Prepared for the U.S. Nuclear Regulatory Commission
Office of State and Tribal Programs

Sherwood Tailings Reclamation Plan

Responses to NRC Comments

Prepared by Washington Department of Health
Environmental Health Programs
Division of Radiation Protection
Waste Management Section

July 2000

APPENDIX A

GEOTECHNICAL STABILITY

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
DIVISION OF RADIATION PROTECTION
Airdustrial Center, Bldg. 5 • P.O. Box 47827 • Olympia, Washington 98504-7827

May 3, 1995

Stephanie J. Baker
Manager, Environmental Services
Western Nuclear, Inc.
200 Union Blvd., Suite 300
Lakewood, Colorado 80228

Dear Ms. Baker:

Following our telephone meetings dated April 4 and April 26, 1995, regarding portions of the Sherwood Tailing Reclamation Plan (TRP) the following comments were discussed. You agreed to begin working on these issues and provide responses.

1. Earthquake recurrence interval: Correct the record regarding probability of earthquake occurrence from Page 6 Figure 4 Appendix L of your TRP.

2. Peak ground acceleration during an earthquake event: Although your TRP addresses peak bedrock acceleration, the overlying soil column also influences acceleration. Provide an analysis of peak ground acceleration by considering amplification of the peak bedrock acceleration through the soil column.

3. There is a potential for liquefaction to disrupt the tails cover in two ways, differential settlement because of "rafting" and sand boils. The Byrne (1994) paper suggests certain analysis to determine if wholesale movement or rafting could occur. Please perform additional analysis to develop a response to this issue. Please provide an analysis to determine if the final cover could be affected by the phenomenon known as "sand boils."

4. Sedimentation in the diversion channel: We do not believe the sedimentation model in the TRP App. D Att. E is sufficiently conservative. Your analysis should consider additional storm events besides just the ten-year storms, and erosion of deposited sediments relative to infiltration in the channel.

5. Trees growing in the diversion channel: Your analysis must include how you will deal with trees growing in the diversion channel and how that affects water flow and deposition of sediments.

If you should have any questions, do not hesitate to contact me at (360) 586-7848.

Sincerely,

Leo Wainhouse
Radiation Health Physicist

LW:krf

cc: Warren Seyler, Spokane Tribe
Duane Bird Bear, BIA, WA
Stanley Speaks, BIA, OR

MEMORANDUM

TO: John Blacklaw, P.E.

FROM: Sheila Pachernegg, P.E.

DATE: October 18, 1995

RE: **REVIEW COMMENTS**

Ref: ***Sherwood Project Responses to WDOH Issues Regarding Erosion Protection and Diversion Channel Realignment*, prepared by SMI for WNI, October 1995**

I concur with the responses provided by SMI/WNI to requested information/clarifications with the following comments:

- Rock durability testing approach, performance criteria, and appropriate placement (locations within the site) as riprap for erosion control will need to be specified as part of the quality assurance plan for construction. Petrographic analyses are still needed to evaluate suitability of the quartz monzonite quarry site.

- Realignment of the diversion channel will increase surface area for runoff from the impoundment cover. However, in Bruce Barker's (WDOE, Dam Safety) memo to file of October 17, 1995, his recalculation using the additional area indicated the spillway capacity is still sufficient.

Dewatering of Tailings and Structural Integrity

There will be ponding in depressions occurring from settlement that will probably persist even after vegetative cover is established. However, if during construction efforts are made to either surcharge the area to induce settlement, or condition the license to regrade the cover after a specified estimated settlement occurs, most of the areas ponding water can be dealt with. Jerald LaVassar's (WDOE - Dam Safety) October 17, 1995 letter to file indicated that solid and hazardous waste site cover systems have minimum slopes of 2% to induce runoff. Although this is true, the typical cover systems are engineered barriers and need to laterally channel infiltration to maintain integrity of the cover system. Additionally, ponded water at the Sherwood Site has different (and lesser) ramifications than ponded water at a solid or hazardous waste site (due to the beneficial condition of keeping the tailings saturated).

Long-Term Performance

In Appendix P, did SMI model the condition of dewatered tailings with subsequent infiltration? Is this a concern?

Attachment A - Tailings Under Reducing Conditions

"Goetite" should be "goethite".

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cc: Dorothy Stoffel

WESTERN NUCLEAR, INC.

SHERWOOD PROJECT
P. O. BOX 392 · WELLPINIT, WASHINGTON 99040 · (509) XXXXXX
258-4521

03-317

May 20, 1999

Mr. Gary Robertson, Head
Waste Management Section
Washington Department of Health
Division of Radiation Protection
Airdustrial Park, Building 5
Olympia, Washington 98504-7827

Re: WN-I0133-1, License Condition No. 22 (Amendment No. 30), Sherwood Project Monitoring and Stabilization Plan, Post-reclamation Construction Monitoring.

Dear Mr. Robertson:

At our September 22, 1998 meeting in Spokane, we discussed the results of 1998 post-reclamation monitoring programs as described in the 09/97 Sherwood Monitoring and Stabilization Plan (MSP). Our presentation of vegetation monitoring results included discussion of vegetation within the predicted settlement area near the center of the reclaimed impoundment. There, a vernal pond environment has developed due to differential settlement as predicted in the 12/94 Sherwood Tailing Reclamation Plan (TRP), as revised. The pond environment has significantly impacted the vegetation reestablished as new seeding in 1996. In response to this predicted change in environmental conditions, WNI proposed remediation to enhance vernal pond vegetation with seed mixes amenable to wet-soil conditions. Remediation was performed during October 1998 and an as-built report (dated November 16, 1998) was submitted. It was also noted that several pond environment species had already pioneered and established themselves within the settlement area.

During further discussion at the September 22, 1998 meeting, your staff requested further information about the settlement area. In response to this request, we submit the following. Attached to this letter is an evaluation of the settlement measured to date and an evaluation of erosional stability given the observed settlement. These evaluations were based upon level survey data collected in October 1998 utilizing the construction verification grid.

Settlement measured at 27 stations is shown in Table 1 of Attachment 1; Settlement Analysis. Level survey data were taken relative to the elevation of a point located on exposed quartz monzonite where settlement is zero. Maximum settlement was 3.86 feet while the 12/94 TRP predicts settlement up to 6.1 feet. Settlement outside of the settlement area has occurred in varying degrees up to approximately 1 foot. The settlement analysis concludes that observed settlement is consistent with predicted settlement.

The erosional stability analysis (Attachment 2) shows that a gully of up to three feet in depth may occur during worst case conditions, ie.; a PMF event. However, impact to the surface cover system is minimal since erosional impacts only occur within the settlement area.

Structural stability elements requiring repair(s) **have not been observed** by either WNI or WDOH staff/inspectors when viewing the settlement area relative to the entire reclaimed impoundment structure. All inspectors have been of the consensus that the settlement area will not be problematic to any structural stability element in the future.

Our discussion reviewed the 1998 vegetation monitoring results observed at five transects located within the settlement area. Statistical tests compared these transects to the remaining transects outside the settlement area. Significant differences were found, a quantified conclusion supported by field observation. All five transects failed the vegetal cover requirements specified in the MSP. In fact, vegetal cover decreased on these transects from 1997 to 1998.

Further analysis demonstrated conclusively that the 45 transects outside the settlement area provide adequate representation of vegetation on the impoundment surface. In addition, the attached analysis demonstrates that the cover in the settlement area will achieve its performance objectives without vegetation. As such, we request that WDOH approve modification to the Sherwood MSP which reflects these findings. Specifically, future vegetal cover sampling on the impoundment surface will continue on the 45 transects sampled in both 1997 and 1998 which lie outside the settlement area. All quantification for success evaluations would remain unchanged.

Should you require additional information regarding the description of the settlement area or justification for our request for modification to the Sherwood MSP, please contact us at your earliest convenience.

Sincerely,

Brad K. DeWaard, Resident Agent

/bd Attachments - 1

cc: LJC (w/ attach.)
JRG (w/ attach.)
MAP (w/ attach.)
EMS (w/ attach.)
LLM (SMI) (w/ attach.)
HWS (S&L) (w/ attach.)
WNI Central Files

SHEPHERD MILLER
INCORPORATED

May 11, 1999

SMI # 03-317

Brad DeWaard
Western Nuclear, Inc
Eiljah Road
Wellpinit, WA 99040

Dear Brad:

As you requested, we have evaluated the erosional stability of the portion of the reclaimed tailing impoundment where the seasonal pond exists. The purpose of this evaluation was to determine if vegetation is required to ensure that the cover system meets the reclamation objectives. Specifically, the erosional stability of the cover was evaluated with out vegetation to determine if the radon flux rates would meet the required flux rate of 20 pCi/m2/s.

An approximately ten-acre area has experienced settlement with the maximum amount being approximately 3 feet. A summary of the current settlement is included in Attachment 1. This settlement is consistent with the settlement previously predicted and determined to be acceptable. The settlement analysis was included in the "Sherwood Project Revegetation Reclamation System Evaluation" submitted to the Washington Department of Health in September 1995 and approved along with the overall reclamation plan via license amendment 22 on November 28, 1995.

The area in question fills with water in the spring and dries out in the late summer/early fall. Plant species adapted to these fluctuating water levels have been planted but have yet to become established in the pond area. It is anticipated that recently planted species will become established in the next few years and that natural plant succession will occur to meet the changing soil moisture conditions.

Modeling results, included in "Sherwood Project Revegetation Reclamation System Evaluation" indicate that the entire cover will be saturated in the spring of each year. This water in the cover

will contribute water to the low area and a seasonal pond will form until deep-rooted trees and shrubs become established over the reclaimed surface. It is expected that in 5 to 10 years the deeper rooted trees and shrubs will have consumed enough of the water in the soil profile so that saturated conditions will not occur to a high enough elevation in the cover to cause the pond to fill. After this time, the only water that will be in the low area will be a result surface water runoff from heavy rain or snow melt events and will be short lived. It is expected that the plant community that will develop in the low area will change over time to adjust to the localized soil moisture conditions. The low area will likely have a greater density of plant life in the long term because of slightly moister conditions are anticipated for the area.

An erosional stability analysis was performed to determine the potential for erosion if the possible maximum precipitation (PMP) event were to occur when the pond is empty but before vegetation were to be established at a density of at least 36%. The erosional stability analysis was performed using parameters and techniques consistent with previous analyses used in the Tailing Reclamation Plan development.

The conditions used in the analysis will only occur during the late summer or fall of the next few years. If ponded water exists during the PMP, erosion will not occur since water will be flowing into a ponded area. If the PMP occurs a few years in the future, vegetation that is suited to the specific moisture conditions in the area will have become established and will provide the necessary erosional stability protection. Therefore, the analysis evaluates worse case conditions that will only be present for a portion of the year and only for a few years. Additionally, the analysis did not take into account the fact that the low area will begin to fill with water during the PMP and this ponded water will prevent any additional erosion.

The analysis, which was performed assuming worse case conditions, is included in Attachment 2. This analysis indicates that erosion could occur for the unrevegetated surface. Additionally, the analysis indicates that the maximum depth of the erosional gully would be approximately 3 feet. Material from the erosional gully would be deposited in the bottom of the low area.

The analysis shows that under worse case assumptions, a gully approximately 3 feet deep could occur over the surface. This erosion will not however adversely impact the performance of the cover. First, since the cover is 13.6 feet thick (only 12.6 feet was required), removal of a small portion of the total thickness of the cover over a very small area would not cause any change to the overall radon flux from the cover. The area over which the erosion would occur would be so small as to be insignificant relative to the area of the rest of the reclaimed impoundment. In addition, the material removed from the erosion feature would be deposited over anther portion of the cover. Therefore the total material covering the tailings would not change. Furthermore, the water content in this area will be greater than the water content assumed for the radon modeling (likely saturated in at least the lower portion of the cover which would eliminate all radon flux from the tailing). Therefore, the flux from this area and the overall average flux from the reclaimed tailing impoundment will be less than 20 pCi/m2/s requirement.

In summary, an evaluation was performed that indicated that a minor amount of erosion could occur under worse case conditions. These conditions could only exist for a few years until vegetation becomes established. Any erosion that might occur will not impact the performance of the cover. Therefore, the area where the seasonal pond exists could be excluded from the vegetation success requirements presented in the monitoring and stabilization program without impacting the performance of the reclamation system.

If you have any questions, please give me a call.

Sincerely,

SHEPHERD MILLER, INC.

Lou Miller
Vice President

LLM:eks
Enclosure

ATTACHMENT 1

SETTLEMENT ANALYSIS

SHEPHERD MILLER, INC.
Environmental and Engineering Consultants

TECHNICAL MEMORANDUM

DATE: 8 October 1998 **SMI #** 03-317-1

TO: Lou Miller

FROM: Jeff Coleman

SUBJECT:Sherwood Settlement

COPY:

Survey results for areas around and within the settlement area were taken at the end of construction (9/95) and subsequently in 5/5/97 and 10/5/98. The results of the surveys are shown on Table 1. The 10/5/98 configuration is shown on Figure 1.

Table 1 Settlement Area Survey Data

Point #	Elevation Final Verif. (ft)	5/5/98 Survey Elev. (ft)	Difference from Final (ft)	10/5/98 Survey Elev. (ft)	Difference from Final (ft)
154	2080.62	2080.1	-0.52	2079.50	-1.12
155	2080.65	2080.6	-0.05	2080.00	-0.65
185	2081.16	2080.9	-0.26	2080.45	-0.71
206	2080.16	2079.9	-0.26	2079.26	-0.90
209*	2079.63	2077.3	-2.33	2076.22	-3.41
211*	2079.90	--	--	2076.33	-3.57
214	2080.77	2080.3	-0.47	2079.74	-1.03
240*	2079.54	2078.1	-1.44	2076.84	-2.70
246	2080.00	2079.6	-0.40	2078.98	-1.02
274*	2078.64	2076.6	-2.04	2074.78	-3.86
276*	2078.87	--	--	2075.51	-3.36
277*	2078.98	2077.1	-1.88	2075.48	-3.50
279*	2079.50	2078.5	-1.00	2077.47	-2.03
281	2079.91	2079.5	-0.41	2078.95	-0.96
305*	2078.37	2077.2	-1.17	2076.40	-1.97
311*	2078.95	2077.5	-1.40	2076.38	-2.57
342*	2077.70	--	--	2075.01	-2.69
344*	2078.00	--	--	2074.73	-3.27
346*	2078.40	2077.3	-1.10	2076.52	-1.88
384	2078.38	2078.0	-0.38	2077.44	-0.94
386	2079.17	2079.1	-0.07	2078.64	-0.53
413*	2077.60	2076.9	-0.70	2076.46	-1.14

416*	2077.78	2077.6	-0.18	2076.54	-1.24
448	2077.83	2077.8	-0.03	2077.30	-0.53
483	2078.03	2078.3	0.27	2078.33	0.30
515	2077.80	2077.9	0.10	2077.82	0.02
579#	2077.74	2077.7	-0.04	2077.74	0.00

* Indicates stations within or on border of settlement area.

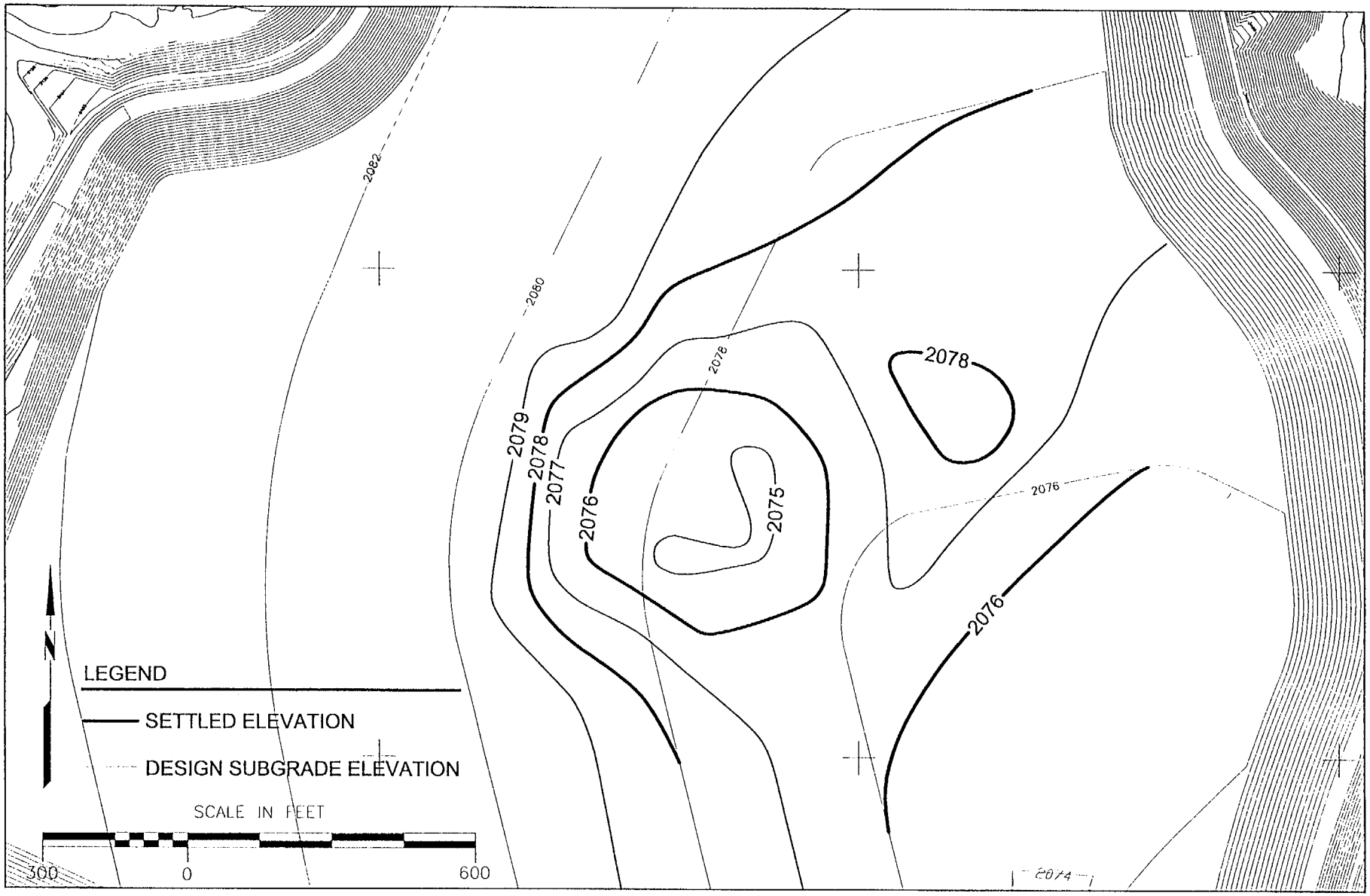
Point 579 is located on quartz monzonite outcropping on east side of impoundment surface. Settlement is assumed to be nonexistant.

An evaluation was conducted to determine if observed settlement is consistent with the settlement that was predicted. Attached are three plots comparing field surveyed settlement to predicted settlement. Predicted settlement from locations SM-2, SM-(5-6), and SM-8 (see "Sherwood Project Revegetation Reclamation System Evaluation, Appendix 4, SMI, 9/95) was compared to field surveyed settlement at locations nearby.

Method

A plot of displacement versus square-root-of-time was generated for SM-2, SM-(5-6) and SM-8 using the information presented in Appendix 4 of the "Sherwood Project Revegetation Reclamation System Evaluation" For each location, the calculated t90 was used to determine an "effective" drainage length using the Terzaghi one dimensional consolidation equation. The effective drainage length was then used to generate a plot of displacement versus square-root-of-time for 10%, 20%, 30% etc consolidation based on the total settlement predicted for each location. An example calculation is attached along with the spreadsheet calculations.

The predicted curve for SM-2 was plotted with actual data from survey points 240, 274, and 305. The predicted curve for SM-(5-6) was plotted with actual data from survey point 276. The predicted curve for SM-8 was plotted with actual data from survey points 279, 311. SM-2 and SM-(5-6) were chosen because they produced the highest predicted settlement. Points 240, 274, and 305 are all about the same distance from SM-2. Point 276 is the closest point to SM-(5-6). SM-8 was chosen because of its proximity to point 279. As can be seen, the observed settlement is consistent with the predicted settlement.



SHEPHERD MILLER
INCORPORATED

FIGURE 1
TAILINGS COVER ELEVATIONS
AS OF 10/5/98

Date:	MAY 1999
Project:	03-317
File:	SETTLE-99.DWG

ATTACHMENT 2
EROSIONAL STABILITY
ANALYSIS

BACKGROUND

The surface stability of the tailing impoundment was analyzed in the 1994 Tailing Reclamation Plan (TRP), Appendix G (WNI, 1994). A settlement analysis was performed on the impoundment, and the surface stability for the settled configuration was performed and is presented in the 1995 Revegetation Reclamation System Evaluation (RRSE) (WNI, 1995). Seeding of the impoundment took place in 1996, and under the Monitoring and Stabilization Plan (MSP) (WNI, 1997) vegetation surveys are conducted annually.

After reclamation, as predicted in the 1995 RRSE, a vernal pond formed near the center of the impoundment as a result of settlement of the tailing and saturated soils in the area. Permanent vegetation has yet to become established in this area. In the original stability analyses, the impoundment surface is erosionally stable if vegetation is established. However, because there is no vegetation in the ponded area, the potential for surface erosion prompted an erosion analysis to determine the magnitude of gullying, if any, that might occur.

SURFACE STABILITY

The methods used to analyze the ponded area of the impoundment surface were identical to methods used in Appendix G of the 1994 TRP and in Appendix 7 of the Revegetation Reclamation System Evaluation. Erosional stability was checked using the Tractive Force (Temple, 1987) and Permissible Velocity (NRC, 1990) Methods. Once the stability analyses were completed, the Horton/NRC Method (NRC, 1990) was used to estimate the depth of scour that might occur.

In Figure 1 of Appendix 7 of the Revegetation Reclamation System Evaluation report, two 100-foot wide strips were delineated over the reclaimed, post-settled configuration of the impoundment. The strips were selected to represent the longest and steepest slopes on the impoundment. The Probable Maximum Flood (PMF) discharges were calculated

for the strips using the Army Corps of Engineers' HEC-1 computer model. The hydraulic properties and resulting discharges from the analysis are presented in Table 1.

Table 1 Strip Hydraulic Properties and Discharges

Strip	Curve Number	Hydraulic Length (ft)	Time of Concentration (min.)	Slope (%)	Discharge (cfs/ft)
A-A	78	1650	51.3	1.0	0.28
B-B	78	1370	34.2	1.6	0.31

After the PMF flows were calculated, the Tractive Force and Permissible Velocity Methods were used to determine if the impoundment surface was erosionally stable with no vegetation. In the Tractive Force Method, the actual soil and vegetal stresses are compared to the allowable stresses, and the slope is determined to be erosionally stable if the actual stress is less than the allowable stress. Because there is no vegetation in the ponded area, the vegetal stress component of the method was not used, and erosional stability was a function of only the soil stress. An allowable soil stress of 0.028 pounds per square foot was calculated in the previous analysis and applied here. The actual stress on the soil is calculated as follows:

$$\tau_e = \gamma DS(1 - C_f)(n_s / n)^2$$

where: τ_e = the actual soil stress (lb/ft^2)

γ = unit weight of water (lb/ft^3)

D = depth of flow (ft)

S = slope (ft/ft)

C_f = vegetative cover factor

n_s = soil grain roughness, and

n = Manning's roughness coefficient

The depth of flow for each strip was calculated as follows:

$$D = \left[\frac{qn}{1.49\sqrt{s}}\right]^{0.6}$$

where: D = the depth of flow (ft)

q = the unit flow (cfs/ft)

n = Manning's roughness coefficient

s = the slope (ft/ft)

For the bare, sandy soil present on the surface of the impoundment, a Manning's n of 0.020 was used, consistent with the value presented in Appendix C of the TRP. Using the discharges and slopes presented in Table 1, the PMF flow depths for Strip A-A and B-B were calculated to be 0.14 feet and 0.13 feet, respectively.

The actual stress on the soil was calculated, given the calculated flow depths. A soil grain roughness of 0.0164 was used, consistent with the previous analysis. The cover factor acts to reduce the soil stress, and because there is no vegetation in the ponded area, a value of zero was used. Using the Manning's n values and slopes previously presented, the actual stresses on the soil were calculated to be 0.059 and 0.087 lb/ft^2 for Section A-A and B-B, respectively. The actual stresses exceeded the allowable stress.

In the Permissible Velocity Method, the actual flow velocity is compared to the permissible velocity, which is defined as the greatest mean velocity that will not cause erosion. Permissible velocity is a function of the soil type and depth of flow, and a value of 1.50 feet per second was obtained from Chow (1959), representative of a fine sand soil with a Manning's n equal to 0.02. Because the flow depth is less than 0.25 feet, a shallow flow reduction factor of 0.5 was applied, resulting in a permissible velocity of 0.75 feet per second.

As presented in the Temple Method, the flow velocity of each strip was calculated using the unit discharge and depth of flow. The velocity is calculated as follows:

$$V = \frac{q}{D}$$

where: V= the flow velocity (ft/sec)

q = the unit discharge (cfs/ft), and

D = the depth of flow (ft)

The PMF flow velocities for Strip A-A and B-B were calculated to be 2.0 and 2.4 feet per second, respectively. The calculated flow velocities exceed the permissible velocity.

GULLY DEPTH

The allowable soil stress and the permissible velocity will both be exceeded on the bare slopes in the area of the pond during the PMF. Although the Tractive Force and Permissible Velocity Methods both indicate that the bare soil will be subject to erosion, neither method quantifies the potential for or depth of gullying that would result. Therefore, a third analysis was performed to estimate the depth of scour.

The Horton/NRC Method can be used to design the maximum stable slope that will prevent the initiation of gullies. The stable slope of the unvegetated area was calculated, and the maximum gully depth was estimated by comparing the vertical components of the stable slope and existing slope. The stable slope is calculated as follows:

$$S_s^{7/6} = \frac{65\tau_a^{5/3}}{PLFn}$$

where: S_s = the stable slope (ft/ft)

τ_a = the allowable shear stress (psf),

P = the rainfall intensity (in./hr.),

L = the length of the stable slope (ft),

F = the flow concentration factor, and

n = the Manning's roughness coefficient

The slope of Strip B-B is steeper than that of Strip A-A. Because scour is a function of slope, a steeper slope will be eroded more easily than a flatter slope. Also, for an identical slope length the vertical component of a steep slope will be greater than that of a flatter slope, which will result in a larger calculated depth of scour. Finally, a steeper slope will have a shorter time of concentration, which will result in a higher rainfall intensity. Therefore, the hydraulic parameters for Strip B-B were used to estimate the maximum depth of scour.

The PMP intensity-duration curve for the Sherwood site was previously derived in Attachment A to Appendix C of the TRP. The rainfall intensity for Strip B-B was determined by plotting the time of concentration of 34 minutes on Figure A.3, and reading the associated rainfall intensity. A rainfall intensity of 11 inches per hour was obtained.

Flow concentration factors are conservatively applied to unit discharges flowing over flat surfaces to account for expected concentrations of flow. Such factors can range from one to three, with one for overland flow, two for concentrated flow, and three corresponding to channelized flow. For this analysis, a factor of three was used, as recommended by the NRC in Appendix A of the STP. The length of the stable slope was measured to be 214 feet. As previously discussed, an allowable shear stress of 0.028 pounds per square foot and a Manning's n of 0.020 were used in the analysis.

The stable and settled slopes are shown on Figure 1. The stable slope for the bare area was calculated to be 0.0031 ft/ft, which corresponds to a vertical drop of 0.66 feet for the 214-foot slope length. The slope of the impoundment surface for Section B-B was measured to be 0.0160 ft/ft, corresponding to a vertical drop of 3.42 feet. The amount of scour that could potentially occur during the PMF is 2.8 feet.

CONCLUSIONS AND RECOMMENDATIONS

The analysis shows that under worse case assumptions, a gully approximately 3 feet deep could occur over the surface. This erosion will not however adversely impact the performance of the cover. First, since the cover is 13.6 feet thick (only 12.6 feet was required), removal of a small portion of the total thickness of the cover over a very small area would not cause any change to the overall radon flux from the cover. The area over which the erosion would occur would be so small as to be insignificant relative to the area of the rest of the reclaimed impoundment. In addition, the material removed from the erosion feature would be deposited over anther portion of the cover. Therefore the total material covering the tailings would not change. Furthermore, the water content in this area will be greater than the water content assumed for the radon modeling (likely saturated in at least the lower portion of the cover which would eliminate all radon flux from the tailing). Therefore, the flux from this area and the overall average flux from the reclaimed tailing impoundment will be less than 20 pCi/m2/s requirement.

In summary, an evaluation was performed that indicated that a minor amount of erosion could occur under worse case conditions. These conditions could only exist for a few years until vegetation becomes established. Any erosion that might occur will not impact the performance of the cover. Therefore, the area where the seasonal pond exists could be excluded from the vegetation success requirements presented in the monitoring and stabilization program without impacting the performance of the reclamation system.

REFERENCES

Chow, V.T., 1959. "Open Channel Hydraulics." McGraw-Hill Publishing Company.

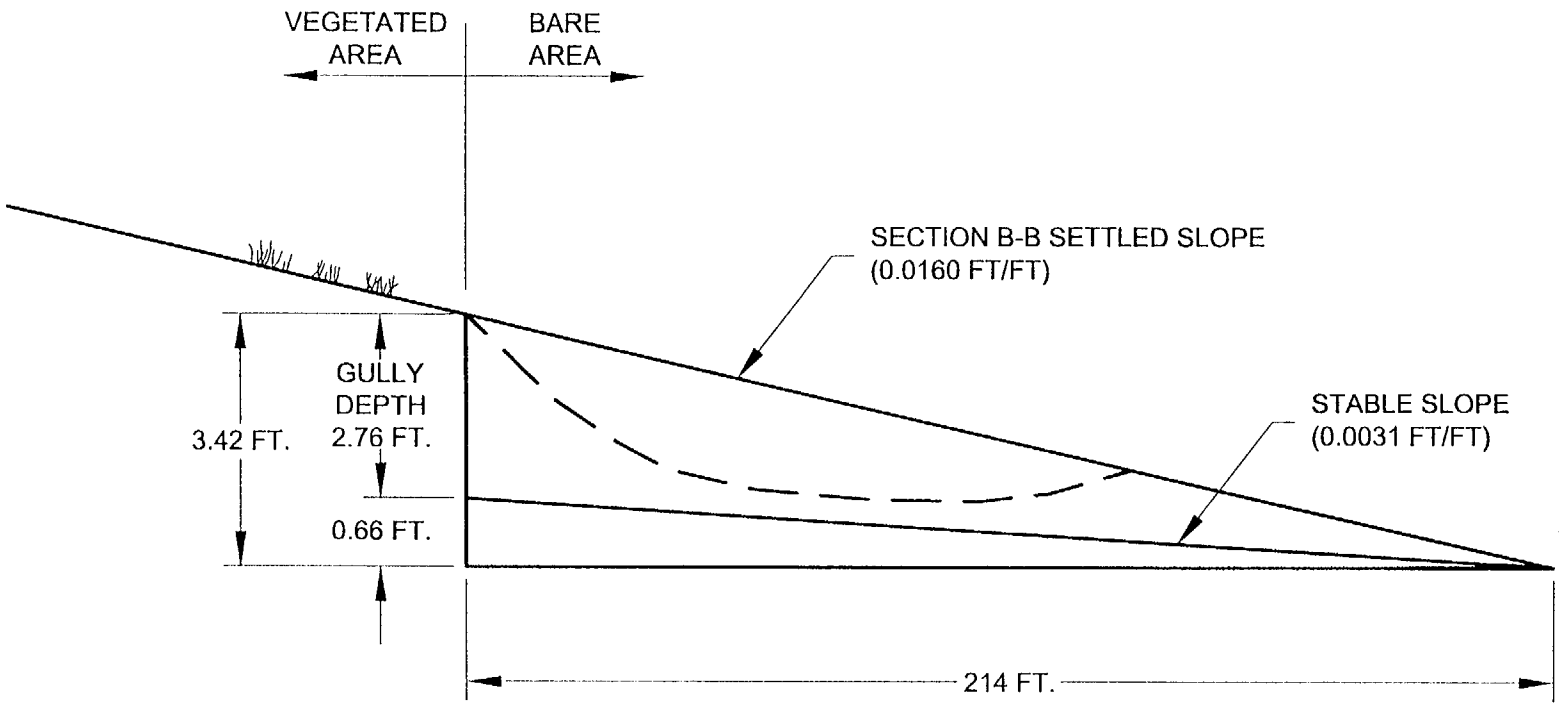
NRC, 1990. "Final Staff Technical Position Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites". August, 1990.

Temple, D.M., K.M. Robinson, R.M. Ahring, and A.G. Davis, 1987. "Stability Design of Grass-lined Open Channels." Agricultural Handbook 667. Water Resources Publications, Littleton, CO.

WNI, 1994. "Sherwood Project, Tailing Reclamation Plan." December, 1994.

WNI, 1995. "Sherwood Project, Revegetation Reclamation System Evaluation." September, 1995.

WNI, 1997. "Sherwood Project, Monitoring and Stabilization Plan." September, 1997.



NOT TO SCALE

SHEPHERD MILLER
INCORPORATED

FIGURE 1
PREDICTED SCOUR ON
IMPOUNDMENT SURFACE

Date:	MAY 1999
Project:	03-317
File:	SCOUR.DWG

APPENDIX B

NATIONAL DAM SAFETY ACT

WNI

March 1, 1995

To: File

From: Bruce Barker, P.E. BB

Subject: Western Nuclear Tailings Project (Sherwood Dam) Closure
File No: ST54-378

The closure plan developed by SMI for the Sherwood Tailings dam was reviewed with respect to the hydrologic and hydraulic aspects. The plan meets Dam Safety requirements for hydrology and hydraulics and no changes are required.

The only comment regarding the design is that the tributaries to the diversion channel will carry sediment into the diversion channel during storm events. If this channel is not maintained, the diversion channel will silt in over time resulting in the diversion channel being blocked at each confluence, and flow and sediment passing onto the tailings cap. While this will likely not result in the failure of the dam, the introduction of flow onto the cap may have other undesirable impacts to the project.

The following paragraphs document the project review.

The closure plan consists of placing a cap on the tailings and seeding with grass. The surface of the cap will be graded to drain towards an open channel spillway near the southeast corner of the reservoir. The diversion channel around the perimeter of the pond will be regraded to improve the hydraulic capacity and will collect all drainage from the tributary basin and divert it around the tailings to the southeast corner. The diversion channel as well as the tailings spillway will be lined with riprap to prevent erosion.

The Dam Safety Section (DSS) performed an inspection of the facility in 1984, performed a hydrologic and hydraulic analysis, and issued a report. Several recommendations were made in this report regarding required modifications at closure (see attachment). The closure report was reviewed to ensure that these requirements were met in the closure plan.

Hydrologic Design The standard for the design flood is the PMF. HMR-43 was used to compute the PMP depth for both the general storm and the thunderstorm. The thunderstorm depth was greater and was therefore used to compute the inflow design flood. The 6-hour thunderstorm depth computed by SMI was 11.5 inches which compares favorably with the 11.15 inches computed by the DSS.

The temporal distribution used by SMI was developed by using the incremental precipitation amounts presented in HMR-43 for the thunderstorm and placing the peak of the storm in the center. The mass curve was then disaggragated to 5 minute intervals. The peak 5-minute intensity was 1.81 inches/5 minutes which when divided by the total storm volume, has a unit intensity of 0.157

inches/5 minutes. Using information contained in *Characteristics of Extreme Storms* by Schaefer, this intensity has an exceedance probability of 0.85. This intensity is lower than that used by the DSS for current hydrologic design. The DSS currently utilizes an intensity with an exceedance probability of 0.33 for design purposes which would result in a higher PMF value. However, the procedure used by SMI is standard PMF computation practice and will result in a sufficiently rare flood. In eastern washington, the annual exceedance probability of the PMF has been estimated to be 10^{-7}. The PMF value computed by SMI was 5325 cfs which compares favorably with the DSS computed value of 5400 cfs.

Hydraulic Design The PMF from the various tributaries was routed through the diversion channel using HEC-2. It appears that the channel has capacity to pass this flood with sufficient freeboard. Several of the sharp corners will be removed from the channel and rounded curves put in their place to improve the hydraulics and the channel gradient will be graded to range from 0.75% to 0.25%. The hydraulic capacity of the channel was checked by computing the depth of flow to pass the PMF (see attached calculations). The available freeboard in the diversion channel near the outlet was computed to be 2.4 feet, which is acceptable.

The design calls for riprap to be placed along the bottom of the diversion channel to a depth equal to the depth of the PMF plus 1 foot of freeboard. The riprap is to have a filter layer below it. This design appears acceptable. In addition, riprap will be placed up the tributaries to the channel to an elevation equal to the top of the channel. This will protect the confluence of the tributary with the diversion channel from erosion.

The outlet of the spillway channel consists of riprap underlain by a sand filter. The riprap extends downstream of the spillway opening 250 feet and is embedded into native ground to a depth of 4.5 feet at the end. This configuration appears adequate to resist headward migration of erosion during the thunderstorm PMF, which has a relatively short duration.

Sherwood Project

WATER RESOURCES PROGRAM
DAM SAFETY SECTION

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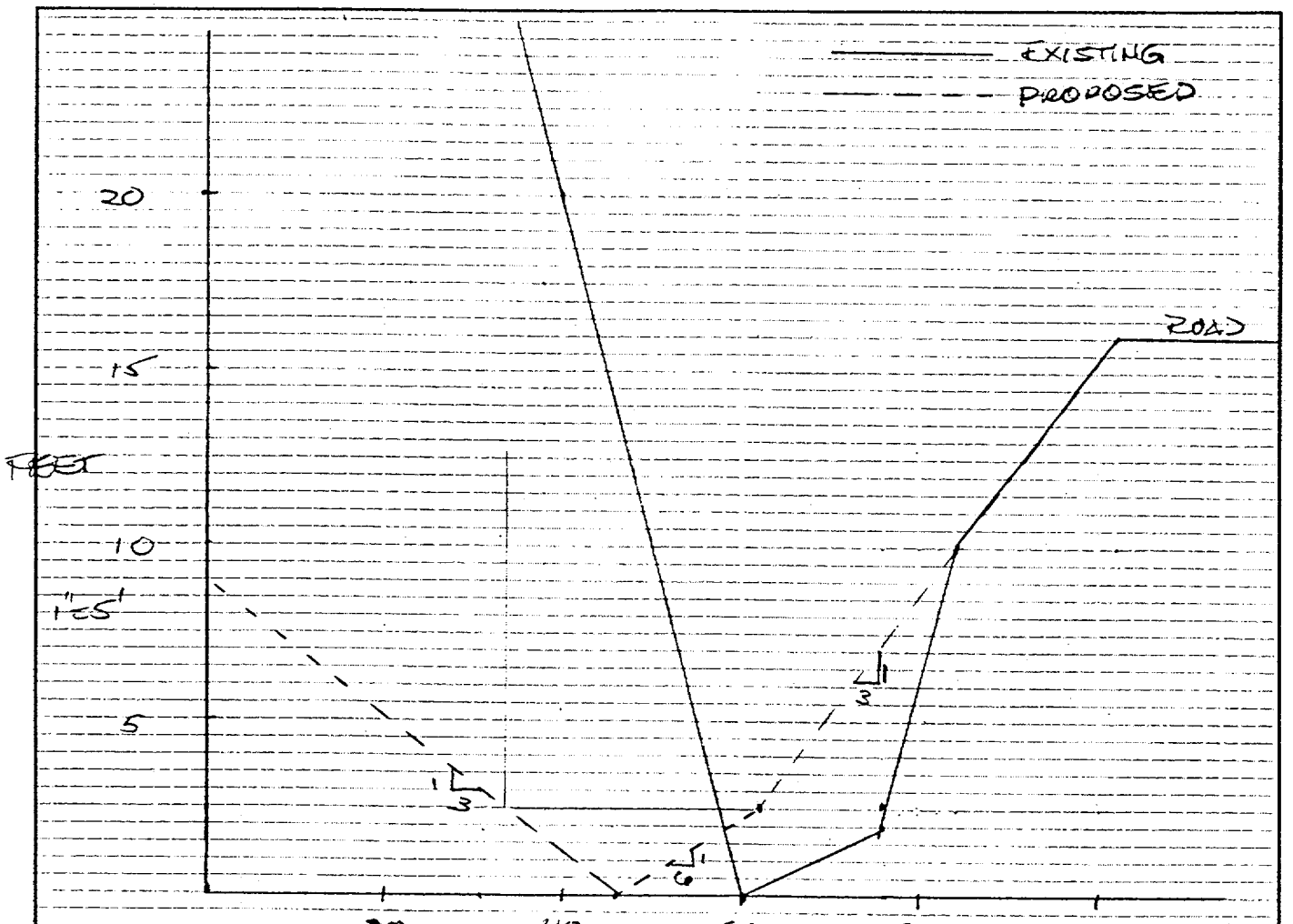

EAST CHANNEL CROSS SECTION

COMPUTE NORMAL DEPTH OF PROPOSED CHANNEL

$Q = \frac{1.49 A R^{2/3} S^{1/2}}{n}$ $\quad Q = 5325$ CFS

$n = 0.0313$

$S = .0025$

$A = \frac{1}{2}(28)(2.6) = 36.4$

$A = 36.4 + \frac{(H-2.6)^2 3}{2} + (H-2.6)28 + \frac{(H-2.6)^2 3}{2}$

$A = 36.4 + (H-2.6)^2 3 + 28(H-2.6)$

$P = 24.3 + 2\left(\left((H-2.6)3\right)^2 + (H-2.6)^2\right)^{1/2}$

BY TRIAL, DEPTH = 12.6', Q = 5390

CHANNEL DEPTH AT OUTLET IS 15'

∴ FB = 2.4' ∴ OK

WATER RESOURCES PROGRAM
DAM SAFETY SECTION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

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RMF VALUES

① Schaefer : Q: 4650 -- East channel

Q: 750 -- west channel

5400 CFS

CLOSURE PLAN 5325 CFS

= OK.

