary. The terrain is fairly level west from the Slatt Substation at Pebble Springs, but becomes steep in the canyons, especially crossing the John Day River. Most of the land that would be crossed is used for rangeland (18 miles), and the rest is used for dryland wheat farming. Other than disturbance during erection of towers and stringing of lines, terrestrial habitat disturbance would be minimal and the land uses would remain the same. On the rangeland, the dirt road created by movement of heavy equipment would remain for at least several decades because such areas do not naturally revegetate for many years (as evidenced by the continued existence of the nearby dirt Oregon Trail). Such dirt roads would probably be used for recreational purposes by off-road vehicles. Thus, the road proper and adjacent areas would be subject to continuing disturbance which can sometimes be very destructive. In the canyon areas, terrestrial habitat disturbance would depend on the specific construction method employed. If heavy machinery moved up and down the steep slopes, there would be high potential for soil erosion (wind and water erosion) which would continue for many years. If more expensive methods--e.g., helicopter stringing--were used, disturbance would be minimal or negligible. There should be no need for use of herbicides for vegetation control because of the low-growing nature of the vegetation.

If the Skagit two units were moved to the Hanford site, new 500-kV lines would need to be constructed to the e isting Ashe Substation, which is adjacent to the existing units of WPPSS 1, 2, and 4. Assuming that the Skagit units could be located close to the existing units, the new transmission lines would be about 1 to 2 miles long. Also, the BPA grid would need reinforcement by constructing a second 500-kV line from the Ashe Substation northwest across the Hanford Reservation to the Hanford Substation.[7] This new line would cross 18 miles of fairly flat land on the Columbia River plateau. The vegetational communities disturbed by construction would be sagebrush-bitterbrush/cheatgrass in the immediate vicinity of the power plant site and sagebrush/cheatgrass for the majority of the distance to the Hanford Substation.[22] As in the case of the Pebble Springs BPA transmission line, there would be habitat disturbance during erection of towers and stringing of lines, but the land use would remain essentially the same (currently, ungrazed land set aside as part of the Hanford National Environmental Research Park). Likewise, the dirt road created by movement of the heavy machinery would remain for several decades. Since public use of the Hanford Reservation is restricted, this road and adjacent areas would not be subject to disturbance by off-road vehicles as is the case for Pebble Springs. There should be no need for herbicide use for vegetation control.

In conclusion, although habitat disturbance and land use changes along the transmission lines proposed for the alternative scenarios would be of different natures, the overall impacts would be comparable for Skagit, Pebble Springs, and Hanford. At Skagit, only a few miles of forest would be cleared and permanently changed from use as tree farm to use as a transmission line right-of-way covered by low-growing vegetation. At Pebble Springs, several miles of sagebrush grazing land and dryland wheat farms would be temporarily disturbed but would continue in the same uses. There might be some adverse impacts due to construction at a few canyon crossings and at the John Day River crossing, and there would probably be continued disturbance by off-road vehicles along the transmission line access road. At Hanford, there would be a moderate number of miles of sagebrush disturbed on the Hanford Reservation, but further disturbance by off-road vehicles would be unlikely.

5.2.4 Summary

A summary of comparisons of alternative sites with the Skagit site, based on terrestrial ecology, is presented in Table 3. Although terrestrial communities would be disturbed both temporarily and permanently at each site, the overall environmental costs associated with development of two units at the Hanford and Pebble Springs altern··ive sites are comparable to the overall costs associated with development at Skagit.

Table 3. Summary of Comparisons of Alternative Sites with the Skagit Site, Based on Terrestrial Ecology

	Hanford		Pebble Springs
Characteristic	Five Units	Seven Units	Four Units
Habitat disturbance and land use on and near the site	Comparable or less desirable	Comparable or less desirable	Comparable
Regional land use	Comparable	Comparable	Comparable
Habitat disturbance and land use along transmission lines	Comparable	Comparable	Comparable
OVERALL	Comparable	Comparable	Comparable

5.3 SOCIOECONOMIC CHARACTERISTICS

Six criteria of site characteristics are used in the analysis: population, land and water use compatibility, disruption due to site access (traffic, transmission lines, and component delivery), labor force relocation and community disruption, cultural resources, and aesthetics. The staff rated the alternative sites, as compared to Skagit, based on (1) whether there are more or fewer competing values and views of the future at each site area, (2) whether more or fewer people will be impacted, and (3) whether an impact will persist that can distinguish the relative qualities of the sites even after appropriate mitigation of impacts.

5.3.1 Population

Both Hanford and Pebble Springs have extremely low population densities close to the site (Table 4), ranking them among the best sites in the nation in terms of remote siting. The settlement pattern in relation to industrial facilities generally favor remote siting unless there are economic disadvantages associated with a remote site. Disadvantages are discussed under the heading of labor force relocation and community disruption.

The settlement patterns near Hanford and Pebble Springs indicate there are few, if any, residences near the sites. This feature of these sites enhances the ability to maintain buffer zones between the site and residential areas.

Another advantage of remote siting is that future development is not likely to create problems associated with urbanizing areas growing toward the site and creating potential environmental conflicts. In this respect Hanford and Skagit sites have less to distinguish them. Although Skagit has more small communities near the site than Hanford, the upriver area of the Skagit Basin has a stable population and future industrial development would not be expected. In contrast, Hanford is a growing urban area where future development is planned.

In contrast to both Skagit and Hanford, Pebble Springs has a sparse settlement pattern in the context of no nearby urban areas and no conflict with farms and other urban residential areas. Pebble Springs and Hanford are both preferable to Skagit as sites where adequate buffer zones can be assured. However, Hanford and Skagit sites are comparable with respect to potential future growth.

