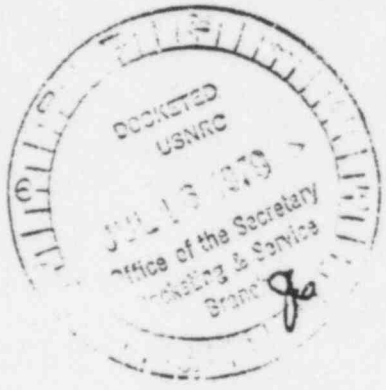

INTERVENORS SUPPLEMENTAL TESTIMONY ON

ALTERNATIVE SITE COMPARISON

E. S. Cheney

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SUMMARY

The applicants have identified six alternative sites for the Skagit nuclear plants. With the exception of the hazard of a nearby oil refinery at Cherry Point, Washington, non-geological factors do not seem to be critical in choosing between these sites. Preliminary geological analyses indicate that Cherry Point and Skagit should be eliminated because they are adjacent to faults in a region of high seismicity. Goshen is better than Skagit, but because it is in the same region of high seismicity and may be too close to faults, it probably is, at best, marginal. Hanford, Pebble Springs, and Ryderwood clearly are superior sites compared to Skagit, but this preliminary study is not sufficient to endorse these as nuclear power plant sites.

This evaluation differs markedly from the evaluations of the applicant's (Bechtel, 1979, p. 50) and the NRC's (Leech, et. al., 1979, p. 13, 15) which concluded that the Skagit was the superior site in western Washington. The NRC even concluded that no known geological, seismological, or geotechnical reason preclude construction of nuclear power plants at any of the six sites (p. 14, 18).

Because detailed geological mapping of bedrock and surfical sediments must still be undertaken before the Skagit area can be evaluated in detail, additional delays may be minimized by moving the proposed Skagit plants to Hanford.

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INTRODUCTION

The applicants have identified six alternative sites for the Skagit nuclear plants:

Skagit in Skagit County, Washington

Goshen in Whatcom County, Washington

Cherry Point in Whatcom County, Washington

Hanford, in Benton County, Washington

Pebble Springs in Gilliam County, Oregon

Ryderwood in Lewis County, Washington

Of these, I have only studied Skagit in detail (Cheney, 1978 a); so evaluation of the other five sites is preliminary and, therefore, comparable, to the screening that might be done in the initial selection of areas for further evaluation as potential nuclear power sites.

Table 1 compares the six sites. The information contained in the table indicates that Cherry Point and Skagit are unacceptable sites and Goshen is, at best, marginal; whereas, Hanford, Pebble Springs, and Ryderwood are clearly superior to Skagit and Goshen.

NON-GEOLOGICAL ACTORS

The prefiled testimony of Leech et. al. (1979) indicates that non-geological factors are not critical in choosing between the six sites (Table 1). However, Leech et al. do indicate that on socio-economic grounds, Skagit is less desirable than either Hanford or Pebble Springs.

Transmission costs are not critical in the selection of sites. Electricity is already transmitted from the hydroelectric plants east of the Cascades to western Oregon and western Washington. The transmission costs from Skagit are obviously minimal for Puget Sound Power and Light because the site is within its service area. However, the Oregon utilities, which own 50% of the proposed plants, would experience lesser transmission costs if the plants were to be located at Ryderwood. If the plants were located at Hanford or Pebble Springs, the transmission costs to the Oregon utilities probably would be somewhat less than from the Skagit, Goshen or Cherry Point sites which are more distant from the utilities service areas. Transmission costs to Washington Water Power, which owns 10% of the proposed plants, would be minimal if the plants were in Hanford or Pebble Springs. In summary, although the transmission costs to Puget Sound Power and Light would be least if the plants were at Skagit, when all of the utilities are considered, the transmission costs are probably least from Ryderwood, and Hanford and Pebble Springs are even better than Skagit.

GEOLOGICAL FACTORS

The limiting factors in choosing between the six sites identified by the applicant are geological. Skagit and Cherry Point are unacceptable because they are in an area of high seismicity and are adjacent to faults. Additionally, Skagit has potential landslide problems and its water intake wells adjacent to the Skagit river cannot be protected because flood-control structures will not be allowed. Cherry Point may have a potential for liquifaction.