- Channel Roughness = 0.035 (Rip Rap)

MEC used 0.030 for a sand bottom channel to account for channel bottom forms and changes in channel alignment

Because the closure plan proposes to straighten the channel, and regrade the channel, 0.033 is reasonable

WATER RESOURCES PROGRAM
DAM SAFETY SECTION

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PMP (Thunderstorm)

~~PMP~~

Time	Depth	% TOT
6 hr	11.5	1.0
5 hr	10.75	.94
4	10.4	.90
3	10	.87
2	9.2	.80
1	7.75	.67
1/2	5.75	.50

.5 hr

∴ increases the Peak Intensity in the 6 hr PMP mass curve

HYDRAULIC CAPACITY AND EROSIONAL CHARACTERISTICS OF THE DIVERSION CHANNELS AT THE WESTERN NUCLEAR INC., SHERWOOD PROJECT

Prepared by:
Washington Department of Ecology
Dam Safety Section
August 16, 1984

5. Raise the containment dike crest elevation between stations 76+50 and ~~45~~42+00 to provide adequate freeboard (2 ft. min.) above the maximum water level to be expected while passing the PMF, (see Figure 5B).

MGS

4. RECOMMENDED MODIFICATIONS TO DIVERSION CHANNELS FOR PROJECT ABANDONMENT SCHEME

The major considerations at project abandonment are that the diversion channels have adequate hydraulic capacity and long term stability in order to minimize maintenance and repair costs.

Based on our hydraulic capacity analyses, the Dravo channel erosion study and visual inspection of the channel, the following modifications are recommended as a means of providing long term channel stability:

1. All embankment channel slopes, including those sections of the slope in rock should be flattened to a 1V:3H slope while maintaining the existing channel base width. Channel side-slopes, with the exception of areas of rock exposure, should be seeded to protect from ravelling.

2. Provide filtered riprap protection for those channel side slopes throughout bend locations near stations 28+00 and 44+00 wherever competent rock does not exist.

3. A gravel and small cobble lining should be applied to the channel bed. This would minimize the potential for a small

meandering channel to form within the existing channel which could undercut the channel sideslopes. This type of problem could occur as a result of the more typical minor flood events which would be carried by the channel. The material should be placed in way that will maintain the original channel geometry.

4. When design concepts are being formulated for abandonment, consideration must be given to the manner in which surface water can be collected from the covered tailings area and directed to the diversion channels. This abandonment scheme should incorporate measures to provide controlled drainage from the covered tailings area so as to minimize surface erosion and gully formation on the channel sideslopes. It is recommended that criteria contained in NRC document NUREG/CR-3199[15] be used as a guideline in developing the abandonment scheme.

File Copy: W.D.2

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. BOX 47600 • Olympia, Washington 98504-7600 • (206) 459-6000

March 22, 1995

TO: Leo Wainhouse, Maxine Dunkelman & John Blacklaw
Div. of Radiation Protection, Dept. of Health

FROM: Jerald LaVassar JL
Dam Safety Section, Dept. of Ecology

SUBJECT: Geotechnical Review comments on the Reclamation Plan for Western Nuclear's Sherwood Project

The scheme to cap the slimes as detailed on the plans and specifications does not pose geotechnical concerns that would preclude the Dam Safety Section approving the plan documents. Our approval ultimately is contingent upon receiving a satisfactory demonstration that the likelihood of an uncontrolled release of the reservoir contents is acceptably remote. With regard to geotechnical issues the plan documents do this.

In reviewing the plan documents and supporting engineering reports covering geotechnical aspects of the project's design, I have a few recommendations and a number of observations regarding the seismic stability of the cap on the slimes. These are as follows:

Varying thicknesses of fill will be required to raise existing grade to achieve the proposed subgrade elevations for the cap. The specifications only require that construction traffic be routed over the surface of each lift to compact the fill. As a minimum I recommend that the final subgrade elevation be proof-rolled with a smooth drum roller to provide a relatively uniform surface for founding the 2 feet thick clay layer component of the cap. Where proof-rolling discloses an unsuitable area, that is an area that likely will not satisfactorily support the overlying clay layer, the unsuitable zone should be removed and replaced. Finally, I did not find provisions in the specifications for the project engineer to review and approve the subgrade prior to placing the clay element of the cap. It would be prudent to provide such a provision if indeed one does not presently exist in the specifications.

I also could not find a requirement in the specifications to utilize construction practices that minimize drying and cracking of the clay layer during construction. The importance of the integrity of the clay layer in the satisfactory functioning of the cap is outside my expertise. However, if limiting the depth and extent of cracking of the clay layer is of particular concern, typical practice is to require that the clay layer be blanketed with a lift of the cover sand as soon as practicable. For large areas like this site, often the cap is constructed in segments. A segment corresponds to the maximum portion of the footprint of the clay cover that can be completed full height and covered within a day or two time frame.

I have no concerns with either the static or dynamic stability of the existing embankments. I do differ however with some of the elements of the seismic stability analysis of the slimes area done by Mr. Volpe (Appendix L - "Earthquake-Induced Settlement Investigation, Sherwood Tailing Impoundment" in the owner's submittal). Differences in our assessment of the seismic stability of the slimes area from that of Mr. Volpe do not preclude our approval of the reclamation plan. The remainder of this memorandum presents a summary of our observations on seismic issues associated with the slimes cap.

Page 4 Maximum Random Earthquakes
The 1872 earthquake remains controversial but, work by Malone and Bor[1] suggests that the event was likely shallow and of a magnitude on the order of 7¼ (not the 6.5 magnitude cited by Mr. Volpe). While of academic interest, such an event is believed too distant to generate the controlling ground motions at the project site.

Page 6 & Figure 4 Probability associated with USGS peak accelerations on rock
The statement on probability on the figure is incorrect. Mr. Volpe paraphrased the probability of experiencing the accelerations listed on the map as 90% in the next 250 years. It is my understanding that these accelerations have a 10% chance of exceedance in the next 250 years; stated conversely, there is a 90% chance that peak accelerations on rock this large or larger will not be experienced in the next 250 years. The 10% chance of exceedance in 250 years translates into an annual probability of occurrence on the order of 1 in 2370, much more remote than the 1000 year recurrence interval cited by Mr. Volpe.

Page 10 Peak ground accelerations
Note that the previous discussions of peak accelerations relate to those predicted on the rock surface. I did not find in Mr. Volpe's work a discussion of the amplification of the peak bedrock accelerations in passing through the soil column. The peak ground acceleration is the value to be used in the liquefaction analysis not the bedrock acceleration. Utilizing the 0.3 second period spectral accelerations from the preliminary maps of ground accelerations for the US published in 1991 by the National Earthquake Hazards Reduction Program (NEHRP), one can estimate the peak ground acceleration. (Note that one has to divide these spectral values by a factor of 2.5 to convert them to peak ground accelerations that would be recorded on a seismograph.) Interpolating between the values for a 10% chance of exceedance in 50 and 250 years, I estimate a peak ground acceleration of 0.07g for an annual exceedance probability of 1 in a thousand. Mr. Volpe assigned a peak acceleration of 0.05 g to this design event. My estimate is 40% larger than that of Mr. Volpe but it still does not

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[1] Malone, Stephen, and Bor, Sheng-Sheang, "Attenuation Patterns in the Pacific Northwest Based on Intensity Data and the Location of the 1872 North Cascades Earthquake", Bulletin of the Seismological Society of America, April 1979, Vol. 69, No. 2, pp. 531-546.

pose a significant dynamic loading to embankments constructed as engineered fills. An engineered fill is an earthen structure that is constructed in uniform lifts with a systematic compaction effort to achieve a dense unyielding condition, e.g., the embankments impounding the main reservoir and the recovery pond. However, this level of acceleration may pose liquefaction concerns for the slimes contained by the main embankment.

Liquefaction Prediction

I conducted a simplified liquefaction analysis similar to that done by Mr. Volpe but which used my estimate of the peak ground acceleration of 0.07g. The only other principal difference in our analyses is in the estimation of the soil properties based on the Standard Penetration Test N-value (SPT N-value). Mr. Volpe added 7 blows per foot to the uncorrected field SPT N-values to reflect the high silt fraction. The application of a uniform correction to all borings with a high silt fraction is questionable. Seed et. al.[2] applied corrections of 2, 4, and 5 blows per foot for fines contents of 25%, 50%, and 75%, respectively. Work by Soydemir[3] among others suggests that in addition to the percentage of fines, that the correction is also a function of the N-value corrected only for energy (see following figures).

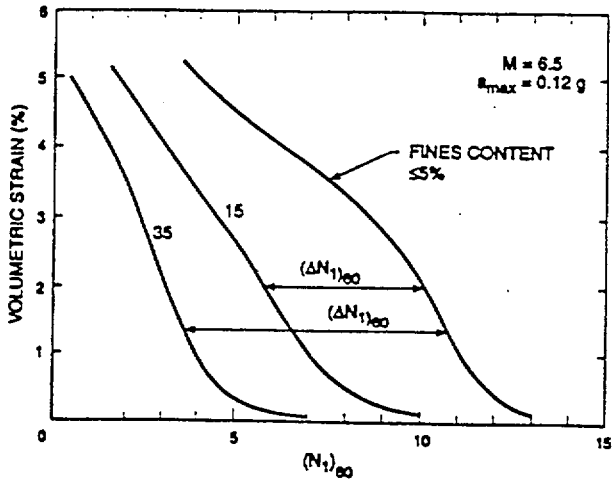

Figure 6. Average Volumetric Strain vs $(N_1)_{60}$ Relationships for Different Fines Content

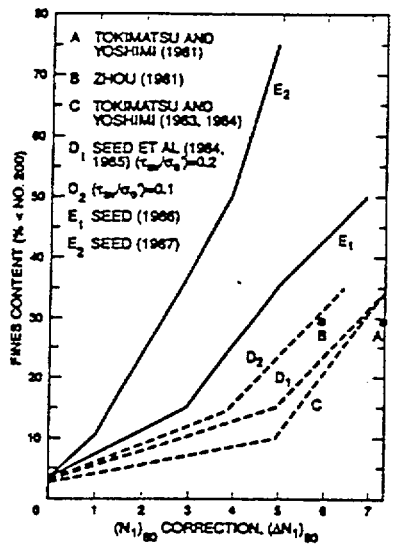

Figure 2. $(N_1)_{60}$ Correction Values for Respective Fines Content

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[2] Seed, H.B., Seed, R.B., Harder, L.F., Jong, Hsing-Lian, (1988). Re-evaluation of the Slide in the Lower San Fernando Dam in the Earthquake of Feb. 9, 1971, Earthquake Engineering Research Center, Report No. UCB/EERC-88/04, April 1988, pg. 56.

[3] Soydemir, C., (1994). "Earthquake-Induces Settlements in Silty Sands for New England Seismicity", Ground Failures under Seismic Conditions, ASCE Geotechnical Special Publication No. 44, Oct. 1994, pg. 84.

In 7 out of the 10 borings within the slimes, beginning at a depth of some 8 feet, a zone typically 10 feet or thicker of saturated, low plasticity silt, sandy silts and silty sands was encountered. The N-values recorded in this soft layer of slimes typically ranged from zero to two. A zero N-value signifies that the sampler sank 18 inches into the slimes solely under its own weight and that of the rods and hammer. Even an N-value of 2 still denotes an extremely soft soil. The silt correction to these low SPT N-values is a crucial factor in the analysis as the predicted likelihood of liquefaction is empirically correlated to the SPT N-values. Correcting an N-value of 0 to 7 as Mr. Volpe does is sufficient to change one's prediction of a liquefaction condition potentially developing to one where it does not. Utilizing what I believe is a more appropriate correction of 3.5 to the N-values, one predicts that should the site experience the design ground motions that a liquefaction condition is incipient.

I am not concerned that liquefaction of the slimes would precipitate a large scale flow type failure that would spill outside the limits of the reservoir. Rather, the concern arising from a possible liquefaction of the slimes is that the overlying 5 feet thick cap would be damaged. Specifically, in the event the slimes were to liquefy, the shear stresses generated by the 0.8% surface slope would cause the "softened", post-liquefied zone to undergo additional shear deformations. These deformations would be expressed as lateral displacements and potentially lead to cracking of the cap. The magnitude of predicted displacements is a function of among other things the thickness of both the liquefied and non-liquefied (crust) zones, the ground surface slope, and the stress-strain properties of the liquefied zone.

The prediction of post-liquefaction displacements is a rapidly evolving field. In the mid-1980s, one conducted conventional slope stability analyses utilizing estimates of the undrained residual strengths of liquefied zones to predict whether a lateral spread failure was likely. A successful design was one in which the analysis did not predict a factor of safety less than 1.2 or so. The embankment displacements arising out of the soil's response as it reverted to its undrained residual strengths were not typically analyzed. However, it has become evident that an understanding of the post-liquefaction stress-strain behavior of soils is necessary to rationally predict seismic induced displacements. Vaid & Thomas[4] found in laboratory testing that immediately following the development of a liquefied condition in a saturated soil, the soil experiences a period of very low shear resistance en route to achieving its residual undrained shear strength. This low shear resistance phase[5] appears to be a

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[4] Vaid, Y.P., (1994). "Liquefaction of Silty Soils", Ground Failures Under Seismic Conditions, ASCE, Geotechnical Special Publication No. 44, Atlanta Georgia, October 9-13, pg. 1-16.

[5] Vaid, Y.P., Thomas, J., (1995). "Liquefaction and Postliquefaction Behavior of Sand", Journal of Geotechnical Engineering, ASCE, Vol. 121, No. 2, pg. 168-172.

function of: 1) the maximum shear strain during dynamic loading, 2) the magnitude of effective confining stress immediately after the earthquake, and 3) the relative density. Utilizing a methodology developed by Byrne[6] post-liquefaction displacements are predicted to vary from near zero to an upper bound of 9 feet of horizontal movement. Again, one must experience accelerations at the site approaching the design ground motions to trigger liquefaction before such ground movements are even possible.

In the event such ground movements occurred, the cap surface would probably resemble a series of soil "plates" that had shifted differentially both horizontally and vertically relative to one another. The majority of the differential movements between "plates" likely would be expressed as cracks at the perimeter of the plates. Additionally, a small volume of the liquefied slimes would likely erupt through these cracks and spill unto the ground surface. It is the outside our expertise and purview to comment on the acceptability of such a remote occurrence.

JL:jl

[6] Byrne, P.M., (1994) "A Model for Predicting Liquefaction Induced Displacements", University of British Columbia, Dept. of Civil Engineering, Soil Mechanics Series No. 147, Sept. 1990 updated March 1994.

F'u Copy: W.D.Z

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. BOX 47600 • Olympia, Washington 98504-7600 • (206) 459-6000

March 23, 1995

To: File

From: Bruce Barker, P.E.

Subject: Western Nuclear Tailings Project (Sherwood Dam) Closure
File No: ST54-378

The closure plan developed by SMI for the Sherwood Tailings dam was reviewed with respect to hydrology and hydraulics. The plan meets Dam Safety requirements for hydrology and hydraulics *provided* that accumulated sediment in the diversion channels is removed periodically.

If periodic maintenance of the diversion canal is not planned to occur in perpetuity, then the design will not meet the flow capacity criteria in the future. During large storms, sediment will be deposited in the diversion ditch from the drainages that are tributary to it. Sediment will build up over time in the ditch limiting the discharge capacity, eventually to the point where the channel will overtop and flow will pass onto the tailings cap. The entire upstream area will be tributary to the tailings cap spillway channel under this scenario. Thus, the tailings cap spillway must be sized to accommodate the full PMF design flow of 5325 cfs. The current spillway opening is only 40 feet wide and will pass only a small fraction of this discharge before the dam is overtopped. In addition, it is required that a concrete erosion cutoff barrier be constructed perpendicular to the flow path in the spillway. This cutoff should extend approximately four feet deep or to an erosion resistent layer, such as bedrock. The cutoff will prevent headward migration of erosion into the tailings.

The following paragraphs document the project review.

The closure plan consists of placing a cap on the tailings and seeding with grass. The surface of the cap will be graded to drain towards an open channel spillway near the southeast corner of the reservoir. The diversion channel around the perimeter of the pond will be regraded to improve the hydraulic capacity and will collect all drainage from the tributary basin and divert it around the tailings to the southeast corner. The diversion channel as well as the tailings spillway will be lined with riprap to prevent erosion.

The Dam Safety Section (DSS) performed an inspection of the facility in 1984, performed a hydrologic and hydraulic analysis, and issued a report. Several recommendations were made in this report regarding required modifications at closure (see attachment). The closure report was reviewed to ensure that these requirements were met in the closure plan.

Hydrologic Design The standard for the design flood is the PMF. HMR-43 was used to compute the PMP depth for both the general storm and the thunderstorm. The thunderstorm depth was greater and was therefore used to compute the inflow design flood. The 6-hour thunderstorm depth computed by SMI was 11.5 inches which compares favorably with the 11.15 inches computed by the DSS.

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The outlet of the spillway channel consists of riprap underlain by a sand filter. The riprap extends downstream of the spillway opening 250 feet and is embedded into native ground to a depth of 4.5 feet at the end. This configuration appears adequate to resist headward migration of erosion during the thunderstorm PMF, which has a relatively short duration.

Sherwood Project

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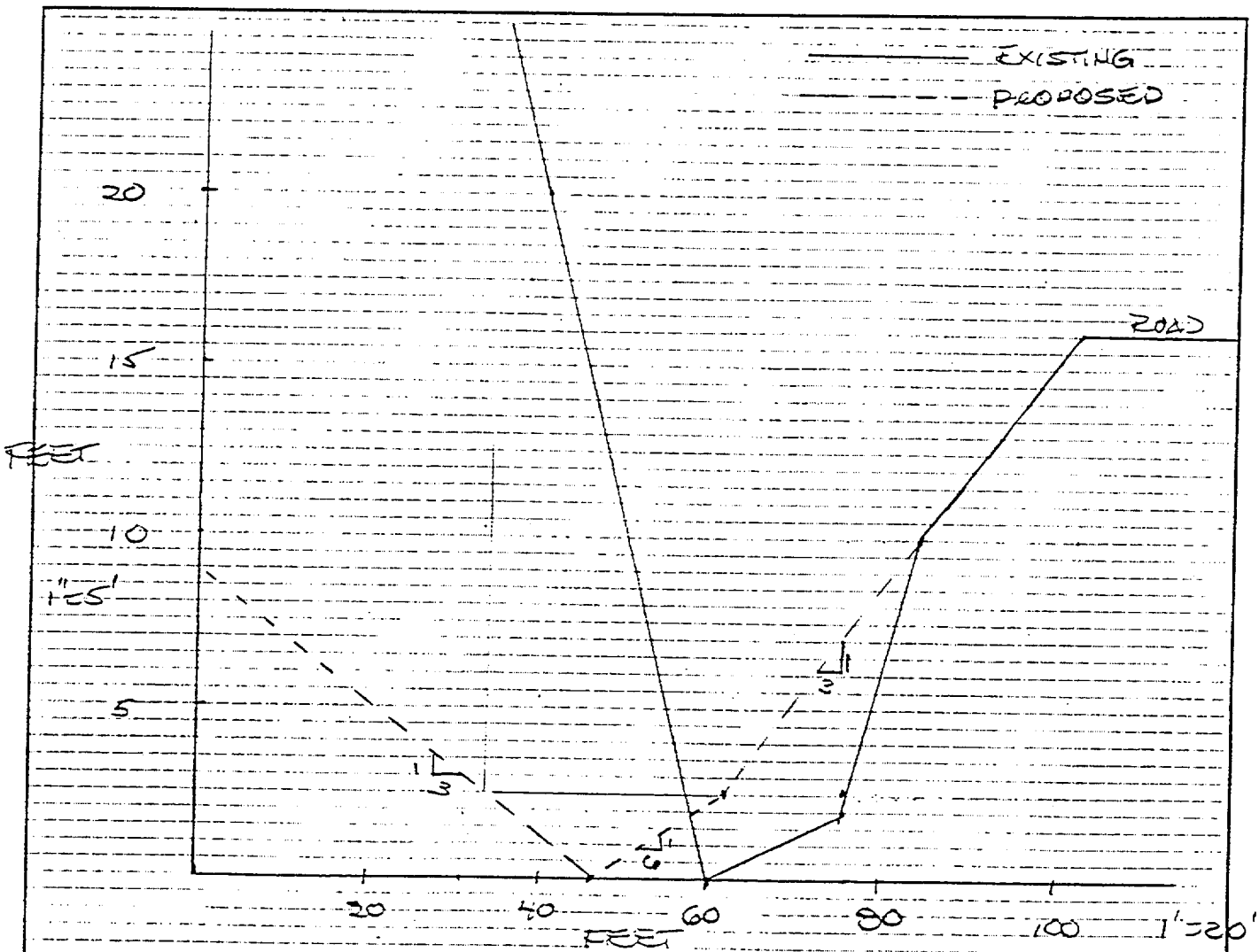


EXIST CHANNEL CROSS SECTION

COMPUTE NORMAL DEPTH OF PROPOSED CHANNEL

$Q = \frac{1.49}{n} A R^{2/3} S^{1/2}$ $\quad Q = 5325$ CFS

$n = 0.013$

$S = .0025$

$A = \frac{1}{2}(28)(2.6) = 36.4$

$A = 36.4 + \frac{(H-2.6)^2 3}{2} + (H-2.6)28 + \frac{(H-2.6)^2 3}{2}$

$A = 36.4 + (H-2.6)^2 3 + 28(H-2.6)$

$P = 24.3 + 2\left(\left((H-2.6)3\right)^2 + (H-2.6)^2\right)^{1/2}$

BY TRIAL, DEPTH = 12.6', Q = 5390

CHANNEL DEPTH AT OUTLET IS 15'

∴ FB = 2.4' ∴ OK

PMF VALUES

① Schaefer : Q: 4650 -- East channel

Q: 750 -- West Channel

5400 CFS

CLOSURE PLAN 5325 CFS

-- OK.

- Channel roughness = 0.031 (Rip Rap)

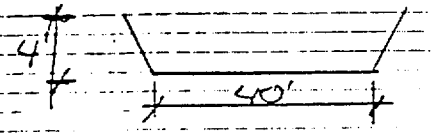
Was used 0.030 for a sand bottom channel to account for channel bottom forms and changes in channel alignment

Because the closure plan proposes to straighten the channel, and regrade the channel, 0.031 is reasonable

- If diversion channel silts in, then flow from the tributaries will flow over the cap.

Thus, the spillway must be sized for the PMF.

Q = 5325 CFS (Reg'd)



$Q = CLH^{3/2}$ $L = 40'$

$Q = (3.1)(40)(4)^{1.5}$

Q = 480 CFS X NO GOOD

Discharge capacity would be a little higher because of the trapezoidal section it's but no where near 5325 CFS

WATER RESOURCES PROGRAM
DAM SAFETY SECTION

PROJECT _____ FILE _____
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PMP (thunderstorm)

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.5 hr

∴ Multiplies the Peak Intensity in the 6 hr PMP mass curve

HYDRAULIC CAPACITY AND EROSIONAL CHARACTERISTICS OF THE DIVERSION CHANNELS AT THE WESTERN NUCLEAR INC., SHERWOOD PROJECT

Prepared by:
Washington Department of Ecology
Dam Safety Section
August 16, 1984

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MGS

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The major considerations at project abandonment are that the diversion channels have adequate hydraulic capacity and long term stability in order to minimize maintenance and repair costs.

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STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
P.O. BOX 47600 • Olympia, Washington 98504-7600 • (206) 459-6000

March 24, 1995

TO: Leo Wainhouse, Maxine Dunkelman & John Blacklaw
Div. of Radiation Protection, Dept. of Health

FROM: Bruce Barker & Jerald LaVassar
Dam Safety Section, Dept. of Ecology

SUBJECT: Reclamation Plan for Western Nuclear's Sherwood Project

In accordance with WAC 173-175-040 (enclosed), the owner has submitted plans detailing the reclamation scheme for the impoundment system to the Dam Safety Section for our review and approval. Our review of those documents has been completed. With the exception of issues associated with the impoundment spillway, the plan submittal details an acceptable reclamation scheme. A Dam Safety approval can be issued upon satisfactory resolution of the spillway issues described below, submittal of a construction permit application and payment of the plan review and construction inspection fee of $500.

Once a Dam Safety approval is issued, it should not be interpreted as an approval to proceed with the reclamation work. Rather, it is but one of a number of permits that are required to implement the reclamation plan. Furthermore, a Dam Safety approval denotes solely that the scheme affords a level of protection against an uncontrolled release of the reservoir contents that meets or exceeds our design criteria. Others have the responsibility for approving the adequacy of the proposed capping scheme for the slimes.

Spillway Issue
We understand that the facility must be designed on the presumption that it will receive no maintenance for its design life of a 1000 years. In the absence of any periodic maintenance of the diversion channel, its capacity will be reduced as the result of tree growth and sedimentation. Regarding the latter, large storms will entrain sediments in the flows from the relatively steep surrounding drainage courses. These entrained sediments will drop out of suspension at the point the tributary drainages enter the much flatter diversion channel. This process was observed occurring during the operational life of the facility. These sediments will build up over time in the ditch and limit the discharge capacity. At some point in the design life of a 1000 years, the channel capacity will be so reduced that a major flood event will overtop the channel sidewall and flow onto the tailings cap. This flow would have to be passed through the spillway that was sized solely to carry the flow falling on the tailings cap. The additional flows conceivably could exceed the present spillway capacity and precipitate an erosional breach of the adjacent embankment. To minimize this likelihood, the spillway would have to be sized to accommodate the full PMF design flow of 5325 cfs.

To provide reasonable assurance that the spillway will function as intended, it should be provided with a concrete erosion cutoff barrier to address headward erosion concerns. This barrier should be constructed at the downstream end of the spillway perpendicular to the flow path. The depth of the barrier should be a minimum 4 feet. This depth could be reduced to that of the surface of an erosion resistant layer, such as bedrock, if one exists within the 4 foot depth. In addition, steps should be taken to minimize the development of trees at the mouth of the spillway that could occlude the spillway opening. This could be accomplished by the extension of the concrete floor a short distance upstream of the spillway mouth.

As the principal contact with Western Nuclear, we would appreciate your passing on to them our construction application form at the back of Part II of our enclosed guidelines.

If you have any questions on the forgoing, please contact either of us at (360) 407-6624.

JL/BB:jl

JL:jl

W.Q.S.e John Goodlaw

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DIV. OF RADIATION PROTECTION

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

P.O. Box 47600 • Olympia, Washington 98504-7600
(206) 407-6000 • TDD Only (Hearing Impaired) (206) 407-6006

July 18, 1995

Mr. Lou Miller, P.E.
Shepherd Miller
1600 Specht Point Drive, Suite F
Fort Collins, CO 80525

Subject: Reclamation Plan for Western Nuclear's Sherwood Project
File No.: ST54-378

Dear Mr. Miller:

This is a follow-up letter to the meeting held on July 6, 1995, regarding the revised design concepts for the closure of the Sherwood Project. Since the meeting, we have further examined the proposal to increase the size of the diversion channel to account for tree growth and sediment accumulation using a risk based framework. Based on this examination, we find the channel enlargement proposal acceptable. The following paragraphs describe our review of this proposal and administrative issues regarding the issuance the dam safety permit.

Design Issues Discussed at the July 6, 1995 Meeting

In our memorandum dated March 24, 1995, we expressed concern over the original design and whether or not it would function to pass the Probable Maximum Flood (PMF) over the entire 1000 year life span without maintenance. The concern was whether a representative suite of storms were assumed for the sediment transport calculations. If too small of storms were considered, then the diversion channel would silt in over time resulting in a loss of capacity. Clearly the diversion channel could not pass the PMF design discharge under these circumstances.

Two approaches were presented at the meeting for addressing this issue. The first was to keep the original design and perform maintenance in perpetuity. This option is acceptable and guarantees that the facility will perform as designed in the future. The second option proposed to increase the size of the diversion channel to account for sediment deposition and tree growth.

The analysis presented for Option 2 included sediment transport and diversion channel hydraulics assuming trees were growing in the channel. The intent was to size the channel such that the full PMF could be passed during the entire 1000 year design life. The channel hydraulic calculations are acceptable; however, there is

uncertainty in the estimation of sediment yield from the watershed and subsequent transport down the diversion channel. To account for this uncertainty, the design was examined in the context of the Dam Safety Section (DSS) risk based design criteria.

The Dam Safety Section employs an 8 step risk based design approach whereby design storms range from a minimum of 1 in 500 annual exceedance probability (Step 1) to the PMF (Step 8) depending on the hazard the structure poses to downstream life and property. An appropriate design level for this project based on DSS criteria is Step 4 which is in the middle of the design storm scale. Your calculations indicate that a relatively minor amount of sedimentation occurs in the diversion channel during the 1000 year design life. If in fact more sediment accumulates than you have estimated, then the channel will not pass the full PMF but will likely have sufficient capacity to pass the minimum required Step 4 flood. Thus, the proposed design is acceptable.

In summary, the channel maintenance and channel enlargement options presented at the meeting are acceptable alternatives.

Administrative Issues

A Dam Safety permit can be issued upon receipt of two sets of final plans and specifications, a construction permit application, and payment of the plan review and construction inspection fee of $500.

If you have any questions, please call me at (360) 407-6618.

Sincerely,

Bruce Barker

Bruce Barker, P.E.
Dam Safety Section
Shorelands and Water Resources Program

BB:dkh

cc: Ms. Stephanie Baker, Western Nuclear
Mr. John Blacklaw, P.E., Department of Health

File Copy: ~~WD-2~~ WCSC

WATER RESOURCES PROGRAM
DAM SAFETY SECTION
WASHINGTON STATE DEPARTMENT OF ECOLOGY

PROJECT Sherwood FILE
SUBJECT Closure Plan Review
INITIALS JML DATE 3/10/95 PAGE 1 OF

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Review of Closure Documents

Volume 1 (Executive Summary)

Cap sloped @ 0.5%

Cap erosion control provided by vegetation

(Technical Specifications)

Reclamation cover

Main pond

Top soil	6"	5 feet
SAND	24"	
Clay 2	20"	
Clay 1	10" min	

1 Minus 200 fraction 56% or greater
2 Min " " 27% or " "

Compaction Standard ASTM D 698 (Standard proctor)

For clay Compact to 95% with moisture content limited to 2% below to 4% above optimum

Fill to achieve subgrade for cover to be placed in 8 inch loose height lifts & compacted with construction traffic.

* Encourage proof-compaction of the subgrade for the cover cap., TJ-23

* Requiring no compaction of the sand cover layer increased potential for erosion in areas where grass cover not well developed. Not a DSS issue.

SIEVE ANALYSIS

SAMPLE Sherwood DATE 3/10/95

WT. COMBINED ANALYSIS SAMPLE (AFTER SPLITTING), W_S _____ WT. SAMPLE > #4 _____

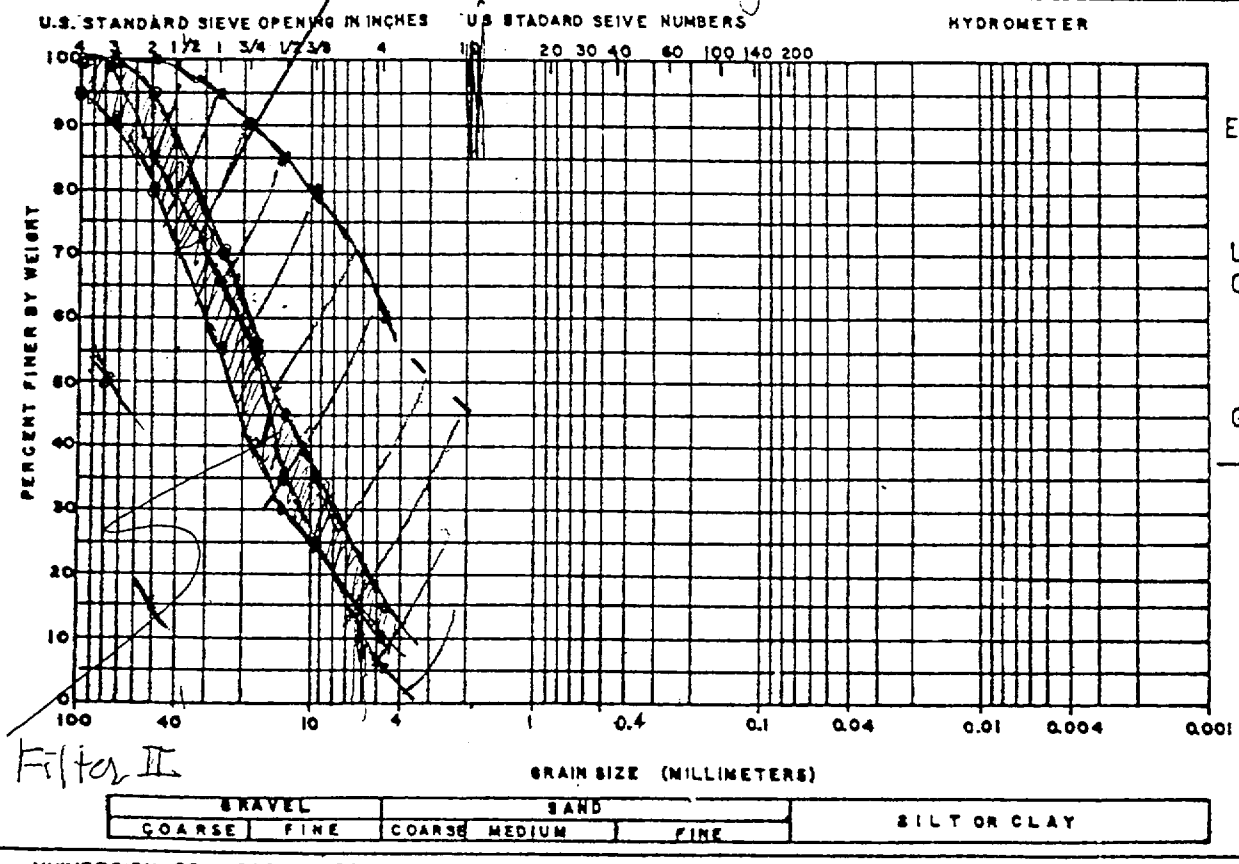
WT. SAMPLE < #200 _____ WT. SAMPLE USED FOR HYDROMETER _____

PARTIAL % RETAINED = WT RETAINED / WT RETAINED TOTAL ; TOTAL % RETAINED = PARTIAL % RETAINED x WT RETAINED TOTAL / WT COMBINED ANALYSIS ; % FINER = % FINER FOR NEXT LARGER SIEVE − TOTAL % RETAINED

SIEVE DESIGNATION	SIEVE OPENING		WEIGHT RETAINED	PERCENT RETAINED		PERCENT FINER BY WEIGHT
	MILLIMETERS	INCHES		PARTIAL	TOTAL	
	Filter No 1.		See TABLE 2B Volume 1			
PAN						
TOTAL						

Native SAND Layer

Note: Found Figure 2 in Volume 1 Appendix 5 showing larger fines



Filter II

EFFECTIVE SIZE D_{10} _____

UNIFORMITY COEFFICIENT $\frac{D_{60}}{D_{10}}$ _____

GRADATION _____

UNIVERSITY OF MISSOURI - ROLLA SOILS LAB

WATER RESOURCES PROGRAM DAM SAFETY SECTION	PROJECT Sherwood Closure Plan FILE ____
WASHINGTON STATE DEPARTMENT OF ECOLOGY	SUBJECT Closure Plan Review
	INITIALS JML DATE 3/10/95 PAGE 2 OF ___

Review of Filter Criteria on Riprap

Diversion channel STATIONS – First block of segments i.e., 0+00 – 7+02 ENDING with 68+71 – 90+00

Worst case first filter gradation for riprap: $\frac{D_{85}}{D_{15}} = \frac{15}{(45 \text{ to } 50)} \sim 3$ — O.K

STATIONS 53+45 – 63+93 & ending with ~~48+10~~ 53+...

Worst case: $\frac{d_{85}}{D_{15}} \sim \frac{15}{70 \text{ to } 90} \sim 4.6 \sim 6.0$

Mean: $\frac{d_{85}}{D_{15}} \sim \frac{35}{70-90} \sim 2 \sim 2.5$

OK

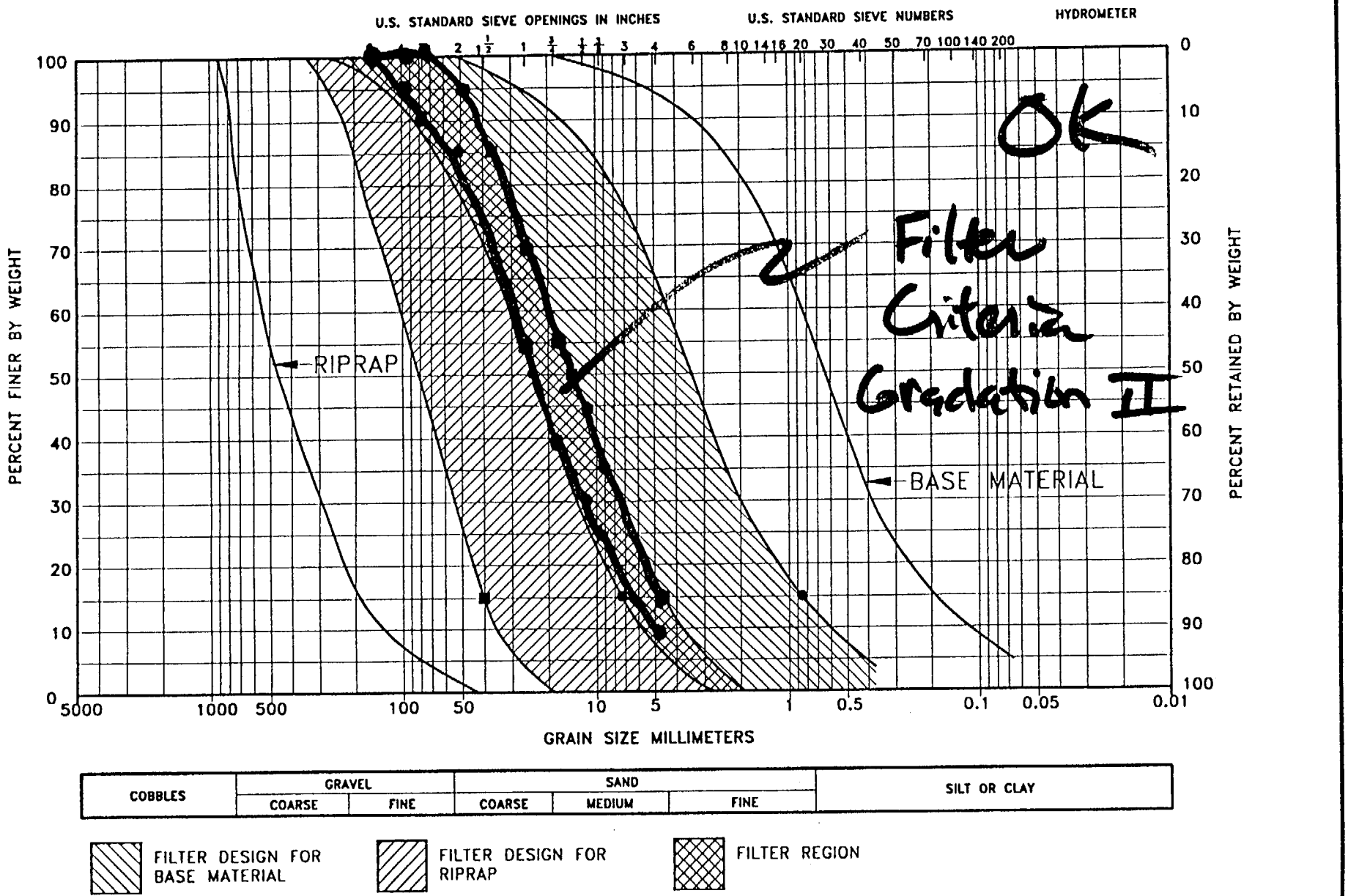
If life & death situation such as dam the 4.6 to 6.0 would be unacceptable as it is marginal. However, this is simply a channel lining whose failure poses essentially only maintenance issues for the channel section.