Table 4. Population Within Specified Distance of Site

Miles from Site	Skagit 1970	Skagit 1980	Pebble Springs 1970	Pebble Springs 1980	Hanford 1970	Hanford 1980
0-2	306	308	9	9	0	0
0-5	3,854	4,226	460	480	130	130
0-10	16,075	17,732	550	570	5,860	8,700
0-30	151,222	171,360	4,263	5,573	63,960	82,020
0-50	505,723	604,863	69,250	75,376	185,660	219,730

5.3.2 Social Aspects of Land and Water Use Compatibility

The criterion of social aspects of land and water use compatibility reflects the extent to which construction and operation of the nuclear plant is more or less consistent (or would interfere more or less) with existing uses of the land and water in the vicinity of the plant. Compatibility is reflected by existing activities in the vicinity of the site and the land use values placed on those activities. Factors considered include (1) description of land use and activities at and surrounding the existing site, (2) relative intensity of use, and (3) proximity to areas where future development is precluded or undesirable.

The Skagit environs are more intensively developed for agricultural use than Pebble Springs and supports a greater diversity of farm products. It is the intent of Skagit Planning Board County to keep areas subject to flooding in agricultural use and restrict or prohibit development within the floodplain. Both Hanford and Pebble Springs are less intensely developed. The Pebble Springs area has dry farming as its principal economic activity and this activity guarantees a sparse development pattern and, by extension, minimal conflicts with surrounding uses. Hanford is already developed for nuclear power plants, and more units at the Reservation would be consistent with the future development of the Reservation. In contrast, the Skagit Valley is more developed for agriculture and is planned for increased recreational use. The economic base of the Skagit Valley would consequently not depend on nuclear development to the same degree that it would in the Pebble Springs and Hanford areas. The staff concludes that the alternative sites are preferable to Skagit based in the types of land uses. The staff also concludes the alternative sites are preferable based on potential conflicts with surrounding uses relative to intensity and types of use.

There is a history of divergence of views regarding the future development pattern in the Skagit area.[24] The Skagit site was subject to an amendment of the Skagit County Interim Zoning Map in March 1974. At that time, the Bacus Hill property was reclassified industrial from forestry-recreation and residential. The Skagit County Board of Commissioners found that the rezone "will further the objectives and goals of the comprehensive plan" and "will be in harmony with and in no way create any inconsistency or conflict of use with uses allowed in the surrounding areas."[23]

During the 1970s, the Forest Service studied the Skagit River system, resulting in two reports.[25,26] It was noted that the Skagit River was eligible for recreational classification for its entire length, and it was proposed that the area from the pipeline crossing upstream to Bacon Creek be classified as recreational, and the remainder of the system as scenic (Ref. 26, p. 1). Implementation of the proposed action indicates that development along the Skagit would be for limited uses.

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In April 1978 the Department of Agriculture made a 7(b) determination[27] that the project will pose "direct and adverse effects upon the values for which the Skagit River is proposed for inclusion." In April 1979 the Department of Agriculture accepted almost intact the mitigation measures proposed by the applicant.[28]

Primarily because of the documented history of a divergence on views regarding future development on the Skagit relative to no such perceived divergence at the other sites, the staff concludes that the land use compatibility criterion favors Pebble Springs and Hanford. One view of the Skagit Valley's future land use development places more weight on the economic base of Skagit which has included farming, forestry, food processing, and some manufacturing. The other view places more weight on the maintenance of the natural and scenic character of traditional lifestyle. The staff is aware that one aspect of maintenance of this lifestyle is the Native American interest in the preservation and enhancement of "usual accustomed" fishing sites along the Skagit and in the vicinity of the plant.

With respect to the difficulty of siting at either Pebble Springs or Hanford, the staff is aware of two potential drawbacks at these sites. At Pebble Springs, the applicant would be subject to Oregon siting laws and legislation, and future laws may prohibit nuclear plants. At Hanford, the Columbia River between McNary Dam and Priest Rapids was cited by President Carter's 23 May 1977 message as a river segment <u>for study</u> "as a potential addition to the National Wild and Scenic River System." Whether the Columbia River will take the same route to inclusion in the system as the Skagit is speculative. This route would require that the Columbia be named for potential addition to the system--in contrast to potential study [Sec. 5(a) rather than Sec. 5(d)]--and based on the outcome of the study, that Congress would include it in the river system.

The staff recognizes that delay involves exposure to these kinds of land use decisions. However, based on land use planning compatibility criteria, Pebble Springs and Hanford are preferable to Skagit as nuclear sites.

5.3.3 Traffic Congestion, Transmission Lines, and Site Access

The staff has considered the relative impacts from (1) transmission access, (2) railroad and road construction, (3) barge delivery, and (4) traffic congestion. All of the impacts associated with these features at all sites are considered to be not significant, but perceptible. The staff has previously assessed both the traffic impacts on SR-20 and delivery of the reactor vessel. Congested conditions at the worst intersections near the Skagit plant were estimated to be present 60 hours of the year without mitigation (Ref. 29, p. 16).

Although there are factors which distinguish the three sites, they are insufficiently impactive to rate one site preferable to another. For example, traffic congestion is an existing problem to and from the Hanford site. Comparison to Skagit does not yield a basis for choice. Pebble Springs has no similar traffic problem nor would it be forecast to have traffic congestion with construction of two or four units. However, because the Pebble Springs site is currently undeveloped, the perception of change and inconvenience associated with construction may be greater; local roads may have to be improved and upgraded. Overall, the impacts are sufficiently minor at each site that the staff rates each site comparable to the other.

