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MEMORANDUM FOR: Michael J. Bell, Chief
High-Level Waste Licensing
Management Branch
Division of Waste Management

FROM: Hubert J. Miller, Chief
High-Level Waste Technical
Development Branch
Division of Waste Management

SUBJECT: REVIEW OF DOE'S DRAFT ENVIRONMENTAL ASSESSMENT FOR THE BASALT WASTE ISOLATION (BWIP)

Enclosed are the WMHT comments on portions of Chapter 1, 2 and 3 as outlined in your memo dated March 18, 1983.

ORIGINAL SIGNED BY PSJ

Hubert J. Miller, Chief
High-Level Waste Technical
Development Branch
Division of Waste Management

Enclosure:
WMHT Comments

OFC	WMHT	WMHT	WMHT for				
NAME	PPRESTHOLT:ls	RWRIGHT	HJMILLER				
DATE	83/03/25	03/ /83	03/25/83				

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Page 1-1, Last paragraph

1.2 REPOSITORY DEVELOPMENT SUITABILITY

The Act requires that each guideline be used in evaluating the suitability of the site for characterization, but that in evaluating the suitability of the site for development as a repository, only those guidelines that do not require characterization need be used. Only five of the eighteen proposed siting guidelines were determined to not require site characterization prior to assessing site suitability for development as a repository. These five technical guidelines dealt with human intrusion, surface characteristics, population density and distribution, environmental protection, and socioeconomic impacts. The candidate site, when evaluated against each of the five guidelines, did not reveal any disqualifying factors applicable to the Hanford Site (see Section 3.2). The preliminary conclusions drawn after evaluating each of the five guidelines are presented in Section 3.1.

The NRC staff agrees with the thrust of this paragraph. The majority of the guidelines, particularly numerical guidelines, cannot be applied at this early stage of site characterization.

Page 2-6, paragraph one

The EA states, "However, the intraflow structure of some of the thicker flows (greater than 30 meters (100 feet)) does show considerable continuity and uniformity within the Pasco Basin."

The evidence, as seen in outcrop at Emerson Dipple and in various boreholes, such as RRL-2, indicates that there is considerable variation in the intreflow zones (thickness of flow tops, presence of fracture zones in the dense interior, high permeability zones in flowtops and dense interior as indicated by excessive drilling mud loss). See NUREG 0960, chapters 3 and 4.

The DOE should indicate where non-uniformity occur. This would strengthen their position

Page 2-6, paragraph two

The EA states, "**the results of laboratory and field testing indicate that the volume of unfilled fractures is small, as attested by the low total fracture porosity and permeability.**"

Since the majority of fractures in the basalts are vertical or sub-vertical, only a small percentage of the fractures that occur in the basalts will be seen in core from vertically drilled boreholes. Therefore, there is no basis for stating that "the volume of unfilled fractures is small."

Such statements should have the proper caveats associated with them, such as: the volume of unfilled fractures is small, as observed in the core recovered from coreholes .....

Page 2-6, paragraph 4

The EA states, "The poor quality of groundwater in the Grande Ronde Basalts restricts its use for these purposes."

The Grande Ronde is a major aquifer, pumped for use in irrigation east of the Columbia River where it is much closer to the surface. The EA does not show that the water in the Grande Ronde under the Hanford Reservation has a different chemical composition from the waters pumped for irrigation from the same formation.

The EA should ~~contain~~ give the data that shows the difference in Grande Ronde water from the Hanford Site and from irrigation waters pumped from the Grande Ronde.

Page 2-8, paragraph 7

The EA states," the low permeability measured in boreholes for the basalt-flow interiors indicate these portions of the flows will provide the isolation necessary to prevent the radionuclides reaching the accessible environment in concentrations above established guidelines."

This statement does not consider the fracture zone found in the lower part of the dense interior of the Umtanum flow in borehole RRL-2 or the fact that no vertical permeability measurements in dense flow interiors have been documented. See Chapter 3, NUREG 0960 for a discussion of this topic.

Page 2-9, paragraph one

The EA states, "

"No faults have been identified on the Hanford Site that would have an adverse impact on a repository constructed at the reference repository location"

There are a number of anomalouse zones, such as the Nancy Linear, that have be located by geophysical surveys or remote sensing studies that have not been identified. DOE has not determined what the anomalies are. See chapter 4 of NUREG 0960 for a discussion of these anomalous zones.

Page 2-9, last sentance

The EA states,

"Where positive resolution of the criteria requirements cannot be satisfied by technical data, performance-assessment modeling will be conducted."