For greater D_{15} sizes on the bottom of the first sheet of Table 2A ~~...~~ the d_{85}/D_{15} ratio is ~~...~~ considerably larger than what is called for in typical filter design criteria, i.e., sections: 21+14 – 22+48 to 67+42 – 68+71.

Mention it in note.

Same problem occurs again on the lower portion of the continuation sheet for the embankment ~~sc~~ but no head to speak of here.

OK on Filter layer functioning to protect sand Subgrade assuming d_{85} of sand typically No 10 sieve or large. The ... data in Table 3.2 suggest this is typically the ...



SMI
SHEPHERD MILLER, INC.

FIGURE 9
FILTER REGION FOR 18" RIPRAP

Date: DEC., 1994
Project: 317
File: CTRP9

WATER RESOURCES PROGRAM
DAM SAFETY SECTION

PROJECT Sherwood FILE
SUBJECT Sherwood Closure Plan Review
INITIALS JMC DATE 3/8/95 PAGE 3 OF

Review of information in Appendix H of Volume 4 shows acceptable factors on d85/D15 OK see Following Sheets on Filter Criteria

Review of seismic study by R.L. Volpe
Appendix L / Volume 5

Comments
pg. See following sheets & memorandum

WATER RESOURCES PROGRAM
DAM SAFETY SECTION

PROJECT Sherwood Reclam. FILE
SUBJECT Liquefaction Assessment
INITIALS JMH DATE 3/15/95 PAGE 1 OF

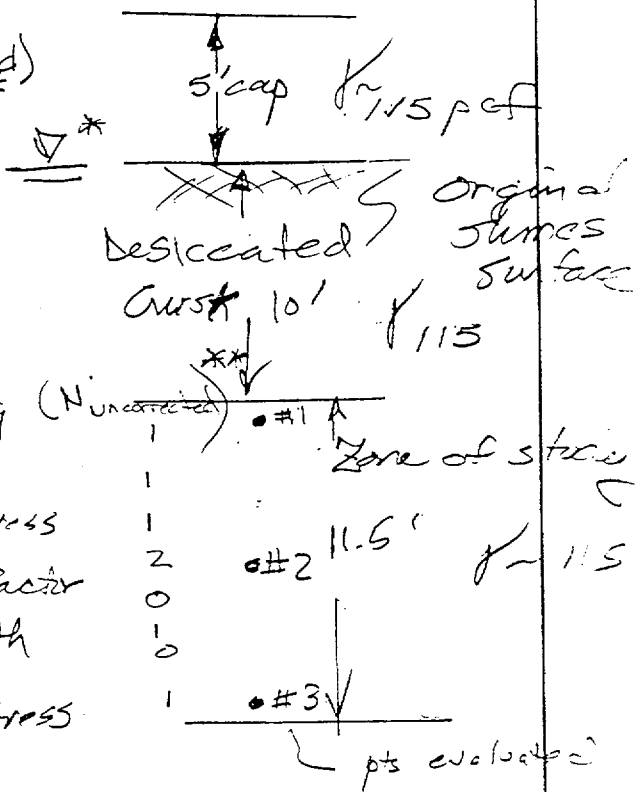
Sample Calculation

Borehole T-4 Depth Interval 11 to 22.5

Determine cyclic stress ratio (load) @ 15' / 20' / 25' Depths

$$\left(\frac{\tau_{ave}}{\sigma_o'}\right) = (0.65)\, a_{max} \left(\frac{\sigma_o}{\sigma_o'}\right) r_d$$

where a_{max} is the peak ground acceleration ~0.07g
σ_o ~ is the total stress
σ_o' ~ is the effective stress
r_d ~ is the reduction factor for a_{max} with depth
τ_{ave} ~ Cyclic shear stress



Point	① a_{max}	② r_d*	③ ①×②	σ_o psf	σ_o	④ σ_o/σ_o'	0.65×③×④	Reduction factor for Earthquake <7.5	$\frac{\tau_{ave}}{\sigma_o'}$ corrected for Earthquake
1	0.07	0.9	0.063	1725	1100	1.568	0.064	0.8	0.051
2	0.07	0.9	"	2300	1365	1.685	0.069	0.8	0.055
3	0.07	0.9	"	2875	1627	1.767	0.072	0.8	0.058

(See Following page)

These values are represented as a band on Figure S-7 (2nd following page)

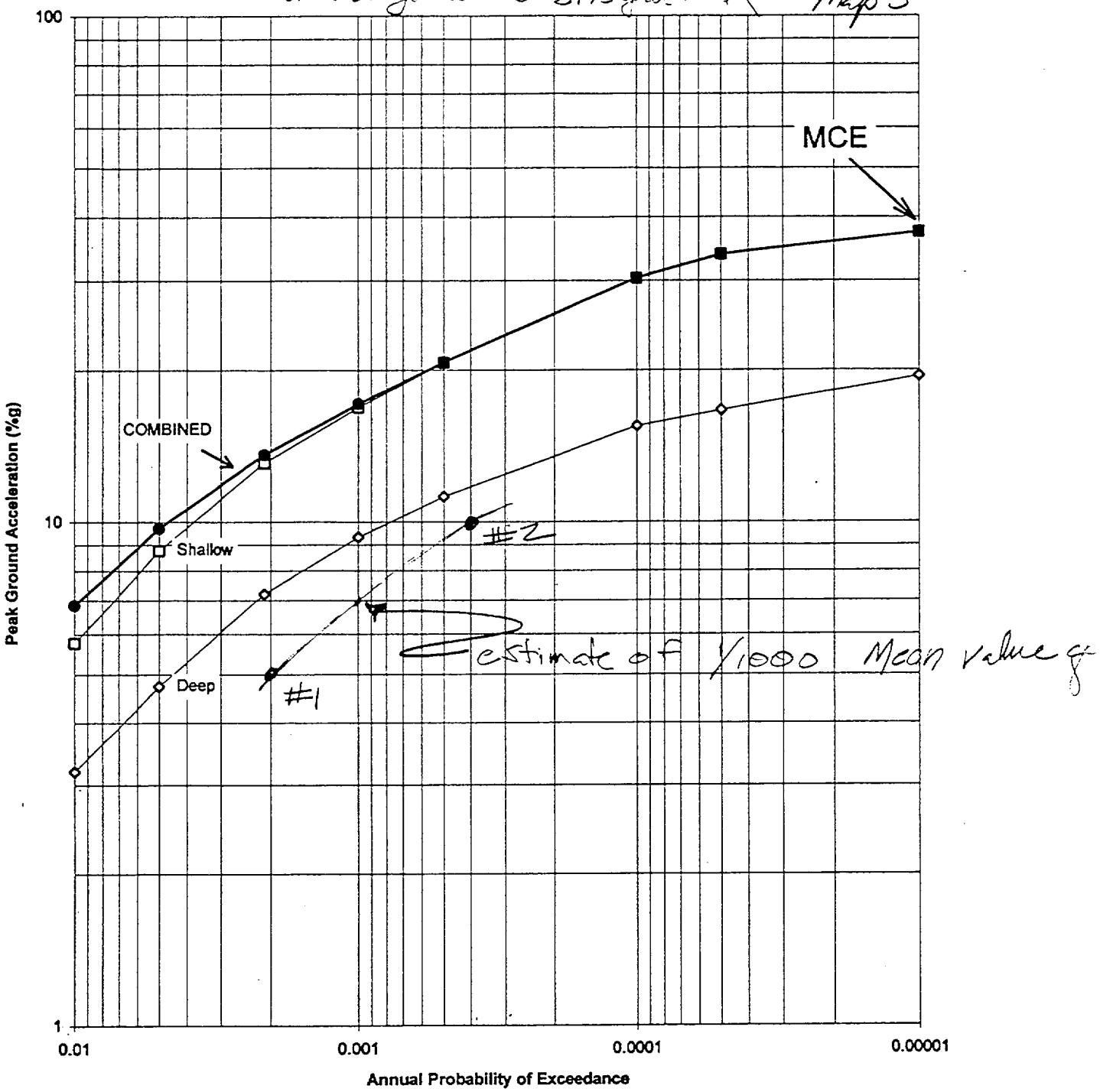
* Volpe Assumed that post cap placement, the ground water surface would rise to the base of the cap.

** Assume no appreciable change in void ratio due to placement of the cap.

FIGURE 5
SEISMIC HAZARD CURVE

#1 0.3 sec spectral acce... divided by 2.5 to gi... Ap from 1991 NEHRP at... 10% chance of exceed... in 50 years ~ 475 ex... Map 5

#2 0.3 sec spectral acceleration at 10% chance of exceedance in 250 years ~ 2475 year event



CONCLUDE: LIQUEFACTION POSSIBLE — AS A CONSEQUENCE ESTIMATE PROBABLE MAGNITUDE OF DISPLACEMENT (See Follow-

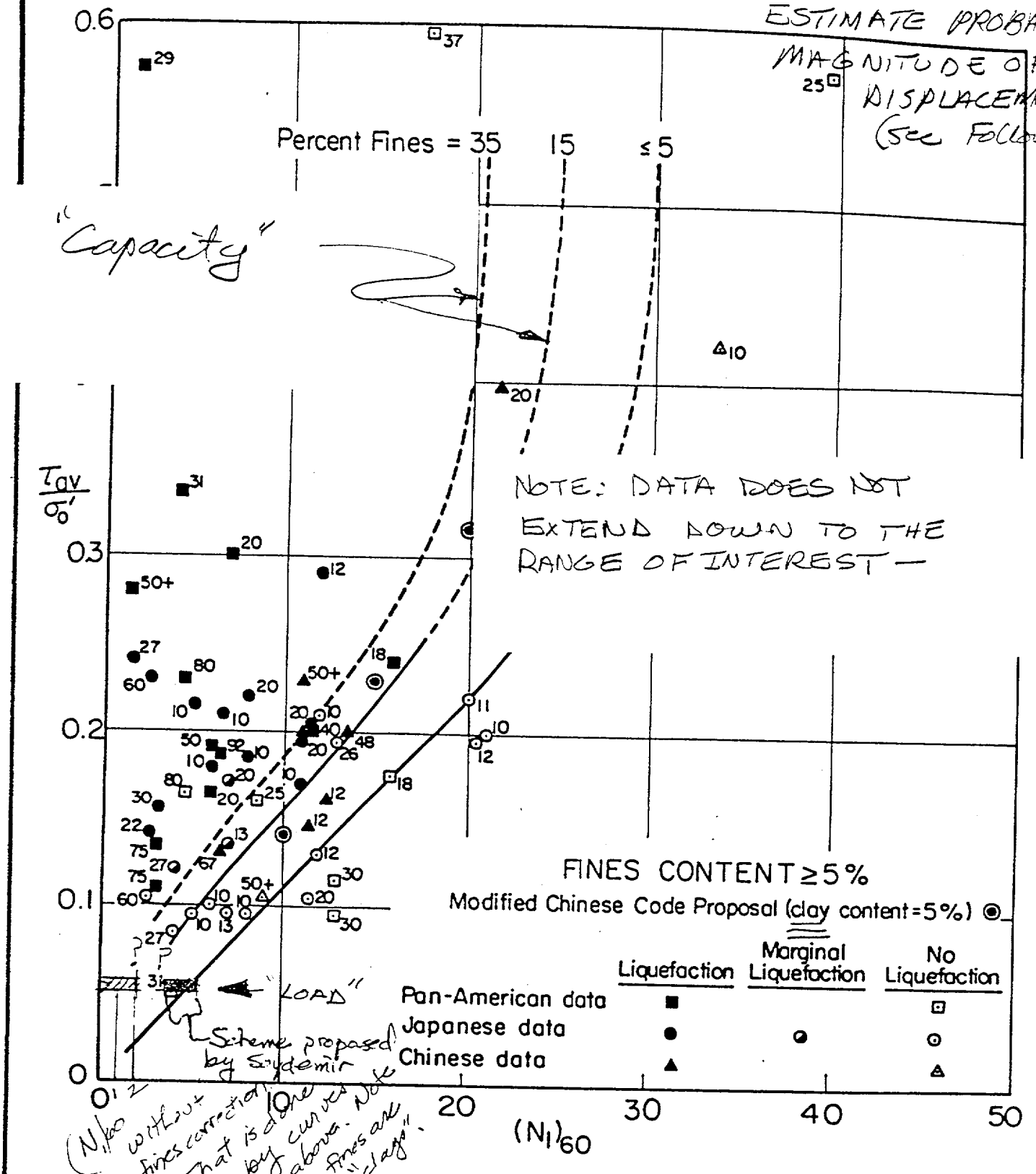


Fig. 5-7 RELATIONSHIPS BETWEEN STRESS RATIOS CAUSING LIQUEFACTION AND $(N_1)_{60}$-VALUES FOR SANDS AND SILTY SANDS IN M ≈ 7 1/2 EARTHQUAKES (after Seed et al., 1985)

1A/
JMC

				Corrections to Obtain SPT-Equivalent Blow Counts										
JOB NAME:	SMI - Sherwood Tailings Impoundments													
JOB NO.:	SMI-1													
BY:	RLV	10/27/94												
BOREHOLE	DEPTH	SPT or	UNCORRECTED	SOIL	GRAVEL?		CORRECTION FACTORS				FINAL	Effective		
	(ft)	MOD. CAL.	BLOW COUNT	TYPE	Y=yes	MOD. CAL.	DRILL ROD	HAMMER EFF.	SPT w/o Liner	SILTS	CORRECTED	Overburden	Cn	(N1)60
			N		N=no	(*.55)	(*.75@<10')	(*.75)	(*1.2)	(add 7)	N	(psf)		
T-1	4.5	SPT	5	SM	N	5	4	3	3	10	10	1294	1.60	17
	6	SPT	7	SM	N	7	5	4	5	12	12	1425	1.60	19
	7.5	SPT	8	ML	N	8	6	5	5	12	12	1557	1.12	14
Non-plastic	9	SPT	2	SM	N	2	2	1	1	8	8	1689	1.08	9
"	11	SPT	3	SM	N	3	3	2	3	10	10	1826	1.05	10
"	12.5	SPT	2	SM	N	2	2	2	2	9	9	1899	1.03	9
"	14	SPT	1	ML	N	1	1	1	1	8	8	1971	1.01	8
T-2	4.5	SPT	5	SM	N	5	4	3	3	10	10	1294	1.60	17
WL	6	SPT	4	SM	N	4	3	2	3	10	10	1425	1.60	16
	7.5	SPT	3	SM	N	3	2	2	2	9	9	1557	1.12	10
NP	9	SPT	0.5	SM	N	1	0	0	0	7	7	1689	1.08	8
NP	11	SPT	1	SM	N	1	1	1	1	8	8	1826	1.05	8
NP	12.5	SPT	3	SM	N	3	3	2	3	10	10	1899	1.03	10
NP	14	SPT	3	SM	N	3	3	2	3	10	10	1971	1.01	10
33	16	SPT	3	SM	N	3	3	2	3	10	10	2069	0.99	10
NP	17.5	SPT	2	SM	N	2	2	2	2	9	9	2142	0.98	9
	21	SPT	1.5	ML	N	2	2	1	1	8	8	2312	0.95	8
38	24.5	SPT	3	ML	N	3	3	2	3	10	10	2482	0.91	9

PP

Identified as non-plastic

$L_L = \frac{36-27}{6} + 4.5$

L.C.-1-7

Zones potentially liquefiable based on following criteria marked in yellow:

1. Liquidity Index ≥ 0.9 (or Non-plastic)
2. Liquid Limit < 35 (not applicable when non-plastic)
3. Sediment fraction finer than 0.005 less than 15%. *Hydrometer data for samples was not found in the text to confirm this

Not used →

2A/

				Corrections to Obtain SPT-Equivalent Blow Counts										
JOB NAME:	SMI - Sherwood Tailings Impoundments													
JOB NO.:	SMI-1													
BY:	RLV	10/27/94												
BOREHOLE	DEPTH	SPT or	UNCORRECTED	SOIL	GRAVEL?		CORRECTION FACTORS				FINAL	Effective		
	(ft)	MOD. CAL.	BLOW COUNT	TYPE	Y=yes	MOD. CAL.	DRILL ROD	HAMMER EFF.	SPT w/o Liner	SILTS	CORRECTED	Overburden	Cn	(N1)60
WL			N		N=no	(*.55)	(*.75@<10')	(*.75)	(*1.2)	(add 7)	N	(psf)		
T-3	4	SPT	3	SM	N	3	2	2	2	9	9	1250	1.60	14
NP	5.5	SPT	3	SM	N	3	2	2	2	9	9	1381	1.60	14
NP	7	SPT	2	SM	N	2	2	1	1	8	8	1513	1.60	13
NP	9	SPT	0.5	SM	N	1	0	0	0	7	7	1689	1.08	8
NP	11	SPT	0.5	SM	N	1	1	0	0	7	7	1826	1.05	8
	13	SPT	0.5	SM	N	1	1	0	0	7	7	1923	1.03	8
	14.5	SPT	0.5	ML	N	1	1	0	0	7	7	1996	1.01	8
40	16	SPT	0.5	ML	N	1	1	0	0	7	7	2069	0.99	7
44	17.5	SPT	0.5	ML	N	1	1	0	0	7	7	2142	0.98	7
34	19	SPT	0.5	ML	N	1	1	0	0	7	7	2214	0.96	7
NP	20.5	SPT	0.5	SM	N	1	1	0	0	7	7	2287	0.95	7
NP	22	SPT	0.5	SM	N	1	1	0	0	7	7	2360	0.94	7
NP	24	SPT	3	SM	N	3	3	2	3	10	10	2457	0.92	9
	29	SPT	4	SM	N	4	4	3	4	11	11	2700	0.88	9

$L_L = \frac{64-34}{4} = 7.5$

Potentially Liquefiable Zones shown in yellow

7.C-155

Corrections to Obtain SPT-Equivalent Blow Counts

JOB NAME: SMI - Sherwood Tailings Impoundments
JOB NO.: SMI-1
BY: RLV 10/27/94

BOREHOLE	DEPTH (ft)	SPT or MOD. CAL.	UNCORRECTED BLOW COUNT N	SOIL TYPE	GRAVEL? Y=yes N=no	CORRECTION FACTORS MOD. CAL. (*.55)	DRILL ROD (*.75@<10')	HAMMER EFF. (*.75)	SPT w/o Liner (*1.2)	SILTS (add 7)	FINAL CORRECTED N	Effective Overburden (psf)	Cn	(N1)60
T-4	4.5	SPT	6	SM	N	6	5	3	4	11	11	1294	1.60	18
	6	SPT	4	SM	N	4	3	2	3	10	10	1425	1.60	16
	7.5	SPT	2	SM	N	2	2	1	1	8	8	1557	1.12	9
	9	SPT	3	SM	N	3	2	2	2	9	9	1689	1.08	10
	11	SPT	1	ML	N	1	1	1	1	8	8	1826	1.05	8
	12.5	SPT	1	ML	N	1	1	1	1	8	8	1899	1.03	8
	14	SPT	1	ML	N	1	1	1	1	8	8	1971	1.01	8
	16	SPT	2	SM	N	2	2	2	2	9	9	2069	0.99	9
	17.5	SPT	0	SM	N	0	0	0	0	7	7	2142	0.98	7
	19	SPT	1	ML	N	1	1	1	1	8	8	2214	0.96	8
	21	SPT	0	SM	N	0	0	0	0	7	7	2312	0.95	7
	22.5	SPT	1	SM	N	1	1	1	1	8	8	2385	0.93	7
	24	SPT	4	SM	N	4	4	3	4	11	11	2457	0.92	10
	26	SPT	4	SM	N	4	4	3	4	11	11	2555	0.90	10
	29	SPT	4	SM	N	4	4	3	4	11	11	2700	0.88	9
	31	SPT	6	SM	N	6	6	5	5	12	12	2798	0.86	11
	32.5	SPT	6	SM	N	6	6	5	5	12	12	2871	0.85	11
	34	SPT	16	SM	N	16	16	12	14	21	21	2943	0.84	18
	36	SPT	14	SM	N	14	14	11	13	20	20	3041	0.83	16
	37.5	SPT	13	SM	N	13	13	10	12	19	19	3114	0.82	15
	39	SPT	17	SM	N	17	17	13	15	22	22	3186	0.81	18
	41	SPT	14	SM	N	14	14	11	13	20	20	3284	0.79	16
	42.5	SPT	18	SM	N	18	18	14	16	23	23	3357	0.78	18
	44	SPT	13	ML	N	13	13	10	12	19	19	3429	0.77	14
	46	SPT	16	ML	N	16	16	12	14	21	21	3624	0.75	16
	49.5	SPT	15	ML	N	15	15	11	14	21	21	3697	0.74	15
	51	SPT	14	ML	N	14	14	11	13	20	20	3770	0.73	14
	52.5	SPT	12	ML	N	12	12	9	11	18	18	3843	0.73	13
	54	SPT	8	ML	N	8	8	6	7	14	14	3915	0.72	10
	56	SPT	12	ML	N	12	12	9	11	18	18	4013	0.71	13
	57.5	SPT	11	ML	N	11	11	8	10	17	17	4086	0.70	12
	61	SPT	24	ML	N	24	24	18	22	29	29	4256	0.68	19
	62.5	SPT	12	ML	N	12	12	9	11	18	18	4329	0.67	12
	64	SPT	10	SM	N	10	10	8	9	16	16	4401	0.67	11

WL | LL
34
NP
35
4 | 4.6

L-C-134

A4/

				Corrections to Obtain SPT-Equivalent Blow Counts											
JOB NAME:	SMI - Sherwood Tailings Impoundments														
JOB NO.:	SMI-1														
BY:	RLV	10/27/94													
BOREHOLE	DEPTH	SPT or	UNCORRECTED	SOIL	GRAVEL?		CORRECTION FACTORS				FINAL	Effective		
	(ft)	MOD. CAL.	BLOW COUNT	TYPE	Y=yes	MOD. CAL.	DRILL ROD	HAMMER EFF.	SPT w/o Liner	SILTS	CORRECTED	Overburden	Cn	(N1)60
			N		N=no	(*.55)	(*.75@<10')	(*.75)	(*1.2)	(add 7)	N	(psf)		
T-5	4.5	SPT	4	SM	N	4	3	2	3	10	10	1294	1.60	16
	6	SPT	4	ML	N	4	3	2	3	10	10	1425	1.60	16
	7.5	SPT	4	ML	N	4	3	2	3	10	10	1557	1.12	11
	9	SPT	3	SM	N	3	2	2	2	9	9	1689	1.08	10
	11	SPT	4	SM	N	4	4	3	4	11	11	1826	1.05	11
	12.5	SPT	2	ML	N	2	2	2	2	9	9	1899	1.03	9
	14	SPT	1.5	ML	N	2	2	1	1	8	8	1971	1.01	8
	16	SPT	0	ML	N	0	0	0	0	7	7	2069	0.99	7
	17.5	SPT	0	ML	N	0	0	0	0	7	7	2142	0.98	7
	19	SPT	0	ML	N	0	0	0	0	7	7	2214	0.96	7
	23	SPT	3	SM	N	3	3	2	3	10	10	2409	0.93	9
	24.5	SPT	4	SM	N	4	4	3	4	11	11	2482	0.91	10
	26	SPT	6	SM	N	6	6	5	5	12	12	2555	0.90	11
	27.5	SPT	0	SM	N	0	0	0	0	7	7	2628	0.89	6
	29	SPT	2	SP-SM	N	2	2	2	2	2	2	2700	0.88	2
T-6	4.5	SPT	6	SM	N	6	5	3	4	11	11	1294	1.60	18
	6	SPT	4	SM	N	4	3	2	3	10	10	1425	1.60	16
	7.5	SPT	3	SM	N	3	2	2	2	9	9	1557	1.12	10
	9	SPT	0.5	ML	N	1	0	0	0	7	7	1689	1.08	8

L.C-135

A5/

Corrections to Obtain SPT-Equivalent Blow Counts

JOB NAME: SMI - Sherwood Tailings Impoundments
JOB NO.: SMI-1
BY: RLV 10/27/94

BOREHOLE	DEPTH (ft)	SPT or MOD. CAL.	UNCORRECTED BLOW COUNT N	SOIL TYPE	GRAVEL? Y=yes N=no	CORRECTION FACTORS MOD. CAL. (*.55)	DRILL ROD (*.75@<10')	HAMMER EFF. (*.75)	SPT w/o Liner (*1.2)	SILTS (add 7)	FINAL CORRECTED N	Effective Overburden (psf)	Cn	(N1)60
WL														
NTP														
T-7	4	SPT	9	SM	N	9	7	5	6	13	13	1250	1.60	21
	6	SPT	4	SM	N	4	3	2	3	10	10	1425	1.60	16
	7.5	SPT	4	SM	N	4	3	2	3	10	10	1557	1.12	11
	9	SPT	3	ML	N	3	2	2	2	9	9	1689	1.08	10
	11	SPT	4	ML	N	4	4	3	4	11	11	1826	1.05	11
	12.5	SPT	2	ML	N	2	2	2	2	9	9	1899	1.03	9
	14	SPT	1	ML	N	1	1	1	1	8	8	1971	1.01	8
	16	SPT	1	SM	N	1	1	1	1	8	8	2069	0.99	8
	17.5	SPT	1	ML	N	1	1	1	1	8	8	2142	0.98	8
NP														
	19	SPT	5	ML	N	5	5	4	5	12	12	2214	0.96	11
TS														
	21	SPT	1	SM	N	1	1	1	1	8	8	2312	0.95	7
NP														
	22.5	SPT	3	SM	N	3	3	2	3	10	10	2385	0.93	9
	24	SPT	3	SM	N	3	3	2	3	10	10	2457	0.92	9
NP														
	26	SPT	2	ML	N	2	2	2	2	9	9	2555	0.90	8
49														
	27.5	SPT	4	SM	N	4	4	3	4	11	11	2628	0.89	9
	29	SPT	4	ML	N	4	4	3	4	11	11	2700	0.88	9
	31	SPT	6	ML	N	6	6	5	5	12	12	2798	0.86	11
	32.5	SPT	6	SM	N	6	6	5	5	12	12	2871	0.85	11
	34	SPT	8	SM	N	8	8	6	7	14	14	2943	0.84	12
	36	SPT	2	SM	N	2	2	2	2	9	9	3041	0.83	7
	37.5	SPT	3	SM	N	3	3	2	3	10	10	3114	0.82	8
	39	SPT	4	ML	N	4	4	3	4	11	11	3186	0.81	9
	41	SPT	4	ML	N	4	4	3	4	11	11	3284	0.79	8
	42.5	SPT	5	ML	N	5	5	4	5	12	12	3357	0.78	9
	44	SPT	7	ML	N	7	7	5	6	13	13	3429	0.77	10
	46	SPT	10	ML	N	10	10	8	9	16	16	3527	0.76	12
	47.5	SPT	5	ML	N	5	5	4	5	12	12	3600	0.75	9
	49	SPT	6	ML	N	6	6	5	5	12	12	3672	0.75	9
	51	SPT	9	ML	N	9	9	7	8	15	15	3770	0.73	11
	52.5	SPT	4	ML	N	4	4	3	4	11	11	3843	0.73	8
	54	SPT	12	ML	N	12	12	9	11	18	18	3915	0.72	13
	56	SPT	20	SM	N	20	20	15	18	25	25	4013	0.71	18
	57.5	SPT	22	SM	N	22	22	17	20	27	27	4086	0.70	19
	59	SPT	20	SM	N	20	20	15	18	25	25	4158	0.69	17
	61	SPT	18	ML	N	18	18	14	16	23	23	4256	0.68	16
	62.5	SPT	22	ML	N	22	22	17	20	27	27	4329	0.67	18
	64	SPT	24	ML	N	24	24	18	22	29	29	4401	0.67	19

L.C-136

Corrections to Obtain SPT-Equivalent Blow Counts

JOB NAME: SMI - Sherwood Tailings Impoundments
JOB NO.: SMI-1
BY: RLV 10/27/94

BOREHOLE	DEPTH (ft)	SPT or MOD. CAL.	UNCORRECTED BLOW COUNT N	SOIL TYPE	GRAVEL? Y=yes N=no	CORRECTION FACTORS MOD. CAL. (*.55)	DRILL ROD (*.75@<10')	HAMMER EFF. (*.75)	SPT w/o Liner (*1.2)	SILTS (add 7)	FINAL CORRECTED N	Effective Overburden (psf)	Cn	(N1)60
T-8	4.5	SPT	5	SM	N	5	4	3	3	10	10	1294	1.60	17
	6	SPT	4	SM	N	4	3	2	3	10	10	1425	1.60	16
	7.5	SPT	3	ML	N	3	2	2	2	9	9	1557	1.12	10
	9	SPT	2	SM	N	2	2	1	1	8	8	1689	1.08	9
	11	SPT	0.5	ML	N	1	1	0	0	7	7	1826	1.05	8
	12.5	SPT	4	ML	N	4	4	3	4	11	11	1899	1.03	11
	16	SPT	2	SM	N	2	2	2	2	9	9	2069	0.99	9
	17.5	SPT	2	SM	N	2	2	2	2	9	9	2142	0.98	9
	19	SPT	1	ML	N	1	1	1	1	8	8	2214	0.96	8
	21	SPT	1	ML	N	1	1	1	1	8	8	2312	0.95	7
	22.5	SPT	1	SM	N	1	1	1	1	8	8	2385	0.93	7
	24	SPT	2	ML	N	2	2	2	2	9	9	2457	0.92	8
	25.5	SPT	3	ML	N	3	3	2	3	10	10	2530	0.91	9
	29	SPT	1	ML	N	1	1	1	1	8	8	2700	0.88	7
	31	SPT	4	ML	N	4	4	3	4	11	11	2798	0.86	9
T-9	4	SPT	8	SM	N	8	6	5	5	12	12	1250	1.60	20
	6	SPT	4	SM	N	4	3	2	3	10	10	1425	1.60	16
	7.5	SPT	3	SM	N	3	2	2	2	9	9	1557	1.12	10
	9	SPT	5	SM	N	5	4	3	3	10	10	1689	1.08	11
T-10	4.5	SPT	28	SM	N	28	21	16	19	26	26	1294	1.60	41
	6	SPT	10	SM	N	10	8	6	7	14	14	1425	1.60	22
	7.5	SPT	5	SM	N	5	4	3	3	10	10	1557	1.12	12
	9	SPT	6	ML	N	6	5	3	4	11	11	1689	1.08	12
	11	SPT	8	ML	N	8	8	6	7	14	14	1826	1.05	15
	12.5	SPT	2	SM	N	2	2	2	2	9	9	1899	1.03	9
	14	SPT	1	SM	N	1	1	1	1	8	8	1971	1.01	8

TABLE 4.2. SUMMARY OF TEST RESULTS ON TAILING SPLIT SPOON SAMPLES

SAMPLE ID	DEPTH (ft)	NATURAL MOISTURE %	SIEVE ANALYSIS (% PASSING)					LIQUI LIMI		
			3/4"	#4	#10	#40	#200			
T-1	5.5-5.7	55.7	100.0	100.0	100.0	99.0	76.6	41		
T-1	6.5-8.0	21.9	100.0	100.0	100.0	94.0	39.5	NP		
T-1	10.3-11.4	46.7	100.0	100.0	100.0	84.0	26.1	NP		
T-1	13.0-14.5	27.4	100.0	100.0	100.0	83.0	28.3	NP		
T-2	5.3-5.6	43.7	100.0	100.0	100.0	93.0	47.4	34		
T-2	5.6-6.0	56.1	100.0	100.0	100.0	99.0	72.3	41		
T-2	6.8-8.0	19.0	100.0	100.0	100.0	87.0	15.8	NP	NP	
T-2	13.0-14.5	29.9	100.0	100.0	100.0	76.0	22.2	NP	NP	
T-2	15.2-16.1	36.0	100.0	100.0	100.0	90.0	42.2	33	6	
T-2	16.5-17.2	27.4	100.0	100.0	100.0	72.0	21.7		...	
T-2	20.9-21.5	85.9	100.0	100.0	100.0	99.0	79.6	37	7	ML
T-2	24.3-24.6	63.0	100.0	100.0	100.0	99.0	73.9	38	8	ML
T-3	4.5-6.0	30.9	100.0	100.0	100.0	93.0	38.3		NP	SM
T-3	10.0-11.5	40.0	100.0	100.0	99.0	94.0	36.5		NP	SM
T-3	16.1-16.5	64.2	100.0	100.0	100.0	99.0	78.5	40	6	ML
T-3	17.7-18.0	188.0	100.0	100.0	100.0	96.0	70.5	44	8	ML
T-3	18.0-19.5	64.0	100.0	100.0	100.0	99.0	63.2	34	4	ML
T-3	21.0-22.5	24.7	100.0	100.0	100.0	90.0	17.1		NP	SM
T-3	28.0-29.5	27.1	100.0	100.0	100.0	83.0	14.2		NP	SM
T-4	8.0-8.8	52.4	100.0	100.0	100.0	96.0	45.6	34	1	SM
T-4	10.5-11.5	27.3	100.0	100.0	100.0	92.0	36.7		NP	SM
T-4	12.2-13.0	370.0	100.0	100.0	95.0	92.0	64.9	69	6	MH
T-4	13.0-13.8	65.1	100.0	100.0	100.0	92.0	53.1	44	4	ML
T-4	18.8-19.5	50.9	100.0	100.0	100.0	99.0	73.0	37	6	ML
T-4	21.5-23.0	51.8	100.0	100.0	100.0	97.0	54.4	34	5	ML
T-4	26.5-28.0	24.1	100.0	100.0	100.0	85.0	15.9		NP	SM
T-4	41.5-43.0	27.0	100.0	100.0	100.0	98.0	37.1		NP	SM
T-4	43.0-43.8	80.6	100.0	100.0	100.0	100.0	78.8	45	8	ML
T-4	48.5-50.0	50.0	100.0	100.0	100.0	99.0	59.4	32	2	ML
T-4	51.5-52.5	38.3	100.0	100.0	100.0	100.0	68.2		NP	ML

Liquefaction Criteria of Seed et al. (1983) JGE March
① Liquidity Index > 0.9
② Liquid Limit < 35
③ ± Sediment fraction finer than 0.005 less than 15% — Data not provided here

Liquidity Index LI

Nonplastic

Potentially Liquefiable Zone 4.6

$$LI = \frac{w_n - w_p}{w_L - w_p} = \frac{w_n - w_p}{I_p}$$

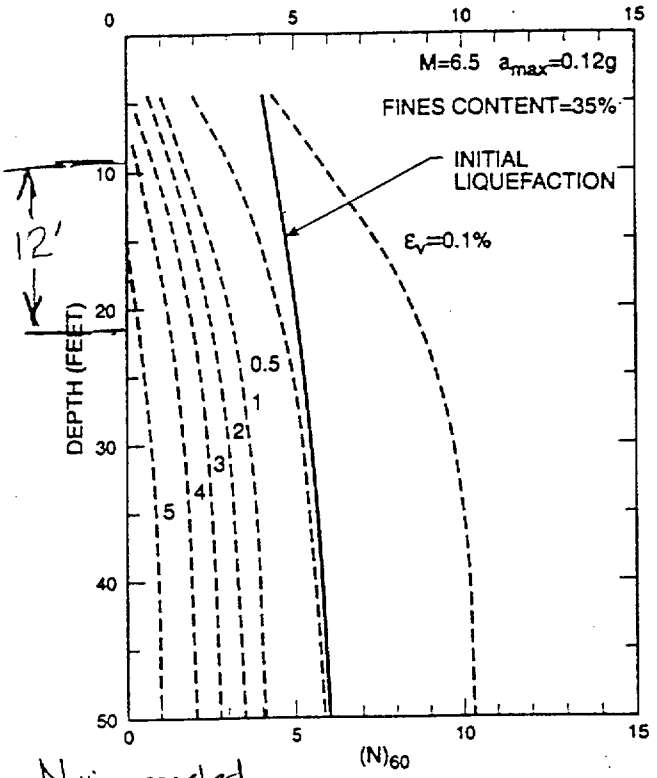
Potential Liquefiable Layers

TABLE 4.2 (cont.), SUMMARY OF TEST RESULTS ON TAILING SPLIT SPOON SAMPLES

SAMPLE ID	DEPTH (ft)	NATURAL MOISTURE %	SIEVE ANALYSIS (% PASSING)					LIQUID LIMIT	PLASTICITY INDEX	UNIFIED SOIL CLASS	RADIUM-226 (pCi/g)	RADIUM-226 uncertainty (pCi/g)
			3/4"	#4	#10	#40	#200					
T-4	53.2-53.9	66.6	100.0	100.0	99.0	99.0	84.3	48	12	ML	238.6	1.6
T-4	56.5-57.0	52.8	100.0	100.0	100.0	100.0	96.4	51	18	MH	528.0	2.1
T-4	57.5-58.0	52.8	100.0	100.0	100.0	99.0	89.7	35	4	ML	449.0	2.0
T-4	61.5-63.0	47.1	100.0	100.0	100.0	100.0	72.4	36	5	ML	253.3	1.5
T-5	6.5-8.0	26.4	100.0	100.0	100.0	90.0	37.3		NP	SM	170.5	1.1
T-5	8.0-9.5	23.9	100.0	100.0	100.0	68.0	17.5		NP	SM	143.8	1.0
T-5	10.2-10.6	41.6	100.0	100.0	100.0	96.0	48.0	30	1	SM	243.3	1.4
T-5	13.4-14.5	55.6	100.0	100.0	100.0	99.0	72.7	46	14	ML	279.8	1.5
T-5	18.0-19.5	29.0	100.0	100.0	100.0	90.0	34.8		NP	SM	176.0	1.1
T-5	25.0-26.5	19.0	100.0	100.0	100.0	56.0	6.7			SP-SM	61.2	0.7
T-6	3.5-5.0	18.0	100.0	100.0	100.0	77.0	23.7		NP	SM	145.3	1.0
T-6	8.3-8.7	45.2	100.0	100.0	100.0	96.0	53.7	35	5	ML	258.8	1.6
T-6	8.7-9.0	241.0	100.0	100.0	100.0	100.0	72.0	61	10	MH		
T-7	6.5-8.0	27.1	100.0	100.0	99.0	93.0	35.9		NP	SM	167.4	1.1
T-7	8.6-9.5	59.2	100.0	100.0	100.0	84.0	36.7		NP	SM	100.2	1.0
T-7	16.5-17.6	38.9	100.0	100.0	100.0	97.0	33.5		NP	SM	207.2	1.3
T-7	18.0-18.5	101.0	100.0	100.0	98.0	89.0	57.0		NP	ML	136.2	1.4
T-7	18.5-19.1	190.0	100.0	100.0	100.0	73.0	56.7	75	7	MH	32.0	0.5
T-7	19.1-19.3	177.0	100.0	100.0	100.0	97.0	74.1		NP	ML		
T-7	20.0-21.5	38.8	100.0	100.0	100.0	87.0	28.4		NP	SM	107.7	1.0
T-7	28.5-29.0	98.0	100.0	100.0	100.0	99.0	78.7	44	10	ML	208.0	1.6
T-7	33.0-34.5	38.9	100.0	100.0	100.0	94.0	36.9		NP	SM	95.2	0.8
T-7	36.5-37.5	31.2	100.0	100.0	100.0	90.0	27.5		NP	SM	83.3	0.8
T-7	40.0-41.5	96.5	100.0	100.0	100.0	99.0	91.1	52	8	MH	319.5	1.9
T-7	50.0-51.5	53.9	100.0	100.0	100.0	99.0	80.0	36	5	ML	160.2	1.2
T-7	53.0-53.9	46.9	100.0	100.0	100.0	99.0	54.6		NP	ML	125.4	1.0
T-7	58.0-59.5	20.4	100.0	100.0	100.0	93.0	11.0			SP-SM	44.7	0.6
T-7	61.5-63.0	77.7	100.0	100.0	100.0	99.0	92.1	56	9	MH	401.2	2.1
T-7	63.5-64.5	39.4	100.0	100.0	100.0	99.0	82.3	35	3	ML	213.7	1.3
T-8	5.0-6.5	26.9	100.0	100.0	100.0	92.0	39.0		NP	SM	146.1	1.0