5.3.4 Labor Force Relocation and Community Disruption

Two related aspects are reflected with regard to labor force relocation and community disruption. The first is the expected numbers of newcomers to the area during the construction period relative to Skagit; the second is the relative ability of the communities receiving those newcomers to accommodate the change without social disruption and/or obvious identifiable expansion of public services. As these two factors are interrelated, they are assessed as an overall community impact stemming from newcomers.

A key factor in community disruption is the timing of construction. Two or four units built in sequence with construction phased over a period of time is less disruptive than two or four units built simultaneously. It is assumed that "normal" construction sequence from the utility's point of view is a 2-year lag in completion dates between units. This schedule represents approximately an 8-year construction period for two units and 12 years for four units at the same location. Any compression of this schedule for any purpose (e.g., need for power) has a concomitant impact on nearby communities by raising the peak construction force and by making the community more prone to a cyclical local economy. Compression of schedule also raises the demand for skilled labor which may indirectly raise the project cost.

The West Group forecast has normally called for a new nuclear or coal plant approximately each year.[30] A "normal" schedule at a particular site would call for a plant every 2 years.

The staff has previously assessed the potential for boom town impacts as a result of the Skagit project.[29] No boom town impacts would occur, and approximately 20 percent of the work force would relocate to communities within convenient commuting distance of the site. The range of relocation may be estimated from 10 to 30 percent, depending upon availability of skilled craft trades.

The staff is also aware of the WPPSS 3 and 5 nuclear project under construction at Satsop with approximately 2,000 workers currently at the site. In the staff's view, Skagit has similar prior conditions with respect to boom towns as the Satsop project. Preliminary data indicate that the choice of residence by nuclear plant workers shows considerable distribution to a large number of communities within 50 to 60 miles of the project, without a concentration of workers in any one or more communities. This dispersal of residence will reduce impacts. In the staff's view, neither the Satsop nor Skagit project is likely to create a boom town.

One definition of a boom town adopted by the Congress is the following: "such a development has increased employment by at least 8 percent annually over the next 3 years from the same activities."[31] An area designated by the governor of the state as an impact area would be eligible for federal impact assistance, although the above definition is not meant to apply eligibility to electricity generation. In comparing sites, only Pebble Springs may potentially create the growth impacts that fit the Congressional definition. The staff would view a compressed schedule at Pebble Springs as having a high potential for boom town effects, but the impact of an orderly schedule of construction might mitigate such rapid growth.

Based on experience at Satsop, the staff may revise its assessment of the percent of in-movers to communities within commuting distance of the Skagit site. The staff does not believe, however, that any new information will require a reassessment of the boom town phenomenon nor produce growth rates that come close to those adopted by Congress as indicative of a boom town.

With two units at Skagit and two or four additional units at Hanford or Pebble Springs, only Pebble Springs has the potential for boom town impacts. Impacts are more likely with a compressed schedule, where a compressed schedule is defined as a new unit due for completion at a rate faster than one every two years. Based on this assessment, Hanford is considered comparable to Skagit, and Pebble Springs is considered less desirable than Hanford or Skagit.

With a normal schedule, particularly with four units at Pebble Springs, the impact at Pebble Springs is greater than at Hanford or Skagit. Whether this impact is undesirable depends on attitudes toward growth, particularly industrial kinds of activity. If four units are located at Pebble Springs, the opportunity for some kind of sustained growth is greater than with two units. No industries would move to Pebble Springs because of the electricity generation benefits, but the relative remoteness of the area might be attractive to other nuclear fuel cycle activities. The desirability or undesirability of such growth at Pebble Springs depends on community attitudes about the future of their area.

The staff has examined the land use plan for Gillum County for views regarding the proposed Pebble Springs project. This project is endorsed. Despite this, staff is not in a position to meaningfully assess cummunity attitudes on growth in the vicinity of the various sites. On the bases of similarity of Pebble Springs to the other areas with a similar economic base and lifestyle, staff assumes that the disruption impacts associated with nuclear construction at the site would be interpreted as a reasonable trade-off to nearby communities. For this reason, the staff does not assume a negative feature of Pebble Springs.

5.3.5 Cultural Resources

Historical sites of Native American villages have been identified all along the Skagit. The nearest village site with permanent settlement to the east of the proposed site was Cho-Bah-Ah-Bish, north of Lyman near the mouth of the slough. The nearest village to the west was No-Qua-Cho-Mish, east of Sedro Woolley and north of Dead Man's Slough.[32] The continuous Native American occupation of the Skagit River basin and its tributaries, the longstanding relationship to the river for livelihood, and the expressed desire to maintain and expand the fishery industry economic base would all argue that cultural resources are more diverse in the Skagit Valley[32-36] than near the other sites.

In constrast to Skagit, both Hanford and Pebble Springs have a more strictly palentological and archaeological interest. A similar interest may exist at the Skagit site particularly in regard to the historic settlement of the Valley by native Americans. Moreover, in contrast to the alternative sites, the Skagit area has an interest to the living memory of the residents there to a much greater degree. For this reason, the cultrual interest in the vicinity of the plant is wider, and therefore can be clearly distinguished from the alternative sites.

5.3.6 Aesthetics

Aesthestic impacts are based on visual aspects of the cooling towers. A detailed visual analysis is available for the Skagit site. With regard to the alternative sites, the staff bases its assessment primarily on site visits. The visual aspects were assessed according to three simple criteria: (1) would the cooling towers be more or less consistent with the surrounding land uses relative to the Skagit site, (2) would the cooling towers be more or less visible to a comparable number of observers relative to Skagit, and (3) what would the visual quality of the setting be in the vicinity of the site with and without the cooling towers?