Goshen, about 8 miles northeast of Bellingham, appears to be a marginal site. It is in the same area of high seismicity as the Skagit and Cherry Point sites, but it is more distant from the Bellingham Bay-Lake Chaplain fault. The suitability of the site would depend critically upon investigation of the age of the Vedder Mountain fault which passes within 5 miles of the site.

Ryderwood, Hanford, and Pebble Springs all appear to be good candidate sites. Ryderwood is in the same area in which Woodward-Clyde Consultants (1975) independently identified two good candidate sites.

CRITIQUE OF THE APPLICANTS' AND THE NRC'S EVALUATION OF SITES

The applicants' (Bechtel, 1978) and the NRC's (Leech, et al., 1978) evaluations of the alternative sites deserve some response. In this section I will note some differences in the geological evaluations in those reports and in Table 1 of this report.

Skagit

Although Leech et al. (1979, p. 19) and the applicant (Bechtel, 1978, p. 13) expect no landslides, the report of R. H. Blunden (1978) suggests differently.

Leech and others consider the Shuksan thrust, which is three miles west of the plant site, to be the closest significant fault. This fault is not significant in that it is not capable. What is significant is that the USGS (Whetten testimony of June, 1978) believes that his is not the easterly dipping Shuksan thrust fault, but a somewhat younger westerly dipping th[illegible]st fault. This controversy indicates how poorly known the geology of the Skagit site is. Leech, et al. 1979 and the applicants (Bechtel, 1978) fail to mention that the Day Creek and Gilligan Creek faults (noted by Whetten) and the inferred Hamilton fault (Cheney, 1978 a) pass within three miles of the plant site.

Although Leech et al. consider the Devil's Mountain fault 13 miles south of the plant site to be capable (p. 19) they do not consider it a hazard because they assume that an earthquake on it would be less than 6.0 to 6.5 M, p. 20). However, if this assump-

tion is wrong and the earthquake is >6.8 M, acceleration at the plant site could exceed 0.35g (Cheney, 1978 a, Table 3).

Leech et al. believe that the controlling earthquake at Skagit would be associated with the subduct oceanic plate at a depth of 50 km or more below the site (p. 20) and that attenuation from such a great depth would cause acceleration to be less than 0.35g. However, this would not be the controlling earthquake. The controlling earthquake would be comparable to the shallow 1946 or 1872 earthquakes. The 1946 earthquake was 7.3 M, less than 30 km deep, and on a preferred fault plane solution that was northwesterly and right lateral (Rogers and Hasegawa, 1978). The 1946 earthquake was spatially associated with the Beaufort Range fault; a meter of historic displacement has been noted on this fault (Rogers, September, 1978, personal communication). Furthermore, the 1872 earthquake, which was somewhere in the northern Cascades, probably in the vicinity of Ross Lake (Malone and Bos, 1979), was shallow and about 7.3 M (Cheney, 1978 a, Table 5). Because the causitive structure of this earthquake has not been identified, and because the earthquake is in the same geological province as the Skagit site, according to CFR Part 100, Appendix A, the 1872 earthquake must be assumed to occur at the plant site. A 7.3 M earthquake within 15 miles of the plant site could exceed 0.35g (Cheney 1978 a, Table 3). Furthermore, because the 1872 and 1946 earthquakes were greater than equal to 7.3 M, the maximum credible earthquake must be correspondingly larger.

The problem of preserving the integrity of the coolant water is not addressed by Leech et al., 1979, or by the applicants (Bechtel,

1978). Dunne (1979) points out that the bend of the Skagit River where the Ranney wells are planned cannot be stabilized without rip rap. The Wild and Scenic River Act presumably excludes such engineering structures.

Cherry Point

This site is within five miles of what Leech et al. term the Northern San Juan Island Fault, which I considered to be part of the BB-LC (Cheney, 1978 a). The presence of this fault and the presence of this site in the same seismic province as the Skagit suggests that the controlling earthquake for the two sites is the same.