TABLE 4.2 (cont.), SUMMARY OF TEST RESULTS ON TAILING SPLIT SPOON SAMPLES

SAMPLE ID	DEPTH (ft)	NATURAL MOISTURE %	SIEVE ANALYSIS (% PASSING)					LIQUID LIMIT	PLASTICITY INDEX	UNIFIED SOIL CLASS	RADIUM-226 (pCi/g)	RADIUM-226 uncertainty (pCi/g)
			3/4"	#4	#10	#40	#200					
T-8	7.8-8.0	84.9	100.0	100.0	99.0	97.0	83.6	54	14	MH	215.5	2.4
T-8	10.9-11.5	61.6	100.0	100.0	100.0	99.0	68.0	44	8	ML	408.1	2.3
T-8	15.0-15.8	28.5	100.0	100.0	100.0	94.0	21.7		NP	SM	124.1	1.0
T-8	15.8-16.1	61.5	100.0	100.0	100.0	100.0	84.2	41	6	ML	256.9	1.8
T-8	18.7-19.0	225.0	100.0	100.0	99.0	96.0	84.3	52	4	MH	43.8	0.9
T-8	20.0-21.5	26.8	100.0	100.0	100.0	91.0	34.6		NP	SM	128.0	1.0
T-8	23.3-23.7	57.6	100.0	100.0	100.0	98.0	69.0	44	8	ML	411.4	1.9
T-8	30.0-31.5	55.1	100.0	100.0	100.0	95.0	56.2	33	7	ML	170.0	1.2
T-9	5.4-5.6	47.6	100.0	100.0	100.0	93.0	55.8		NP	ML		
T-9	5.6-6.5	26.1	100.0	100.0	100.0	87.0	26.3		NP	SM	157.4	1.1
T-9	8.0-8.5	36.0	100.0	100.0	100.0	94.0	47.3		NP	SM	234.8	1.4
T-9	8.5-9.1	14.8	100.0	100.0	100.0	67.0	13.1		NP	SM	148.9	1.1
T-10	3.5-4.2	23.1	100.0	100.0	100.0	88.0	12.0			SP-SM	54.3	0.7
T-10	6.5-8.0	11.6	100.0	100.0	100.0	89.0	19.2		NP	SM	112.0	0.9
T-10	8.4-8.6	37.6	100.0	100.0	100.0	99.0	62.2	29	5	ML	287.0	2.3
T-10	11.5-13.0	25.2	100.0	100.0	100.0	94.0	31.6		NP	SM	146.4	1.1
ST-1	0.00	2.1	100.0	96.0	88.0	52.0	9.4			SP-SM	15.4	0.2
ST-2	0.00	142.0	100.0	100.0	98.0	94.0	75.4	66	11	MH	73.2	0.5



(0-1) Ncorrected

Figure 5. Volumetric Strain vs (N_{60}) at a Depth for Fines Content of 35 Percent

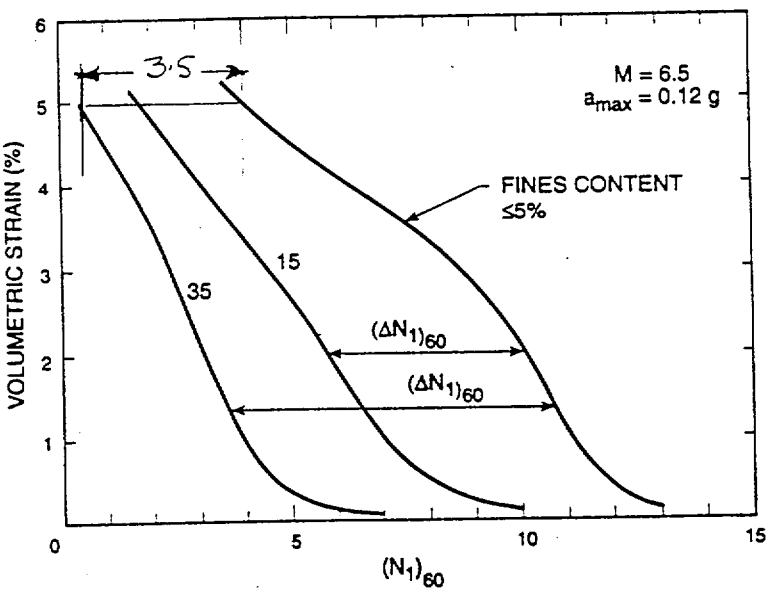
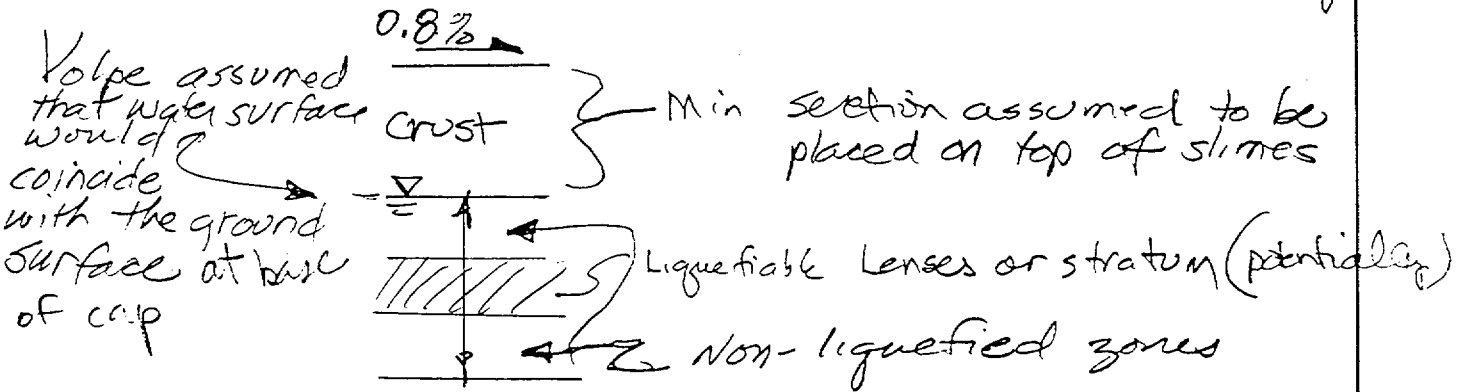


Figure 6. Average Volumetric Strain vs $(N_1)_{60}$ Relationships for Different Fines Content

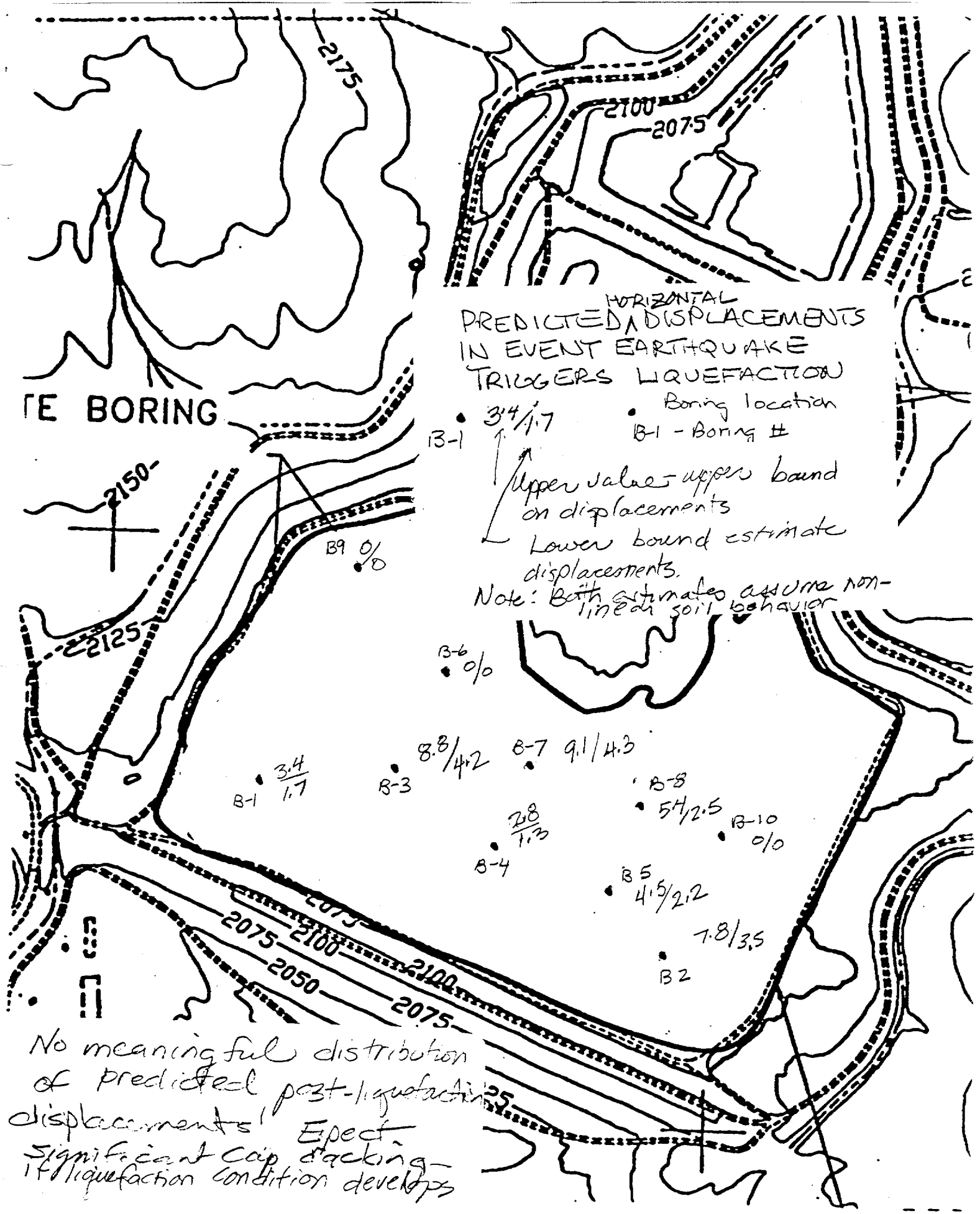
Potentially Liquefiable zones in the series of ten borings in the slimes! - Data for input to Peter Byrne's program to predict post-liquefaction, ground surface displacements (see section below)

BORING	CRUST ZONE-FT	LIQUEFIABLE ZONE - Ft	(N values)* Uncorrected	(N_1) * corrected for Silt	HORIZONTAL DISP. Uncorrected	HORIZONTAL DISP. Silt correction
1	14	5	2	8.1	3.4	1.7
2	13	11	2.1	9	7.8	3.5
3	15	11	1	7.4	8.8	4.2
4	27	4	1.7	8.3	2.8	1.3
5	15	8	4 exclude "0"	10	4.5	2.2
6	—	—	—	—	—	—
7	10	13	2.5	9.1	9.1	4.3
8	15	8	2.3	9	5.4	2.5
9	Uncorrected N-values suggest boring not likely to liquefy					
10	Again Uncorrected N-values suggest liquefaction unlikely					



* Mean Value

* See Following sheets for scheme to assess liquefaction potential of layers based solely on Liquid Limit & Liquidity Index


2175
2100
2075
TE BORING
2150
2125
2075
2100
2050
2075
2100
2075
PREDICTED HORIZONTAL DISPLACEMENTS IN EVENT EARTHQUAKE TRIGGERS LIQUEFACTION
Boring location
B-1 - Boring #
B-1 3.4/1.7
Upper value - upper bound on displacements
Lower bound estimate displacements.
Note: Both estimates assume non-linear soil behavior
B9 0/0
B-6 0/0
B-1 3.4/1.7
B-3 8.8/4.2
B-7 9.1/4.3
B-8 5.4/2.5
B-10 0/0
B-4 2.8/1.3
B5 4.5/2.2
7.8/3.5
B2
No meaningful distribution of predicted post-liquefaction displacements
Effect Significant cap cracking - if liquefaction condition develops

STATE OF WASHINGTON
DEPARTMENT OF ECOLOGY
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October 13, 1995

Mr. Lou Miller, P.E.
Shepherd Miller
1600 Specht Point Drive, Suite F
Fort Collins, CO 80525

PROJECT: Reclamation of Western Nuclear's Sherwood Project
FILE NO.: ST54-378

Dear Mr. Miller:

A dam construction permit is but one of the various permits that will be needed to reclaim the tailings impoundments. This letter serves to identify the outstanding items that need to be submitted to our office to secure a dam construction permit. The outstanding items are as follows:

A construction permit application (enclosed) must be completed and returned to our office with a check for $500. The check should be made payable to the Department of Ecology and mailed to the Dam Safety Section at the address on the letterhead. Please note on the check that is for the reclamation of the Sherwood Project.

Two sets of the plans and specifications covering the construction of the tailings cap and the spillway should be submitted to our office. Additionally, a construction inspection plan should be provided outlining the program to confirm that the facility is constructed in accordance with the approved plans and specifications. In previous draft plan document submittals the necessary construction control program was included in the specifications. This approaches is of course satisfactory for the final plan submittal.

If you have any questions, please call me at (360) 407-6625.

Sincerely,

Jerald M. LaVassar, M.S., P.E.
Shorelands & Water Resources Program
Dam Safety Section

JL:jl
Enclosure

cc: Stephanie J. Baker, Western Nuclear, Inc.
Gary Roberston, Dept. of Health

WNI Sta

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FILE COPY
W.D.S.E

October 17, 1995

To: File

From: Jerald LaVassar, P.E.

Subject: Sherwood Tailings Dam Closure Plan
File No.: ST54-378

GEOTECHNICAL REVIEW OF THE COVER DESIGN
The following comments were generated by a review of the Shepherd Miller, Inc reports cited below and a follow up phone conversation (on 10/13) with Mr. John Blacklaw of WDOH, Radiation Control Section:

Sherwood Project Revegetation Reclamation System Evaluation, Sept. 1995, and

Responses to WDOH Issues Regarding Erosion Protection and Diversion Channel Realignment, Oct. 1995.

The principal concern generated by these reports that we communicated to Mr. Blacklaw in our 10/13 phone call was that the functioning of the slimes cap would likely differ from that described in the above reports. Our differences of opinion involves two elements of the analysis. First, we question the ability of the cover crops initially to have the root depth and density to recover the volume of infiltration allotted them in the analysis. Second, the type of analysis performed would not model the behavior of the depression that is predicted to develop as the cap settles. This depression will collect runoff and likely support a standing pool of water for a couple of months annually. Such a standing pool would dramatically increase moisture inputs to the cap. Of the two issues, the standing pool is probably the more significant element in trying to predict the actual moisture that will be infiltrated into the cap. The following paragraphs expand on the above issues.

Evaporation and Transpiration - Simply put, we envision that a lengthy time span must elapse for the establishment of the root depth and density necessary for transpiration to be able to recover water from the majority of the 12.5 foot thick cap. The typical water balance for a year utilizes considerable summer months' transpiration potential to recover combined snow melt and rainy season infiltration. But, transpiration is effectively limited to the rooting depth. Water below this depth cannot be recovered by this mechanism. Thus, initially the cap will likely experience increased moisture inputs until a mature root system of diverse plants and trees develops. The Shepherd Miller report shows a net export on their overall water budget for the immediate post-construction period. However, the duration of

years of export will likely be much longer possibly until the roots are fully established in the cap.

Seasonal Ponding in the Depression - The Shepherd Miller studies predict that the settled cap surface will include a depression that will be as much as 4 feet below the spillway crest elevation. Obviously, during the Spring runoff period this area will likely receive flows that will generate a standing pool of water. This standing pool of water will substantially increase the amount of moisture infiltrated into the cap and likely produce a ground water mound that extends the full thickness of the cap locally. While we did not attempt to numerically assess the magnitude of infiltration, we felt the amount of infiltration would be greater than that suggested in the executive summary discussion by the Shepherd Miller Revegetated Reclamation study. That study on pages 1 and 2 states,

> "Infiltration would be minimized through removal of precipitation via evaporation and transpiration by vegetation. Under upper bound long-term average precipitation conditions, excess water that would not be stored in the soil profile would exit the cover as clean surface and subsurface flow. Because of the short period of time when excess water might be available, contact with tailing fluid would be essentially precluded. In general, all of the water that would enter the soil profile during the winter and spring would be removed by evapo-transpiration during each summer growing season. Groundwater quality, therefore, would remain protected."

Furthermore, we wished to alert Mr. Blacklaw that it is our experience that reclamation designs for solid waste and hazardous waste facilities typically involve going to considerable length to preclude the opportunity for a standing pool to develop on the cap. To this end, minimum settled slopes of 2% are normally specified for these facilities.

Our office has no expertise in assessing the consequences and/or the acceptability of allowing infiltration to come into contact with the pore fluids in the slimes on a seasonal basis. This decision is that of the WDOH. In discussing the issue with Mr. Blacklaw, he expressed uncertainty as to the acceptability of a scheme that involved temporary pools atop the cap. On the one hand there are benefits to maintaining the slimes in a saturated state. Mr. Blacklaw stated that the mining industry is increasingly employing this technique. Keeping the mine wastes saturated suppresses the development of an oxidative environment which favors the generation of acid waste discharges. In discussing this point with Mr. John Blacklaw of the Department of Health, he had not made a decision as to whether the benefits of infiltration outweighed the potential disadvantages associated with seepage coming in contact with the slimes and then moving outside the footprint of the liner.

If the decision is made to minimize infiltration, then it would be advantageous to eliminate the predicted depression from developing on the cap as the result of long term settlement.

The Sherwood study predicts that the settled surface of the cap will locally be as much as 4 feet below the spillway crest. Overbuilding of this portion of the cap could theoretically eliminate the depression. If an overbuild option is selected, it would be prudent to undertake some type of preloading of the predicted depression area. The purpose of the preload is twofold. First, it accelerates the rate at which settlements occur. Second, it provides site specific data on the relationship of the load-settlement behavior of the slimes. The latter point is important in better estimating the overbuild thickness. To minimize the thickness of the overbuild, it would be prudent to consider possibly lowering the crest of the spillway or at least cutting a small channel through the current crest section.

If it proves impractical to overbuild the embankment, one alternative scheme to consider would be the clay lining of the depression area. The function of the clay liner would be to minimize the rate of infiltration, retaining a greater portion of the standing pool to be eliminated by evaporation in the summer. To assure proper functioning, the clay liner would have to be constructed as an engineered fill. A moisture content wet of optimum would be necessary for the clay liner to undergo the predicted settlements with minimal cracking of the liner.

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October 17, 1995

To: File

From: Bruce Barker, P.E.

Subject: Sherwood Tailings Dam Closure Plan
File No.: ST54-378

DAM SAFETY REVIEW OF HYDROLOGIC ASPECTS

Diversion Channel Realignment - The engineering report submitted under the October 9, 1995 cover letter regarding the above project was reviewed. The submittal addresses comments made by the Department of Health in a checklist sent to the consultant on August 29, 1995.

The consultant adequately addressed the questions posed to them in the October 9, 1995 letter by the Department of Health with one minor exception. Item II-4 states: *Address the differences between the original alignment and the proposed alternative for re-alignment of the diversion channel; in terms of impact to the tailings impoundment surface configuration, to the watershed areas and flood flow rates, and to adequacy of design (sufficient conservatism).*

For the hydrologic differences, the consultant correctly states that the tributary area to the diversion channel is reduced with the new diversion channel alignment and that the design is therefore more conservative. While the tributary to the diversion ditch is reduced under the revised proposal, the tributary area to the tailings cap is increased. The consultant does not address this increased tributary area to the tailings cap in the report. The effect on the design would be a higher runoff rate to the tailings cap spillway under the PMF design flood. From Appendix G of the December 1994 engineering analysis submittal, the cap spillway was designed for a PMF discharge of 626 cfs. The additional tributary area to the cap represents approximately 15% additional area. Thus, an estimate of the additional flow from this area would be 626 cfs + 15% = 720 cfs. The 140 foot wide cap spillway will discharge approximately 3500 cfs before the embankment is overtopped. Thus, the spillway has sufficient capacity to safely pass the PMF from the tailings cap with the additional area from moving the diversion channel.

Diversion Channel Outfall Erosion Protection - If the diversion channel alignment is changed as shown in Figure 4 of the October 9, 1995 submittal then the consultant proposes to eliminate the erosion protection at the diversion channel outfall. The rationale for this is that although erosion will occur during large storm events, it is very unlikely that the erosion path will intercept the tailings impoundment.
To compute the lateral spreading of flow from the channel, the consultant estimated a flair angle of 39° at the end of the channel based on the following formula:
$\text{Tan}\,\Theta = \frac{1}{3Fr}$: where Θ is the angle of divergence at the end of the channel and Fr is the Froude Number. The consultant used a Froude Number based on the velocity in the channel. This is a conservative assumption, because in reality the flow will accelerate as it passes onto the steep downstream slope. The flow will pass through critical and Fr be greater than 1. If Fr is assumed to be 1, then Θ will be 18°. Thus, the angle of divergence will likely be less than that assumed by the consultant and the separation distance computed will likewise be greater.

The divergence will be defined by the angle Θ only if there are no topographic features that will confine the flow further. In looking at the topography downstream of the diversion channel outfall, there are a number of swales that would confine the flow and train it to a path even narrower than computed by the consultant. The attached figure shows the most likely flow path for diversion channel discharges based on the topography of the hillside below the channel outlet. This flow path remains a substantial distance away from the tailings cap.

Flows passing out of the diversion channel and onto the steeper slope downstream would accelerate to the point where erosion of the hillside would begin. A drop or "knick point" would develop and the erosion would progress upstream back toward the diversion channel outfall. The erosion would continue to attack in an upstream direction with the knick point migrating back into the diversion channel until either the storm ended or the slope immediately downstream of the knick point was sufficiently flat so as to not continue the erosion process. It is important to note that the erosion processes will migrate upstream toward the diversion channel outlet in a path parallel to the flow. Thus, with the diversion channel relocated some 600 feet from the tailings cap, it is very unlikely that the tailings could be compromised by erosion induced by diversion channel flows.

To summarize, the proposed design meets standards for Dam Safety and the proposal to eliminate the diversion channel erosion protection if the channel is relocated is reasonable.

HYDROLOGIC REVIEW OF THE COVER DESIGN

The hydrologic analysis of the revised cover of the tailings cap was reviewed. This review covers hydrologic issues apart from the dam safety aspects.

The proposed capping scheme consists of a 12.5 foot thick, uncompacted soil layer. This is to take the place of a clay cap with a shallow soil layer as proposed in earlier submittals. One of the purposes of this cap is to reduce the potential for precipitation to infiltrate to the tailings. The consultant performed an analysis tracking the precipitation into the cap and the amount removed by evapotranspiration from the various vegetative covers that will establish themselves on the cap with time. Their analysis shows that all of the annual moisture from precipitation and snowmelt will be evaporated by the vegetative cover on the cap.

This is reasonable provided that a well established vegetative cover exists with roots that penetrate the full cap depth. In the years immediately following placement of the cap, the root system will extend only a few feet into the cap and removal of the full annual moisture input is unlikely. Only the soil in the upper few feet of soil will be dried by this young vegetative cover. Thus, in the spring, the upper zone influenced by the plant roots will wet up rapidly to field capacity from snowmelt and the spring rains, and the remaining moisture will be transmitted downward past the root zone. Although the water uptake by the plant species characteristic of the vegetative growth of the first several years may theoretically be capable of withdrawing more than the annual precipitation, the moisture below the root zone is not available for uptake. Thus, it appears that the amount of recharge into the cap may in reality be higher than estimated in the first years following placement of the cap.

In the future when an extensive root system has been established over the full depth of the cap, the soil moisture will drop below field capacity over a large percentage of the cap depth. This will provide storage for the annual snowmelt in the spring and the deep root system will remove the moisture throughout the summer growing season. Under this scenario, the consultant's assertion that the majority of the annual precipitation will be evapotranspirated is more correct.

A further complication is the settlement of the cap. The consultant's analysis shows a significant settlement with a topographic depression forming in the center of the cap. This depression will collect surface runoff and snowmelt in the spring and concentrate it, likely forming a pond which will be present each year until infiltration and increased evaporation rates in the summer deplete it. The infiltrated moisture from the pond will produce a localized concentrated moisture input that will result in a groundwater mound forming on the tailings directly below the pond. In addition, the ponded water will

adversely affect the growth of vegetation on the cap in the area of the ponded water reducing the moisture removal potential in this area.

To summarize, the assessment of water withdrawal by the vegetation growing on the cap appears to be overly optimistic in the early years immediately following placement of the cap. This will result in more water reaching the tailings than estimated by the report. Once the vegetation matures and the root system is established over the entire depth of the cap, then it appears likely that the majority of the annual moisture input will be evapotranspirated.

A further complication is the settlement of the cap which will provide a local depression that will collect water during the spring melt. Thus, all surface water will be concentrated at this point and infiltrated providing an even greater potential for surface water to reach the cap.

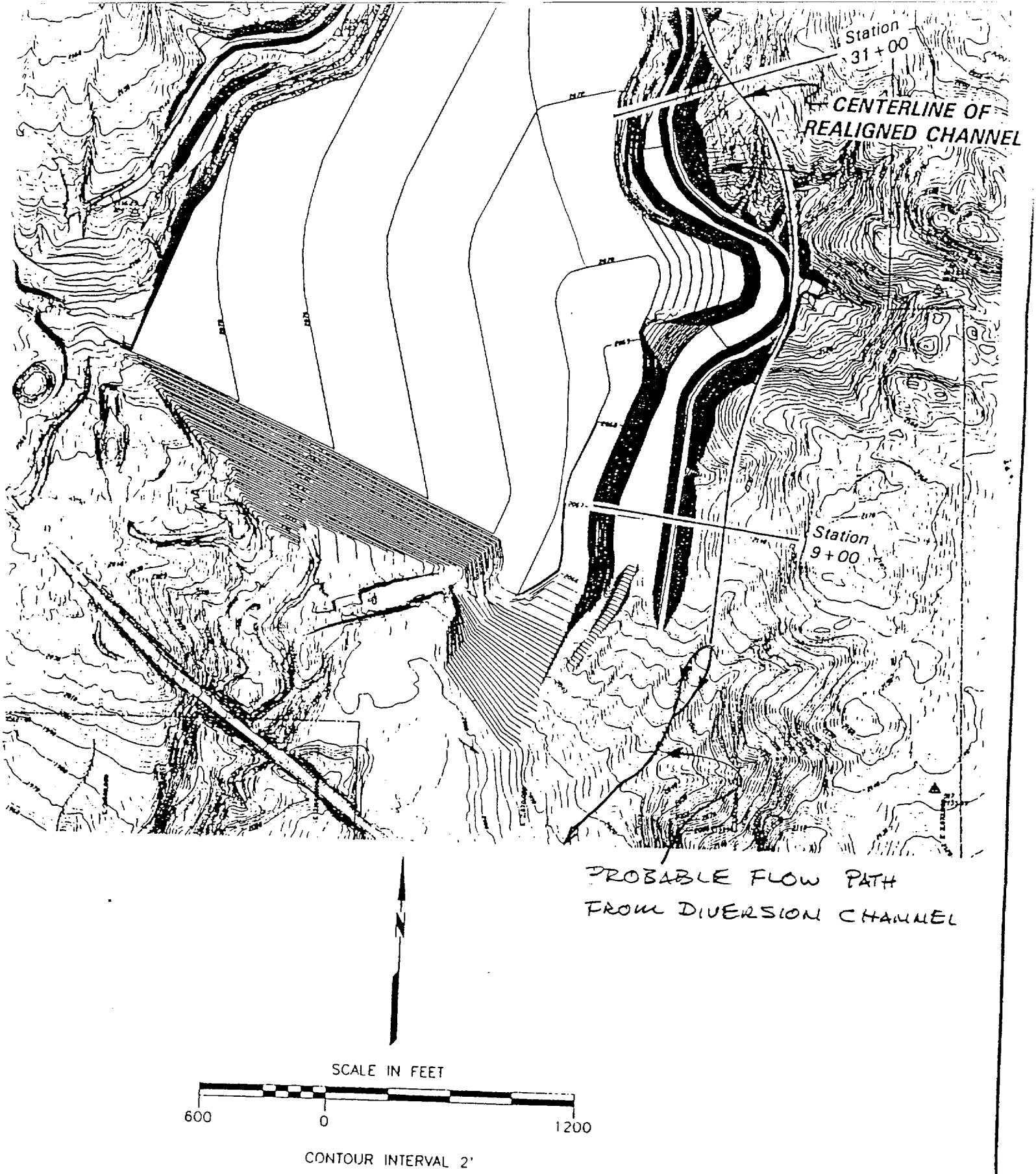

FIGURE 6
REALIGNED DIVERSION CHANNEL LOCATION

Date:	DEC., 1994
Project:	317/TASK31
File:	DIVERS

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November 21, 1995

Mr. Louis Miller, P.E.
Shepherd Miller, Inc.
1600 Specht Point Dr. Suite F
Fort Collins, CO 80525

PROJECT: Sherwood Project Tailing Reclamation Plan
FILE NO.: ST54-378

Dear Mr. Miller:

Our office has reviewed the plans and technical specifications element of your firm's report "**Revised Executive Summary & Technical Specifications**", dated November 1995. The plan documents detail an acceptable scheme to reclaim the tailings and recovery water impoundments. The permit application fee has been received. Having satisfied the requirements of the Dam Safety Section, a Dam Construction Permit is enclosed. Please post the permit prominently at the construction site. In addition to the permit, one copy of the plans are enclosed bearing our approval stamp. The second copy you provided will be retained in our files.

Our office should be contacted when a contractor has been selected and a preconstruction meeting has been set. We would like to attend the preconstruction conference to introduce ourselves to the contractor and identify the elements of the construction our staff would like to observe. If you have any questions, my phone number is (360) 407-6625.

Sincerely,

Jerald LaVassar

Jerald LaVassar, M.S., P.E.
Shorelands & Water Resources Program
Dam Safety Section

Enclosures

cc: Stephanie J. Baker, Western Nuclear Inc.
Gary Robertson, DOH
John Blacklaw, DOH

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December 8, 1995

Mr. Lou Miller, P.E.
Shepherd Miller Inc.
1600 Specht Point Dr., Suite F
Fort Collins, CO 80525

PROJECT: WNI's Sherwood Tailings Facility Reclamation
FILE NO.: ST54-378

Dear Mr. Miller:

This letter serves to document the substance of a conference call on December 8, between myself, you and Ms. Baker of WNI. The conference call was made to clarify the Dam Safety Section role in the construction phase of the reclamation of the project now that all the necessary permits and licenses have been secured.

Three issues were covered in the conference call.

First, I expressed the desire to attend the preconstruction conference. I envision my participation in that meeting will involve introducing myself to the contractor and learning the appropriate protocol for future site visits to review the construction. Additionally, I would describe the minimal elements of the construction I will wish to observe. I anticipate that my construction reviews will be limited to inspecting the diversion channel and spillway to confirm that the section geometries conform to the plan documents. I will wish to inspect both the filter(s) layer and overtopping riprap that that together serve as armoring of the diversion channel. Following completion of the construction, if necessary, we will do a final walk through to confirm that the discharge facilities conform to the approved plans.

To facilitate scheduling our site visits I would request a copy of the contractor's proposed schedule. These schedules invariably change as the result of unanticipated field difficulties or construction expediencies. Recognizing this, I would request that the contractor keep my office informed of any changes to the preceding elements of the construction that we will be reviewing.

Second, elements of the Washington Administrative Code (WAC) 173-175 that govern the operation of the Dam Safety Section set out a number of requirements on the scope of design and construction oversight to be provided. In drafting the WAC it was our intent to provide for the close oversight of the construction of those elements of an impounding barrier that are crucial to the containment of the impounded fluids. The work at Sherwood involves the reclamation of a site that has in the past contained fluids. However, the reclamation scheme has been devised to expressly prevent the future impoundment of any fluids. In fact, upon completion of the reclamation work there will remain no element of the project that requires our future interaction and accordingly our involvement with this facility will end.

The design information that has been submitted in support of your construction application is acceptable as noted in our approval letter of November 21, 1995 and is sufficient to satisfy the requirements of WAC 173-175. The regulatory oversight that the Dam Safety Section requires as per WAC 173-175 includes

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FILE 03-31-4 2.1.3

December 15, 1997

Ms. Stephanie J. Baker
Manager, Environmental Services
Western Nuclear, Inc.
200 Union Blvd., Suite 300
Lakewood, CO 80228

PROJECT: Sherwood Mine Tailings Reclamation
FILE NO.: ST54-378

Dear Ms. Baker:

On September 25, I toured the reclaimed tailings pond area in the company of Mr. Corn Abeyta of WNI and Mr. John Blacklaw of the DOH. Based on the conditions I observed during that tour, it is my opinion that the mine tailings impoundments have been reclaimed in accordance with the approved plans and specifications. In addition, our office has been provided with a copy of the three volume construction control and inspection reports.

As the provisions of the Dam Safety Section's reclamation requirements have been satisfied, the project is hereby reclassified as reclaimed. This office will maintain files on this project. However, no periodic inspections will be made of the facility. Any future involvement of the Dam Safety Section with this project would be at the behest of the project owner and/or the Department of Health.

If you have any questions or comments, I can be reached at (360) 407-6625 or by e-mail at jlsd461@ecy.wa.gov

Sincerely,

Jerald LaVassar

Jerald LaVassar, M.S., P.E.
Water Resources Program
Dam Safety

cc: Lou Miller, SMI ✓
Gary Robertson, DOH-DRP
John Blacklaw, DOH-DRP
Dorothy Stoffel, DOH-DRP
Pat Hallinan, WDOE-WQS
Mary Verner, Spokane Tribe

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Gary

September 3, 1996

TO: File for Record

FROM: Jerald LaVassar, P.E.

SUBJECT: Western Nuclear Sherwood Project Closure
File Number: ST04-378

On August 27, 1996 I visited the project to observe the ongoing construction. At the time of my visit, the contractor's staff were concentrating their efforts on three elements of the project. They were working on completing the 13 foot plus thick soil cover over the floor of the original impoundment. They also were actively hauling and placing the riprap for the diversion channel for the facility. Finally, they had one piece of hauling equipment working on knocking down the original embankment section.

I was escorted about the site by Mr. Corn Abeyta. He is the project manager for Phelps Dodge, the parent company and licensee for the facility. He indicated that the earthwork is considerably ahead of the timeline originally proposed for construction. If things continue as they are at present, they estimate that the earthwork should be completed on the cap by the second week of September. They have achieved subgrade elevation for the majority of the impoundment surface. What remains to be accomplished of the impoundment cap is the filling of a void in the northwest corner of the main impoundment. Here, the residual volume of water from the slimes has been chased into a small pond approximately an acre in surface area. The embankment fill surrounding it is approximately 6-8 feet higher than the present water surface. They are continuing to shove the fill on the perimeter of this pond to eventually fill in the void and achieve final subgrade.

The topsoil that has been obtained from site stripping is stockpiled. They anticipate spreading the topsoil and hydroseeding the subgrade in September. It is their desire to get the seeds in place in the month of September so they will have both the moisture from the fall and spring to initiate and establish a vigorous grass cover. Additionally, scrub brush of some form is to be planted in the cap to assist in the evapo-transpiration of moisture. The idea is to utilize the vegetation to minimize infiltration through the cap, eventually dewatering the underlying slimes. Based on

my observations of the construction of the cap, the work appears to be being done in general accordance with the plans and specifications provided to our office.

The particular elements of the project that our office reviewed and approved are the diversion channel and the spillway outlet for the low-lying segment of the slimes cap. In both the outfalls for the spillways, I observed rock exposures at the floor of the spillways. These materials should dramatically enhance the resistance of these subgrades should they be subject to significant flood flows in the unlikely event of a major storm on the basin. The primary goal of today's site visit was to review this subgrade and to confirm that the subgrade had been properly prepared for burial with either a rock riprap or a filter layer and overlying rock riprap. I observed that the subgrade had indeed been properly prepared. The stockpiles of the transition material and rock ripraps were reviewed as were actual treatments of segments of the channel. In all cases, it was my professional opinion that the lining of the channel was being done in general accordance with the approved plans and specifications.

Following my tour of the site I met with John Blacklaw and Dorothy Stouffel of the Department of Health. They were on-site with representatives from the Bureau of Indian Affairs and a representative for the tribe. The Spokane tribe owns the property upon which the licensed project sits. I stated to these individuals that based on my inspection of the work to-date, I believe the subgrade was suitable and they could proceed with the lining of the diversion channel.

JLV:avs

John Blacklaw

Westnuc.mem

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July 19, 1999

Mr. John Blacklaw
Washington Department of Health
Division of Radiation Protection
Airdustrial Park, Building 5
P. O. Box 47827
Olympia, WA 98504-7827

Re: Comments on Riprapped Elements of the Reclaimed Impoundment and Diversion Channel

Dear Mr. Blacklaw:

On June 14, 1999 I met with you and Mr. Earl Fordham to discuss isolated defects in the riprap lining of elements of the reclaimed project. I was shown photographs of three defects:

> Erosion of the cover soil on the riprap lining for the outfall of the reclaimed impoundment area,
>
> Gaps in the riprap lining of the diversion channel floor, and
>
> Erosion of a swale in the northwest corner of the diversion channel that has infilled a portion of the channel base.

My recommendations on addressing those defects are as follows:

Erosion of the cover soil cap on the outfall of the reclaimed impoundment area – The plans called for terminating the downstream end of the riprap armor a maximum of 4.5 feet below finished grade. This involved steepening the slope of the last 30 feet of the armoring layer to provide a maximum burial of 4.5 feet below finished grade. This segment of the riprap was covered with a relatively fine grained soil that was then seeded. The expectation was that the root mass associated with a mature vegetative cover would provide an erosion resistant cap to the fine grained soil. Unfortunately, heavy runoff from the abnormally wet winter immediately following construction occurred before the root system of the vegetative cover had a chance to develop and armor the subgrade. Lacking a protective cover, the fine grained soil layer suffered the creation of a network of erosion channels. The eroded soils were variously washed into the underlying relatively large

interstices between pieces of riprap or were transported and deposited in the swale at the toe of the riprap lined segment of the spillway.

It should be understood that this erosion of the cover soil does not pose a threat to the integrity of the underlying riprap layer. It is rather an unsightly situation that gives the appearance of a problem. Thus, your agency faces a decision as to whether other administrative concerns warrant treatment of this "cosmetic damage".

Should your agency elect to minimize further erosion damage, the fine grained soil cover will have to be removed to expose the more erosion resistant riprap layer. This addresses the erosion concern. Unfortunately, exposing the toe of the riprap layer poses an additional concern in that the underlying rock is subject to increased rates of degradation given the greater exposure to extremes of freeze-thaw and wet-dry cycles. These natural processes allow the surficial zone of rock to weather to a soil like medium over time. Eventually, this process could deprive the riprap of its present toe support. If there is actual loss of toe support, the riprap could experience raveling and headward erosion when subjected to intense runoff. To address this issue, it would be prudent to construct a concrete toe support for the downstream end of the riprap. We can assist your agency with conceptual details on such a concrete toe support if topographic and subsurface data are provided of the outfall area of the channel.

Gaps in the riprap lining of the diversion channel – Photos revealed a few isolated areas where the riprap did not form a dense protective blanket. Typically the defects consisted of a few square feet where the blanket was a single rock thick and the rocks were poorly nested together. The lack of intermediate size rocks left relatively large interstitial voids where the underlying filter layer could be seen. In one extreme case, reportedly some 50 square feet of the riprap armoring layer was absent. This situation increases the potential in the immediate area around the poorly graded segments of the lining of increased erosion of the underlying filter and movement of the adjacent riprap. These areas should be reworked to comply with the original specifications for the channel armoring.

Erosion of a swale in the northwest corner of the diversion channel – A swale was cut into the sidewall slope of the diversion channel in the northern end of the "recovery pond area". Reportedly, this swale was not graded appropriately to conduct intercepted runoff from upland areas to a suitable discharge point. Consequently, the swale ponds water during the spring melt. Apparently last spring the ponded water overtopped or breached the sidewall of the swale in one area. The concentrated flow discharged through the breach cut an erosion gully down the sidewall of the channel and dumped appreciable sediments onto the channel floor.