The staff has concluded that the visual values along the Skagit River would be impacted by the 520-foot cooling towers.[37] The Department of Agriculture stated that "without question the towers would have a visual impact on the scenic qualities of the river" and that "there would be a subjective impact on the recreational users of the river by the presence of these towers."[26] Although the Department of Agriculture found the towers to represent visual impacts that would be direct and adverse the Department did not feel that the towers would "unreasonably diminish" the values of the Skagit River.[27]

Skagit is less visually consistent with surrounding land uses. In contrast, Hanford is an area reserved for energy development in which industrial-like structures are expected to be seen. Pebble Springs is in an undeveloped area in which no outstanding environmental values have been identified.

Skagit is also less desirable based on the other two aesthetic criteria. With regard to visibility to a comparable number of observers, both the Pebble Springs and Hanford sites are assumed to be developed with mechanical-draft towers which are approximately 320 feet shorter than the Skagit towers. At Pebble Springs, the traffic volumes on I-80 may be comparable to SR-20, but the cooling towers would be about 1 mile more distant. At Hanford, the cooling towers would be considerably more distant from the general population (at least 8 miles) with the exception of those who use the Columbia River for fishing or recreation in the vicinity of the plant.

With regard to the third criterion--visual quality of the setting with and without the cooling towers--Pebble Springs is an undeveloped site, and therefore, no comparable visual analysis is available for comparison with Skagit. However, the record on Skagit, in contrast to Pebble Springs, tends to indicate that notable visual values exist upriver. The vicinity of the

Skagit plant is exemplified by a rural environment with intensive agriculture. No comparable findings regarding visual values have been recorded in the Pebble Springs environmental impact statement. For Hanford, the visual quality is already preconditioned by WPPSS Units 1, 2, and 4. Consequently, no qualitative change in the visual aspect would be expected with expansion of units on the reservation, as long as they were located further from the Columbia River and nearby communities than existing units.

The staff concludes that on the criteria of (1) visual compatibility, (2) physical obtrusiveness, and (3) quality of setting, Skagit is inferior to both Pebble Springs and Hanford as a location for a nuclear power plant. These conclusions are valid even after considering differences in plume height and length due to meteorological conditions, and variations in cloud cover at the sites. The staff recognizes that Hanford and Pebble Springs are different visual experiences, but these differences are not sufficient to make a distinction on the criteria identified; Hanford and Pebble Springs are considered to have comparable aesthetic impacts.

5.3.7 Summary

Both Pebble Springs and Hanford are clearly preferable to Skagit with regard to socioeconomic criteria. The only drawback to the Pebble Springs site is the social disruption and financial impact assistance required to provide adequate community facilities and social services during construction. (Table 5). These impacts would be exacerbated under conditions of an accelerated construction schedule. Overall, Pebble Springs and Hanford are clearly preferable, even with these siting drawbacks being considered.

Table 5. Summary of Comparisons of Alternative Sites with the Skagit Site, Based on Socioeconomic Characteristics

Characteristic	Hanford Five Units	Hanford Seven Units	Pebble Springs Four Units
Population	Comparable or preferable	Comparable or preferable	Preferable
Social aspects of land and water use compatibility	Preferable	Preferable	Preferable
Traffic congesiton and transportation access	Comparable	Comparable	Comparable
Labor force relocation and community disruption:			
Normal schedule	Comparable	Comparable	Greater impact*
Compressed schedule	Comparable	Less desirable	Less desirable
Cultural resources	Preferable	Preferable	Preferable
Aesthetics	Preferable	Preferable	Preferable
OVERALL	Preferable	Preferable	Preferable

*Desirability depends on attitudes toward growth. Pebble Springs would produce more changes to the communities nearby.

6.0 ENVIRONMENTAL CONCLUSIONS

Table 6 summarizes staff testimony about the relative preferability of each alternative site for each discipline. Both sites are comparable to Skagit on the basis of terrestrial ecology, and both sites are comparable to Skagit for aquatic ecology and resources. Clear preferability has been determined for socioeconomic characteristics of the Pebble Springs and two Hanford scenarios. Briefly, this preference for the alternative sites is based on: (1) social aspects of land and water use compatibility, (2) aesthetics, (3) cultural resources, and (4) population. Whether these socioeconomic factors are sufficient by themselves to show clear overall preferability for the alternative sites depends on how much weight the socioeconomic aspects are given relative to the biological aspects. Irrespective of the weight placed on socioeconomic factors, the staff has estimated the cost to move the Skagit units as directed by the Board (see Section 7).

Table 6. Summary of Staff Conclusions About the Preferability of Alternative Sites

	Hanford	Pebble Springs
Aquatic ecology and resources	Comparable	Comparable
Terrestrial impacts	Comparable	Comparable
Socioeconomic characteristics	Preferable	Preferable
OVERALL	Preferable*	Preferable*

*Depends upon the weight ascribed to the socioeconomic characteristics.

7.0 ECONOMIC COMPARISONS

7.1 COST TO MOVE SKAGIT UNITS

The cost to move the two Skagit units are evaluated as impacts to the ratepayer and impacts to society at large. If a particular cost item is not considered likely to be passed on to either of these groups, it is not included as a cost. For comparative purposes, the cost presentation is made consistent with total costs presented in the prefiled cost-benefit testimony,[39] but updated in Appendix A of this testimony.

Seismic and geologic conditions are considered with regard to the cost of building to safe-shutdown-earthquake (SSE) standards. For Skagit, the design level of 0.35 g is considered to be required, whereas 0.25 g is adopted for Pebble Springs and Hanford. Although the difference in SSE levels indicates a savings to these East Cascades sites, there is also an allowance for redesign costs of the Skagit units.