This statement needs qualifying, modeling cannot substitute for facts and data.

Page 2-10, paragraph one

The EA states, "The flow tops and dense flow interiors of the Grande Ronde Basalt are overall hydraulically tighter than the shallower basalts and produce less groundwater than shallow basalts."

Data from borehole RRL-2 indicates that 103,000 gallons of drilling mud was pumped into the Umtanum flow top and that more than 20,000 gallons of drilling mud was pumped into a fracture zone near the base of the dense interior of the Umtanum flow. Mud losses in other bore holes show very high mud losses in Grande Ronde flow tops. The NRC staff does not consider that the data confirms this statement.

Page 2-10, paragraph 2

The EA states, "The groundwater movement is generally in an east to southeast direction within the Cold Creek syncline beneath the Hanford Site. Data on hydrologic properties, hydraulic heads, and groundwater chemistry indicate that lateral groundwater flow takes place primarily through permeable flow tops and sedimentary interbeds."

The NRC staff considers that there is evidence of northward flow of groundwater through the RRL. A discussion of this topic is found in NUREG 0960.

Page 2-10, paragraphs 3 and 4

The EA states "Modeling of the near-field groundwater flow system around a repository indicates that the groundwater flow paths are primarily controlled by the more permeable flow tops between successive flows. Results of modeling also indicate that the minimum groundwater travel-times from the repository site to the accessible environment, a distance defined by the EPA in its proposed regulations (EPA, 1982) as 10 kilometers (6.2 miles), appear to be greater than 10,000 years. The very small quantities of radionuclides, which do ultimately travel to the accessible environment, appear to remain small and well below the EPA-proposed regulations.

Over the past several years, a number of far-field hydrologic modeling studies have been conducted by independent organizations. Each study had limiting assumptions and used the most recent data available at the time of the study. Traveltimes were estimated for groundwater movement between the repository and a discharge point at the Columbia River, a distance of 8 to 60 kilometers (5 to 35 miles) depending on the assumed flow path. Traveltimes estimated exceeded 13,000 years. Regardless of the different assumptions used, these estimated pre-waste-emplacement traveltimes are significantly longer than the NRC-proposed technical criterion (NRC, 1981a) of a 1,000-year minimum traveltime between the repository and the accessible environment."

The NRC staff challenges the statements made concerning the long groundwater travel times to the accessible environment. NRC staff calculations, using DOE supplied data, show possible travel times to the accessible environment to be as little as 20 years. See chapter 3 and appendix D of NUREG 0960 for a discussion of this topic.

Page 3-16, paragraph 2

The EA states, "At least three candidate repository horizons, the Umtanum, Cohassett, and McCoy Canyon flows, appear to meet the thickness, lateral extent, and depth requirements needed for construction of an underground facility and for assurance that the projected releases of radionuclides would be less than those specified in Section 960.3-2 of the proposed siting guidelines (DOE, 1983)."

Data from borehole RRL-2 raises significant doubt that the Umtanum flow, at that location, would be suitable for a HLW repository. Since all basalt flows in the Grande Ronde formation were deposited in the same manner, the NRC staff considers that this statement is premature.

Page 3-19, paragraph 3

The EA states,

"3.1.3.1.2.1 Summary of Available Information. Available borehole data (five boreholes) indicate that throughout the reference repository location, the Cohassett flow is 73 to 81 meters (239 to 266 feet) thick, the McCoy Canyon flow is 34 to 45 meters (110 to 147.5 feet) thick, and the Umtanum flow is 60 to 71 meters (197 to 232 feet) thick. All three candidate repository horizons appear to be laterally continuous throughout the reference repository location and the northern Pasco Basin (see Fig. 3-3). The candidate repository horizons are known to occur at least 27.8 kilometers (16.7 miles) north, 26.4 kilometers (15.8 miles) east, 13.6 kilometers (8.2 miles) south, and 21.4 kilometers (12.8 miles) west of the center of the reference repository location."

It is important to note that it is the thickness and competency of the dense interior of the candidate flow that is important to the construction of a repository, NOT the total thickness of the flow. See Chapter 4 of NUREG 0960 for a discussion of this point.

Page 3-19, paragraph 6

The EA states, "based on data for basalt, numerical models are being developed to address questions regarding groundwater traveltimes and radionuclide concentration releases to the accessible environment under both undisturbed and reasonable scenario conditions."