All parties have to recognize that there will be local erosion of the channel sidewalls given the sandy nature of the overburden. To minimize the magnitude of this erosion it is prudent to eliminate any ponding of water on channel sideslopes. Swales that pond water

dramatically increase the frequency and erosive power of discharges down the slope over that of sheet flow. Accordingly, it is recommended that the present swale in the northern portion of the diversion channel sidewall be removed. The area should be regraded to eliminate the depression. Unfortunately, regrading the swale area will disturb the developing vegetative cover. To accelerate the "healing" of disturbed areas, it would be prudent to hydroseed all bare soil areas left by the construction. Finally, it would be prudent to remove the accumulation of eroded sediments from within the channel floor. While this is not essential, it would remove one more potential concern that the Nuclear Regulatory Commission might have in reviewing the condition of the facility.

If you have any questions or comments, please call me at (360) 407-6625.

Sincerely,

Jerald LaVassar, M.S., P.E.
Water Resources Program
Dam Safety Office

JL:jl

cc: Earl Fordham, DOH, Radiation Control Section

JAN 20 2000

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January 19, 2000

Mr. John Blacklaw, P.E.
Washington State Department of Health
Division of Radiation Protection
7171 Cleanwater Lane, Bldg. 5
P.O. Box 47827
Olympia, WA 98504-7827

Re: Sherwood Project – 1/12/2000 DOH Soil Erosion Stability Inspection Report

Dear Mr. Blacklaw,

Your January 12, 2000 memorandum details the manner in which concerns with the lining of the diversion channel and the outfall of the reclaimed impoundment were addressed. I did not observe the remedial work but, your description of the work is consistent with the engineering recommendations expressed in my July 19, 1999 letter. There were three issues of note.

Erosion of the cover soil cap on the outfall of the reclaimed impoundment– As noted in my July 19th memorandum, this erosion was unsightly but not a threat to the structural integrity of the buried riprap lining. Thus, while actions could be taken to dress the area; no reworking of the area was necessary. The owner elected to forego reworking the area.

Gaps in the riprap lining of the diversion channel – Locally, the lining had small deficiencies. These included the absence or inadequate thickness of riprap, undersized rock and improperly placed rock. In the latter case the rock particles were not placed in a manner to yield a dense, erosion resistant lining. These deficiencies were reported reworked to bring the lining into uniform compliance with the original specifications.

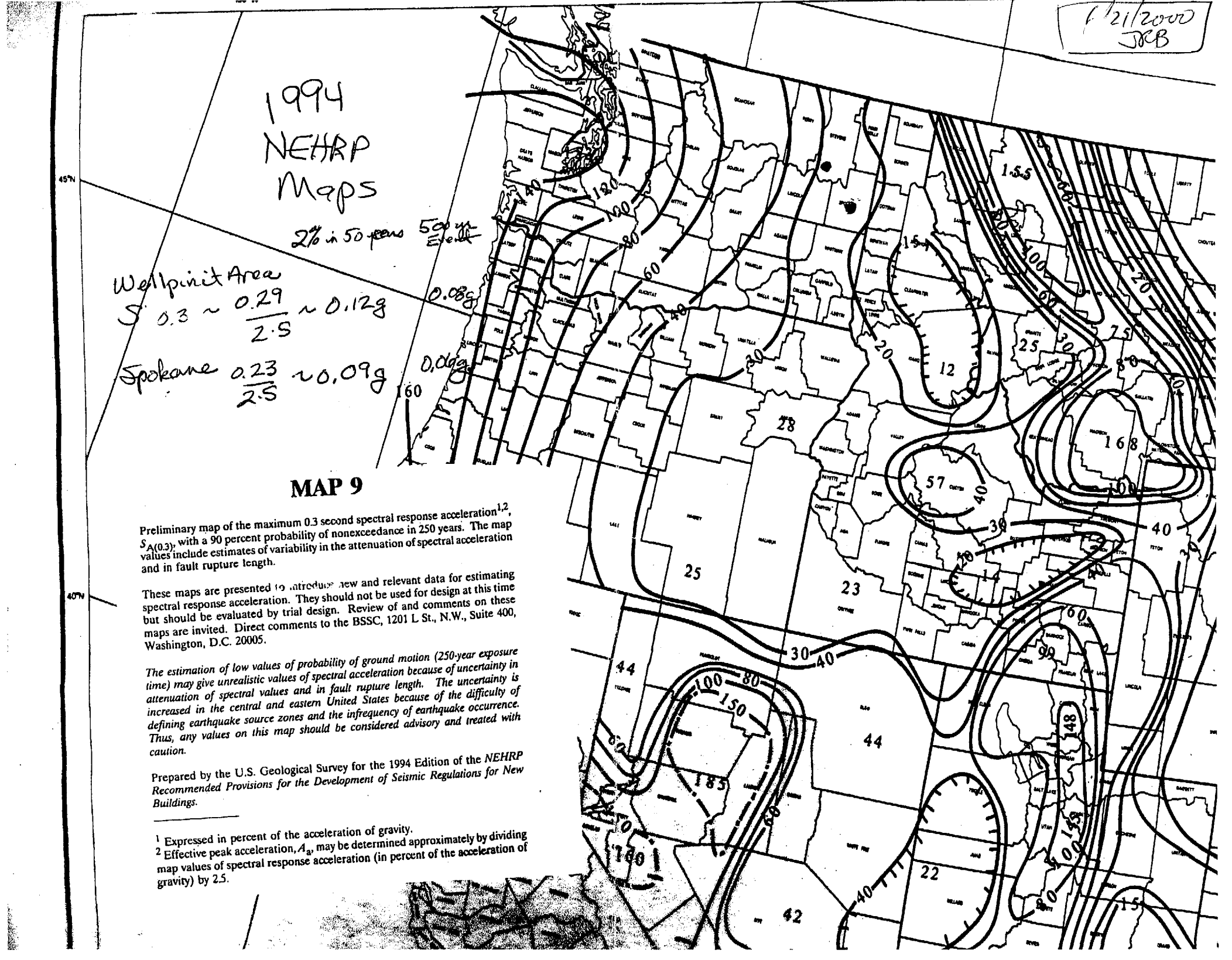
Erosion associated with a swale in the northwest corner of the diversion channel - A swale on the diversion channel sideslope intercepted runoff and channeled that runoff to a depression on the slope. This depression lacked a suitable outfall. The depression reportedly overtopped, eroded the channel slope and dumped the eroded sediments onto the diversion channel floor. The problem has been addressed by eliminating the swale to facilitate sheet flow of runoff.

The recent remedial work satisfactorily addressed concerns with the diversion channel and reclaimed pond outfall. If you have any comments, please call me at (360) 407-6625.

Sincerely,

Jerald LaVassar, M.S., P.E.
Water Resources Program
Dam Safety Office

JL:jl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2% in 50 years 500 yr Event
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S 0.3 ~ 0.29/2.5 ~ 0.12g
Spokane 0.23/2.5 ~ 0.09g
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0.06g
45°N
40°N
MAP 9
Preliminary map of the maximum 0.3 second spectral response acceleration[1,2], $S_{A(0.3)}$, with a 90 percent probability of nonexceedance in 250 years. The map values include estimates of variability in the attenuation of spectral acceleration and in fault rupture length.
These maps are presented to introduce new and relevant data for estimating spectral response acceleration. They should not be used for design at this time but should be evaluated by trial design. Review of and comments on these maps are invited. Direct comments to the BSSC, 1201 L St., N.W., Suite 400, Washington, D.C. 20005.
The estimation of low values of probability of ground motion (250-year exposure time) may give unrealistic values of spectral acceleration because of uncertainty in attenuation of spectral values and in fault rupture length. The uncertainty is increased in the central and eastern United States because of the difficulty of defining earthquake source zones and the infrequency of earthquake occurrence. Thus, any values on this map should be considered advisory and treated with caution.
Prepared by the U.S. Geological Survey for the 1994 Edition of the NEHRP Recommended Provisions for the Development of Seismic Regulations for New Buildings.
[1] Expressed in percent of the acceleration of gravity.
[2] Effective peak acceleration, A_a, may be determined approximately by dividing map values of spectral response acceleration (in percent of the acceleration of gravity) by 2.5.

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JUN 2 7 2000

DIVISION OF RADIATION PROTECTION

STATE OF WASHINGTON

DEPARTMENT OF ECOLOGY

P.O. Box 47600 • Olympia, Washington 98504-7600
(360) 407-6000 • TDD Only (Hearing Impaired) (360) 407-6006

June 23, 2000

Mr. John Blacklaw, P.E.
Department of Health
Division of Radiation Protection
7171 Cleanwater Lane, Bldg. 5
P.O. Box 47827
Olympia, WA 98504-7827

Re: Sherwood Project

Dear Mr. Blacklaw:

At the June 21, site meeting with representatives of the Nuclear Regulatory Commission, the Department of Energy, FERC, your agency, and the project's owner and engineer, the question of whether the reclaimed impounding structure was still a dam figured prominently. This letter serves to clarify Ecology's Dam Safety Office's (DSO) position on the matter.

As stated at the site meeting, the DSO views the reclaimed impounding barrier as a dam. Reclaiming the impounding structure involved reducing the embankment height, flattening the downstream slope and armoring the downstream face. These measures represented a practical scheme to provide a high likelihood of the structure safely impounding the process waste for the thousand-year design life assuming little, if any, maintenance. The DSO's approval of the reclamation plans for the impounding barrier reflected our concurrence as engineers that the design provided adequate static and seismic stability and erosion protection. The DSO remains steadfast in its opinion that the engineering assessment of the reclaimed impounding structure is valid.

On the administrative side the reclaimed dam is considered a jurisdictional dam under the provisions of Washington Administrative Code (WAC) 173-175-020 Applicability, copy attached. The practical consequences of that classification are that the impounding barrier would be inspected on a 6 to 8 year frequency or following the occurrence of an extreme storm or earthquake in the immediate vicinity. The frequency of inspections is dictated by Water Resource Program Policy 5404, copy attached. The project would be removed from our jurisdiction in the event a Federal Agency assumes ownership of the project, provided that it has (or can contract with) a dam safety program which will conduct periodic inspections of the impoundment, see WAC 173-175-020(3) of attachment. Presently, there is no cost for DSO's periodic inspections and the resulting report of findings. The only cost to the project owner would arise should a serious deficiency be found with the integrity of the impounding barrier. In that remote instance, the owner would be required to undertake the necessary repairs to the impounding barrier to address the identified concern.

If there are any questions in this matter, please contact me at (360) 407-6625.

Sincerely,

Jerald M LaVassar

Jerald LaVassar, M.S., P.E.
Water Resources Program
Dam Safety Office

Attachments

POL 5404 **WATER RESOURCES PROGRAM POLICY**

Resource Contact: Dam Safety Office

Effective Date: 07-01-91

References: RCW 43.21A.064
RCW 86.16.035
Chapter 173-175 WAC

Revised: 07-01-1999

FREQUENCY OF PERIODIC DAM INSPECTIONS

POLICY STATEMENT:

Periodic inspections of existing dams should be conducted on regularly scheduled intervals. The time interval between inspections should depend on the dam and reservoir size and the potential downstream hazard posed by the facility. Those dams which reside above populated areas should ideally be inspected on a 6 year cycle. Those dams which do not pose a threat to life can be inspected less frequently.

Should staffing levels be insufficient to inspect all dams under Ecology jurisdiction, the dams will be ranked according to size and downstream hazard and a prioritization scheme will be used to aid in the selection of dams for inspection. Those dams which could pose the greatest threat to life and property will be selected for inspection on regular intervals. The remaining dams would be inspected as the workload and time permit.

DISCUSSION:

Guidelines for dam safety prepared by the Federal Emergency Management Agency recommend annual inspections of high hazard dams (3 or more homes at risk), a 2-year interval for significant hazard dams (1 or 2 homes at risk), and a 5-year interval for low hazard dams (no homes at risk). The Bureau of Reclamation currently inspects their high and significant hazard dams on a 3 year interval for an Operation and Maintenance Inspection, and a 6 year interval for a Comprehensive inspection. Considering the large number of high and significant hazard dams to be inspected by the Dam Safety Section and the limited staffing currently available, a goal of a 6 year comprehensive inspection interval was selected and is considered to provide the minimum acceptable level of protection to the public.

This policy also identifies a longer inspection interval for dams with "low" downstream hazards. The primary reason for inspecting low hazard dams is to evaluate the downstream floodplain for new development. If development has occurred and lives could be at risk by a dam failure, then the inspection frequency should be increased.

Staffing is anticipated to be insufficient for the foreseeable future to meet the desirable goals for frequency of periodic inspections. This policy identifies that a ranking and prioritization scheme is to be used to aid in the selection of projects to be inspected with available workforces.

PROCEDURES:

The physical characteristics of dam size, reservoir storage and magnitude of a dam break flood are to be used to assess the consequences of dam failure on lives and property in the downstream valley. This information is to be used to rank the dams according to their potential public safety threat if a dam failure were to occur.

A prioritization scheme is to be used to aid in the selection of dams for inspection from the ranked dam listing. Those dams which could pose the greatest threat to life and property will be selected for inspection on regular intervals. The remaining dams would be inspected as the workload and time permit.

The following periodic inspection schedule is a minor modification of the schedule that was reviewed and accepted by the Ecology Executive Management Team during the 1991 Strategic Budget Planning Process. Table 1 outlines the general format for conducting the periodic inspection program.

Keith E. Phillips

Keith E. Phillips
Program Manager
Water Resources Program

PERIODIC INSPECTION CLASSIFICATIONS

TYPE	PURPOSE	USAGE	DESCRIPTION
CLASS I	COMPREHENSIVE INSPECTION	First Periodic Inspection	Visual inspection of all project elements; Detailed engineering analysis of project elements under extreme flood and earthquake; Prepare comprehensive report of findings.
CLASS II	INTERMEDIATE LEVEL INSPECTION	Subsequent Periodic Inspections	Visual inspection of all project elements; Some engineering analysis of selected elements; Prepare summary report of findings.
CLASS III	RECONNAISSANCE INSPECTION	Preliminary Inspection	Visual inspection of most project elements; Minimal engineering analyses; Prepare memo to file summarizing inspection.

PRIORITIZATION SCHEME FOR PERIODIC INSPECTION OF EXISTING DAMS

DOWNSTREAM HAZARD CLASSIFICATION	CYCLE	NUMBER OF DAMS	INSPECTIONS	
			NUMBER /YEAR	TYPE
FIRST TIER				
High Downstream Hazard Dams (Downstream Hazard Class 1A, 1B, 1C)	6 years	111	18	Class I or II
Significant Downstream Hazard Dams (Downstream Hazard Class 2) Greater than 20 ft. high	8 years	75	9	Class I or II
SECOND TIER				
Significant Downstream Hazard Dams (Downstream Hazard Class 2) & Low Downstream Hazard Dams (Downstream Hazard Class 3) Greater than 15 ft. high	10 Years	106 119	23	Class III
THIRD TIER				
Low Downstream Hazard Dams (Downstream Hazard Class 3) Less than 15 ft. high	None	471	5	Class III
TOTALS			**55**	

APPENDIX A
STATE STATUTES AND ADMINISTRATIVE RULES
PERTAINING TO DAM SAFETY

Dam Safety Guidelines

Part I:
General Information & Owner Responsibilities

WASHINGTON STATE STATUTES

RCW 43.21A.064 Powers and duties - Water resources.
Subject to RCW 43.21A.068, the director of the department of ecology shall have the following powers and duties:

(2) Insofar as may be necessary to assure safety to life or property, he shall inspect the construction of all dams, canals, ditches, irrigation systems, hydraulic power plants, and all other works, systems and plants pertaining to the use of water, and he may require such necessary changes in the construction or maintenance of said works, to be made from time to time, as will reasonably secure safety to life and property;

RCW 43.21A.068 Federal power act licensees - Exemption from state regulations.

(1) With respect to the safety of any dam , canal, ditch, hydraulic power plant, reservoir, project, or other work, system or plant that requires a license under the federal power act, no licensee shall be required to:

(a) submit proposals, plans, specifications or other documents for approval by the department;

(b) seek a permit, license or other form, permission, or authorization from the department;.

(c) submit to inspection by the department; or

(d) change a design, construction, modification, maintenance, or operation of such facilities at the demand of the department.

(2) For the purposes of this section, "licensee" means an owner or operator, or any employee thereof, of a dam, canal, ditch, hydraulic power plant, reservoir, project, or other work, system, or plant that requires a license under the federal power act.

RCW 86.16.035 Department of Ecology - Control of dams and obstructions.
Subject to RCW 43.21A.068, the department of ecology shall have supervision and control over all dams and obstructions in streams, and may make reasonable regulations with respect thereto concerning the flow of water which he deems necessary for the protection to life and property below such works from flood waters.

RCW 90.03.350 Construction or modification of storage dam - Plans and specifications.
Except as provided in RCW 43.21A.068, any person, corporation or association intending to construct or modify any dam or controlling works for the storage of ten acre feet or more of water, shall before beginning said construction or modification, submit plans and specifications of the same to the department for examination and approval as to its safety. Such plans and specifications shall be submitted in duplicate, one copy of which shall be retained as a public record, by the department, and the other returned with its approval or rejection endorsed thereon. No such dam or controlling works shall be constructed or modified until the same or any modification thereof shall have been approved as to its safety by the department. Any such dam or controlling works constructed or modified in any manner other than in accordance with plans and specifications approved by the department or which shall not be maintained in accordance with the order of the department shall be presumed to be a public nuisance and may be abated in the manner provided by law, and it shall be the duty of the attorney general or prosecuting attorney of the county wherein such dam or controlling works, or the major portion thereof, is situated to

institute abatement proceedings against the owner or owners of such dam or controlling works, wherever he is requested to do so by the department

A metal minings and milling operation regulated under chapter 232, Laws of 1994, is subject to additional dam safety inspection requirements due to the specific hazards associated with failure of a tailings impoundment. The department shall inspect these impoundments at least quarterly during the project's operation and at least annually thereafter for the postclosure monitoring period. in order to ensure the safety of the dam or controlling works. The department shall conduct additional inspections as needed during the construction phase of the mining operation in order to ensure the safe construction of the tailings impoundment.

RCW 90.03.470 Schedule of fees.

The following fees shall be collected by the department in advance:

(8) For the inspection of any hydraulic works to insure safety to life and property, the actual cost of the inspection, including the expense incident thereto.

(9) For the examination of plans and specifications as to safety of controlling works for storage of ten acre feet or more of water, a minimum fee of ten dollars, or the actual cost.

WASHINGTON STATE ADMINISTRATIVE RULES

DAM SAFETY REGULATIONS
CHAPTER 173-175 WAC

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CHAPTER 173-175 WAC
DAM SAFETY REGULATIONS

PART ONE - GENERAL

WAC 173-175-010 Purpose and Authority. These regulations provide for the comprehensive regulation and supervision of dams in order to reasonably secure safety to life and property pursuant to Chapters 43.21A, 43.27A, 86.16, 90.03, 90.28, and 90.54 RCW. The purposes of these regulations are to:

(1) Designate the types of dams to which these regulations are applicable;

(2) Provide for the design, construction, operation, maintenance and supervision of dams in a manner consistent with accepted engineering practice;

(3) Establish and administer a program for permitting of construction work for new dams and for modifications of existing dams;

(4) Establish a fee schedule based on dam size that will reflect the actual cost to the department of engineering review of plans and specifications and for construction inspections;

(5) Establish the requirements and owner responsibilities for developing and executing plans for Operation and Maintenance, Owner Inspection and Emergency Actions; and

(6) Encourage owners to establish a program for the Periodic Inspection of their projects.

WAC 173-175-020 Applicability. (1) These regulations are applicable to dams which can impound a volume of 10 acre-feet or more of water as measured at the dam crest elevation. The 10 acre-feet threshold applies to dams which can impound water on either an intermittent or permanent basis. Only water that can be stored above natural ground level and which could be released by a failure of the dam is considered in assessing the storage volume.

The 10 acre-feet threshold applies to any dam which can impound water of any quality, or which contains any substance in combination with sufficient water to exist in a liquid or slurry state at the time of initial containment.

(2) For a dam whose dam height is six feet or less and which meets the conditions of subsection (1) of this section, the department may elect to exempt the dam from these regulations.

The decision by the department to exempt a dam will be made on a case by case basis for those dams whose failure is not judged to pose a risk to life and minimal property damaged would be expected (Downstream Hazard Class 3).

(3) These regulations do not apply to dams that are, or will be, owned, by an agency of the Federal government which has oversight on operation and maintenance and has its own dam safety program for periodic inspection of completed projects. The department will continue to be the state repository for pertinent plans, reports and other documents related to the safety of Federally owned dams.

(4) These regulations do not apply to transportation facilities such as roads, highways or rail lines which cross watercourses and exist solely for transportation purposes and which are regulated by other governmental agencies.

Those transportation facilities which cross watercourses and which have been, or will be, modified with the intention of impounding water on an intermittent or permanent basis and which meet the conditions of subsection (1) of this section, shall be subject to these regulations.

(5) These regulations do not apply to dikes or levees constructed adjacent to or along a watercourse for protection from natural flooding or for purposes of floodplain management.

(6) These regulations do not apply to concrete or steel water storage tanks.

(7) These regulations do not apply to FERC licensed and to FERC exempted projects. The department will continue to maintain a repository for pertinent plans, reports, and other documents related to the safety of FERC licensed and FERC exempted projects.

WAC 173-175-030 Definitions. As used in this chapter:

"Acceptance" means acceptance by the department that the proposed plan(s) will satisfactorily address issues associated with proper operation, maintenance, inspection or emergency action.

"Approval" means approval by the department that the proposed design, plans and specifications conform to accepted engineering practice and department guidelines.

"Appurtenant Works" means such structures as outlet works and associated gates and valves; water conveyance structures such as spillways channels, fish ladders, tunnels, pipelines or penstocks; powerhouse sections; and navigation locks, either in the dam or adjacent thereto.

"Authorization" means written acknowledgement from the department to proceed with proposed actions.

"Construction change order" means a revision to the department approved plans and specifications that is initiated during construction.

"Construction permit" means the permit which authorizes construction and that the project's plans and specifications and construction inspection plan have been reviewed and approved by the department.

"Construction permit process" means the sequence of activities specified in WAC 173-175-110 inclusive, beginning with the application for construction permit and ending with the submission of a report summarizing construction records.

"Crest length" means the total horizontal distance measured along the axis of the dam, at the elevation of the top of the dam, between abutments or ends of the dam. Where applicable, this includes the spillway, powerhouse sections and navigation locks, where they form a continuous part of the impounding structure.

"Critical project element" means an element of a project whose failure could result in the uncontrolled release of the reservoir.

"Dam" means any artificial barrier and/or any controlling works, together with appurtenant works that can or does impound or divert water.

"Dam abutment" means that contact location at either end and beneath the flanks of a dam where the artificial barrier joins or faces against the natural earth or rock foundation material upon which the dam is constructed.

"Dam height" means the vertical distance from the natural bed of the stream or watercourse at the downstream toe of the impounding barrier to the maximum storage elevation. If the dam is not across a stream or

watercourse, the height is measured from the lowest elevation of the outside limit of the impounding barrier to the maximum storage elevation.

"Department" means the Department of Ecology.

"Design Step Level" means an integer value between one and eight used to designate increasingly stringent design loadings and conditions for design of critical project elements.

"Downstream Hazard Classification" means a rating to describe the potential for loss of human life and/or property damage if the dam were to fail and release the reservoir onto downstream areas. Downstream hazard classifications of 3, 2 and 1C, 1B, 1A correspond to low, significant and high downstream hazard classes respectively.

"Emergency condition" means a situation where life and property are at imminent risk and actions are needed within minutes or hours to initiate corrective actions and/or warn the public.

"Enlargement" means any modification of a project that will result in an increase in normal pool height and/or dam height.

"Exigency condition" means a situation where the dam is significantly underdesigned according to generally accepted engineering standards or is in a deteriorated condition and life and property are clearly at risk. Although present conditions do not pose an imminent threat, if adverse conditions were to occur, the situation could quickly become an emergency.

"FERC exempted project" means a project that is classified as exempt by the Federal Energy Regulatory Commission (FERC) under provisions of the Federal Power Act.

"FERC licensed project" means a project whose operation is licensed by the Federal Energy Regulatory Commission (FERC) under provisions of the Federal Power Act.

"Freeboard" means the vertical distance between the dam crest elevation and some reservoir level of interest below the dam crest.

"Hydrograph" means a graphical representation of discharge, stage, or other hydraulic property with respect to time for a particular location on a watercourse.

"Impounding barrier" means the structural element of the dam that has the primary purpose of impounding or diverting water. It may be constructed of natural and/or man-made materials.

"Incident" means the occurrence of any dam-related event where problems or conditions arise which may have posed a threat to the safety or integrity of the project or which may have posed a threat of loss of life or which resulted in loss of life.

"Inflow Design Flood (IDF)" means the reservoir inflow flood hydrograph used for sizing the spillways and for determining freeboard. It represents the largest flood that a given project is designed to safely accommodate.

"Maintenance" means those tasks generally accepted as routine in keeping the project and appurtenant works in a serviceable condition.

"Maximum storage elevation" means the maximum attainable water surface elevation of the reservoir pool that could occur during extreme operating conditions. This elevation normally corresponds to the crest elevation of the dam.

"Miscellaneous construction elements" means a variety of construction elements or activities such as, but not limited to: reservoir linings; parapet walls or low berms for wave containment; minor reconstruction of isolated portions of the impounding barrier; internal drainage improvements; and erosion protection.

"Modification" means any structural alteration of a dam, its reservoir, spillway(s), outlet(s) or other appurtenant works that could significantly influence or affect the project safety.

"Normal pool height" means the vertical distance between the lowest point of the upstream toe of the impounding barrier and the normal storage elevation.

"Normal storage elevation" means the maximum elevation to which the reservoir may rise under normal operating conditions. Where the principal spillway is ungated, the normal storage elevation is usually established by the elevation of the spillway crest.

"100 year floodplain" means the area inundated during the passage of a flood with a peak discharge having a one percent chance of being equalled or exceeded in any given year at a specified location on a watercourse.

"Outlet" means a conduit and/or channel structure for the controlled release of the contents normally impounded by a dam and reservoir.

"Owner" means the person holding lawful title to the dam or any person who owns or proposes to construct a dam.

"Periodic inspection" means a detailed inspection of the dam and appurtenant works conducted on regular intervals and includes, as necessary, associated engineering analyses to confirm the continued safe operation of the project.

"Person" means any individual, firm, association, county, public or municipal or private corporation, agency, or other entity whatsoever.

"Plans and specifications" means the detailed engineering drawings and specifications used to describe the layout, materials, construction methods, etc., for assembling a project or project element. These do not include shop drawings or other drawings prepared by the construction contractor for temporary construction support systems.

"Population at risk" means the number of people who may be present in areas downstream of a dam and could be in danger in the event of a dam failure.

"Project" means a dam and its reservoir, either proposed or existing.

"Project engineer" means a professional engineer licensed in Washington, having direct supervision, as defined in WAC 196-24-095, in managing the engineering aspects of the project as representative of the owner.

"Reservoir" means any basin that contains or will contain the water impounded by a dam.

"Reservoir routing" means the procedures used to determine the attenuating effect of reservoir storage on a flood as it passes through a reservoir.

"Rule curve" means the rules and procedures used to regulate reservoir levels and project operation for various reservoir inflows and for both normal and unusual seasonal conditions.

"Significant enlargement" means any modification of an existing dam that results in the dam height or normal pool height being increased by an amount greater than 5.0 feet, and which also represents a ten percent or greater increase in dam height or normal pool height over that which existed prior to the modification.

"Spillway" means a channel structure and/or conduit for the safe release of water or floodwater.

"Stop work order" means an administrative order issued to temporarily halt construction work until a problem can be resolved.

"Substantially complete" means that a plan, action or project element requires only minor additions to be complete, and in its present state will perform the necessary functions for its intended use.

"Surficial inspection" means a visual inspection conducted to identify obvious defects or changed conditions.

WAC 173-175-040 Activities that Require Department Review, Approval, Acceptance, Authorization or Notification. (1) Activities related to the safety of dams that require review and approval by the department as detailed in this chapter include:

(a) Construction of a new dam

(b) Modification of an existing dam

(c) Removal or abandonment of an existing dam

(d) Construction Change Orders for project elements that could have an effect on public safety.

(2) Activities related to the safety of dams that require review and acceptance by the department as detailed in this chapter include:

(a) Adoption of an operation and maintenance (O&M) plan;

(b) Adoption of an emergency action plan (EAP);

(c) Changes to existing operation and maintenance procedures or to an emergency action plan that could have an effect on public safety.

(3) Activities related to the safety of dams that require authorization from the department before proposed actions can proceed include:

(a) Startup of construction: for a new dam; modifications to an existing dam; or removal or abandonment of an existing dam;

(b) Initial controlled filling of a reservoir following new dam construction and implementation of procedures for normal reservoir operation;

(c) Resumption of normal reservoir operation following dam modifications or emergency actions.

(4) Activities related to the safety of dams that require a notification to the department as detailed in this chapter include:

(a) Change of dam ownership;

(b) Advance notice of the startup of dam construction;

(c) Declaration by the project engineer of project completion in accordance with the department approved plans and specifications and construction change orders;

(d) Advance notice of periodic inspection; and

(e) The occurrence of an incident at the dam.

WAC 173-175-050 Provision of Guidelines. (1) The department will develop and maintain *Dam Safety Guidelines* to aid dam owners and project engineers in complying with the department requirements in developing, producing or conducting:

(a) Engineering design reports;

(b) Plans and specifications;

(c) Construction Inspection Plans ;

(d) Operation and Maintenance Plans;

(e) Periodic Inspections; and

(f) Emergency Action Plans.

WAC 173-175-060 Change of Ownership. (1) When a change of ownership of a dam occurs, the new owner shall notify the department within 90 days following the transaction and provide:

(a) The mailing address and telephone number where the owner can be contacted.

(b) The name(s) and telephone number(s) of the individual(s) who will be responsible for operation and maintenance of the dam.

WAC 173-175-070 Effective Date. The effective date of Parts One through Five of this chapter shall be July 1, 1992..

CONSTRUCTION PERMIT PROCESS

PART TWO

WAC 173-175-100 Construction Permit. (1) Any person intending to construct or modify any dam shall, before beginning said construction or modification, submit plans and specifications and a construction inspection plan for review and approval by the department.

(2) The approval of these documents will be indicated by the department's plan approval stamp on the cover sheet of the plans signed by the department's professional engineer who had primary responsibility for the engineering review.

(3) The return of the construction plans to the owner will be accompanied by a construction permit which authorizes construction and which must be prominently displayed at the construction site.

(4) A copy of the department approved plans and specifications shall be maintained at the construction site.

(5) Construction work shall not proceed until the plans, specifications and construction inspection plan have been approved by the department.

WAC 173-175-110 Sequence of Permitting Actions. The sequence of tasks to be completed by the owner or the project engineer and the actions taken by the department in permitting dam construction are outlined below. A more complete description of the required tasks, reports and plans are described in later sections, and additional guidance in meeting department requirements is contained in the department documents titled *Dam Safety Guidelines*.

The following outline is listed to give an overview of the normal sequence of actions for construction of a new dam. Subsections (9), (10) and (11) of this section will not be required for modification of an existing dam where the department has previously accepted the project's operation and maintenance manual and emergency action plan.

(1) Submission of application for construction permit, including initial non-refundable fee payment
(2) Submission of engineering design reports
(3) Submission of plans and specifications
(4) Payment of construction permit fee
(5) Submission of construction inspection plan
(6) Resolution of any outstanding engineering issues
(7) Department approves plans and specifications and issues construction permit
(8) Construction or modification of dam
(9) Submission of Operation and Maintenance (O&M) plan
(10) Submission of Emergency Action Plan (EAP)
(11) Department accepts O&M Plan and EAP
(12) Declaration by project engineer that project was constructed or modified in accordance with approved plans and specifications and construction change orders
(13) Department concurs with project engineer that project was constructed or modified in accordance with approved plans and specifications and construction change orders
(14) Department authorizes filling of reservoir at new dam or resumption of normal operations at existing dam
(15) Submission of a report summarizing the construction records

WAC 173-175-120 Application for Construction Permit. (1) The department shall supply an application form to be used to initiate the process for obtaining the construction permit.

(2) The application form shall be submitted to the department at the time that the first substantive engineering information becomes available about the proposed project.

(3) An initial, non-refundable payment, which may represent all or a portion of the Construction Permit Fee, shall be included along with the application form. The amount of the initial construction permit fee payment is defined in WAC 173-175-390.

WAC 173-175-130 Engineering Design Reports. (1) Engineering design reports summarizing the various engineering investigations and pertinent project information are an important element of the project design documents. All pertinent engineering design reports that have been prepared during project formulation shall be submitted for review. The engineering design report(s) must bear the seal and signature of the project engineer.

(2) The engineering design reports shall be sufficiently complete so as to support the development of plans and specifications without substantial change or additional information.

(3) The engineering design report(s) shall be comprehensive in description of the various engineering investigations and analyses.

(a) For new project construction, the engineering design report(s) shall include, as a minimum, the items listed in subsection (4) of this section:

(b) For modifications of existing dams, the engineering design report(s) shall include, as a minimum, those items listed in subsection (4) of this section which represent changed conditions from original construction or which address items that have not been previously addressed in prior reports that were submitted to the department:

(4) Contents of Engineering Design Report(s):

(a) A description of the basic purposes of the project, normal operational characteristics and any unique or important design considerations associated with the site or project configuration.

(b) A description of the site geology, seismicity and geotechnical considerations including: a presentation of the findings from subsurface explorations based on test pits and/or boring logs; field tests; laboratory testing and classification of samples; and an identification of the seismotectonic provinces that could generate earthquakes large enough to significantly affect the project site.

(c) A description of the climatic and hydrologic characteristics of the site and tributary watershed including the computation of the inflow design flood and, where applicable, a listing of the input and output data for the computer model used to determine the inflow design flood.

(d) A listing of all sources of inflow to the reservoir.

(e) The size classification of the proposed project as defined by Table 1.

TABLE 1. DAM SIZE CLASSIFICATION

SIZE CLASSIFICATION	DAM HEIGHT
Small Dam	Less than 15 feet
Intermediate Dam	15 feet or greater but less than 50 feet
Large Dam	50 feet or greater

(f) The reservoir operation classification of the proposed project as defined by Table 2.

TABLE 2. RESERVOIR OPERATION CLASSIFICATION

RESERVOIR OPERATION CLASSIFICATION	DETERMINING FACTOR
Permanent Pool or Seasonal Pool Operation	Steady state seepage or saturated flow conditions occur in impounding barrier and foundation at or near normal pool conditions.
Intermittent Operation	Duration of normal high pool condition is insufficient for steady state seepage or saturated flow conditions to develop in impounding barrier and foundation.

(g) An assessment of the consequences of dam failure on downstream areas, including:

(i) An estimation of the magnitude of the dam break flood hydrographs resulting from hypothetical dam failures occurring with the reservoir at normal storage elevation and maximum storage elevation.

(ii) A general description of the areas downstream of the dam that could be affected by floodwater from a dam failure;

(iii) If there is the potential for loss of life, an inundation map delineating the maximum areal extent of flooding that could be produced by a dam failure. Inundation mapping should extend to a point downstream where the inundation from the dam failure is within the 100 year floodplain for the affected watercourse;

(iv) The downstream hazard classification as defined by Table 3, which reflects the current conditions of development in downstream areas. The most serious potential consequences of failure of those listed in Columns 3A, 3B and 3C shall be used to establish the appropriate downstream hazard classification.

(h) Engineering calculations and data supporting the detailed design of project elements. This would include, as a minimum:

(i) The design step levels used in design of the various critical project elements, based on guidance contained in the department's *Dam Safety Guidelines*.

(ii) Stability analyses corroborating the design of the proposed embankment/barrier section under static and seismic loadings and rapid drawdown conditions;

(iii) Calculations for the design of any hydraulic structures, which are subject to high lateral earth pressures, relatively large seismic loads and/or uplift pressures;

(iv) Computations for sizing the principal and emergency spillway, including, where applicable, reservoir routing computations defining the reservoir inflow and outflow design flood hydrographs.

TABLE 3. DOWNSTREAM HAZARD CLASSIFICATION

DOWNSTREAM HAZARD POTENTIAL	DOWNSTREAM HAZARD CLASSIFICATION	COLUMN 3A POPULATION AT RISK	COLUMN 3B ECONOMIC LOSS GENERIC DESCRIPTIONS	COLUMN 3C ENVIRONMENTAL DAMAGES
Low	3	0	Minimal. No inhabited structures. Limited agriculture development.	No deleterious materials in reservoir contents
Significant	2	1 to 6	Appreciable. 1 or 2 inhabited structures. Notable agriculture or work sites. Secondary highway and/or rail lines.	Limited water quality degradation from reservoir contents and only short term consequences.
High	1C	7 to 30	Major. 3 to 10 inhabited structures. Low density suburban area with some industry and work sites. Primary highways and rail lines.	Severe water quality degradation potential from reservoir contents and long term effects on aquatic and human life.
High	1B	31-300	Extreme. 11 to 100 inhabited structures. Medium density suburban or urban area with associated industry, property and transportation features.	
High	1A	More than 300	Extreme. More than 100 inhabited structures. Highly developed, densely populated suburban or urban area with associated industry, property, transportation and community life line features.	

WAC 173-175-140 Plans and Specifications.

(1) Two copies of the plans and specifications, bearing the seal and signature of the project engineer, shall be submitted to the department for engineering review. Upon approval, one copy will be retained by the department and the other copy will be returned to the owner or the project engineer.

(2) For large or complex projects, one copy of the preliminary or intermediate level plans, in addition to the final plans, shall be submitted to the department for review.

(3) To be approved, the plans and specifications must contain sufficient detail to describe the proposed construction work.

(a) The following items, as a minimum, shall be included as part of the construction plans:

(i) Project location and vicinity maps;

(ii) Site map of dam, reservoir area and appurtenances;

(iii) Sectional view along longitudinal axis of dam and foundation;

(iv) Cross-sectional view of dam at location of maximum height;

(v) Cross-sectional views and profiles of spillway(s), outlet facilities and other appurtenances;

(vi) Steel reinforcement placement and bar sizing for concrete construction must be shown in at least one section or profile; and

(vii) The plan for diversion and control of water during construction.

(b) The following items, as a minimum, shall be included as part of the construction specifications:

(i) Type, class or description of all materials to be used;

(ii) The requirements for fill placement, moisture conditioning and minimum level of compaction of all earthen zones;

(iii) The requirements, procedures and minimum standards for concrete construction and/or structural details.

WAC 173-175-150 Construction Permit Fee. There is a fee for the review of plans and specifications and for construction inspections conducted by the department. The amount of the fee and owner requirements for fee payment are contained in WAC 173-175-350 through 173-175-400.

WAC 173-175-160 Review Standards. The department will review engineering design reports, plans and specifications and the construction inspection plan to ascertain that the proposed project will be designed and constructed in a manner which will reasonably secure safety to life and property.

(1) The department's review is intended to address issues of safety directly related to the structural stability and integrity of the completed project. The review is not intended to extend to more general issues of safety not directly related to the structural stability and integrity of the project which are the purview of other governmental agencies such as the Washington Department of Labor and Industries (L&I), which administers the Washington Industrial Safety and Health Act (WISHA).

(2) In addition to the above, the department will review documents submitted pursuant to this chapter to ascertain that they conform to accepted engineering and construction practice and are in conformance with guidance contained in the department's *Dam Safety Guidelines*.

(3) Those elements of a document(s) which are found not to be in conformance with the above will be identified to the owner or the project engineer and changes may be required as appropriate to conform to accepted engineering practice.

(4) Where differences of opinion arise on the suitability of certain engineering or construction practices and cannot be readily resolved, the burden of proof will rest on the owner and the project engineer to demonstrate the suitability of the proposed plan or action.

WAC 173-175-170 Construction Inspection Plan. (1) A detailed plan shall be submitted to the department describing how adequate and competent construction inspection will be provided.

(2) The Construction Inspection Plan shall be prepared by a professional engineer and shall bear his/her seal and signature.

(3) The Construction Inspection Plan shall include, as a minimum:

(a) A listing of construction activities related to critical project elements and planned inspection effort including staffing levels, responsibilities, frequency and duration of site visits;

(b) A description of the quality assurance testing program which describes the type of test, general frequency, acceptable results, handling of deficient materials and the individuals(s) responsible for overseeing the testing;

(c) Description of construction management organization, lines of communication and responsibilities;

(d) Description of the change order process including who is responsible for coordinating the change order review process with the department;

(e) Description of the technical records handling and the content and frequency of construction progress reports.

WAC 173-175-180 Issuance of Construction Permit. (1) After the department has determined that the plans and specifications and construction inspection plan conform to accepted engineering practice, these documents will be approved and a construction permit will be issued which authorizes construction to commence.

Construction shall not commence until the Construction Permit has been issued by the department.