In most cases, the staff has relied on the applicant's cost estimates[40] and checked these for reasonableness. In other instances, the staff has estimated a cost whether or not the applicant has previously made an estimate.

7.1.1 Reliability

The staff has considered the Bonneville Power Administration (BPA) planning criteria and analysis for its conclusions regarding costs that can be attributed to differences in reliability.[7] The BPA has planned the bulk transmission system to meet its system-wide reliability criteria and to meet criteria of the Western Systems Coordinating Council. Location of plants west of the Cascades, where there is 75 percent of the load, minimizes the amount of transmission facilities needed, but the same reliability criteria can be met with a more extensive transmission system required of plants located east of the Cascades. It is clear, however, that a more extensive bulk transmission system is more expensive than a smaller system where load centers match generation centers. The staff does not attribute any reliability cost to moving the Skagit units east of the Cascades.

7.1.2 New Transmission Lines

The staff recognizes that as more units are located east of the Cascades there evolves the need to either upgrade existing lines and corridors or acquire new corridors. Whether a specific improvement in the transmission system can be attributed to a specific siting decision depends on the existing capacity of lines, planning criteria of BPA, and whether or not BPA planning is conducted with the siting of specific units in mind.

The applicant has stated: "In the event the Skagit units were located on the east side of the Cascades, such as at the Pebble Springs site, then replacement of the BPA 345-kV transmission line across the Cascades via Stevens Pass would be required.[38] The applicant has estimated the cost in 1976 as $92 million.

BPA has evaluated transmission line needs under a variety of siting conditions discussed previously.[7] The capital cost of interties with the BPA grid attributable to Skagit units at Pebble Springs or Hanford are noted in Table 7. Siting the Skagit units at Hanford or Pebble Springs would not require more capital than at the proposed site. (Any such costs are covered by the BPA wheeling charges.) However, other costs such as line losses and wheeling are substantially different.

Table 7. Differential Transmission Costs to Move Skagit Units to Alternative Sites (in 10^6 dollars)

Cost Item	Skagit	Hanford	Pebble Springs
Capital cost (1987)	19.3[a,b]	2.7[b]	2.7
Annual wheeling cost[c]	6.375	13.125	13.125
Annual wheeling cost with 40% credit for Puget Sound Power & Light Co.	3.825	13.125	13.125
Present Value of Wheeling	59	202	202
Levelized cost of wheeling (1987)	6.2	21.4	21.4
Levelized cost of capital	3.1	0.4	0.4
Total transmission cost (excluding losses)	9.3	21.8	21.8

[a]From applicant's testimony on financial qualifications, 1 June 1979, Table 1-2. All other costs from R. B. Eastvedt, "Testimony on Bulk Transmission System Requirements Associated with Alternative Sites for the Skagit Nuclear Generating Facilities," 25 June 1979, Table 1.

[b]Escalation at 6%.

[c]Assumes 50% increase in charge by 1987.

7.1.3 Transmission Line Losses

The staff has examined the approximate loads of each utility in proportion to the shares in the two Skagit units. If the service areas were considered as approximately quadrants, where the dividing line east and west is the Cascades and north and south is the Washington and Oregon border, then the load distribution would be as follows: northwest quadrant (Washington, west of the Cascades), 40%; northeast quadrant (Washington, east of the Cascades), 12%; southwest quadrant (Oregon, west of the Cascades), 42%; and southeast quadrant (Oregon, east of the Cascades), 6%. With this approximation, 82% of the load would be west of the Cascades.

With 82% of the load west of the Cascades, line losses represent the most significant cost to the transmission line impacts of Pebble Springs and Hanford siting. In 1976, BPA indicated that line losses up to 100 MW would be incurred at the Pebble Springs site.[21] The staff estimates of line losses, based on more recent BPA analysis, are summarized in Table 8. Because all power loss attributable to alternative sites are in addition to Skagit the staff values these losses at the cost to produce power (54.5 mills/kWh) which would otherwise be sold.

7.1.4 Wheeling Costs

The staff has also based wheeling costs on BPA analysis.[7] Wheeling costs on the BPA grid were increased by 50% to reflect possible costs in 1987. A credit of 40% was assumed to account for PSP&L's ability to use their own transmission system at Skagit, but not at the alternative sites. The current zone rates of BPA are $1.70/kW for Skagit and $3.50/kW for Hanford or Pebble Springs.

Table 8. Incremental Transmission Line Losses
(based on January 1989 conditions)

Site	Total PNW System Line Losses (MW)	Staff Estimate of Cost: Annual (10^6 \$)[a]	Staff Estimate of Cost: Present Value (10^6 \$)	Staff Estimate of Cost: Levelized (10^6 \$)
Skagit (Base Case)	-	-		-
Pebble Springs (4 units)	57	27.2	418	44.4
Hanford (5 units)	97.1	46.4	713	75.7
Hanford (7 units)	144.4	68.9	1059	112.4

[a]Based on 54.5 mills/kWh (staff estimate).

Source: R. B. Eastvedt, "Testimony on Bulk Transmission System Requirements Associated with Alternative Sites for the Skagit Nuclear Generating Facilities," 25 June 1979, Table 2.

502 116

7.1.5 Labor Costs

Site labor costs can be expected to be greater east of the Cascades under most conditions. For example, the Pebble Springs area does not have a skilled craft labor supply and workers would come from western Washington, western Oregon, and the Richland, Pasco, and Kennewick areas. If the Skagit units were moved to Hanford, there could be a relatively sufficient work force, depending on the timing of the WPPSS 1 and 4 units and other projects in the area. The WPPSS 4 unit is scheduled for completion in 1985. The applicant estimated in 1976, however, that construction of Skagit units at another site would entail a 2.5-year delay.[39] This estimate has been increased to a 3-year delay.[40] In the staff's view, this revised delay is a reasonable, albeit conservative expectation. When delay is considered, there is no assurance that a substantial work force would be available at Hanford, and it is reasonable to assume that a number of workers would come from western Washington and western Oregon.