There appears to be considerable disagreement as to the age of the sediments at Cherry Point. This is significant because a till reportedly overlies a silt that dips as high as 7° (Easterbrook, 1963, Bechtel, 1978). Such lush and laterally persistant dips in a silt are surely tectonic as Gower (1978) notes. Bechtel cites Gower (1978) as stating that the silts are pre-Frazer (older than 13,000 to 20,000 years), but Easterbrook explicitly states that Frazer and older sediments do not crop out in the area. He shows the area around Cherry Point underlain by the Bellingham drift that has locally been dated at 11,000 to 12,000 years B. P. Thus the deformation at Cherry Point would appear to be very young, deformation of such young strata would not be a desirable feature at a nuclear site.

Leech et al. point out that extent and age of the Northern San Juan Island fault have not been determined and that to do so would be difficult, costly, time-consuming, and possibly futile (p. 26). Although such determinations may be costly they should be relatively

easy. Seismic reflection profiling at low frequencies discovered the fault in the bedrock, and such surveys could be used again. Presumably, some experimentation with higher frequencies would be needed to find those that will penetrate the overlying unconsolidated sediments and still have enough resolution to detect any faulting in these sediments. If the fault strikes eastward as Leech et al. imply, it might be traced onto land. The overlying sediments could then be drilled to date them paleontologically or radiometrically. Even if the fault does not strike landward, seismic reflection profiling might recognize the landward extension of the sediments overlying it, so that the sediments could be sampled by drilling.

The Boulder Creek and Vedder Mountain faults may need to be evaluated for this site. However, evaluation of these faults is described below in the discussion of the Goshen site.

Goshen

Because it is the same seismic province as Skagit, Goshen has many of the same problems as Skagit. The site is, therefore, probably unacceptable. Furthermore, it is only 17 miles distance from Northern San Juan Island fault (the BB-LG).

The southwesterly striking Boulder Creek and Vedder Mountain faults may pass within five miles of the site, and thus they would have to be evaluated. According to Miller and Misch, 1963, the Boulder Creek fault does not cut the middle Eocene Huntingdon formation, and this relationship should be easy to confirm by geology (contrary to the opinion of Leech e al., p. 22, 26).

The southwesterly striking Vedder Mountain fault might be more difficult to evaluate because it is covered by Pleistocene sediments.

However, conventional seismic reflection profiling across the strike of this fault should indicate whether it cuts the Miocene and Pleistocene sediments in the Bellingham basin.

Ryderwood

Numerous small faults are known in the vicinity of the Ryderwood site. Leech et al. (p. 24) consider that adequate definition and delineation of these faults might be possible but time consuming and costly due to the lack of marker units. The presence of Tertiary, Early Pleistocene, and Late Pleistocene strata in this area (Woodward-Clyde Consultants, Table 3) suggests that the faults can be dated. In fact without such a possibility, the two sites in the area would not have been considered by Woodward-Clyde Consultants (p. 39). In this respect Ryderwood may be superior to Skagit.

DELAYS

Changing the Skagit plants to the Hanford or Pebble Springs sites might not result in greater delay than persisting to insist that they be at Skagit. The applicants have not yet undertaken the detailed geological mapping of bedrock and surficial sediments at scales greater than one inch = one mile (1:62,500) that is regarded as necessary by geoscientists familiar with the area to evaluate the Skagit area (Cheney, 1978 a, Appendix 2; Cheney, 1978 b). The applicants' apparent reluctance to do such mapping suggests that they would not be able to complete it within a year. Presumably, Goshen or Ryderwood would take equally long to map. In contrast, the Hanford Site has already been licensed for WPPSS numbers 1, 2 and 4, suggesting that additional studies at Hanford would be minimal. Similarly, geological investigation at Pebble Springs are well advanced.

Therefore, assuming that the costs of delay are important, the applicants might find it advantageous to cite the proposed Skagit plants at Hanford. This consideration may be especially important, because absolutely no assurance exists that if the applicants or disinterested third parties were to map the area around Skagit at scales greater than 1:62,500, all geological problems would disappear. In fact, the reverse is highly likely.

SITES FOR FOSSIL FUEL PLANTS

Because the hazards caused by the destruction of a plant by earthquakes are not nearly as serious for a fossil fuel plant as for a nuclear power plant, the requirements for siting fossil fuel plants are not nearly as stringent. A preliminary study by Woodward-Clyde Consultants (1975, Figure A-6) shows that most of Puget Lowland, including must of the service area of Puget Sound Power and Light, is suitable for fossil fuel sites. Of the six alternative sites, only the Skagit site was eliminated as a fossil fuel plant site in this study.