Preliminary work such as mobilization of equipment, stripping and grubbing and other site access and preparation work is allowed prior to receipt of the construction permit, provided no permanent features of the dam are initiated.

(2) Receipt of the construction permit does not relieve the owner of the responsibility to secure all other applicable permits and approvals before proceeding with construction work.

WAC 173-175-190 Construction Change Orders. (1) All dam projects subject to the provisions of these regulations shall be constructed in accordance with the plans and specifications approved by the department. Any proposed changes to the department-approved plans which could have an effect on structural integrity or safe operations of the project must first be presented to the department for a determination if an approval is required.

(2) If the department determines that the proposed construction change order represents a significant modification of the approved plans or specifications that could have an effect on structural integrity or safe operations of the project, then approval of the change order will be required.

The department will review the construction change order and provide a response to the project engineer in a timely manner, consistent with the complexity and safety concerns of the situation.

(3) If department approval of the proposed construction change order is required, no action can be taken by the owner to make the construction change until approval is given by the department.

WAC 173-175-200 Department Role in Construction Inspection. (1) It will be the department's role during construction to confirm that the project engineer, as representative for the owner, is properly implementing the department approved Construction Inspection Plan.

(2) The department will periodically observe the construction work to independently confirm that conditions assumed in the design stage are valid for field conditions and that construction is proceeding in accordance with the approved plans and specifications.

(3) Changes may be required by the department to be made to the approved plans and specifications to reasonably secure safety to life and property. Reasons for changes may include, but are not limited to the following:

(a) To address unanticipated field conditions;

(b) To correct omissions or errors in the approved plans and specifications;

(c) To correct situations where the construction work clearly is not being performed in a workmanlike manner and does not, in the opinion of the department, meet the performance intent of the specifications.

(4) Where deemed necessary by the department, a stop work order may be issued to temporarily halt construction until a problem can be resolved.

WAC 173-175-210 Operation and Maintenance Plan. (1) An Operation and Maintenance (O&M) Plan shall be developed and submitted to the department for review and acceptance. The O&M Plan shall outline and summarize how the project is to be operated and how the basic elements of monitoring, inspection and maintenance, as listed in WAC 173-175-500(1), are to be accomplished.

The department may issue an acceptance after determining the O&M Plan is substantially complete.

(2) Owners are responsible for incorporating the details of the O&M Plan into an O&M Manual suitable for use by dam operators. Requirements associated with O&M Manuals are listed in WAC 173-175-500.

WAC 173-175-220 Emergency Action Plan. (1) In those cases where a failure of the dam could pose a risk to life based on the current level of development in downstream areas (Downstream Hazard Classes 1A, 1B, 1C, and 2, WAC 173-175-130), an Emergency Action Plan (EAP) shall be developed and submitted to the department for review and acceptance. The purpose of the plan is to establish procedures for responding to unusual or emergency situations and procedures for detecting, evaluating, communicating and initiating notification or warning to individuals who may be at risk in downstream and upstream areas. Requirements associated with EAP's are listed in WAC 173-175-520.

The department may issue an acceptance after determining the EAP is substantially complete.

WAC 173-175-230 Declaration of Construction Completion. Within 30 days following substantial completion of construction or modification of a dam, the project engineer shall submit to the department:

A declaration stating the project was constructed in accordance with the department approved plans and specifications and construction change orders.

The department will provide a declaration form which may be used or altered, as appropriate, by the project engineer.

WAC 173-175-240 Authorization to Commence or Resume Project Operation. (1) Upon receipt of the project engineer's declaration of construction completion, the department will authorize the owner or the project engineer, as appropriate, to commence or resume normal project operation, provided that:

(a) The department concurs with the project engineer that the project was constructed in accordance with the approved plans and specifications and construction change orders.

(b) The proposed O&M plan is acceptable to the department;

(c) The proposed Emergency Action Plan, if required (see WAC 173-175-220), is acceptable to the department.

(2) If the above conditions are not met, the owner shall not commence or resume normal operation of the project until all outstanding issues or problems are resolved. When outstanding issues or problems are not resolved in a timely manner, the department may:

(a) Order the outlet works to remain fully open and not allow filling of the reservoir;

(b) Restrict reservoir water levels or reservoir operation;

(c) Order the breaching of the impounding barrier;

(d) Take other measures as appropriate to reasonably secure safety to life and property.

WAC 173-175-250 Construction Records Summary. Within 120 days following completion of construction or modification of a dam, the project engineer as representative of the owner, shall submit a report to the department on construction activities which includes:

(1) A summary of results from field testing of materials used in construction. The summary shall identify both representative values and the range of test values;

(2) A discussion of any notable items encountered during construction.

(3) One complete set of drawings depicting the as-built condition of the dam.

WAC 173-175-260 Exceptions to Construction Permit Process If the department determines that emergency or exigency conditions exist at a dam and that it is in the best interests of public safety to expedite the construction or modification of a dam, the department may elect to temporarily suspend the normal construction permit process. To allow this exception, the department will issue a written conditional construction permit, which:

(1) May initially be oral;

(2) Will specify the construction activities to be allowed;

(3) May be terminated at a time deemed appropriate by the department;

(4) Shall incorporate, to the extent possible and not inconsistent with the situation, all applicable requirements of this chapter.

WAC 173-175-270 Department Review Response Time. In reviewing the various documents required in the construction permit process, the department shall respond in a timely manner to the owner or project engineer with written review comments, approval or acceptance as appropriate.

If the department response is anticipated to occur 60 days or more beyond the date of receipt of the document(s), the department shall notify the owner and/or project engineer in writing and advise them of the expected response date.

PART THREE

CONSTRUCTION PERMIT FEES

WAC 173-175-350 Authority for Construction Permit Fees. It is required by RCW 90.03.470(9) that fees be collected by the department for the examination of plans and specifications. The fee shall be a minimum of ten dollars or the actual cost. In addition, the department is required by RCW 43.21A.064(2) to inspect the construction of all dams. It is required by RCW 90.03.470(8) that fees be collected for the actual cost to the department for inspection including the expense incident thereto.

WAC 173-175-360 Construction Permit Fees for New Project Construction. Fees for the review of plans and specifications and for construction inspection for new project construction shall be the amounts shown in Table 4 as determined by the nearest values of dam height and crest length, in feet, which correspond to the project's planned dam height and crest length.

WAC 173-175-370 Construction Permit Fees for Modifications of Existing Dams. (1) Fees for the review of plans and specifications and for construction inspections for project modifications involving significant enlargements shall be the greater of five hundred dollars or the amount determined by those applicable percentages shown in Table 5A of the fees in Table 4. The appropriate Table 4 fee amount is to be determined using the nearest values of dam height and crest length, in feet, which correspond to the overall dimensions of the modified dam.

TABLE 4. CONSTRUCTION PERMIT :S - NEW PROJECT CONSTRUCTION

DAM HEIGHT (FEET)	DAM CREST LENGTH (FEET)															
	50	100	150	200	250	300	350	400	500	600	700	800	1000	1500	2000	4000
400	15810	17640	18320	18730	19060	19320	19540	19730	20000	20000	20000	20000	20000	20000	20000	20000
300	13680	16220	17320	17890	18240	18500	18720	18920	19240	19500	19720	19920	20000	20000	20000	20000
250	12150	15100	16370	17190	17620	17980	18210	18400	18720	18990	19210	19400	19720	20000	20000	20000
200	10100	13260	15000	15890	16610	17130	17420	17690	18090	18350	18570	18770	19090	19670	20000	20000
180	8930	12370	14090	15250	15940	16530	17030	17280	17720	18060	18280	18470	18790	19380	19790	20000
160	7730	11390	13140	14340	15230	15790	16280	16720	17270	17620	17930	18140	18460	19050	19460	20000
150	7150	10840	12590	13800	14770	15400	15880	16310	17030	17380	17680	17950	18280	18870	19280	20000
140	6570	10080	12000	13250	14180	14990	15460	15880	16600	17120	17420	17680	18090	18670	19090	20000
130	6010	9260	11400	12620	13570	14340	15020	15430	16130	16720	17140	17400	17830	18460	18880	19880
120	5450	8400	10670	11950	12930	13680	14340	14930	15630	16210	16720	17090	17530	18240	18650	19650
110	4900	7560	9740	11250	12180	12990	13620	14180	15120	15680	16170	16600	17200	18000	18410	19410
100	4370	6740	8680	10300	11400	12170	12850	13410	14350	15110	15580	16000	16730	17630	18140	19140
95	4110	6330	8160	9760	11010	11740	12410	13010	13920	14720	15280	15690	16400	17430	18000	19000
90	3850	5930	7640	9140	10410	11320	11950	12530	13490	14260	14940	15360	16060	17230	17790	18320
85	3590	5530	7130	8530	9800	10820	11490	12050	13040	13780	14450	15030	15710	17020	17320	17320
80	3340	5140	6630	7930	9120	10160	11020	11560	12510	13300	13940	14520	15350	16320	16320	16320
75	3090	4760	6130	7340	8440	9460	10320	11060	11970	12780	13420	13980	14960	15320	15320	15320
70	2840	4380	5640	6750	7770	8700	9580	10320	11420	12190	12870	13430	14320	14320	14320	14320
65	2600	4010	5160	6180	7100	7960	8770	9530	10780	11580	12240	12830	13320	13320	13320	13320
60	2360	3640	4690	5610	6450	7230	7970	8660	9930	10950	11590	12150	12320	12320	12320	12320
55	2130	3280	4230	5060	5820	6520	7180	7800	8970	10010	10880	11320	11320	11320	11320	11320
50	1900	2930	3770	4520	5190	5820	6410	6960	8010	8970	9860	10320	10320	10320	10320	10320
46	1720	2650	3420	4090	4700	5270	5800	6310	7250	8120	8950	9520	9520	9520	9520	9520
42	1540	2380	3070	3670	4220	4730	5210	5660	6510	7290	8030	8720	8720	8720	8720	8720
38	1370	2110	2720	3260	3750	4200	4630	5030	5780	6480	7130	7760	7920	7920	7920	7920
34	1200	1860	2390	2860	3290	3690	4060	4410	5070	5680	6260	6800	7120	7120	7120	7120
30	1040	1600	2060	2470	2840	3180	3500	3810	4380	4910	5400	5870	6320	6320	6320	6320
28	960	1480	1900	2280	2620	2940	3230	3510	4040	4530	4980	5420	5920	5920	5920	5920
26	880	1360	1750	2090	2400	2690	2960	3220	3700	4150	4570	4970	5520	5520	5520	5520
24	820	1230	1590	1900	2190	2450	2700	2940	3380	3780	4170	4530	5120	5120	5120	5120
22	770	1120	1440	1720	1980	2220	2440	2660	3050	3420	3770	4090	4710	4720	4720	4720
20	710	1000	1290	1540	1770	1990	2190	2380	2730	3070	3370	3670	4220	4320	4320	4320
18	660	890	1140	1370	1570	1760	1940	2110	2420	2720	2990	3250	3740	3920	3920	3920
16	610	800	1000	1200	1370	1540	1700	1840	2120	2370	2620	2840	3270	3520	3520	3520
15	590	770	930	1110	1280	1430	1580	1710	1970	2210	2430	2640	3040	3320	3320	3320
14	570	730	860	1030	1180	1320	1460	1580	1820	2040	2250	2440	2810	3120	3120	3120
13	550	690	810	950	1090	1220	1340	1460	1680	1880	2070	2250	2580	2920	2920	2920
12	540	650	770	870	1000	1110	1230	1330	1530	1720	1890	2060	2360	2720	2720	2720
11	530	620	720	810	910	1010	1110	1210	1390	1560	1720	1870	2150	2520	2520	2520
10	520	590	670	760	830	910	1000	1090	1250	1400	1550	1680	1930	2320	2320	2320
9	510	560	630	700	770	830	900	970	1120	1250	1380	1500	1720	2120	2120	2120
8	500	540	590	640	710	760	810	860	980	1100	1210	1320	1510	1920	1920	1920
7	500	520	550	600	640	690	740	780	850	950	1050	1140	1310	1690	1720	1720
6	500	510	530	560	590	630	660	700	770	820	890	970	1110	1430	1520	1520
5	500	500	510	530	550	570	600	620	680	730	780	820	920	1180	1320	1320

(2) Fees for the review of plans and specifications and for construction inspection for project modifications not involving significant enlargements shall be the greater of five hundred dollars or the amount determined by those applicable percentages shown in Table 5B of the fees in Table 4. The appropriate Table 4 fee amount is to be determined using the nearest values of dam height and crest length, in feet, which correspond to the overall dimensions of the modified dam.

(3) Fees for the review of plans and specifications and for construction inspection for the removal or partial removal of a dam with safety deficiencies for the purpose of eliminating a public safety hazard shall be the minimum fee of ten dollars.

(4) Fees for the review of plans and specifications and for construction inspection for the planned abandonment and reclamation of dams and reservoir areas used in mining operations shall be the minimum fee of $500.

TABLE 5 - FEES FOR MODIFICATIONS OF DAMS
MODIFICATION FEE AS PERCENTAGE OF FEE FOR NEW DAM CONSTRUCTION

FEATURES MODIFIED	TABLE 5A MODIFICATIONS INVOLVING SIGNIFICANT ENLARGEMENTS	TABLE 5B MODIFICATIONS NOT INVOLVING SIGNIFICANT ENLARGEMENTS
Spillway(s)	35%	25%
Impounding Barrier	35%	25%
Appurtenant Works and Miscellaneous Construction Elements	10%	10%

WAC 173-175-380 Maintenance. It will not be necessary to submit plans and specifications for review for routine maintenance, normal replacement or repair of items to keep them in a serviceable condition, seasonal removal or replacement of stoplogs, or other similar minor operational activities.

WAC 173-175-390 Payment of Construction Permit Fees. (1) The amount of the construction permit fee will be determined by the department based upon procedures contained in WAC 173-175-360 and WAC 173-175-370 and information contained in the construction plans.

(a) An initial payment, which may represent all or a portion of the construction permit fee shall be paid in conjunction with the submittal of the construction permit application described in WAC 173-175-120. The amount of the initial payment shall be:

(i) Ten dollars for the removal of a dam with safety deficiencies as described in WAC 173-175-370(3); or

(ii) Five hundred dollars for construction of a new dam or modification of an existing dam or project.

(b) The balance of the fee amount (less the initial payment above) is to be paid following notification by the department of the balance due.

(c) All fees collected are non-refundable.

(2) No fee shall be required for the review of conceptual plans which describe proposed repairs or improvements to existing dams to correct safety deficiencies. The normal construction permit process will apply at the time plans and specifications are submitted to the department.

(3) No additional fees shall be required for plan and specification changes and resubmittals required by the department as part of the review process.

(4) No additional fees shall be required for review of construction change orders.

WAC 173-175-400 Cost of Expert Opinion. In resolving differences of opinion on engineering issues between the department and project engineer or owner, it may be necessary for the department to employ an expert in dam design, analysis or construction.

(1) The expert who is chosen, the assigned tasks and the estimated cost for the expert's services shall be determined by negotiation between the owner and the department.

(2) The cost associated with employing the expert shall be paid by the owner of the proposed or existing project.

PART 4

PROJECT OPERATION

WAC 173-175-500 Operation and Maintenance. (1) The owner shall develop and maintain a current Operation and Maintenance (O&M) Manual.

The manual shall describe procedures for operation of the project under normal and extreme reservoir inflow conditions and provide technical guidance and procedures for monitoring, inspection and long term maintenance. Information on the development of the O&M manual is contained in the department's *Dam Safety Guidelines*. The O&M Manual shall include, as a minimum, the following items:

(a) Identification of the individual(s) responsible for implementing the plan;

(b) A project data sheet describing the pertinent features of the dam and reservoir, including the spillway(s), outlet works and appurtenant structures and their locations at the dam site;

(c) The rules and procedures (rule curve) used to regulate reservoir levels and project operation for various reservoir inflows and for both normal and unusual seasonal conditions;

(d) A description of each hydraulic element used to regulate or release water, including information on proper operation and scheduled maintenance;

(e) A listing of the items requiring periodic monitoring, the frequency of monitoring and procedures for monitoring, measurement and record keeping;

(f) A listing of the items requiring periodic maintenance and procedures for conducting and documenting maintenance and recording of problems;

(g) A listing of items to be inspected or test operated the frequency and procedures for conducting the same and for documenting the findings.

(2) It shall be the duty and responsibility of the owner to, at all times, operate and maintain the dam and all appurtenant works in a safe manner and condition and follow the method and schedule of operation of the dam as outlined in the O&M manual.

(3) For dams constructed before July 1, 1992, owners are required to develop an O&M manual by December 31, 1997. In those cases where a failure of the dam could pose a threat to life (Downstream Hazard Classes 1A, 1B, 1C and 2), the O&M Manual shall be submitted to the department for review and acceptance.

(4) Any proposed changes to the O&M manual which could have an effect on public or project safety must be submitted to the department for review and acceptance before implementation.

WAC 173-175-510 Inspection. (1) Owners are required to evaluate the safety of their dam(s) and all appurtenant works and to make modifications, as becomes necessary, to reasonably secure safety to life and property. To accomplish this, owners are:

(a) Required to conduct annual surficial inspections and to maintain records of their findings, including records of actions taken to correct problem conditions. Copies of such records shall be provided to the department upon request.

The annual surficial inspections may be conducted by the owner or by agent(s) designated by the owner.

(b) Encouraged to implement a program for the periodic inspection of their projects(s) on a five year frequency to be conducted by a professional engineer.

(c) Required to notify the department at least thirty days in advance of when periodic inspections are scheduled to allow department engineers to participate in the inspection.

(d) Required to submit a copy of the engineering report(s) and other documents which contain the findings, conclusions and recommendations resulting from the periodic inspection within 30 days following the completion of the various documents.

(2) In order to correct safety deficiencies and exigency conditions, owners are required to take actions and make modifications as prescribed by the department to preserve the structural stability and integrity of the project and attain levels of safety in accordance with accepted engineering practice.

(3) The department may elect to conduct periodic inspections of particular projects to reasonably secure safety to life and property.

(a) The department will give at least 30 days advance notice of the date of the periodic inspection and advise the owner of any requirements such as gates or valves that are to be operated during the inspection.

(b) Owners are required to develop an Operation and Maintenance Manual (WAC 173-175-500) and an Emergency Action Plan (WAC 173-175-520) within 180 days following completion of a periodic inspection conducted by the department.

WAC 173-175-520 Emergency Action. (1) In those cases where a failure of the dam could pose a threat to life (Downstream Hazard Classes 1A, 1B, 1C and 2), the owner shall develop and maintain an Emergency Action Plan (EAP) acceptable to the department.

(a) The EAP shall describe procedures for responding to unusual or emergency situations and procedures for detecting, evaluating, communicating, and initiating of notification or warning of individuals who may be at risk in downstream and upstream areas. Information on the development of an EAP is contained within the department's *Dam Safety Guidelines*.

(b) It shall be the duty and responsibility of the owner to implement the EAP when conditions warrant and to follow the method and schedule contained within the EAP.

(c) For dams constructed before July 1, 1992, owners are required to develop an EAP and to submit it to the department for review and acceptance by December 31, 1997.

(i) Owners are required to coordinate the development of the EAP with representatives from the local emergency services staff, state department of community development, emergency management division and appropriate local authorities.

(ii) Copies of the completed EAP must be provided to the State Emergency Management Division, local Emergency Services Office and to the department.

(2) Any proposed changes to the EAP which could have an affect on public or project safety must be submitted to the department for review and acceptance before implementation.

(3) Owners are required to exercise components of the EAP as needed to confirm the viability of the plan.

(4) The department will coordinate and solicit review comments from the local emergency services office and the state emergency management division on the acceptability of proposed EAPs. Those comments will constitute the primary basis for accepting or requesting modifications to a proposed EAP.

WAC 173-175-530 Reporting of Incidents. Owners are required to notify the department when incidents occur or when problems or conditions arise which may pose a threat to life or property or a threat to the integrity of the dam.

(1) The owner shall report by telephone to the department on any condition affecting the safety of the project or when an incident has occurred. The initial oral report must be made as soon as practicable after the condition is discovered or following any incident.

(2) A written report may be required by the department within 30 days following the discovery of the condition or after the incident. The report shall describe the condition affecting the safety of the project or the incident which has occurred and shall describe the preliminary plans for correcting the condition and for preventing the recurrence of a similar incident.

PART FIVE

COMPLIANCE AND ENFORCEMENT

WAC 173-175-600 Right of Entry. The department or its duly appointed agent(s) shall have the right to enter at all reasonable times in or upon property, public or private, for the purpose of inspecting and investigating conditions relating to the construction, operation, maintenance or performance of dams. The department shall comply with the owner's reasonable rules for access to the project.

WAC 173-175-610 Emergencies. (1) When, in the opinion of the department, an emergency condition exists which poses an imminent threat to life, the department may take such action as necessary to eliminate or mitigate the hazard and potential consequences. The dam owner or the owner's agent(s) may be directed to take actions, and if that failing, the department may take control of the project and take actions, including, but not limited to:

(a) Altering the operation of the project;
(b) Lowering the reservoir water level;
(c) Draining the reservoir;
(d) Making emergency repairs or modifications to the project;
(e) Enlisting the services of federal, state or local authorities to make emergency repairs or modifications to the project;
(f) Breaching the dam.

(2) All costs incurred by the department as a result of taking control of the project will be charged to the owner.

WAC 173-175-620 Enforcement. (1) In enforcement of this chapter, the department may impose such sanctions as appropriate under authorities vested in it, including but not limited to, the issuance of regulatory orders under RCW 86.16.081 and 43.27A.190 and civil penalties under RCW 86.16.081 and 90.03.600.

(2) Any dam which is found to be under construction or recently constructed without prior approval of the plans and specifications is in violation of RCW 90.03.350 and will be presumed to be a public nuisance. The owner will not be allowed to fill the reservoir or continue to operate the reservoir until the structural integrity and safety of the facility can be demonstrated to the satisfaction of the department. In addition:

(a) Regulatory orders may be issued to enforce the restriction of reservoir filling and fines may be levied at $100 per day up to an amount equal to 150% of the amount the owner would have been charged under the construction permit fee schedule listed in this chapter;

(b) Owners are required to submit as-built drawings and all available documentation describing the manner in which the dam or portion thereof was constructed;

(c) If the structural integrity and safety of a dam project cannot be demonstrated or confirmed to the satisfaction of the department, the owner shall not commence or resume normal operation of the project until all outstanding issues or problems are resolved to the satisfaction of the department. To accomplish the above, the department may:

(i) Order the outlet works to remain fully open and not allow filling of the reservoir;
(ii) Restrict reservoir water levels or reservoir operation;
(iii) Order the breaching of the impounding barrier;
(iv) Take other measures as appropriate to reasonably assure safety to life and property.

(d) If, in the opinion of the department, the owner is unwilling or incapable of resolving the outstanding safety issues in a timely manner, the department may take action to have the dam abated as prescribed by law under RCW 90.03.350.

WAC 173-175-630 Appeals. All final written decisions of the department pertaining to permits, regulatory orders, and related decisions made pursuant to this chapter shall be subject to review by the pollution control hearings board in accordance with chapter 43.21B RCW.

APPENDIX C

ROCK DURABILITY AND LONGEVITY

89-2

STAFF TECHNICAL POSITION
ON
TESTING AND INSPECTION PLANS
DURING
CONSTRUCTION OF DOE'S REMEDIAL ACTION
AT
INACTIVE URANIUM MILL TAILING SITES

DIVISION OF LOW-LEVEL WASTE MANAGEMENT AND DECOMMISSIONING
U.S. NUCLEAR REGULATORY COMMISSION
Revision 2
JANUARY, 1989

Revision 2
January 1989

STAFF TECHNICAL POSITION ON TESTING AND INSPECTION PLANS DURING CONSTRUCTION OF DOE'S REMEDIAL ACTION AT INACTIVE URANIUM MILL TAILING SITES

1. INTRODUCTION

Title I of the Uranium Mill Tailings Radiation Control Act of 1978, as amended (UMTRCA) requires Nuclear Regulatory Commission (NRC) concurrence in DOE's selection and performance of remedial actions at inactive uranium mill tailings sites. The NRC provides reviews, concurrences, and licensing actions during the remedial process. Among the specific technical aspects of the remedial action performance is field control, including testing and inspection.

This staff technical position describes the engineering practices, testing, inspection, record keeping, nonconformance corrective action and "stop work order" controls considered satisfactory for the implementation of remedial action programs. These criteria reflect the approaches and state-of the art methods that are considered to be adequate to protect public health and safety, and as such acceptable to the NRC staff. If alternate methods are proposed, they will be considered on a case-by-case basis.

2. DISCUSSION

DOE is responsible for planning and conducting remedial actions for stabilization of inactive uranium mill tailings in accordance with EPA standards. The options presently being considered and implemented by the DOE for stabilization of the inactive tailings consist of (i) stabilization of tailings in place, (ii) stabilization on site, and (iii) relocation and stabilization of tailings at another location. The detailed design and construction procedure for each remedial action depends upon the site-specific plan selected by the DOE.

The objective of NRC's review and concurrence with DOE's remedial action plans is the verification of compliance with the requirements of the EPA standards issued pursuant to the UMTRCA. To meet this objective, the DOE's remedial action plan and construction must assure adequacy of (i) geotechnical stability, (ii) erosion protection, (iii) radon attenuation, and (iv) protection against existing and future groundwater contamination. Acceptance testing and adequate inspection during construction are essential to assure compliance with specification requirements and to provide confidence that the intended design criteria are implemented during construction.

In its review of the Remedial Action Inspection Plans (RAIP's), the NRC staff must assure that acceptable criteria are used for the inspection and testing performed during construction of each remedial action. To facilitate this action, the staff has developed this position paper. It identifies remedial action inspection plan features related to geotechnical engineering that may be necessary to control, verify, and document the DOE's remedial action activities. It does not cover the general quality assurance requirements for an acceptable inspection and testing plan.

Since conditions are likely to vary from site to site and the various RAP's may differ in scope and extent, only relevant portions of the staff position on testing and inspection requirements need be applied at a given site.

3. STAFF POSITION

The establishment of the adequacy of construction is usually accomplished by visual examination, measurements, and testing. The extent of inspection and testing should be sufficient to provide adequate quality control, to satisfy requirements of plans and specifications, and to furnish the necessary permanent record. Also, it is essential that the personnel performing the inspection and testing have the required training and experience to perform a professional job.

It is impracticable to test completely all the work performed. An acceptable procedure would be to select samples of the work or materials for testing which are representative of some unit of work or material. Conditions which produce test results below the requirements should be remedied. For each failing test, representative sampling and testing should be accomplished before the material is accepted. If there is an appreciable number of borderline test results, immediate steps should be taken to ascertain the cause and to correct it.

Section 3.1 describes the NRC staff position on an acceptable testing and inspection plan for various geotechnical aspects of the design. Acceptable procedures and frequency of testing and inspection to implement this plan are given in Section 3.2 of the staff position.

3.1 Testing and Inspection Plan

3.1.1 Foundation and Subgrade

Prior to placing the first layer of material on the foundation, a final inspection of the subgrade should be made to assure that it has no sign of deterioration due to frost action, erosion due to rainwater, rutting, areas of subsidence, or drying out of the surface. The inspection should verify that the foundation surface has been moistened, but there is no standing water on the surface. In addition, the inspection should also verify that the foundation surface of cohesive soils has been scarified or penetrated by tamping rollers to insure proper bonding with the material to be placed above it. Any unacceptable surface material should be either removed or excavated and recompacted to design specifications.

3.1.2 Capillary Break (non-cohesive)

Capillary break materials should be inspected and tested to verify that the gradation requirements of the materials have been met. Testing of in-place capillary break materials should be accomplished to assure that the in-place density of the materials is in conformance with the specified percentage of maximum relative density.

3.1.3 Geotextile Separators

In some Remedial Action Plans, a geotextile separator may be specified for placement between two different construction materials. This separator should be inspected to verify that the specified fabric is being used and that the fabric has no tears and has sufficient overlap of material between adjoining pieces when emplaced.

3.1.4 Seepage Barrier/Liner (Cohesive)

Inspection and testing of seepage barrier/liner materials should include verification that gradation, classification, plasticity index, and the moisture-density relationship conform with the specifications.

3.1.5 Tailings/Contaminated Material

Inspection and testing of tailings/contaminated material should be accomplished to assure that the quantity and maximum size of foreign material placed in the encapsulation cell is in conformance with the applicable specifications. Compaction of tailings around the relatively large sized foreign material should meet the specified requirements. Inspection should verify that segregation of tailings (pockets of slimes) is avoided during placement of tailings/contaminated material, and that any organic materials are uniformly distributed throughout the emplaced tailings. Compaction testing should be accomplished to assure that the in-place density and moisture content of the emplaced tailings are in compliance with applicable specifications.

3.1.6 Radon Barrier/Soil Covers

Materials for the radon barrier/soil cover should be inspected and tested to ensure verification of gradation, plasticity index, classification, and moisture-density relationship to conform with the specifications. Testing of in-place density and moisture should also be accomplished to ensure compliance with appropriate compaction specifications. When additives are used with the cover soils to decrease permeability, inspection should verify that thorough mixing has been achieved for the total layer depth, and that the percentage (by weight) of additive meets the specified requirements.

3.1.7 Filter Bed

Inspection of filter bed materials emplacement should be accomplished to assure that they are being properly placed. Testing of emplaced materials should be accomplished to assure that the gradation is in conformance with applicable specifications. Inspection should assure that the gradation of filter materials are not altered by segregation at the time of emplacement or by physical breakdown of grains by compaction equipment.

3.1.8 Riprap

The placement of the riprap materials should receive inspection to assure that proper placement techniques are employed to prevent degradation of the material due to improper handling, to assure that the distribution is uniform and that voids are kept as small as possible, and to assure proper gradation. The inspection should also verify that the size and classification of riprap rock, the lift thickness, and elevations comply with applicable specifications and drawings. Inspection of riprap quality may be provided at the material source if required to assure compliance to the specification requirements. The testing should include durability tests including tests such as specific gravity, soundness, abrasion, and absorption. Inspection of riprap at placement should include visual inspection of size and shape of riprap materials to ensure that riprap is nonsegregated (free of pockets of small stones or of clusters of large stones), that the gradation tolerance is met and that the riprap is not emplaced in layers.

3.1.9 Top Soil

If top soil is used over the riprap, the inspection should assure that the loose thickness of the top soil conforms with the specifications. The inspection and testing should also verify that the lower layers of top soil are adequately compacted. The inspection should further verify that the upper layers of the top soil are seeded as per specifications.

3.2 Testing and Inspection Procedure

3.2.1 Materials Certification

Materials which are supplied for installation or which require certification should be verified by the project quality department as having met the specified requirements. Appropriate tests should be run whenever there is a visible change in engineering characteristics of the material. The inspector should sign or initial the transmittal indicating acceptance or describing the reason(s) for non-acceptance.

3.2.2 Instrument Certification

Instrumentation which is received should be inspected by the person responsible for using and maintaining the instrument. The instrument should be inspected

for damage, for correct operation, and for proper calibration records. Equipment which does not meet the applicable requirements should not be used.

The calibration records should be included in the instruments calibration system. The system should identify the required frequency of calibration checks and methods of calibration for various instruments.

3.2.3 Compaction Evaluation Procedure

Inspections and testing should assure that specified materials are emplaced and compacted as designated on drawings. The loose thickness of the lifts of material and elevations should be verified frequently to ensure compliance to the specification requirements for the particular type of material emplaced. Inspection should also verify that the compaction equipment (or equivalent), as per specifications, is being used for compacting the material and the number of roller passes meets the specification requirements.

In-place field density tests and sufficient laboratory moisture-density tests should be performed to further evaluate compaction. However, the testing procedure should not jeopardize the integrity of the emplaced materials. The field density and moisture testing should be in accordance with ASTM D-698, ASTM D-1557, ASTM D-4253 and D-4254, ASTM D-1556, or ASTM D-2922 and D-3017, as applicable.

Prior to the start of field compaction operations, appropriate laboratory compaction curves should be obtained for the range of emplaced materials. During construction, one point Proctor tests at a frequency of one test for every five field density tests should be performed. Similar checks should be provided for verifying relative densities of granular materials. Supplementary laboratory compaction curves (based on complete Proctor tests) should be obtained, approximately one for every 10 or 15 field tests, depending on the variability of materials.

The moisture/density field test frequency should be a minimum of one test per 1,000 cubic yards of contaminated material placed and one test per 500 cubic yards of other compacted materials including seepage barrier and/or radon barrier earth cover. There should be a minimum of two tests taken for each day that an appreciable amount of fill is placed (in excess of 150 cubic yards). There should be a minimum of one test per lift and at least one test for every full shift of compaction operations.

If the nuclear density gauge is used for density (ASTM D-2922) and moisture content (ASTM D-3017) determination in the field, the frequency of correlation tests should be one for every five nuclear gauge tests for contaminated materials, and one for every ten nuclear gauge tests for other compacted materials. The correlation tests are generally sand cone tests (ASTM D-1556) for density determination and oven drying method (ASTM D-2216) for moisture determination. When nuclear gauges are used in testing contaminated material or in areas that may be affected by background radiation, the instruments should be

recalibrated before each density test by taking a standard count at the test location. Additionally, when neutron absorbing elements exist in a soil, a correction factor should be determined for each material type encountered, and the appropriate calibration adjustments should be made to the instrument for that material type. Any adjustments or recalibrations should be performed according to the procedures identified in the operating manual.

Moisture contents may also be determined using the microwave oven method (ASTM D-4643) or the speedy moisture meter (AASHTO T217).

- Each determination of moisture content of soil performed by the microwave oven method should be confirmed by the oven drying method on a 1:1 ratio for each type of soil encountered until it is confirmed that the microwave method is providing accurate drying results. Initial confirmation should consist of at least ten consecutive tests producing results that are each in agreement within plus or minus one percent. Once this confidence level is established, then each tenth microwave oven drying sample should be confirmed by one oven drying sample. Should this tenth test fail to confirm the correlation of the results within plus or minus one percent, then a reevaluation of test results collected since the previous moisture correlation should be performed.

- When speedy moisture meters are used to test contaminated material, radon barrier material, or other compacted materials, a correlation with the oven drying method should be developed for each tenth test, or more frequently if calibration of the moisture meter is necessary after every tenth test. Appropriate oven drying procedures should be used when oven drying soils containing significant amounts of hydrated water (refer to ASTM D-2216).

The field determination of moisture and density should be compared with the appropriate compaction curve to evaluate conformance with requirements. The Remedial Action Inspection Plan should include a criterion for evaluating the inspected field density and moisture data based on a continuous review of data.

3.2.4 Gradation and Classification Testing

The placement of materials should receive continuous inspection and frequent verification testing to assure that specification requirements with respect to gradation and classification are maintained. The inspection should assure that the maximum particle size in the emplaced material meets the specified requirements. For all materials other than random fill and contaminated materials, at least one gradation test should be run for each day of significant material placement (in excess of 150 cubic yards). In addition, there should be a minimum of one test per 1000 cubic yards of radon/seepage barrier material, and one test per 2000 cubic yards of other engineered soil fill materials. Gradation tests should be run on rock bedding and riprap materials at the same frequency discussed for durability tests in Section 3.2.6. Random samples

obtained from material being placed should be used for these tests. Inspection may also be provided at the material source to assure compliance with the specification requirements. Documentation of the test results should be on appropriate laboratory test report sheets and results of visual inspection should be documented in the daily inspection report.

3.2.5 Atterberg Limits Tests

Inspections of cohesive material should assure that the proper material is placed as designated on the drawings. Verification testing should include determination of plasticity index, which determines the range of water content over which a cohesive soil behaves plastically. The tests should be run at least once for each day of significant cohesive cover or liner material placement (in excess of 150 cubic yards). The samples should be randomly selected. The test results should be documented in the laboratory test reports.

3.2.6 Rock Durability Tests

For each gradation of riprap, rock durability tests such as specific gravity, absorption, sodium or magnesium sulfate soundness, and abrasion testing should be performed prior to delivery of any material to the site. The testing program may vary from site to site and is dependent on the type of rock selected and the expected environmental stresses that it will be subject to. During construction activities, additional test series should be performed for each type of riprap when approximately one-third and two-thirds of the total volume of each type of riprap have been delivered. For any type of riprap where the volume is greater than 30,000 cubic yards, a test series should be performed for each additional 10,000 cubic yards of riprap delivered. A final sample should be obtained for each riprap type following completion of delivery of the material.

3.2.7 Distribution of Organics

Continuous visual observation during placement of organics in the encapsulation cell should be accomplished to assure that the organic material is uniform and evenly distributed. Also, the inspection should assure that the maximum size of the emplaced organic material does not exceed the specified requirements. Results of visual inspection should be documented on the daily inspection report.

3.3 Non Conformances, Corrective Action and Stop Work Orders

In the Remedial Action Inspection Plan, the DOE should establish procedures to define, identify, and document non-conformances or deviations from plans, specifications, or procedures. A mechanism to develop, control, approve and implement the necessary corrective action should also be established. Follow-up procedures to assure that proposed corrective actions have been implemented should be documented.

The Remedial Action Inspection Plan should also address provisions for a "Stop Work Order". The situations when a "Stop Work Order" may become necessary should be described. Procedures and level of authority for issuing a "Stop Work Order" should be established and a mechanism for resolving the corresponding nonconformance(s) should be discussed.

3.4 Records

Daily inspection reports should be written that address the adequacy, progress, and details of construction activities, and decisions. The reports should include the results of visual inspection, measurements, and tests performed in the laboratory and in the field. The inspection and test status should be identified by charts, as-builts, or by periodic status reports. The inspector should summarize volume of emplaced materials and the number of field and laboratory tests performed on each material on a weekly basis. The status of inspection and testing should be monitored as appropriate to prevent inadvertently by-passing an inspection point. The inspection and test reports should become part of the permanent record of the implementation of the remedial action plan.

The records should include date, name of tester or inspector, items inspected or tested, type of inspection or test, identification of test method, results, acceptability and acceptance criteria, and name and initials of the reviewer. The records should also identify the testing equipment or instrument used in performing the test. When documenting deviations, nonconformances, and stop work order situations, the report should provide sufficient details so that acceptability of the necessary corrective action and final resolution can be independently reviewed.

WNI

To: *Closure Plans @ EHP1.WA-DOH
From: Blacklaw, John
Subject: WNI engineering review
Date: 3/23/95 Time: 4:52p

This morning, I visited the offices of the Department of Ecology, Dam Safety Section (DSS) in Lacey and spoke with Jerald LaVassar, PE and Bruce Barker, PE. They were both extremely helpful and expressed their recent review conclusions on the Sherwood Mill Closure Plan for Western Nuclear, Inc.

Bruce has prepared a memo to file dated March 1, 1995 (File No: ST54-378) regarding the hydrologic and hydraulic aspects of the Closure Plan. (I have a copy for anyone who may be interested.) His conclusions are that the closure plan, as presented meets Dam Safety requirements without change. He also comments that tributaries will carry sediment into the diversion channel during storm events. If the channel is not maintained, the diversion will silt in over time resulting in the diversion channel being blocked at each confluence, resulting in flood water flow and sediment passing onto the tailings cap. Bruce is expecting that active maintenance will be necessary to avert this possibility. After I explained that our regulatory basis requires that active maintenance is not acceptable, Bruce expressed that the diversions will likely fail early in the 1000 year design life, without active maintenance. Bruce will supplement his review to include an analysis of diversion flood flow across (or around) the impoundment area and out the impoundment spillway. This may be somewhat difficult in that it is not certain at what location of the down-slope dike the flood waters will fail the diversion.

This general failure mode for the present diversion design is also my independent conclusion, particularly in that maintenance is precluded by our regulatory basis (WAC 246-252) and NRC guidance. The reforestation and encroachment of trees into the diversion, after initial sedimentation, will accelerate the sedimentation process and also slow the storm flow rate from the diversion. This will cause the down-slope dike to be overtopped by flood run-off, resulting in an early breach and dike failure. I believe that we must identify a cost/effective design that will likely succeed past the design life of 1000 years without active maintenance.

I also discussed Jerald LaVassar's review of the Sherwood Mill Closure Plan and found that he is in the final throws of documenting his conclusions (His report is expected out today). Jerald will attach his work sheets to help express the basis of his findings. Jerald is recommending that the cover construction include a "proof rolling operation and leveling (evening) operation after the installation of the cover

subgrade features, with a project engineer approval requirement before continued cover installation. He believes that this will enhance the quality of the clay layer performance. In addition, Jerald has identified a concern for liquefaction of the slims portion of the impoundment contents during and slightly after a design basis earthquake. This factor may cause a slumping of the cover layer, even at very low slopes (less than 1%), thus exposing impounded tailings. The amount of exposure and the potential for rapid healing of the surfaces were not addressed, or the potential for reduced cover performance for radon emanation or groundwater infiltration. Jerald expressed that the dam as proposed (modified to a 5/1 slope) is not a concern for structural integrity.