The applicant has estimated that an additional $175 million would be expended to complete Skagit units at Pebble Springs. The staff updated 1976 site labor costs for two BWR nuclear units at 7% per year.[41] This yielded a cost of $398 million for site labor for units built in 1979. When $175 million is discounted to 1979 with a normal 8-year schedule, the resulting cost represents a 20% increase in site labor costs.

A 20% increase in pay is not an unusual increase to induce workers to relocate. At Pebble Springs, this represents both the incremental increase to relocate and expected longer commutation. Unions often are able to negotiate travel allowances in such contracts. Additional labor costs also depend on the labor availability at time of construction.

Another cost not estimated by the staff is the relocation expenses of utility personnel and site supervisor, most of whom are assumed to be in western Washington or Oregon and would be offered incentives to relocate. For Hanford, the staff used the 8 percent differential in cost between Skagit and Hanford. Site labor costs to move Skagit are noted in Table 9.

Table 9. Differential Capital Cost to Move Skagit Units to Alternative Sites (in 10^6 dollars)

Cost Item	Applicant's Estimate: Hanford (1979)	Applicant's Estimate: Pebble Springs (1976)	Staff's Estimate: Pebble Springs (1987)	Staff's Estimate: Hanford (1987)
Licensing and design revisions	109[a]	45[b]	109	109
Reduced taxes	0	-60 -100 ('79)	0	0
Productivity and site labor	45	175	72	29
Community facilities social impact alleviation	20	Not estimated	To be expected; not estimated	Not est.
Escalation on above	87	Estimate incl. below	130[c]	99
Base escalation due to delay (3 years)[d]	675	300	-265	-265
Seismic design	Not estimated	Not estimated	-63	-63
Total plant-related capital cost	936	Not applicable to present cost[e]	-17[f]	-91

[a]Includes design changes, \$20; contract cancellation and revision, \$10; storage/warranty extension, \$15; Bechtel Engineering, \$15; contingency, \$29; and owner's cost, \$20.

[b]Presumably did not include owner's cost and contingency.

[c]At 7% escalation and excludes taxes at 8 years.

[d]Applicant's estimate for Pebble Springs (1976) is for 2.5 years.

[e]Staff assumes it to be greater than Hanford.

[f]With community impact alleviation included, it is more expensive to move.

Sources: D. H. Knight, "Testimony on Alternative Sites - Pebble Springs," 25 June 1976;
Letter from J. E. Mecca, Puget Sound Power & Light Company, to W. H. Regan, U.S. Nuclear Regulatory Commision, 12 June 1979.[40]

502 119

7.1.7 Licensing and Redesign

A cost more difficult to estimate is that associated with licensing and redesign. Redesign would include such items as foundations, and water intake and discharge systems. If, as the staff has assumed, mechanical-draft cooling towers are used, this would require a design change and an energy penalty.

The applicant would also have to start the licensing and permitting process again, including environmental data collection and sampling. The applicant has also indicated contract renegotiation which, in addition to the "cost exposure" associated with the activity, permits those bargaining with the utility to renegotiate perceived inflaction effects. The applicant would also have to make arrangements with other utilities--both participants to the Skagit units and owners of the alternative sites. The staff is not able to precisely verify these costs but they have been itemized (Table 9). The staff is inclined to accept the applicant's estimate given the uncertainties involved.

7.1.8 Energy Penalty of Mechanical Draft Cooling Towers

The staff estimates a 20 Mwe energy penalty per year associated with mechanical draft cooling towers at Hanford or Pebble Springs. At 54.5 mills per Kwh, the annual cost is $9.5 million per year.

7.1.9 Reduced Taxes

The applicant has estimated a reduction of $60 million in taxes attributable to the Pebble Springs unit in 1976 and $100 in 1979. Staff considers these costs real to the ratepayer, but cannot include such a transfer payment as a cost to society in cost-benefit considerations.

7.1.10 Seismic Design

The staff has previously calculated the difference between a seismic design level of 0.25 g and 0.35 g at $53 million in 1977 dollars. With 7% increase, the staff now estimates the difference at $63 million for the cheaper cost of the Pebble Springs and Hanford sites as compared to the Skagit site.

Staff assumes that with the applicant's redesign and renegotiation cost estimates presented in Table 9, that the Pebble Springs and Hanford units will realize a savings from the capital construction costs. However, if these costs can be demonstrated to be unrecoverable and thereby considered sunk costs, then staff would not estimate a saving on seismic design. As these seismic costs have not been demonstrated to be sunk costs, then staff assumes a $63 million saving.

7.1.11 Community Impact Alleviation

The applicant has estimated $20 million in community impact assistance to the Hanford site. The staff has not had the opportunity to assess this estimate. The WPPSS organization has made assistance available to the Hanford area for Units 1 and 4. Whether these costs are significantly higher than similar impacts of Skagit or ultimate costs at Satsop would be difficult to evaluate without study of the various agreements and access to WPPSS payment information. The precedent is set for impact assistance whether or not more nuclear units at Hanford would actually contribute to the same magnitude of impacts as the original units. At Pebble Springs, impact assistance would definitely be called for whether or not local communities would develop agreements similar to those required by the Energy Facility Siting Council in Washington.