The NRC staff considers that a defensible conceptual groundwater model must be developed before a useful numerical traveltime model can be developed. See chapters 3 and 9 of NUREG 0960 for discussions of this topic.

Page 3-19, last paragraph

The EA states,

"The geohydrologic regime in basalt beneath the Hanford Site has characteristics favorable to waste containment and isolation. These include a tectonic setting undergoing a very low rate of deformation, rock layers of low permeability, plus groundwater traveltimes and potential radionuclide release rates well within recommended Federal guidelines. A summary discussion of present and future hydrologic conditions, hydrologic modeling, shaft construction, and dissolution features follows."

The NRC staff takes exception to the statement that groundwater travel times and radionuclide release rates are well within recommended Federal guidelines. See chapters 3 and 9 and appendix D of NUREG 0960 for a discussion of these topics.

Page 3-21, paragraph 3

The EA states,

"Groundwater chemistry provides direct long-term evidence of the water's history. Present data have identified distinct groundwater chemistries in the shallow versus deep basalts, each with distinguishable isotopic signatures. ~~The areal continuity of these chemical types and~~"

The NRC staff take exception to this statement. The groundwater chemistry does not support seperate flow systems. See chapter 3 and appendix F of NUREG 0960 for a discussion of this topic

Page 3-21, paragraph 5.

The EA states, "Because of the greater-than-normal occurrence and length of fracturing in structurally disturbed areas (e.g., Umtanum Ridge-Gable Mountain anticline) (see Fig. 3-3), water is considered to seep vertically through such structures to a larger extent than in nondisturbed areas."

The NRC staff considers that the vertical movement of water in the Umtanum Ridge-Gable Mountain structure could provide a pathway for discharge of radionuclides into the Columbia River. See appendix D of NUREG 0960 for a discussion of this topic.

Page 3-23, paragraph 2

The EA states,

"Hydraulic head data collected from within the reference repository location are being integrated with Hanford-wide information to develop a more complete understanding of the groundwater system. Within the Saddle Mountains Basalt beneath the reference repository location, head elevations decrease with depth from 137 to 127 meters (449 to 417 feet). Lower heads with depth are characteristic of groundwater recharge areas such as found in the shallow basalts along the western Hanford Site. Head elevations are rather uniform within the Wanapum and Grande Ronde Basalts in the reference repository location, averaging 123 ± 1.5 meters (403 ± 5 feet) above mean sea level. These generally uniform head distributions are common in the Cold Creek syncline and are interpreted as indicating an area of lateral groundwater movement--that portion of the groundwater system not undergoing major recharge or discharge. The average areal head gradient in the deep basalts is a low 10^{-4} meter/meter (foot/foot). Groundwater from the reference repository location appears to move southeasterly."

The NRC staff takes exception to the conclusion stated in this paragraph. The staff does not believe the data necessarily indicates groundwater flow to the southeast. Data indicate possible groundwater movement to the north through the RRL. See Chapter 3 of NUREG 0960 for a discussion of this topic.

Page 3-25, paragraph 3

The EA states, "... such hydrochemical and isotopic shifts (coupled with small vertical hydraulic head gradients) are believed to delineate flow system boundaries and suggest the lack of significant vertical mixing of groundwaters in structurally nondeformed areas."

The NRC staff does not believe that hydrochemistry supports separate flow systems. See chapter 3 and appendix F of NUREG 0960 for a discussion of this topic.

Page 3-25, paragraphs 4 and 5.
The EA states,

"Modeling of the near-field groundwater flow system around a repository indicates that the groundwater flow paths are primarily controlled by the more permeable flow tops between successive flows. Results of modeling also indicate that the minimum groundwater traveltimes from the repository site to the accessible enviroment, a distance defined by the EPA in its proposed regulations (EPA, 1982) as 10 kilometers (6.2 miles) appear to be greater than 10,000 years. The very small quantities of radionuclides, which do ultimately travel to the accessible environment, appear to remain small and well below the EPA-proposed regulations.

Over the past several years, a number of far-field hydrologic modeling studies have been conducted by independent organizations. Each study had limiting assumptions and used the most recent data available at the time of the study. Traveltimes were estimated for groundwater movement between the repository and a discharge point at the Columbia River, a distance of 8 to 60 kilometers (5 to 35 miles) depending on the assumed flow path. Traveltimes estimated exceeded 20,000 years. Regardless of the different assumptions used, these estimated pre-waste-emplacement traveltimes are significantly longer than the NRC-proposed technical criterion (NRC, 1981a) of a 1,000-year minimum traveltime between the repository and the accessible environment."