The possibility that the cover design may be modified in the future to include a thick, homogeneous layer was discussed. This potential design change does not seem to adversely affect the conclusions of the DSS review. Instead, even though the likelihood of liquefaction failure is still present, the probability is likely reduced by the thick cover layer. If slumping of the thick layer occurs, it is more likely to heal itself and rebury any exposed tailings quickly with a resulting radon emanation and infiltration performance similar to the initially designed and constructed cover.

Since the diversions may likely fail, we discussed the need to address the diversion flood flow across, around, or next to the covered tailings, and out the impoundment spillway. The spillway design must meet the full flood flow capacity. It was also noted, that with a well armored spillway for the dam, the potential for erosion of the tailings and cover is limited to the elevation of the spillway, and not below it. Thus, with a thick cover and a shallow spillway cut, not below the elevation top of the tailings, erosion of the tailings material will be precluded, at least until the distant time when the spillway and dam eventually erode and fail (likely after the 1000 year design life).

These are today's thoughts on the review of the Closure Plan. There are groundwater impacts, although they may be small, that will need to be quantified and qualified in order to resolve some of these issues. Please give input on your feelings from this discussion, as soon as possible, and hopefully before we meet with WNI and SMI next Tuesday. Maybe there is a consensus here on what may or may not be needed to address these concerns.

Thanks,

John R. Blacklaw, Ph.D., P.E., Environmental Engineer
Environmental Health Programs
Radiation Protection Division
Air Emissions and Defense Waste Section
Airdustrial Park, Building 5, MS 7827
Olympia, WA 98504-7827
Phone: (360 753-3350, FAX: (360) 753-1496
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WESTERN NUCLEAR, INC.

UNION PLAZA SUITE 300, 200 UNION BOULEVARD, LAKEWOOD, COLORADO 80228
TELECOPIER (303) 989-8993 TELEPHONE (303) 989-8675

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WP8E

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DIV. OF RADIATION PROTECTION

February 5, 1996

Mr. Gary Robertson, Head
Waste Management Section
Washington Department of Health
Division of Radiation Protection
Airdustrial Park, Bldg. 5
P.O. Box 47827
Olympia, WA 98504-7827

RE: WN-I0133-1, SHERWOOD PROJECT, TAILING RECLAMATION PLAN, ROCK PETROGRAPHIC ANALYSIS

Dear Mr. Robertson:

As discussed during our January 24-25, 1996 meeting, please find attached the petrographic analysis and associated engineering evaluation regarding the rock from the proposed rock quarry, situated in the Western Nuclear, Inc. Sherwood mine area, that will be used for erosional stability during the forthcoming 1996 tailing reclamation construction.

In accordance with our July 20-21, 1995 and other recent discussions, seven [7] copies of this submittal are being transmitted to you in Olympia. We would appreciate if you would transmit the copies as you previously indicated, as listed below:

- Spokane Tribe of Indians (1 copy)
- Bureau of Indian Affairs (1 copy)
- Nuclear Regulatory Commission (1 copy)
- Clean file copy (1 copy)
- WDOH [Olympia, WA] (3 copies)

In addition, copies are being transmitted directly to the following parties:

- Two copies of this particular submittal are being sent by WNI directly to Ms. Stoffel [WDOH; Spokane, WA].
- One [1] copy is being sent directly to Mr. Fordham [WDOH; Richland, WA].

We request your prompt review and approval of the attached

information, so that permitting and quarrying of the rock borrow source may be completed as soon as possible in support of the forthcoming reclamation construction season.

Should you have any questions, please contact us at your earliest convenience.

Sincerely,

Stephanie J. Baker
Manager of Environmental Services
SJB/tic doh\rockpetr.f96

w/enclosures

cc: CA [w/ attach.]
KCB [w/o attach.]
MAP [w/o attach.]
L. Pruett, Esq. [w/ attach.]
LLM [SMI; w/ attach.]
D. Stoffel [WDOH; w/ attach.]
E. Fordham [WDOH; w/ attach.]

SHEPHERD MILLER
INCORPORATED

February 6, 1996

Ms. Stephanie Baker
Western Nuclear, Inc.
Union Plaza
200 Union Boulevard, Suite 300
Lakewood, Colorado 80228

SMI #03-317

Dear Stephanie:

Enclosed you will find the results of petrographic analysis performed on the three rock samples Corn Abeyta collected from the proposed quartz monzonite quarry near the mine. These analyses, performed by Dr. Theodore Pastor, provided the data necessary to evaluate the rock samples durability relative to NRC guidance. The analyses did not indicate any smectite or expanding lattice clays in any of the samples.

These results have been evaluated relative to the guidelines presented in the NRC "Staff Technical Position - Design of Erosion Protection for Stabilization of Uranium Mill Tailings Sites," August, 1990 and NUREG 4620 "Methodologies for Evaluating Long-Term Stability of Uranium Mill Tailing Impoundments," 1986.

Based upon Dr. Pastor's analyses we found the following:

1) The quartz monzonite samples would be classified in group 2 according to Table 6.1 from NUREG 4620 since they are coarser grained felsic granites.

2) The samples would be classified as fair according to Table 6.4 from NUREG 4620 as they are in group 2, exhibit no significant weathering, and only have trace amounts of clay.

The Staff Technical Position indicates that rock must score at least "fair" according to the procedures presented in NUREG 4620. The appropriate pages from both the STP and NUREG 4620 are attached.

Since the analyses did not identify any smectites or expanding lattice clays and the rock quality score is "fair" (Table 6.4 from NUREG 4620), the quartz monzonite samples pass the petrographic requirements of the rock quality criteria for use as riprap.

Consulting Environmental & Geotechnical Engineers & Scientists

1600 Specht Point Dr., Suite F
Fort Collins, CO 80525
Phone (970) 484-4414
Fax (970) 484-7540

If you have any question or need additional information, please contact me at your convenience.

Sincerely,

SHEPHERD MILLER, INC.

Louis Miller/mmp

Louis L. Miller, P.E.
Vice President

LLM:mmp
Enclosures

cc: Corn Abeyta w/enclosures

WNI Page 1 of 1

WDOH Construction Inspection Report

Day/Date Mon. 3/11/96

Weather Conditions Cloudy - Scattered Temp 45± °F

Field Engineer Dorothy Stoffel

~~Contractor(s)~~

Supervisor(s) Conn Abeyta (contractor site supervisors) Personnel (number of operators, laborers, etc)

Equipment Dozers & Dump Trucks

Work Performed ① Placement of fill at ~~[redacted]~~ southeast area of impoundment

② Reviewed quarry site with Conn & Mo located at mine Proposed Rock visually inspected.

Specific Condition Verified/Inspected

Comments ② Hiked along top bench of mine to proposed quarry site. In general quartz monzonite very competent and very open in appearance. Some areas of intense jointing; however, one area identified where rock mass solid. Took small sledge to various boulders - rock solid in boulders that don't have visual ☒ check if continued on reverse side

Corrective Actions (check appropriate/explain as necessary) ____none; ____yes, see below

____STOP WORK ____ repair ____ rework ____ change design ____waiver (as-is)

Explain

WDOH notification ____QA Manager ____ WDOH Oly ____ WDOH Rhld

WNI Communications Conn reminded me to provide field report from February 15, 1996. I agreed to fax it to him on 3/12.

Have WNI modified their QA/QC forms? X yes (attached); ____no

Is there a new construction schedule? X yes (attached); ____no

Pre bid meeting scheduled April 10
Construction start up - May 15

Inspector's Signature Dorothy Stoffel Date 3/11/96

Distribution: X WDOH Oly; X WNI; ____WDOE DSS; X WDOH Rhld; X File

Form QA-F3 Rev 1

continued from page 1

fractures. Agree with Corn that through rock processing (i.e. blasting, movement and crushing) durable rock will segregate from sub-standard rock. Corn reviewed proposed quarry & processing development.

① Reviewed borrow area presently being utilized for interim cover placement at southeast area of impoundment. Borrow area primarily ~~tipped~~ weathered monzonite with some alluvial sand. Encountered a monzonite zone, approx. 500 yards, that does not break down and meet spec. Discussed with Corn options of either mixing the material to achieve the cover spec or utilizing it at another area. Corn will document where material is placed in his daily summary.

The material that is actually being placed is very suitable weathered quartz monzonite and alluvial material. Relative high fraction of silts & clays — meets spec of < 10% greater than 6" and visually voids are filled.

WESTERN NUCLEAR, INC. – SHERWOOD TAILINGS RECLAMATION QUALITY COMPLIANCE REPORT

Visual Inspection Report – Soil Cover Placement

Borrow Source: _____

Soil Type A: _____

_____

_____

Soil Type B: _____

_____

_____

Soil Type C: _____

_____

_____

Document: VI –

Date: _____

Specification Reference: Page TS–54, 7.2.1

Soil Type			General Location		Upper	Lower	10% Material > 6" diameter		10% Material > 12" diameter		Major Voids Filled	
A	B	C	N	E	7.6 ft	5.0 ft	Yes	No	Yes	No	Yes	No

Non–Conformances : _____

Description : _____

_____

_____

Corrective action required : Yes ☐ No ☐

If Yes, Corrective Action Report No : _____

Inspected By: _____ Date: _____

WNI Construction Manager: _____ Date: _____

Audit Review By:
WNI QA/QC Engineering Manager: _____ Date: _____

Page 1 of 1

WDOH Construction Inspection Report

Day/Date Mon. 3/11/96

Weather Conditions Cloudy - Scattered Temp 45± °F

Field Engineer Dorothy Stoffel

~~Contractor(s)~~

Supervisor(s) Conn Abeyta (contractor site supervisors) Personnel (number of operators, laborers, etc)

Equipment Dozers & Dump Trucks

Work Performed ① Placement of fill at ~~[redacted]~~ southeast area of impoundment

② Reviewed quarry site with Conn & Mo located at mine Proposed Rock visually inspected.

Specific Condition Verified/Inspected

Comments ② Hiked along top bench of mine to proposed quarry site. In general quartz monzonite very competent and dense in appearance. Some areas of intense jointing; however one area identified where rock mass solid. Took small sledge to various boulders - rock solid in boulders that don't have visual ☒ check if continued on reverse side

Corrective Actions (check appropriate/explain as necessary) ____none; ____yes, see below

____STOP WORK ____ repair ____ rework ____ change design ____waiver (as-is)

Explain

WDOH notification ____QA Manager ____WDOH Oly ____WDOH Rhld

WNI Communications Conn reminded me to provide field report from February 15, 1996. I agreed to fax it to him on 3/12.

Have WNI modified their QA/QC forms? X yes (attached); ____no

Is there a new construction schedule? X yes (attached); ____no

Pre bid meeting scheduled April 10

Construction Start up - May 15

Inspector's Signature Dorothy Stoffel Date 3/11/96

Distribution: X WDOH Oly; X WNI; ____WDOE DSS; X WDOH Rhld; X File

Form QA-F3 Rev 1

continued from page 1:

fractures. Agree with Corn that through rock processing (i.e. blasting, movement and crushing) durable rock will segregate from sub-standard rock. Corn reviewed proposed quarry & processing development.

① Reviewed borrow area presently being utilized for interim cover placement at southeast area of impoundment. Borrow area primarily ~~tipped~~ weathered monzonite with some alluvial sand. Encountered a monzonite zone, approx. 500 yards, that does not break down and meet spec. Discussed with Corn options of either mixing the material to achieve the cover spec or utilizing it at another area. Corn will document where material is placed in his daily summary.

The material that is actually being placed is very suitable ~~weathered~~ quartz monzonite and alluvial material. Relative high fraction of silts & clays — meets spec of <10% greater than 6" and visually voids are filled.

WESTERN NUCLEAR, INC. – SHERWOOD TAILINGS RECLAMATION QUALITY COMPLIANCE REPORT

Visual Inspection Report – Soil Cover Placement

Borrow Source: _____

Soil Type A: _____

_____

_____

Soil Type B: _____

_____

_____

Soil Type C: _____

_____

_____

Document: VI –

Date: _____

Specification Reference: Page TS–54, 7.2.1

Soil Type			General Location		Upper	Lower	10% Material > 6" diameter		10% Material > 12" diameter		Major Voids Filled	
A	B	C	N	E	7.6 ft	5.0 ft	Yes	No	Yes	No	Yes	No

Non–Conformances : _____

Description : _____

_____

_____

Corrective action required : Yes ☐ No ☐

If Yes, Corrective Action Report No : _____

Inspected By: _____ Date: _____

WNI Construction Manager: _____ Date: _____

Audit Review By:
WNI QA/QC Engineering Manager: _____ Date: _____

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
DIVISION OF RADIATION PROTECTION
Airdustrial Center, Bldg. 5 • P.O. Box 47827 • Olympia, Washington 98504-7827

April 10, 1996

Stephanie J. Baker
Manager, Environmental Services
Western Nuclear, Inc.
200 Union Blvd., Suite 300
Lakewood, Colorado 80228

Dear Ms. Baker:

The department has completed staff review of the petrographic analyses, samples, and evaluations you provided in support of construction rock qualification. The department concurs that the quarry source for quartz monzonite from the mine face provides a "fair" and passing qualification based on NRC evaluation methodology. Please see the enclosed memorandum and review comments and/or call Dorothy Stoffel at (509) 456-3166, if you have questions.

When available, please provide rock durability test results for the department's final review and approval of the rock source. Earl Fordham at (509) 377-3869 is our staff lead for this review. Please contact him directly if you have questions.

Sincerely,

John R. Blacklaw, P.E.
Environmental Engineer

Enclosure

cc: Warren Seyler, Spokane Tribal Business Council
Alfred Peone, BIA, WA
Stanley Speaks, BIA, OR
Gerald LaVassar, WDOE
Lou Miller, SMI
Gary Robertson

DEPARTMENT OF HEALTH
Environmental Health Programs
Division of Radiation Protection

April 9, 1996

TO: John Blacklaw
Earl Fordham

FROM: Dorothy B. Stoffel

SUBJECT: COMPLETION OF WNI PETROGRAPHIC ANALYSES REVIEW

I have completed my review of the Petrographic Analyses of three quartz monzonite samples, prepared by Theodore P. Paster and dated January 11, 1996. The three quartz monzonite samples were taken from the proposed rock quarry site, located at the mine. I have also reviewed the evaluation of the petrographic analyses prepared by Shepherd Miller, Inc., dated February 6, 1996. My review of the petrographic analyses and evaluation was supplemented with review of pertinent sections from the following documents:

- Best, Myron G., Igneous and Metamorphic Petrology, W.H. Freeman and Company, New York.

- Deer, W. A., R.A. Howie, J. Zussman, An Introduction to the Rock Forming Minerals, John Wiley and Sons Inc., New York.

- U.S. Nuclear Regulatory Commission, Staff Technical Position on Testing and Inspection Plans During Construction of DOE's Remedial Action at Inactive Uranium Mill Tailing Sites, Revision 2, January 1989.

- U.S. Nuclear Regulatory Commission, Final Staff Technical Position Design of Erosion Protection Covers for Stabilization of Uranium Mill Tailings Sites, August 1990.

After detailed review of the text and photo micrographs prepared by Dr. Paster, I concur with the evaluation submitted by Shepherd Miller that the rock samples score at least "fair" according to the U.S. NRC procedures. The petrographic analyses also indicate an absence of smectites or expanding lattice clays, which is consistent with what is known about quartz monzonite. According to NUREG 4620, the rock quality score associated with these quartz monzonite samples is "fair", and therefore, pass the petrographic requirements of the rock quality criteria for use as rip rap.

In order to more fully evaluate the suitability of the proposed rock for use as rip rap, I examined the rock outcrop at the proposed quarry site on March 11, 1996 (WDOH Construction Inspection Report, March 11, 1996). In general, the quartz monzonite is very competent and uniform in appearance (i.e., lack of dikes, biotite rich zones, clay weathering, or other fracture zone weathering features.

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
DIVISION OF RADIATION PROTECTION
Airdustrial Center, Bldg. 5 • P.O. Box 47827 • Olympia, Washington 98504-7827

April 12, 1996

Stephanie J. Baker
Manager, Environmental Services
Western Nuclear, Inc.
200 Union Blvd., Suite 300
Lakewood, Colorado 80228

Dear Ms. Baker:

As a result of an electronic error, Dorothy Stoffel's Petrographic Analysis review memorandum enclosed with our April 10 letter to you was truncated. Therefore, disregard that memo in favor of the one enclosed with this letter. The complete memo more fully justifies the department evaluation and conclusions.

If you have questions, please contact Dorothy Stoffel at (509) 456-3166.

Sincerely,

John R. Blacklaw, P.E.
Environmental Engineer

Enclosure

cc: Warren Seyler, Spokane Tribal Business Council
Alfred Peone, BIA, WA
Stanley Speaks, BIA, OR
Gerald LaVassar, WDOE
Lou Miller, SMI
Gary Robertson

DEPARTMENT OF HEALTH
Environmental Health Programs
Division of Radiation Protection

April 12, 1996

TO: John Blacklaw
Earl Fordham

FROM: Dorothy B. Stoffel

SUBJECT: COMPLETION OF WNI PETROGRAPHIC ANALYSES REVIEW

I have completed my review of the Petrographic Analyses of three quartz monzonite samples, prepared by Theodore P. Paster and dated January 11, 1996. The three quartz monzonite samples were taken from the proposed rock quarry site, located at the mine. I have also reviewed the evaluation of the petrographic analyses prepared by Shepherd Miller, Inc., dated February 6, 1996. My review of the petrographic analyses and evaluation was supplemented with review of pertinent sections from the following documents:

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After detailed review of the text and photo micrographs prepared by Dr. Paster, I concur with the evaluation submitted by Shepherd Miller that the rock samples score at least "fair" according to the U.S. NRC procedures. The petrographic analyses also indicate an absence of smectites or expanding lattice clays, which is consistent with what is known about quartz monzonite. According to NUREG 4620, the rock quality score associated with these quartz monzonite samples is "fair", and therefore, pass the petrographic requirements of the rock quality criteria for use as rip rap.

In order to more fully evaluate the suitability of the proposed rock for use as rip rap, I examined the rock outcrop at the proposed quarry site on March 11, 1996 (WDOH Construction Inspection Report, March 11, 1996). In general, the quartz monzonite is very competent and uniform in appearance (i.e., lack of dikes, biotite rich zones, clay weathering, or other fracture zone weathering features). I pounded on the rock outcrop, as well as boulders that are present as talus at the toe of the rock face, with a small sledge hammer. The rock did not break with the sledge. The rock appears to have crystals that are well cemented, with biotite or muscovite (i.e., sheet silicates) not being a factor in the matrix that influences rock competency.

I did observe some areas of the rock face that display intense areas of jointing. Rock hand specimens from this area did exhibit a high degree of fracturing that would influence the competency of the rock to make the required larger rock sizes. However, I believe that this rock will segregate from the suitable rock during blasting. I anticipate that there may be a significant amount of waste rock generated in the more fractured zones of the proposed quarry. I discussed the issue of sufficient rock volume with Corn Abeyta. He has evaluated the projected volume requirements and has determined that there is sufficient volume at the proposed rock quarry site for their riprap needs.

It is my understanding that additional rock durability test data have not been submitted yet for our review. Because the rating associated with the petrographic analyses is "fair", it is my recommendation that the final determination of the suitability of this quarry not be made until all of the rock durability test results have been submitted and evaluated. A determination related to the need for rock oversizing can best be made when the additional test results have been submitted and evaluated.

DBS:krf

John

Health Services Division
Radiation Control Section

DATE 4/18/96

TELEPHONE OR VERBAL CONVERSATION RECORD

TIME 11:30 ☒ A.M ☐ P.M

☐ INCOMING CALL ☑ OUTGOING CALL ☐ VISIT

PERSON ~~CALLED~~ CALLED	OFFICE/ADDRESS	PHONE NUMBER / EXTENSION
Lou Miller	Sherwood-Miller Inc. Fort Collins, CO	(970) 223-9600
PERSON ~~CALLING~~ CALLING	OFFICE/ADDRESS	PHONE NUMBER / EXTENSION
John Blackburn (Returned call(s))	Radiation Protection	(360) 753-3350

CONVERSATION

SUBJECT Sherwood Uranium Mill Closure

SUMMARY

1. Rock Durability — Test results (78) were received. Below 80 and above 65 require rock placement oversizing. Design Specs, Section 5.2 allows for rock oversizing. Therefore, a design change (modification) is not necessary. However, QA reports and As-Builts must reflect acceptable construction, with oversizing. Future tests must also reflect this approach.
2. Contractors bidding have requested fewer rock sizes. Where 5" is spec'd, 6" will be used, for example.
3. I requested that WNI formally send us their initial rock durability test analysis.
4. The design reflected in the construction drawings has 3:1 slopes on the West margin. The interim benches have been removed. The vegetal sheet erosion protection calculations may not be conservative and may require revision in the Monitoring

OVER

REFERRED TO Design review. Leo Wanhainen (item 6) (item 1-5)

☒ ADVISED SUPERVISOR OF ACTION TAKEN

ACTION REQUESTED Correct as necessary. Meet in design review on 12/22/96. Leo W. to address item 6.

INITIALS

DATE

ACTION TAKEN

INITIALS

DATE

and Stabilization Plan (MSP) (after construction criteria) this could result in a higher vegetal stress and therefore a higher % vegetation coverage, at site qualification. This therefore increases the potential (likelihood) risk of rework of the margins and thereby may cause the license termination date to slip. It is also possible that by analysis, or other means, that the evaluation of erosional stability may be acceptable. This concept was discussed w/ Lou who will review this area of the design and propose changes to the MSP.

5. Final Specs and drawings (for our concurrence approval) will be sent to WDOH today. The radon brief and gamma brief are included.

6. Lou discussed the recent meeting of Doug Wells and Larry Fiske about soil verification analysis, data, correlations and acceptance. Lou stated that WNI uranium data is higher than WDOH data and will accept the higher values. Lou also stated that for thorium, 2 samples are anomalous (WNI ~ 2 pCi/gm, WDOH ~ 12-14 pCi/gm) while others show equivalency (when 2 data points are excluded). When all data is included, WDOH is high by 10% over WNI averages.

Recommended Actions: (1) Larry & Doug discuss (completed)
(2) Doug & WDOH discuss
(3) WDOH & WNI (SMI) discuss
(4) WNI write up results.

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
DIVISION OF RADIATION PROTECTION
Airdustrial Center, Bldg. 5 • P.O. Box 47827 • Olympia, Washington 98504-7827

May 1, 1996

Stephanie J. Baker
Manager, Environmental Services
Western Nuclear, Inc.
200 Union Blvd., Suite 300
Lakewood, Colorado 80228

Dear Ms. Baker:

Department staff have recently reviewed several submitted documents regarding WNI's upcoming reclamation construction project at the Sherwood Uranium Mill. Our comments follow:

Technical Specifications

The April 1996 Tailing Reclamation Plan Technical Specifications (with design drawings included) has been reviewed by department staff. Your recent submittal adequately addresses the housekeeping issues raised in the department's November 28, 1995 approval letter of the Tailing Reclamation Plan, and the department's attached list of Recommended Housekeeping and Specification Additions. Your April 1996 submittal also includes appropriate design improvements developed since the Tailing Reclamation Plan was approved. The design improvements include adjustments for the benefit of construction efficiency and remain consistent with performance criteria in the applicable regulation, WAC 246-252. The April 1996 (or any subsequent department-approved modifications) Technical Specifications constitute the design basis for construction.

The design modification proposal (presented in meetings between WNI and WDOH) to reduce rock sizing in the east groin area below the impoundment dam appears appropriate in principle. Recent discussions by phone regarding clarification of rock durability and rock sizing for rip-rap placement appear to indicate that changes to technical specifications would be beneficial. These and potentially other modifications that may result from quality assurance plan development would require submittal of a request for modification for department review and approval. Please provide technical justification for any proposed modifications and provide updated documentation with an appropriate revision number and date, and a licensed engineer (PE) authorization (seal).

Construction Drawings

The department has received the 57-sheet set of construction drawings that provides the contractor with sufficient detail and clarifications. These drawings satisfy the department's request contained in the housekeeping issues list. They were quite useful during recent technical reviews.

Construction Component Quality Plan

At the department's request, the Construction Component Quality Plan (C/CQP) was separated from the April submittal of the technical specifications and has not yet been received. The department requests that the following additions be made to provide guidance on inspection methodology or procedure: measurement of rip-rap placement thickness, and elevations (subgrade, cover, margins, diversion channel and dam outslope embankment). It is recommended that an elevation allowance of $\pm$ 0.2 feet be made for adjacent elevation measurements to account for local irregularities and instrument error. Also, regulations allow that cover thickness may be established to account for attenuation of radon emanation rates, averaged over the impoundment surface. Therefore, the cover thickness specification of 12.6 feet minimum (subgrade to cover surface) may be attained by averaging. Recent discussions regarding inspection methodology for the cover soils have been concluded and are provided in a separate letter. The methodology used to account for rock durability test results in rock size compliance is needed.

Monitoring and Stabilization Plan

The Monitoring and Stabilization Plan (MSP) submitted in February 1996 was reviewed in detail. The department chose to split its review of the MSP into a construction portion and a post-construction portion. Section 2.0, Reclamation Construction Monitoring, of the MSP is hereby approved, with the understanding that the following additions are incorporated: (A) that section 2.2.1.1 also applies to well extension of wells MW-2 and MW-2A, and that (B) in any case where a written response notification is required within 30 days, a telephone notification (maximum of 72-hours) is also required. The post-construction portion is generally adequate, but requires discussion of vegetation monitoring, frequency of groundwater monitoring, and logistic effects of license termination events. A meeting is recommended to address these issues.

In a related groundwater topic, please provide the few replacement pages for the "Technical Integration Report" once all groundwater issues are resolved.

Technical Briefs

The technical briefs (Gamma Exposure Rate Reduction Technical Brief, and Radon Barrier Design Evaluation Technical Brief) are greatly appreciated and provide the needed realistic understanding of the design basis and the level of conservatism employed. They have been and will continue to be useful in the technical review process.

Soil Verification

Soil Verification (decontamination/soil cleanup) is nearing completion at the Sherwood site. The department is preparing a conditioned approval of releasing the haul roads at the mill site for access and use in the construction process. In particular, the water tank will be accessible for construction purposes, and the rock quarry in the mine area will have roadway access through the mill area. Awaiting conclusion (soil test data/lab results) are the three grids and associated adjacent grids that have not yet met the soil cleanup standard. In addition, a final as-built report is expected that will be used to give final unconditional release of all soil grids. Some discussion is needed to clarify issues regarding this submittal. Please continue to address this issue with Leo Wainhouse.

Monitoring Wells

The extension of monitoring wells MW-2, MW-2A, and MW-4 is required. The department received your written request and design basis by fax and has expedited review and approval, under separate cover.

Well Abandonment

In discussions during an inspection audit meeting held at your site on April 23, 1996, the logistics of well abandonment for monitoring wells MW-1 and MW-3 were discussed. The department has requested that these wells be used during construction and then abandoned. These wells are located in the diversion ditch confluence areas on the east and west sides of the impoundment and are therefore located in a position of difficult access once the areas are graded and construction rock is placed. Future abandonment of these wells must be discussed with the department prior to abandonment to understand logistical effects.

Rock Durability

The department's review of the rock quarry is to ensure that the rock will provide adequate erosion protection. We have already concurred with the petrographic analysis, and recently received the initial (first round) rock durability test results for the mine area quarry. The test results have been scored at a 78%, which means the rock is acceptable as long as it is oversized by 2% at placement.

NRC guidance on rock durability allows unconditional placement of rock if it scores 80% or above. For scores of 65% to 80%, oversizing is required by a percentage amount equal to the difference between the score and 80%. As you are aware, subsequent production tests may vary. In order to simplify the construction sequence, it is recommended that you either (A) make oversized rock by the required percentage (or greater), or (B) be aware that meeting the minimum rock sizing requirements will result in quality assurance nonconformance. Nonconformance will require a decision to either "use as is" or "rework". Using "as is" requires justification and department approval, and "rework" requires replacement of nonconforming rock with oversized rock. If you choose option B and also choose to use the rock "as is", you should prepare your justification in advance to save time. The justification should be based on erosion protection principles, should be related to specific placement locations, and express that an adequate margin of safety will be assured. Or, if you choose option A, a clarification of the design basis is warranted in the technical specifications; e.g., Table 2A could include two additional columns: the first column to show the minimum rock size that passes the design basis analysis, and the second column to show the ratio between the minimum size rock and the design size rock. If this ratio exceeds 1.15 (15% oversized), durability tests indicating a range of 65% to 80% would not require further oversizing.

Please provide the justification (if it is required) with the rock durability test report. However, future rock durability test reports need only be filed onsite for review by department inspectors.

Surety

Department review of surety is ongoing. In order to complete our review, and since conditions have changed at the Sherwood site, please provide updated surety estimate information. You may take credit for cover material placement and any other applicable work completed since the surety estimate was prepared. You may also take credit for initial (up front) and/or installment payments made to your construction contractor(s) that apply toward the surety estimate basis. Please provide your updated surety estimate by July 1, 1996.

Audit

In addition to technical and document reviews, on April 23, 1996 the department performed an audit of the Sherwood site construction activities. A report will be forthcoming. It was a very productive meeting that helped establish the working relations and channels of communication for the construction phase. For clarification, the department's role will be verification and validation of the WNI operations and quality control actions. The department may make independent measurements in support of that role. The department will not enforce "hold points" but must be notified prior to all pending activities. When available, detailed construction scheduling information must be provided to the department.

Kickoff Meeting/Safety Briefing

The department will be represented by Dorothy Stoffel, when available, at any major interface meetings with the contractor that you feel is warranted. Dorothy, Earl Fordham, and John Blacklaw have been identified as construction inspectors. They are interested in attending any safety orientation training that you recommend for site access and staff safety. Please inform department staff of any need to attend any meetings or training that complement their duties.

License Termination

The department is preparing a letter to the U.S. DOE (Joe Virgona) to relinquish the state's interest (in favor of the federal government) in long-term care at the site, after license termination.

The department looks forward to witnessing WNI's successful construction season and concluding reclamation of the Sherwood Uranium mill site. If you have questions, please call me at (360) 753-3350.

Sincerely,

John R Blacklaw, PE

John R. Blacklaw, P.E.
Environmental Engineer

JRB:krf

cc: Warren Seyler, Spokane Tribe of Indians
Mary Verner, Spokane Tribe of Indians
Alfred Peone, BIA, WA
Stanley Speaks, BIA, OR
Corn Abeyta, WNI
Moe Pasha, WNI
Lou Miller, SMI
Joe Virgona, U.S. DOE

cc: Leo
Dorothy
Ed
Gary

July 1, 1996

To: Inspection File
From: John Blacklaw, PE

WNI

Subject: Field Inspection Report for June 26, 1996 at Western Nuclear, Inc's Sherwood Project

Weather: Sunny, warm (mid 70's °F.) with a light breeze.

Compliance: None noted. Subgrade inspection is preliminary, waiting for WNI audit completion. (Corrective action is likely.)

~~Inspection results:~~

Inspectors Present: John Blacklaw, Leo Wainhouse

Inspection Results:

WDOH Construction Inspection Report

Day/Date June 26, 1996

Weather Conditions Sunny, Warm, light Breeze Temp 70s °F

Field Engineer

Contractors(s)

Supervisor(s) (contractor site supervisors) Personnel (number of operators, laborers, etc)

Equipment

Work Performed Inspected records for construction of subgrade to impoundment cover for compliance to design elevations from Dwg #3 in construction specs. Considerable evaluation of survey data had been carefully prepared for about 400 grid point locations (100 foot centers). About 37 grid points were

Specific Condition Verified/Inspected excluded because they were outside the

Comments footprint of the impoundment. About 330 were found in compliance at or below design grade + 0.2 feet of allowed tolerance. About 39 grid points were out of compliance at 0.3 to 2.3 feet above grade. Only about 9 grid points exceeded 1.0 foot above grade. Considerable effort by Lan Miller and Moe Pasha to evaluate the data prepared in detail by Conn Abeyta had already occured. Moe Pasha was in process of auditing (not yet completed) (✓) check if continued on reverse side OVER

Corrective Actions (check appropriate/explain as necessary) X none; ____ yes, see below

____ STOP WORK ____ repair ____ rework ____ change design ____ waiver (as-is)

Explain Re-inspect subgrade data when WNI audit is complete. Review corrective action plan, if applicable.

WDOH notification X QA Manager X WDOH Oly X WDOH Rhld X

WNI Communications Feedback was given to Moe Pasha at the time of the inspection.

Have WNI modified their QA/QC forms? ____ yes (attached); X no

Is there a new construction schedule? ____ yes (attached); X no

Inspector's Signature John R Blacklaw Date 6/27/96

Distribution: X WDOH Oly; X WNI; X WDOE DSS; ____ WDOH Rhld; X File

Form QA-F3 Rev 1

the subgrade as-built condition for compliance and had found the deficiencies noted. Corrective action alternatives have been considered. The likely proposal is to increase the final grade by 1.0 feet and reduce the slope locally in the South-East portion of the impoundment and thereby assure a minimum 12.6 feet of cover at all locations. I explained that our regulations only require compliance to the radon emanation rate limit averaged over the impoundment. I also explained that the design basis is quite conservative, as indicated in the Radon Brief, and that it would be possible to propose not modifying the design and "use as is", with concurrence from the department. I discussed this process further with Lou Miller, who explained that there are other issues in effect. Firstly, the material is expanding about 8% from cut to fill and will produce a need to place more material to meet material balance. And, Lou thinks he can easily justify the design change. All options were discussed and one likely feasible. The choice in resolving this compliance issue rests with WNI. Resolution is expected sooner than later.

My inspection of the subgrade data will be considered preliminary for now and will be completed once the next WNI audit is completed. SMI will also produce a single auto-cad map to show all the data. This will make verification much easier. Also, by then, the corrective action proposal will likely be selected and presented.

During my review of subgrade data, Leo Warehouse reviewed the two audits completed to date by Moe Pasha. The audit process is quite thorough and complete. It was quite impressive to Leo and I when Moe presented it.

I made preliminary inquiries into the methodology of QA/QC for the division channel cross-sections. Moe Pasha and I were able to locate inspection sheets that indicated compliance for the channel cross-sectional areas. This will be needed and Moe Pasha will investigate and assure that forms are available. I also investigated the method of calculating cross-section parameters needed for area calculations and the method of survey that would produce this data.

It appears that there is a need for math calculations for each diversion channel cross-section to convert X, Y, Z survey data into cross-sections. In discussion with Moe Pasha and Lou Miller, it was concluded that development of this methodology and its verification is needed soon before field evolutions are needed to determine compliance to design specs. Lou Miller indicated that he will investigate this with the surveyor and assure a method is available prior to a need for it. At the rate of production, this may be quite soon.

Blasting of the quarry was discussed with Com Abeyta. The first blast will be the small top lift of about 20,000 yds. Two samples will be expedited over the 4th of July holiday in preparation for rock crushing. The first blast is scheduled for next Tuesday, July 2nd.

Total production to date (6/26/96) was 690,000 yards, at a current rate of 50,000 yds per day. 11 scrapers are working 2, 10 hour shifts.

There remains a small lake in the center of the impoundment due to winter rains and run-off (greater than normal). The lay down method is for scrapers to drop their loads parallel to the beach and dozers push the loads into the water. The water level is not rising, indicating that the water is being absorbed and/or evaporating.

A small area near the barge channel remains open to the subgrade to allow final disposal of any contaminated soils and eventually the soil samples. This area is relatively small and at the present rate of production, will need to be capped within about the next 8 weeks or so (my guess). This forces an expedited resolution of all pending aspects of the soil verification process. Someone (both WNI and WDOH) should go through a checklist of items to complete this task and to identify critical schedule items. For example, will we wish to do a back-pack gamma final survey before finally releasing all soil disposal opportunity?

TLD's were exchanged. Vegetation was observed, that had been in place about 2 years. It appeared well established, in the stating succession. Brush and tree varieties were not yet evident.

Other. Surety estimates will be sent to WDOH by July 1st. Plans and Specs for replacement well MW-2B will be provided soon, although a location has not been finalized. Dorothy Stoffel is still considering options. Timing of well installation will be established once a location is established, to coordinate with construction sequencing. Completion of the seal for well MW-4 (down-gradient) on the bench of the dam outslope will be accomplished soon. The soil grade has already been established in the area. A request to release the Ba/Cl_2 drainage area was made recently and discussed. The ~~importance~~ timing and contingencies related to it were discussed. Corn expects that he can manage until after July 4th without our approval. There are some questions remaining on this request that need discussion with WDOH staff.

Discussions with Lou Miller. Lou had performed detailed inspection of the down-stream portion of the diversion channel excavation. He related that they were down 35 feet and had not encounted any appreciable large or competent rock and that the work was very efficient. He estimated that the large pieces were in the 1/4 to 1/2" size with maybe 20% clay. Some places showed up to 100% clay. Areas of alluvium, near the drainages were less clay, as shown in the initial characterization. Lou was quite pleased with the quality (clay content) of the placed material. It should be quite fertile, structurally stable and produce a less permeable cover than used in the design basis calculations. Our inspectors should verify Lou's observations.

Observation related to east groin erosion protection and upstream watershed. The old haul road to the east of the impoundment is unprotected and produces considerable run-off and resulting erosion. The latest technical specification design change (#1) identifies a means of reducing the upstream watershed for the East Groin and thereby

allows reduced sizing of rip rap. This is an excellent idea with a good purpose in general and is under evaluation in our office. The observation of concern is that the watershed directly to the east runs off quite close (maybe 100 feet) in places to the edge of the watershed for the East Groin. There is therefore a slim divide between the watersheds that could be breached, eroded or intentionally diverted in the future, that could cause a considerable increased flow impact to the East Groin. A design investigation is needed to see if the divide can be bolstered or the watersheds further separated by proper grading to the East of the impoundment. This observation was posed to Lou Miller. Lou will begin a preliminary evaluation of this area, while the Department further reviews the tech. spec. change request (#1). We will then pose a question to ask WNT to assure that adequate structural features are present in the design to retain east side watersheds from impacting the East Groin. area.

WNI 7/24/96 JRB

1:30 - 4:30 pm

WNI Inspection
w/ Gary / John & Dorothy

Increased cover by 1.0 ft. & 2.0 ft in South east end to get a 12.6 ft min. Drawing #4 (Rev) will be revised and sent to us soon.

look at outlet of the ditch. (1500 ft) Will place rock next week.

Need to backfill large channel. Need to get soil samples out. Will finish cover in 2 weeks?

La Vasser needs to release his allowance on cutting of dam top, so they can cut top of embankment.

Surface seal on MW-4 well, next week.

Blasting - slow for clean out. Will go to Basalt source. Sampled already. Screened 5000 yds. Will do gradation soon. Blast end of next week.

(East)

two locations of large rock. Wasting into solution holding pond.

Blasted on NW corner.

250,000 yds/week. 1,300,000 yds moved, to date (7/24).

Durability scored 80 on quartz monzonite.

Driving tour. — took pictures. Observed outlet of diversion channel, cover, solution holding pond, NW corner of diversion channel (w/rock requiring blasting Ba-Cl_2 drainage area (large volume filled in the last 2 days) Rock quarry, rock stockpiles, small pond in unlined cover area, old barge channel (small area remaining).

Soil compacts very well.

Very little rock in diversion channel

"No need for Hold Point." Need to inform WNI tomorrow.

Received Draft of drawing 4 revision to plan to increase cover thickness by 1 foot in general and 2 feet in South east area, where subgrade was confirmed to be high. Extra soil approach is to help w/material balance (8% expansion).

Observed first rock segregation for gradation, prior to placement, planned for next week. Screening plant is functional. Crusher is on-site but not yet set-up. They will install it later when they get further along w/ another blast and enough diversion channel cut completion.

WASHINGTON STATE DEPARTMENT OF HEALTH

Division of Radiation Protection

TELECOPY TRANSMITTAL

FROM THE

DIVISION OF RADIATION PROTECTION

WNI

DATE: 7/26/96 NUMBER OF PAGES: COVER + 2

PLEASE DELIVER TO:	Dorothy Stoffel, Ed. (Fordham
FROM:	John Blackburn
INSTRUCTIONS:	FYI – (1) WNI field Inspection report for 6/26, (2) DMC field Inspection report for 6/25, & Engineering Review for GRAD piping.