7.1.12 Escalation

In 1976, the applicant attributed a $300 million delay cost to the 2.5 years in which construction costs would be increasing. The applicant now estimates a $936 million cost to a 3-year delay. This estimate is reasonable, but the staff cannot agree that the cost should be included in a cost-benefit assessment for the reasons covered below.

Escalation in costs would take place, but the ratepayer would be faced with these costs 3 years later. Because the delay would occur prior to construction, there would be no capital expenditures not already estimated which would be tied up in unproductive uses. The impact to the consumer would be whether it was more beneficial to pay for the plant earlier or pay for it later at escalated costs. Be ause the ratepayer also considers later payment better than payment now, the staff cannot attribute any real impact to escalation delay.

In the staff's view, the cost of delay is the cost of replacement power purchased which would not otherwise be required. The staff has made estimates of these costs to both the participants ratepayers and to society at large.

The staff has concluded that the economic rationale for the value assigned to escalation due to delay would depend on the present value of the capital investment in approximately 1987 compared to that investment three years later. The present value would then be less where the opportunity cost of money is 10% and escalation is at 7%. At these rates the present worth of the investment is $265 million less with delay, i.e. $3325.5 without delay compared to $3060.6 with delay.

7.1.13 Replacement Power

The staff has been forced to make a number of simplifying assumptions to estimate the cost of power that would otherwise be generated from the Skagit units beginning in 1986. The assumptions involve a number of considerations as follows: (1) need for power as forecast by the West Group; (2) participants' economic relationship to other members of the West Group and Northwest Power Pool; (3) cost of alternative energy sources and their availability; and (4) expectations regarding utility operating decisions under different hydro conditions. The assumptions are stated below.

STAFF ASSUMPTIONS REGARDING REPLACEMENT POWER

1. All power available from the Skagit units for the years 1986-1989 would be unavailable due to delay and replacement power purchased. Purchased energy is as the West Group has forecast at 3.9 percent.

LOW ESTIMATE

2a. The low estimate assumes the Skagit energy production in each year 1986-1989 will be obtainable entirely from available surplus nuclear energy in excess of firm load carrying capability for 1986, 1987 and 1988 for West Group and from the participants own sources. Only the month of September 1987 and August 16 through December 1, 1988 would require oil purchases.

HIGH ESTIMATE

2.b. The estimate assumes that adverse water conditions prevail and all energy is purchased at the price of oil fired generation.

3. Staff makes no assumption regarding how participants and West Group plan demand and resource allocation prior to Skagit operation (1986).

4. Staff assumes that for the low estimate 402 MWe of existing capacity per year can be used to meet future demand at the price of nuclear fuel in 1987--14.5 mills/kWh; staff assumes that under median water conditions, the participants can also purchase nuclear at the total cost to generate from Skagit (54.5 mills/kWh) less fuel savings from Skagit operation (14.5 mills/kWh). Staff assumes that under adverse water, the participants must purchase oil-fired generation.

5. Oil-fired generation is assumed to cost the following to the ratepayers in 1987: capital, $425/kW; fuel, $43/barrel and 602 kWh/barrel. Staff assumes world price of oil at $20/barrel with an annual increase of 10 percent per year to 1987. Total fuel cost is 71.4 mills/kWh less nuclear fuel savings at 14.5 mills/kWh or 56.9 mills/kWh. For the cost to society it is assumed that the high cost estimate only includes the fuel cost of oil and not the capital cost which is already sunk.

6. Staff assumes that based on hydro conditions the high cost estimate has a 15 percent expectation and the low estimate has an 85 percent expectation.

7. Staff assumes Skagit units are needed for energy other than peak. In order to compute costs, staff updated its previous estimate to reflect 18-month revision in applicant schedule.

Based on the assessment, the staff has estimated costs similar to the applicant, but based on the staff's view of availability of generating sources rather than operating policies of the Northwest Power Pool (Table 10). In considering ratepayer impacts, the staff estimates that the full cost will be borne by the ratepayer. For society at large, only the cost of oil-fired fuel would represent a resource that would otherwise not be used if a 3-year delay were not incurred in moving to an alternative site. The capital cost of oil fired generation would be a cost to the ratepayer which would not be borne by the public as new construction is not assumed to be necessary.

Table 10. Replacement Power Cost at Alternative Sites

	Megawatts Purchased (MWe)		
	Total MWe	@ 40 mills/kWh[b]	@ 56.9 mills/kWh[c]
High estimate	2898	0	2898
Low estimate[a]	1692	1507	185

	Total Cost (10^6 $)	
	to Ratepayers (Nuclear and Oil)	to Society (Oil Only)
High estimate	1800 (1100[d])	1400
Low estimate	620 (1100[d])	92

[a]Assumes that 402 Mwe would be available from participants existing thermal with median water each year 1986-1989.

[b]Cost to ratepayer only.

[c]Cost to society. Cost to ratepayer is 84.6 mills per KwH for oil less nuclear fuel savings 14.5 mills per KwH.

[d]Estimate of Puget Sound Power & Light Company in letter from J. E. Mecca to W. H. Regan, U.S. Nuclear Regulatory Commission, 12 June 1979.[40]

7.1.14 Replacement Power Compared to Delay Cost

The benefits and cost of delay at Skagit units without consideration of the features of the alternative sites indicate a wide range of cost variation. Due to the time value of money, staff has previously indicated (Table 9) that delay would result in a savings of $265 million. In order to realize this saving the cost of replacement power would have to be considered. Because of the difficulty of predicting hydro conditions in the Pacific Northwest, Staff has made a high and low estimate of the replacement power costs. Because the low estimate represents normal hydro conditions, staff leans toward this estimate as more representative of future conditions.