The NRC staff challenges the statements made concerning the long groundwater travel times to the accessible environment. NRC staff calculations, using DOE supplied data, show possible travel times to the accessible environment to be a little as 20 years. See chapter 3 and appendix D of NUREG 0960 for a discussion of this topic.

Page 3-27, paragraph 6

The EA states,"

"As demonstrated in the Site Characterization Report (DOE, 1982c) the local geologic and hydrologic setting can be characterized and modeled."

The NRC staff does not agree that the SCR (DOE 198 domonstrates that the local geologic and hydrologic setting can be characterized and modeled. See chapter 3, 4, 5, 9 and 11 and appendix D of NUREG 0960 for a discussion of this topic.

Page 3-27, paragraph 6

The EA states,

"Uncertainty in understanding the geohydrologic regime is a function of basic data input, the conceptual model, the numerical models, and how uncertainty propagates from each of these model levels to the next higher one. The degree of approximation or error in the numerical codes will be checked in the process of code verification and benchmarking."

The NRC staff believes that the uncertainties of data, conceptual models, and model levels probably far outweigh error in numerical codes, which is at least somewhat quantifiable. See Chapter 9 and appendix D of NUREG 0960 for a discussion of this topic.

Page 3-27, paragraph 7

The EA states, "The near-field and far-field models use the concept of an "equivalent porous continuum" to represent the major basalt flows and confined aquifers."

The NRC staff does not understand the justification for using the "equivalent porous continuum" in the near field.

The DOE should explain why the near field is represented using this concept.

Page 3-28, paragraph 2

The very low solubility properties of major radionuclides (technetium, uranium, plutonium, americium) in the reducing (anoxic) environment of the deep basalt plays an even greater role than sorption in maintaining release rates below the proposed release criterion.

The NRC staff notes that americium is more soluble in a reducing environment. Also, the existance of a reducing environment has not been proven.

Page 3-28, paragraph 4

The EA states,

"As noted in Section 3.1.3.2.1.1, far-field hydrologic modeling has been performed by several independent organizations. Each study concluded that under pre-waste-emplacement conditions, groundwater traveltimes from the repository to the accessible environment substantially exceeded the 1,000-year proposed criteria."

The NRC staff takes exception to the statement that groundwater travel times substantially exceed the 1000-year proposed criteria. See chapter 3 and appendix D of NUREG 0960 for a discussion of this topic.

Page 3-29, paragraph one

The EA states "Scenarios initially considered applicable consisted of the following natural, man-induced, and repository-induced events for the first 10,000 years following repository decommissioning:

- Fault zone directly or indirectly connecting the repository with the biosphere
- Shaft seal degradation or failure
- Intrusion by borehole
- Loss of integrity due to microearthquake swarm zone
- Intrusion by basaltic dike.

The NRC staff believes that other scenarios are possible and should be considered. Appendix D of NUREG 0960 discusses this topic.

Page 3-29, paragraph 2

The EA states,

"Preliminary analysis of the consequences of a microearthquake event centered at the repository indicates no significant effects over the 10,000-year period of interest."

The NRC staff believes that while one event may have little or no effect over 10,000 years, many events, and there are many reported every year within 10 km. of the RRL, may have a significant effect on groundwater travel times. See chapter 4 and appendix N for a discussion of this topic

Page 3-29, last paragraph

The EA states,

~~3.1.3.2.2.2 Preliminary Conclusions.~~ "The basalt geohydrologic environment can be characterized and appears to be a suitable setting for the long-term isolation of radionuclides under nondisruptive and reasonable disruptive scenario conditions."

The NRC staff considers that this statement is premature. See chapter 3 and appendices D, E, F, G, H, I, K and L for discussions of this topic.

Page 3-33, paragraph 2

The EA states,

"The geochemistry of the groundwater in the reference repository location and surrounding area tends to be buffered by reaction with basalts that constitute the bulk of the rocks at depth. Because of the relatively high rock-to-water ratios and because the rock and groundwater compositions do not change appreciably with time and the thermal gradient remains constant, changes in groundwater chemistries would most likely result from an influx of oxygenated surface waters. Such an influx is likely to be very slow; both theoretical considerations and experimental results indicate that such water would react with basalt and become strongly reducing. Thus, oxidization conditions are not expected to persist."

The NRC staff considers that the conclusions stated in this paragraph are unsubstantiated. See chapter 5 of NUREG 0960 for a discussion of this topic.