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WOODWARD-CLYDE CONSULTANTS, 1975: Executive summary Siting Study; available from Washington Public Power Supply System, Richland, Washington, 57 p.

	CRITERIA	HANFORD	PEBBLE SPRINGS	RYDERWOOD	GOSHEN	SKAGIT	CHERRY POINT
NON-GEOLOGICAL	Terrestial Ecology	Comparable to Skagit (1)	Comparable to Skagit (1)		Probably similar to Skagit	Comparable to Skagit and Pebble Springs (1)	
	Aquatic Ecology and Resources	Comparable to Skagit (2)	Comparable to Skagit (2)		Probably similar to Skagit	Comparable to Skagit and Pebble Springs (2)	
	Socio-Economic	Preferable to Skagit (3)	Preferable to Skagit (3)		Probably similar to Skagit	Less Desirable to than Hanford or Pebble Springs (3)	
	Transmission Cost	Approximately Twice as Expensive as Western Washington (4)		Approximately one half as expensive as Hanford or Pebble Springs (4)			
	Other						Too Close to Oil Refinery (5) Once-through Cooling Bad (5)
GEOLOGICAL	Regional Seismicity	In Area of Low Seismicity (6)			In Area of High Seismicity (6,11)	Low Subarea (6) Within Area of High Seismicity (6,11)	In Area of High Seismicity (6,11)
	Distance to Faults	10 Miles; Probably not Capable (7)	2½ Miles, not Capable (8)	Many Small Faults to be Investigated (9)	17 Miles to BB-LC at Hale Passage (10) <5 Miles from Vedder Mtn. Fault	9 Miles to BB-LC 13 Miles to Devils Mtn. <5 Miles to Several Faults in Skagit Valley (10)	<5 Miles to BB-LC - Northern San Juan Island Fault (10,12)
	Controlling Earthquake	Shallow Earthquake, Probably >20 Miles Distant and Probably ≤7.3 to 7.5 M of 1946 and 1872			Shallow Earthquake, Probably <20 Miles Distant and ≥7.3 to 7.5 M of 1946 and 1872		
	Potential for Landslides	None (13)	None (13)	Low (13)	Low (13)	Possibly Severe (14)	Low (13)
	Potential For Liquefaction	With Remedial Work, None (13)	None: Bedrock (13)	None: Bedrock (13)	None: Bedrock (13)	None: Bedrock (13)	Possibly on Sediments
	Vulnerability of Cooling Water					Unprotected on Wild and Scenic River	
OTHER STUDIES	Investigation of Woodward-Clyde Consultants 1975	Not Strictly Evaluated, but Acceptable Benton #2 is Nearby	Not Strictly Evaluated, but Acceptable Benton #1 is Nearby	Best Candidate Sites Lewis #3 and Lewis #2 in Same Area	Eliminated by Regional Seismicity (Figure D4)	Eliminated by Culturally Important Area of Skagit Valley (Figure D1)	Eliminated by Regional Seismicity (Figure D4)
RANKING		GOOD CANDIDATE SITES			MARGINAL	UNACCEPTABLE	

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TABLE 1: COMPARISON FO THE SIX ALTERNATIVE SITES:

References:

1)	Leech, et al., 1979	Table 3
2)	Leech, et al., 1979	Table 2
3)	Leech, et al., 1979	Table 5
4)	Eastvedt, 1979	Page 6
5)	Leech, et al., 1979	Page 13
6)	Woodward-Clyde Consultants, 1975	Figure D4
7)	Leech, et al., 1979	Page 30
8)	Leech, et al., 1979	Page 28
9)	Leech, et al., 1979 Woodward Clyde Consultants, 1975	Page 24 Table 3
10)	Cheney, 1978	Figure 12
11)	Milne, et al., 1978	Figure 10
12)	Leech, et al., 1979	Page 26
13)	Leech, et al., 1979	Table 1
14)	Blunden, 1978	

Format of Table: Note that boxes are drawn around the criteria under each site that make that site questionable for nuclear power plants.