For the high estimate the overall replacement power to the ratepayer is $1,800 million dollars, less $265 million in delay savings, or $1.535 million. For the public the equivalent cost is $1,135 million. For the low estimate, the cost to the ratepayer (replacement cost less delay saving) is $355 million. For the public there is an overall saving of $173 million.

7.1.15 Total Cost to Move Skagit Units

Total cost to move Skagit are summarized in Table 11. All costs have been levelized to reflect previous estimates of total costs. For the ratepayers, the costs represent an increase of 12-19 mills/kWh over recent capital and fuel update estimates. The staff estimates the ratepayer will incur a 23-35 percent increase in Skagit unit costs. Comparable increases to society are 8-13 mills/kWh or 14-24 percent increase in cost.

Table 11. Staff Estimate of Additional Cost to Ratepayers and Society to Move Skagit Units (in 10^6 dollars)

Cost Item	Pebble Springs (2 or 4 units)	Hanford (5 units)	Hanford (7 units)
Present value of capital and replacement power costs (Ratepayer)	58 - 1366 (586 - 1770)	(-16) - 1309 (512 - 1692)	(-16) - 1309 (512 - 1692)
Present value of Annual costs: Transmission losses, wheeling, and mechanical draft towers	707	1002	1348
Present value of cost to society	765 - 2073	986 - 2311	1332 - 2657
Present value of cost to ratepayer	1293 - 2477	1514 - 2694	1860 - 3040
Levelized cost of total costs (Ratepayer)	81 - 212 (137 - 263)	105 - 245 (161 - 286)	141 - 282 (197 - 322)
Total cost to ratepayer Cost in mills/kWh	10.1 - 19.4	11.9 - 21.1	14.6 - 23.8
Percent increase	19 percent to 44 percent		
Total cost to society Cost in mills/kWh	6.0 - 15.7	7.8 - 18.1	10.4 - 20.8
Percent increase	11 percent to 38 percent		

The staff considers the replacement power costs as more uncertain than the other costs as replacement power depends on the need for power. However, staff does not believe that a reassessment of the need for power would lead to better estimates of the actual economic consequence of delay or alternative sites.

8.0 CONCLUSION

The staff has evaluated the site environment features of the site including geological and seismic, terrestrial, aquatic and socio-economic. For aquatic impacts the sites were assessed and differences in impacts were not found to be sufficient to make any one site clearly preferable. For terrestrial impacts the sites are considered comparable. In the evaluation of socio-economic considerations the staff concluded that an overall clear preferability for one of the two alternative sites depends on the weight given to socio-economic considerations. The differences between these sites in seismic and geologic conditions can be accommodated by the engineering design of the plant; these design differences are reflected in the capital cost.

The costs to move the plant to an alternative site were evaluated with respect to the impact on the ratepayer and the public. Staff has found both Hanford and Pebble Springs to be measurably more expensive than Skagit. For the public the range of estimated cost is 11 to 38 percent increase in cost. The staff leans toward the lower estimate. For the ratepayer the costs are a 19 percent to 44 percent increase. The staff concludes that Pebble Springs and Hanford sites are not obviously superior in view of these cost considerations.

APPENDIX A. STAFF UPDATE OF SKAGIT COSTS TO REFLECT SCHEDULE CHANGES

The staff has updated previous estimates of Skagit nuclear costs in Table A.1. Previous estimates of cost comparisons (prefiled cost-benefit testimony) showed close agreement between the applicant's and staff's costs both in the original submission in 1977 and the update in 1978. The staff has updated these costs again to reflect the applicant's testimony on Financial Qualifications dated 1 June 1979. The format for this latter submission is different than previous submissions by the applicant. For consistency, the staff has adjusted the applicant's financial data to reflect (1) scope changes; (2) escalation on new scope; (3) change from 1978 to 1979 dollars; and (4) increased escalation due to an 18-month rather than 12-month schedule change. These changes were added to previous estimates of escalation and AFDC.

The old staff estimates were then updated to reflect the same inflation and escalation factors of 6% and 7% based on previous staff estimates of escalation and capital. The staff estimates of AFDC were retained, but applicant scope changes were added to the staff's previous estimates.

Based on an update of both fuel (14.5 mills/kWh) and capital (40 mills/kWh), the staff now estimates the cost of Skagit at 54.5 mills/kWh. This estimate is used for all staff comparisons for alterative sites.

Table A.1. Adjustments to Capital Cost Comparisons (Units 1 and 2) Due to Revision in Applicant's Schedule and Update of Applicant's Costs (in 10^6 dollars)

	Date of Operation			
	Mar 1985[a] and Mar 1987[a]		Sep 1986 and Sep 1988	
Cost Item	Applicant[b] (Jan 78)	Staff (early 78)	Aplicant[c] (Jan 79)	Staff[d] (Jan 79)
Total direct and indirect cost (at 0.35 g), including escalation and allowance for funds during construction at time of operation	2934	2827	3325.5	3191.1
Total levelized cost to the utility	479.7	462.2	542.0	520.1
Cost in mills/kWh	35.4	34.1	40	38.4

[a]"Emendation to Supplemental Testimony of T. L. Winters on Contentions G, J-10, J-15, Cost-Benefit Analysis," in answer to Interrogatory No. 7, submitted 6 January 1978.

[b]Puget Sound Power & Light Company's answer to Interrogatory No. 7, "Preliminary Estimate Update."

[c]Extracted from applicant's testimony on financial qualifications, 1 June 1979, Tables 1-1 through 1-3. Costs include new plant, percentage of new escalation attributable to new plant, inflation, and previous estimate of AFDC and escalation.

[d]Includes applicant's adjustment factors for inflation, escalation, and plant costs with previous staff estimates.