Page 3-33, Table 3-2

TABLE 3-2. Environmental Conditions in the Candidate Repository Horizons.

Parameter	Flow		
	Cohassett	McCoy Canyon	Umtanum
Depth range* (m)	912.3 - 992.1	1,059.2 - 1,099.4	1,099.4 - 1,170.1
Mean temperature (°C)	51.2	56.0	58.2
Mean hydrostatic pressure (MPa)	9.2	10.4	11.0
pH	9.5 ± 0.05	9.5 ± 0.05	9.5 ± 0.05
Eh (V)	-0.45 ± 0.07	-0.45 ± 0.07	-0.45 ± 0.07

The value of Eh (last line of the table) is not based on measurement, but is based on on theoretical calculations. See chapter 5 of NUREG 0960.

Page 3-34, paragraph 6

The EA states,

"These theoretical and experimental studies generally confirm that the strongly reducing and alkaline groundwaters encountered in a nuclear waste repository in basalt result in lowered solubilities for many key radionuclides. Specifically, reducing conditions led to the formation of low oxidation states for many radionuclides that inhibit production of stable complex species. In addition, it appears that the high pH promotes the precipitation of most actinides in the form of oxides and hydroxides. Insufficient solubility data are available for other important radionuclides. Static and dynamic (flow-through) experiments that will address this question are in progress."

The NRC staff considers that the assertions in the above paragraph have not been demonstrated. See chapter 5 of NUREG 0960 for a discussion of this topic.

Page 3-41, paragraph 2

The EA states,

"Using Bieniawski's (1979) geomechanics classification system, the rock mass rating values for all three candidate flows are in reasonable agreement. Only one of the six parameters in the system (specifically the rock quality designation) differs for the flows. With all three flows in the "good rock" category, estimated rock mass strength and roof support requirements would be the same."

Since vertical fracturing was not taken into consideration (vertical core won't show vertical fracturing), the rock quality designations can not be characteristic so the statement that the flows fall into "good rock" category are premature.

Page 3-42, paragraph 2

The EA states, "No seismic events have been related to specific structure within the Pasco Basin."

Seismic events are related to faults. There are a number of extensive anomalies located by geophysical surveys and air photo's. The seismic events may be associated with one or more of these anomalies or on still undescovered geologic feature. See chapter 4 and appendixes M and N of NUREG 0960 for a discussion of this topic.

Page 3-43, paragraph 2

The EA states, "Faults of major displacement are not anticipated in the shallow-dipping synclinal strata on the basis that only a few tectonic features that have been found in the thousands of meters of core drilled within the Pasco Basin synclines and on the basis of mechanical analysis studies conducted by Price (1982)."

DOE has stated, in BWI-RHO-ST-14, that every borehole that has penetrated the Umtanum flow or the Grande Ronde flow has shown tectonic breccia. The phrase "a few tectonic features" needs to be put in perspective. Tectonic breccias have been present everywhere deep boreholes have been drilled.

Price (1982) has considered only one of the several possible alternatives in his mechanical analysis.

See Chapter 4 of NUREG 0960 for a discussion of these topics.

Page 3-44, paragraph one

Seismicity in the central Columbia Plateau is confined to a thin 28-kilometer (17.5-mile) crust and is characterized by temporally and spatially limited swarms of low magnitude (less than 3.5) shallow earthquakes that may be characteristic of brittle deformation in basalt.

A number of swarm (microearthquakes) events occur every year in the vicinity of the ERL. The statement that these events are "temporally and spatially limited" could give the reader the impression that these events are rare. See Chapter 4 and Appendix D of NUREG 0960 for a discussion of this topic. Refer also to the "Annual Technical Reports on Earthquake Monitoring of the Hanford Region, Eastern Washington, 1981 and 1982," prepared by the Geophysics Program, University of Washington, Seattle, Washington.

P. 3-45, paragraph 2

Uncertainties regarding the location of folds or faults, geologic (long-term) and contemporary rate of deformation, geologic structures, and seismicity of the geologic setting with respect to the site will be addressed during detailed site characterization. These specific studies to resolve uncertainties are necessary to make a final conclusion that seismic factors will not lead to a projection of radionuclide releases greater than those discussed in Section 960.3-2 of the proposed siting guidelines (DOE, 1983).

The studies mentioned mentioned in the above paragraph should be referenced. See chapter 4 of DOE/ES 0960 for a discussion of this topic.