OUR TELECOPIER NUMBERS ARE:

OLYMPIA:	(360) 753-1496	SPOKANE:	(Stoffel)	(509) 456-2997
SEATTLE:	(206) 464-7081	SPOKANE:	(Pike)	(509) 456-4425
RICHLAND:	(509) 377-3871	SPOKANE:	(Cameron)	(509) 235-2713

DEPARTMENT OF HEALTH
Environmental Health Programs
Division of Radiation Protection

July 22, 1996

EXPIRES 2/3/98

TO: Inspection File

FROM: John Blacklaw, P.E.

SUBJECT: FIELD INSPECTION REPORT FOR JUNE 26, 1996 AT WESTERN NUCLEAR, INC.'S SHERWOOD PROJECT

Weather: Sunny, warm (mid-70's) with a light breeze.

Compliance: None noted. Subgrade inspection is preliminary, waiting for WNI audit completion (corrective action is likely).

Inspectors present: John Blacklaw and Leo Wainhouse.

Inspection results: Inspected records for construction of subgrade to impoundment cover for compliance to design elevations from Dwg. #3 in construction specs. Considerable evaluation of survey data had been carefully prepared for about 400 grid point locations (100-foot centers). About 37 grid points were excluded because they were outside the footprint of the impoundment. About 330 were found in compliance at or below design grade +0.2 feet of allowed tolerance. About 39 grid points were out of compliance at 0.3 to 2.3 feet above grade. Only about 9 grid points exceeded 1.0 foot above grade. Considerable effort by Lou Miller and Moe Pasha to evaluate the data prepared in detail by Corn Abeyta had already occurred. Moe Pasha was in the process of auditing (not yet completed) the subgrade as-built condition for compliance and had found the deficiencies noted. Corrective action alternatives have been considered. The likely proposal is to increase the final grade by 1.0 feet and reduce the slope locally in the south-east portion of the impoundment and thereby assure a minimum 12.6 feet of cover at all locations. I explained that our regulations only require compliance to the radon emanation rate limit averaged over the impoundment. I also explained that the design basis is quite conservative, as indicated in the Radon Brief, and that it would be possible to propose not modifying the design and "use as is", with concurrence from the department. I discussed this process further with Lou Miller, who explained that there are other issues in effect. Firstly, the material is expanding about 8% from cut to fill and will produce a need to place more material to meet material balance. And Lou thinks he can easily justify the design change. All options were discussed and are likely feasible. The choice in resolving this compliance issue rests with WNI. Resolution is expected sooner than later.

My inspection of the subgrade data will be considered preliminary for now and will be completed once the next WNI audit is completed. SMI will also produce a single Auto-CAD map to show all the data. This will make verification much easier. Also, by then the corrective action proposal will likely be selected and presented.

During my review of subgrade data, Leo Wainhouse reviewed the two audits completed to date by Moe Pasha. The audit process is quite thorough and complete. It was quite impressive to Leo and me when Moe presented it.

I made preliminary inquiries into the methodology of QA/QC for the diversion channel cross-sections. Moe Pasha and I were able to locate inspection forms that indicated compliance for the channel cross-sectional areas. This will be needed and Moe Pasha will investigate and assure that forms are available. I also investigated the method of calculating cross-section parameters needed for area calculations and the method of survey that would produce these data.

It appears that there is a need for math calculations for each diversion channel cross-section to convert X, Y, Z survey data into cross-sections. In discussion with Moe Pasha and Lou Miller, it was concluded that development of this methodology and its verification is needed soon before field evaluations are needed to determine compliance to design specs. Lou Miller indicated that he will investigate this with the surveyor and assure a method is available prior to a need for it. At the rate of production, this may be quite soon.

Blasting of the quarry was discussed with Corn Abeyta. The first blast will be the small top lift of about 20,000 yards. Two samples will be expedited over the 4th of July holiday in preparation for rock crushing. The first blast is scheduled for next Tuesday, July 2.

Total earth relocation production to date (6/26/96) was 690,000 yards, at a current rate of 50,000 yards per day. 11 scrapers are working two ten-hour shifts.

There remains a small lake in the center of the impoundment due to winter rains and runoff (greater than normal). The lay-down method is for scrapers to drop their loads parallel to the beach, and dozers push the loads into the water. The water level is not rising, indicating that the water is being absorbed and/or evaporating.

A small area near the barge channel remains open to the subgrade to allow final disposal of any contaminated soils and eventually the soil samples. This area is relatively small and at the present rate of production, will need to be capped within about the next eight weeks or so (my guess). This forces an expedited resolution of <u>all</u> pending aspects of the soil verification process. Someone (both WNI and WDOH) should go through a checklist of items to complete this task and to identify critical schedule items. For example, will we wish to do a back-pack gamma final survey before finally releasing all soil disposal opportunity?

TLDs were exchanged. Vegetation was observed, that had been in place about two years. It appeared well established, in the starting succession. Brush and tree varieties were not yet evident.

Other. Surety estimates will be sent to WDOH by July 1. Plans and specs for replacement well MW-2B will be provided soon, although a location has not been finalized. Dorothy Stoffel is still considering location options. Timing of well installation will be established

once a location is established, to coordinate with construction sequencing. Completion of the seal for well MW-4 (down-gradient) on the bench of the dam outslope will be accomplished soon. The soil grade has already been established in the area. A request to release the Ba/Cl_2 drainage area was made recently and discussed. The timing and contingencies related to it were discussed. Corn expects that he can manage until after July 4 without our approval. There are some questions remaining on this request that need discussion with WDOH staff.

Discussions with Lou Miller. Lou had performed detailed inspection of the down-stream portion of the diversion channel excavation. He related that they were down 35 feet and had not encountered any appreciable large or competent rock and that the work was very efficient. He estimated that the large pieces were in the 1/4 to 1/2" size with maybe 20% clay. Some places showed up to 100% clay. Areas of alluvium, near the drainages, were less clay, as shown in the initial characterization. Lou was quite pleased with the quality (clay content) of the placed material. It should be quite fertile, structurally stable and produce a less permeable cover than used in the design basis calculations. Our inspections should verify Lou's observations.

Observation related to West Groin erosion protection and upstream watershed. The old haul road to the west of the impoundment is unprotected and produces considerable runoff and resulting erosion. The latest technical specification design change (#1) identifies a means of reducing the upstream watershed for the West Groin and thereby allows reduced sizing of rip-rap. This is an excellent idea with a good purpose in general and is under evaluation in our office. The observation of concern is that the watershed directly to the west runs off quite close (maybe 100 feet in places) to the edge of the watershed for the West Groin. There is therefore a slim divide between the watersheds that could be breached, eroded or intentionally diverted in the future, that could cause a considerable increased flow impact to the West Groin. A design investigation is needed to see if the divide can be bolstered or the watersheds further separated by proper grading to the west of the impoundment.

This observation was posed to Lou Miller. Lou will begin a preliminary evaluation of this area, while the department further reviews the technical specifications change request (#1). We will then pose a question to ask WNI to assure that adequate structural features are present in the design to assure that west side watersheds will not impact the West Groin area.

JRB:krf

cc: Gary Robertson
Leo Wainhouse
Dorothy Stoffel
Earl Fordham

UMILLS\BLACKLA3.MEM

To: John Blacklaw WNI
Cc: Dorothy Stoffel,Gary Robertson
From: Fordham, Earl
Subject: Rock durability & gradation
Date: 8/9/96 Time: 2:36PM

Originated by: EWF1303 @ WA-DOH

I have finally had a chance to review the data sheets and QA records that I copied at WNI last Monday. I concur with the results (e.g., rock durability score is an 80 for the quarry rock and 90 for each of the two basalt samples). As such, the rock represented by these samples are acceptable for use without restriction except for size (i.e., 3 inch rock goes where the plan calls for 3 inch rock or smaller).

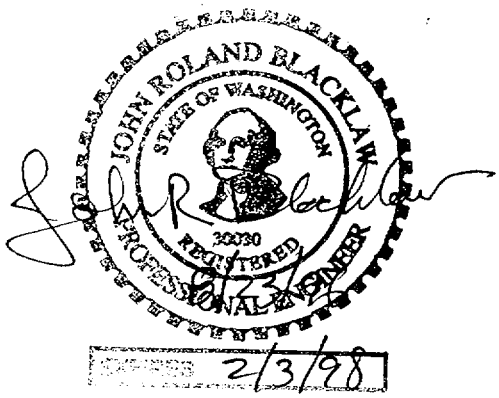
I also reviewed the gradation of Filter I. The first two tests indicated a failure at the smallest screen. A subsequent retest with a better representative sample passed. Since all three tests were in the WNI files, I got copies of all three. For the record, I concur with the bias introduced by retrieving potential test material from the top of a pile. As a result, I believe that the third gradation test that was taken from material mechanical retrieved from the pile is better representative of the filter material. In conclusion, I support the results of the passing score.

If you have any questions, please don't hesitate to call me,

Earl

DEPARTMENT OF HEALTH
Environmental Health Programs
Division of Radiation Protection

August 19, 1996



TO: Inspection File

FROM: John Blacklaw, P.E.

SUBJECT: **FIELD INSPECTION REPORT FOR AUGUST 5, 1996 AT WESTERN NUCLEAR, INC.'S SHERWOOD PROJECT**

Weather: Sunny and warm (mid-80's) with a slight breeze.

Compliance: None noted. Subgrade inspection remains preliminary, subject to corrective action by WNI to provide a revision (#2) to the technical specifications regarding drawing #4 top surface grading and the addition of cover thickness to compensate for a few grid locations where the subgrade is high. The 4 internal audits prepared by WNI were reviewed and found appropriate.

Inspectors present: John Blacklaw, Dorothy Stoffel, and Earl Fordham.

Production Status: Cover soil placement is approximately 90% complete. Top soil placement is progressing. The excavation of the diversion channel cut is approximately 70% complete. Production of rock is continuing. Filter #1 gradation has been adjusted to provide a greater proportion of larger sizes to fit the central portion of the grading tolerance. Soil cleanup is complete, pending final concurrence by the department. Impoundment subgrade is complete, except for a small area (less than 3 acres) near the original barge channel, where the soils are piled to absorb the remaining surface water. The subgrade completion is awaiting final soil verification plan concurrence and disposition of the soil samples. Grading of the mill area has not commenced.

Inspection results: Observed work in progress in the field. Observed and walked the outlet portion of the diversion channel, where filter #1 had been placed and was being prepared for proper depth and extent. Filter #1 appeared as large sand with little fines. As noted above, the rock screening plant has been adjusted to produce a larger particle size for filter #1, although the first run was within tolerances. Driving was carefully executed due to the amount of scrapper traffic in the construction area. Observation of a large Cat with a stout drawbar ripping tool indicated that there was an area, at midpoint of the east margin area approximately midway from the tailings area and the slope of the diversion channel dike, where rock was quite difficult to rip and remove. Rock was found about 3 feet above the construction grading plan. The Cat persisted to remove as much material as possible.

At the north end of the impoundment, we stopped and walked the general area where replacement well MW-2B will be located. Considerable discussion between Dorothy Stoffel and Corn Abeyta identified the likely rock subgrade that channels the subsurface water

needed to prove a monitoring well in the area. It was preliminarily determined that it can be best placed outside the extent of rip rap placement in the north confluence in the natural convergence of natural streambeds coming from the north. Final determination will be made by Dorothy Stoffel.

Observation of the west margin and diversion staking showed a nearly complete margin area and the diversion channel excavation not started in the area. From the top of a west margin viewpoint, the small ponds could be easily seen to add up to 5 to 10 acres in extent and about 1 to 2 feet deep. The areas were generally at final grade, awaiting the water to be absorbed into the soil, prior to final grading and placement of top soil. The barge channel area was observed to be pushed up to displace the small amount of water that was present on previous inspections. The plan for the barge channel area is to allow water to absorb into the soil, leveling below subgrade, place soil sample buckets below grade and flatten them with a Cat, and then add fill to grade.

We drove up the access road west of the impoundment toward the top of the hill to determine runoff pathways and to determine how the final grading of the area will preclude runoff at the southwest corner of the impoundment where it might impact the west groin of the impoundment dam. This concern had been addressed verbally previously and alternatives were considered. The general grading plan for the mill area and the access roads was discussed. There is a small draw coming from the north that just misses the beginning point of the diversion channel, as designed. The runoff from this draw and the watersheds to the west were reviewed and discussed. The general discussion is that all runoff on the west side of the impoundment must be directed toward the west behind the truck shop or to the mill site. It was discussed that the department will make a formal request for a grading plan that directs the runoff away from the impoundment. Final reclamation of both access roads are planned to remove the roadbeds, and/or regrade the general area to eliminate vehicle access from the present roadway area. A road will be constructed and maintained to the truck shop with access from the west of the impoundment through the mill or mine area access.

Observed the impoundment dam, outslope and down gradient area to the south. Major portions of the top of the dam were being removed on the east end. The outslope on the east end was being roughly placed. The plan was to cut the top of the dam in three pieces to facilitate ease of scraper access and turnaround. The area near the downstream well, MW-4, and the general area were at approximately final grade. The well had been sealed. Final rock placement in the groin had not started. The southwest corner of the impoundment, west corner of the dam, and the west groin area were discussed. As much as possible of the general area outside of the impoundment design areas will be graded to the west, toward the mill area.

Observations of the quarry and rock screening plant were made. A large pile of filter #1 was observed. It contained some fines and mostly large sand fraction. A gradation test was performed three times to gain a passing score. Failed tests were discarded because a representative sample had not been obtained. The passing test was marginal toward the

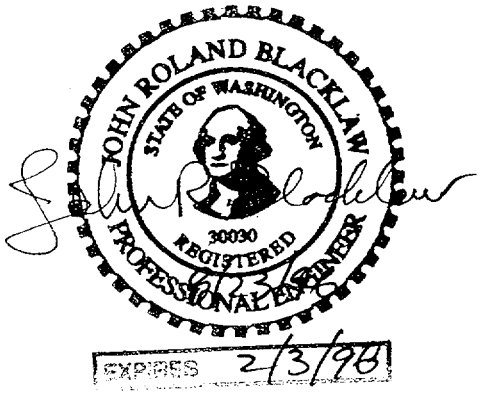
small size. A change in screen sizing was discussed. It was discussed also that the 3 inch rock was qualifying as 2 inch, and the 2 inch rock was qualifying as 1 inch. It was apparent that the screening plant gradation testing phase was causing fine tuning of the method. Production of rock gradation is apparently an "art" of the business. Several other large piles of various size rock are being produced.

In the office, Quality Control records were reviewed. The four available Quality Assurance audits (by Moe Pasha) were reviewed and found to be well done. Most corrections had been made immediately. Corrective action for the subgrade is expected to be to revise the final grade to compensate. Earl Fordham reviewed the records for rock durability and validated the passing test scores for the monzonite rock and for the on-site basalt. Earl Fordham also reviewed the gradation tests available and verified the records to indicate the need for representative sampling that was adopted during the tests. John Blacklaw reviewed the diversion channel inspection records and found that they are properly identifying the design and measured areas, and compliance to design. What was not available was the specific surveyor data used to measure and calculate the areas. A request to discuss the survey methodology with the surveyor on the next inspection was made. The use of "white out" was found and verbally requested to be not used on QA records, and that for necessary corrections, a strike through and signoff was a preferred method, to assure accountability. The survey records were found to be authorized with a note as by C.E. Spurlock, Jr. and Associates, Inc., without a name or signature of the surveyor. A verbal request was made that the responsible surveyor must sign authorization for the work, also to assure accountability. The name of Ken Bryant was added for clarification to the records inspected.

cc: Gary Robertson
Dorothy Stoffel
Earl Fordham
Bruce Barker, P.E.
Jerald LaVasser, P.E.

DEPARTMENT OF HEALTH
Environmental Health Programs
Division of Radiation Protection

August 19, 1996



TO: Inspection File

FROM: John Blacklaw, P.E.

SUBJECT: **FIELD INSPECTION REPORT FOR AUGUST 14, 1996 AT WESTERN NUCLEAR, INC.'S SHERWOOD PROJECT**

Weather: Sunny and mild (mid-70's) with a slight breeze. Vegetation was dry.

Compliance: None noted. Final grade corrective action is pending.

Inspectors present: John Blacklaw

Licensee Staff: Corn Abeyta, Brad DeWaard, and Lou Miller (Shepherd Miller, Inc.)

Production Status: Cover placement is greater than 90% completed. Placement of top soil is greater than 50% complete on the impoundment surface. Diversion channel excavation is about 75% complete. East side confluences are mostly excavated. Remaining diversion channel excavation is on the west and upstream end. Placement of top soil on the margins is in process. Two pools of surface water (about 5 acres total) remain to be absorbed into the surface. The barge channel area has been completed at the subgrade and filled by several feet of soil and contains surface water for absorption into the soil. The barge channel remains below final grade. The evaporation pond area to the north is about 90% complete, about 3 feet below final grade.

Projections are for completion of impoundment cover by September 1, finish grading by October 1, placement of rock and completion of diversion channel by November 1, and seeding by November 1, 1996. Schedule for reclamation of the mill area and the general area west of the impoundment were not discussed, although regrading of that area will surely begin as the impoundment work subsides.

Inspection results: Observed work in the field. Observed and walked the area of confluence E and F, where rock has been encountered. The surface is workable or rippable but contains considerable larger rock. A request was made that this confluence not be fully excavated prior to filter #1 and rock placement and that the excavated surface qualifies as equal or better than the filter #1 material required by design. The design specifications allow that the filter #1 is not required where excavation is in bedrock. It was the judgment of Lou Miller, P.E. and John Blacklaw that this is the case for confluence E and that no further excavation is needed to provide for filter #1 placement and that filter #1 may be excluded from this area. Lou Miller agreed to provide a letter expressing his judgment and justification. Work without filter #1 excavation is to proceed in the interim.

Observed the margin area between the covered tailings and the diversion channel dike outslope toward the impoundment, at station 28, where rock had been encountered during the last inspection. There is an area of 5 to 10 acres where hard rock had been diligently removed to meet the construction grading plan. There are 3 or 4 small areas that add up to 2,000 to 3,000 square feet where the rock could not be ripped. These small rock outcrops are at most 4 feet above the grading plan and could be blasted for removal; however, the area is only about 200 feet from the impounded tailings area and does not justify the small risk of causing shock wave-induced settlement. Although this risk is slight, leaving the small rock outcrops will add ecological diversity to the area which is a benefit to the project. The specifications allow that the margin area may be graded to less than a 3H:1V slope, and therefore this feature is allowable. Top soil will be placed in the general area to meet final grade, except at these outcrops. There is no potential that minor local flowstreams from an impoundment flood flow would be significantly interrupted by these small features. Lou Miller agreed to provide his concurrence with this allowance by letter, for the record.

Observed margins after most areas are at final grade, and before placement of top soil. Approximately 90% of the margin surface is weathered monzonite rock with an average larger grain size of course sand with some fines intermixed. The underlying area below these surface soils is increasingly hard monzonite rock with depth. The remaining approximately 10% of the area is alluvial sand located where the confluence stream beds express themselves and at the southeast outlet end of the diversion channel. Corn Abeyta requested that we consider the monzonite soil areas to be erosionally stable regarding vegetation production and qualification of the surfaces after construction is complete and vegetation has been established. Corn is concerned that these areas, although a nominal six inches of top soil will be placed on the margins, have insufficient water holding capacity to carry vegetation through summer dry periods, and that the vegetation coverage will not develop sufficiently to meet the requirements for stability, as presented in the Monitoring and Stabilization Plan. It seems that deep-rooted vegetation will have greater viability than grasses for this area. The fact that the weathered monzonite soil has a large fraction of larger particles and that the underlying soil transitions to erosionally stable rock, may provide justification that long-term stability (1,000 years longevity) is present, even if some surface erosion occurs. This potential justification does not seem to be present for the alluvial soils. The department has not finally reviewed and approved the Monitoring and Stabilization Plan with regard to erosional stability and will consider the as-built conditions of the margins, as well as the productivity of vegetation. To consider the erosional stability of the monzonite soil, Western Nuclear must provide adequate justification based on evaluation of the soils and subsurface conditions.

Observed rock placement commencing in the northernmost confluence. It is nominally six inch rock placed by dump truck. The plan is to use a dozer to spread the rock, and a back hoe to level the top surface. Early completion of rock placement in this area will allow ease of access to drill the MW-2B replacement well.

Observed that areas where excess vehicle traffic is present produce quite hard surfaces with limited compaction effort. Access roadways will have to be ripped prior to seeding. A

request was made that vegetation will be enhanced by a loose top surface preparation and that this may be contrary to the practical approach necessary to produce the + / - 0.2 feet top surface grading tolerance. Corn Abeyta's expectation is that the contractor will work the surface thoroughly and may grade the surface with graders to produce the required tolerance. We all agreed that this is contrary to the design purpose, and that enhancement of vegetation has priority importance. The surface tolerance was necessary to provide the impoundment slope to limit erosional effects. Local irregularities will not adversely affect long-term erosion potential, but will enhance local ponding on the surface and improve the expectation of initial vegetation production. A loose compaction of the top soil (e.g., after discing) will also enhance the initial vegetation stand. The department is interested in pursuing a proposal to revise the impoundment slope tolerances or construction method specifications to attain enhanced vegetation productivity. Since a specification change is necessary to address the subgrade grid elevation variances, this issue may be addressed in the specification modification being prepared (Revision #2).

Several issues were discussed. WNI will shut down operations for four days during the Labor Day holiday to give the crews a break from the 60-hour work weeks. The question of diversion channel cross-section area verification was discussed. Apparently Moe Pasha, QA Manager, hand-calculated an area that was provided by the surveyors based on field data. The results were equivalent. Moe included this in a recent audit that is not yet available. When completed, department staff will review and concur with Moe's findings. Revision #1 to the technical specifications remains under departmental review. The Department of Ecology, Dam Safety Section has also reviewed it and found cause for some minor revision to rock sizing requirements in the west groin area below the impoundment dam. Lou Miller has prepared a response to the Dam Safety review. Corn Abeyta stated that Western has sufficient excess large rock available and that they plan to place oversized 15 inch rock in the west groin area, as allowed by Revision #1. Departmental review of Revision #1 is not yet complete but will be forthcoming shortly. A meeting is needed to discuss the Monitoring and Stabilization Plan, applicable for the period after completion of construction and until license termination. A one-to-two day format is suggested and is likely best held in Spokane and/or at the Sherwood site. A September or October timeframe is best with invitation for attendance planned for department staff, Western staff, the Spokane Tribe of Indians, and the U.S. BIA. A later meeting, this fall or winter, would address the Long-Term Surveillance Plan, applicable for the period after license termination. Scoping and timelines are needed for both meetings. Corn Abeyta expressed that placement of rock will begin in earnest in about two weeks and that the Dam Safety staff may want to visit and inspect. Direct contact between the parties was suggested. Corn Abeyta expressed that the quarry rock is producing with a deficient quantity of rock in the 10-inch range for the needs at the site. Since Revision #1 to the specifications allows for oversizing, using rock of a larger size is an allowable option, as long as the thickness of the rock placement is consistent with design specifications.

A meeting was held with the contract surveyor to discuss the methods of survey and calculation of diversion channel cross-sectional areas. Ken Bryant, E.I.T. (Engineer-In-Training) represented C.E. Spurlock Jr. and Associates of Lander, Wyoming as their site

surveyor at Sherwood. Ken has performed the surveying at Sherwood. Ken explained his methods. He has Global Positioning System (GPS) equipment. His methods are accurate to less than an inch in all directions. Ken takes the X, Y and Z positions from AutoCAD drawing files supplies by Shepherd Miller, Inc. The exact interface point or grid point identified in the design drawings is represented in the computer file. Ken then takes each location point from the AutoCAD files and walks down the lateral position (X and Y) using his instruments. When he located the exact position, he then measures the elevation (Z) and inputs it to his database. He marks each measurement position with stakes and marks on each stake the relative elevation from design to measurement. The contractor is then able to grade the site to within the slope tolerances required. Ken's database output is also quite useful in performing final surveys for compliance to design tolerances. It is an excellent technique. It was determined when reviewing the QA records for diversion channel cross-sections that only the calculated areas are noted on the forms. Ken's database is set up to calculated areas from the X, Y, Z survey data. His area calculation method was reviewed and found appropriate. Triangles and trapezoids are calculated between measurement points. It was also determined that all the backup data is retained in the database and that such data is available for inclusion in the "as-built" final report for construction completion.

The surveyor qualification was investigated. Charlie Spurlock is a licensed engineer (P.E.) in Wyoming and Washington and a licensed land surveyor (P.L.S.) only in Wyoming. Ken Bryant is an certified Engineer-In-Training (E.I.T.). It was discussed that it is preferred that the surveyor is licensed in the State of Washington and that the radioactive materials license includes language generally to that effect. At the least, a letter of credentials from Charlie Spurlock is required. Apparently, Mr. Spurlock is considering application for a Washington license, by reciprocity. In any case, a licensed land surveyor sign-off on the final survey results is expected.

cc: Gary Robertson
Dorothy Stoffel
Earl Fordham
Bruce Barker, P.E.
Jerald LaVasser, P.E.

John

DEPARTMENT OF HEALTH
Environmental Health Programs
Division of Radiation Protection

October 11, 1996 WNI

TO: Western Nuclear File W.D.9.B

FROM: Leo Wainhouse, Quality Assurance Manager LW

SUBJECT: REVIEW OF MOE PASHA'S CORPORATE AUDIT

On June 26, 1996, I met with Moe Pasha, the corporate auditor and engineer for Western Nuclear, Inc. My objective was to evaluate the thoroughness and completeness of how Moe conducts audits, and determine how he follows up on noted deficiencies.

Moe relies on a checklist which contains all the forms found in their Construction Quality Plan (CQP). He reviews each form for content and completeness and checks the block either yes or no to indicate compliance or deficiencies. I reviewed two of Moe's audits, one performed on 4/21/96 for the period 7/7/95 to 4/20/96, and one performed on 6/5/96 for the period 4/21/96 to 6/26/96. I found Moe to be very thorough. He evaluates each form and completes a report (Summary of Audit Results). The Project Manager, Corn Abeyta, is required to respond to noted deficiencies with his own report (Quality Compliance Field Confirmation Report). Moe then closes the deficiency loop by a follow-up review on Corn's report and notes his comments in the next Summary Report.

During my audits, I will make sure all of the follow-ups are completed and in the file. If we do not keep up with our reviews or if there are long periods of time between a reported deficiency and its completion, problems could arise.

John Blacklaw was also onsite at WNI on June 26. He performed a review of WNI's subgrade elevation records. His findings are noted in his report dated July 1, 1996.

LW:krf

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
DIVISION OF RADIATION PROTECTION
Airdustrial Center, Bldg. 5 • P.O. Box 47827 • Olympia, Washington 98504-7827

August 19, 1997

Stephanie J. Baker
Manager, Environmental Services
Western Nuclear, Inc.
200 Union Blvd., Suite 300
Lakewood, Colorado 80228

Dear Ms. Baker:

The department has received your letter dated August 15, 1997, reporting a surface-stability deficiency in the diversion channel, and proposing corrective action; i.e., addition of riprap to meet grade requirements. After inspection, department staff concur that it is a deficiency, and that your proposed corrective action is appropriate.

Therefore, Western Nuclear, Inc. is approved to proceed with the proposed corrective action. WNI's semi-annual surface-stability inspection must include verification of whether or not the corrective action has been completed and meets the design drawings and specifications.

If you have any questions, please call Earl Fordham at (509) 377-3869, or me at (360) 753-3350.

Sincerely,

John R Blacklaw

John Blacklaw, P.E.
Environmental Engineer

cc: Bruce Wynne, Spokane Tribe
Mary Verner, Spokane Tribe
Shannon Work, Spokane Tribe
Sharon Yepa, BIA, WA
Stanley Speaks, BIA, OR
Lou Miller, SMI
Brad DeWaard
Jerald LaVasser, WDOE

John

WESTERN NUCLEAR, INC.

UNION PLAZA SUITE 300, 200 UNION BOULEVARD, LAKEWOOD, COLORADO 80228
TELECOPIER (303) 989-8993 TELEPHONE (303) 989-8675

August 15, 1997

Mr. Gary Robertson, Head
Waste Management Section
Washington Department of Health
Division of Radiation Protection
Airdustrial Park, Bldg. 5
P.O. Box 47827
Olympia, WA 98504-7827

RE: WN-I0133-1, SHERWOOD PROJECT, LICENSE CONDITION NO. 22 [AMENDMENT NO. 30], [Non-Routine] REPORTING OF SURFACE STABILITY DEFICIENCY AND PROPOSED CORRECTIVE ACTION

Dear Mr. Robertson:

Via letter dated February 28, 1996, Western Nuclear, Inc. [WNI] submitted to Washington Department of Health [WDOH] a proposed Monitoring and Stabilization Plan [MSP] for the WNI Sherwood Project post-construction monitoring program. Section 3.1.2, "Non-Routine Reporting", of the 02/28/96 WNI MSP contained provisions for non-routine reporting, which include the following:

- Within 30 days, provide written notification to WDOH;
- Within 90 days, provide corrective action plan for WDOH review and approval.

This letter notifies WDOH of a structural stability deficiency in the diversion channel that was identified during a field inspection on July 17, 1997 by Mr. Earl Fordham [WDOH], Mr. Corn Abeyta [WNI] and Mr. Lou Miller [Shepherd Miller, Inc.]. In accordance with WNI proposed MSP notification requirements, a detailed explanation of the deficiency and proposed corrective action are included with this notification. Because site conditions currently are optimal for implementing corrective actions, WNI therefore is requesting prompt WDOH approval of the proposed corrective action program

In accordance with our July 20-21, 1995 and other discussions, seven [7] copies of this submittal are being transmitted to you in Olympia. In addition, copies are being transmitted directly to the following parties:

- One [1] copy to Ms. Stoffel [WDOH; Spokane, WA].

○ One [1] copy to Mr. Fordham [WDOH; Richland, WA].

Should you have any questions, please contact us at your earliest convenience.

Sincerely,

Stephanie J. Baker
Manager of Environmental Services
SJB/tic doh\msp\notify97.815

w/attachments

cc: CA [w/attach.]
LLM [SMI] [w/o attach.]
MAP [w/o attach.]
EMS [w/o attach.]
L. Pruett, Esq. [w/o attach.]
H. Shaver, Esq. [S&L] [w/o attach.]

SHEPHERD MILLER
INCORPORATED

August 12, 1997

Ms. Stephanie J. Baker
Western Nuclear, Inc.
200 Union Boulevard, Suite 300
Union Plaza
Lakewood, Colorado 80228

RE: SMI Project No. 03-317

Dear Stephanie:

This letter documents my observations of the transition from confluence E1 to the adjacent portion of the diversion channel. This observation was made during my visit to the Sherwood site on July 17, 1997. This deficiency was not noted in the completion report because the as-built measurements were taken at 100 foot increments which did not identify this small area. I had not previously inspected this area. Inspection of this area was prompted by visual observations made by Earl Fordham of the WDOH who was present during the visual inspection. Since Earl was present during the inspection, and we discussed it with him at that time, no further verbal notification to the WDOH is necessary to meet their verbal notification requirement. This letter documents a "non-routine" inspection and should serve as both the written notification to the WDOH of the deficiency as well as the proposed corrective action plan. This inspection is not intended to replace the regular semi-annual stability inspection.

Identification of Deficiency

The area in question exists at the transition between confluence E1 and the diversion channel immediately south of the confluence. The general location is shown on Figure 1 (attached). At the transition from 15-inch riprap in the confluence to 3-inch riprap in the diversion channel, there is an abrupt elevation change, as the bottom elevation of the channel is approximately 3-4 inches lower than the elevation of the bottom of the confluence. This elevation difference appears to be a result of heavy construction activity which occurred over the 3-inch riprap in the diversion channel as the larger riprap was being placed in the confluence. This heavy construction activity appears to have pushed the 3-inch riprap into the underlying filter and foundation soil.

Corrective Action

The transition from the confluence to the diversion channel should not have an abrupt elevation change. The transition should be corrected by placing additional 3-inch riprap over the area where the previously placed rock was pushed into the underlying filter and subsoil. The 3-inch riprap material should be added until a smooth transition is achieved between the confluence and the downstream portion of the diversion channel.

Environmental & Engineering Consultants

3801 Automation Way, Suite 100
Fort Collins, CO 80525
Phone: (970) 223-9600
Fax: (970) 223-7171

Future Monitoring

Inspection of this area should be included in the next regularly scheduled surface stability monitoring inspection. That inspection should evaluate the effectiveness of the corrective action in providing a smooth transition between the confluence and the diversion channel and determine what, if any, additional actions are necessary.

If you have any questions or need additional information, please call me at your convenience.

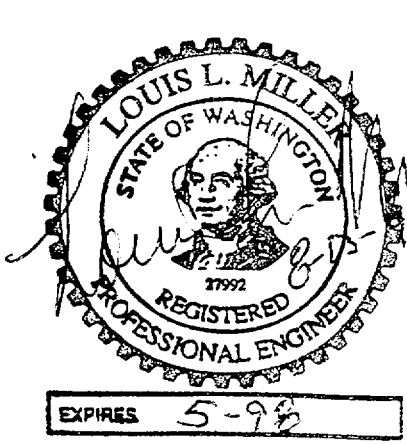
Sincerely,

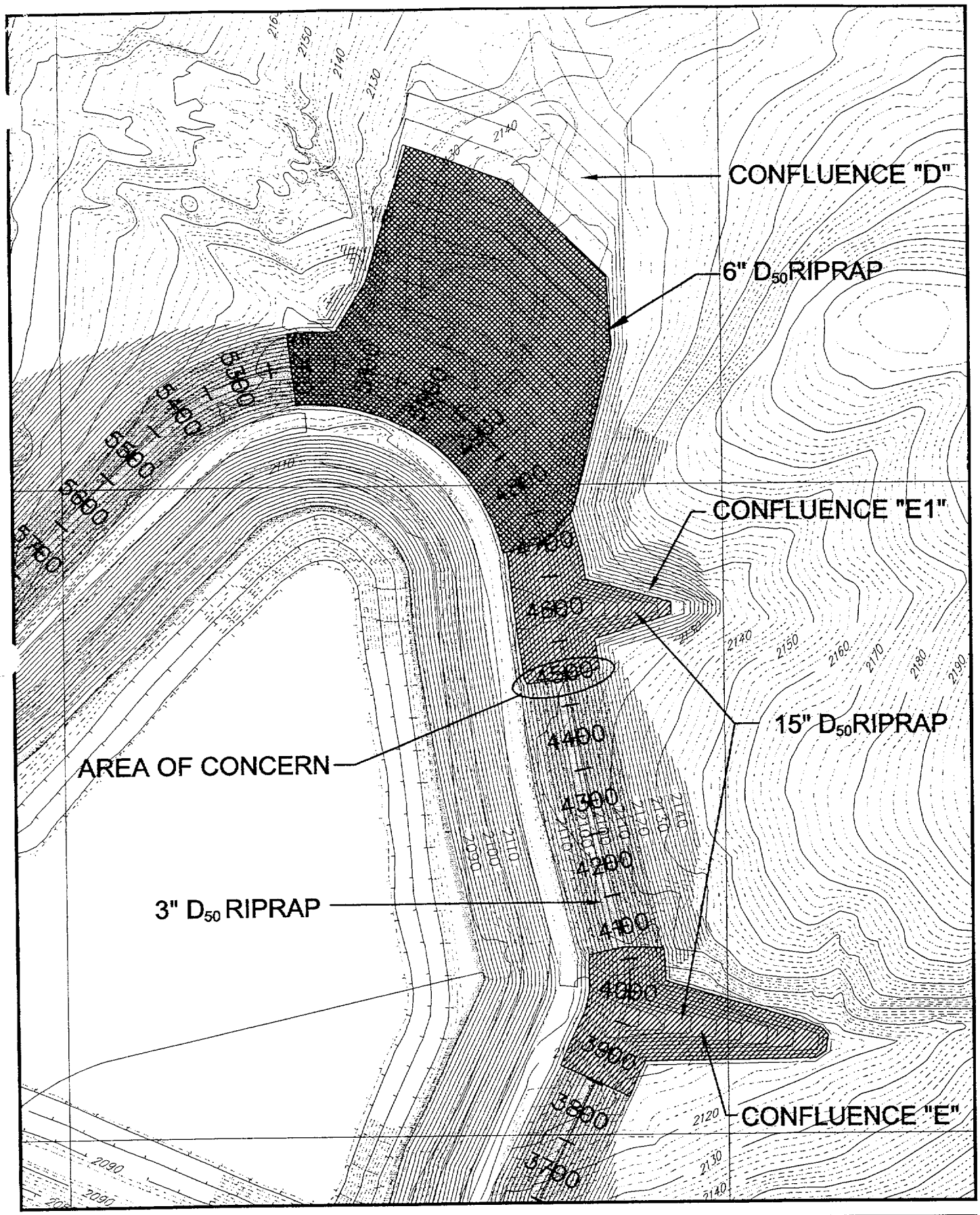
SHEPHERD MILLER, INC.

Louis L. Miller, PE
Vice President

LLM:mp

Enclosure





SHEPHERD MILLER

FIGURE 1
LOCATION OF
NEEDED RIPRAP MODIFICATIONS

Date:	AUG 1997
Project:	03-347\31
File:	CONCRNROCK

To: "Robertson,Gary"@AIR2.WA-DOH,"Blacklaw,John"@AIR2.WA-DOH,"Erickson,John"@AIR2.WA-DOH
From: Stoffel, Dorothy
Subject: Fwd: Re: Texas Title II Sites - Riprap
Date: 7/20/99 Time: 10:12AM

Originated by: CHUCK @ SMTP {Chuck.Mclendon@tdh.state.tx.us} on 7/13/99 7:03AM
Forwarded by: DBS1303 @ WA-DOH on 7/20/99 10:12AM (CHANGED)

Evidently word is getting out about us! Dorothy

Hi Dorothy!

I thought you might have interest and possibly benefit from the following. How's it going out there? Do you miss being in Denver at the Adam's Mark?

Chuck McLendon
TX

------- Forwarded Message Follows -------
From: "Bruce Calder" <Bruce.Calder@tdh.state.tx.us>
To: gary.smith@tdh,
chuck.mclendon@tdh,
george.gonzalez@tdh
Date: Fri, 18 Jun 1999 14:30:45 -0600 (CST)
Subject: (Fwd) Re: Texas Title II Sites - Riprap
Priority: normal

------- Forwarded Message Follows -------
Date: Fri, 18 Jun 1999 15:20:58 -0400
From: Dennis Sollenberger <DMS4@nrc.gov>
To: Bruce.Calder@tdh.state.tx.us
Subject: Re: Texas Title II Sites - Riprap

Bruce,

I want to respond briefly to your email so that you do not think I am totally ignoring you. We have not resolved the concerns noted during the recent visit to the Sherwood site in Washinton State. The Texas sites are unique in that they are grass covered and have relatively steep slopes for grass covers. The period of stability monitoring that is being conducted at this time should assit in mThe

DOE recently made the statement that they think that they should review the activities at the site to deter
Dennis Sollenberger

>>> "Bruce Calder" <Bruce.Calder@tdh.state.tx.us> 06/08 5:09 PM >>>
Dennis,

We spoke once before about a year ago. I am a geologist who works for the Texas Department of Health, Bureau of Radiation Control. One of my main duties is the primary oversight of the three UMTRCA Title II sites that we have in TX.

I was urged to contact you with regards to the recent NRC inspection and subsequent finding of inadequacy of the riprap cover at the "Sherwood Project" Title II mill tailings site in the state of Washington. My understanding from a DOE colleague close to the situation is that the State of WA was all ready and prepared to facilitate the transfer of the property from the private operator of the site to the Spokane tribe/DOE when, at the eleventh hour, the NRC decided to inspect the site and then made allegations that the riprap cover was inadequate, in effect, halting the transfer of the site until the cover is reconstructed to the NRC's satisfaction. I was also informed that such a reconstruction is expected to cost upwards of $1 million.

Our concern here in Texas is that, in spite of the long-held understanding that the omission of riprap covering was deemed acceptable to NRC (i.e., all of the TX Title IIs were approved having only GRASS-covered top and side slopes), has the NRC now changed its position and thus may end up declaring the TX Title II sites inadequate in this regard? Like the State of WA, we would prefer not to get toward the end of the site property-transfer process, only to be broadsided by declarations of construction inadequacy.

Please advise as to this riprap issue (or any other Title II construction issues that we may expect from NRC) as it relates to the TEXAS Title II sites, especially with regard to the planned property transfers to the DOE in the not-too-distant future. Thank you.

Bruce Calder

Appendix E

Geologic and ~~Geo-Technical~~ Geomorphic Stability

FILE COPY
W.D.B.E

STATE OF WASHINGTON
DEPARTMENT OF HEALTH
DIVISION OF RADIATION PROTECTION
Airdustrial Center, Bldg. 5 • P.O. Box 47827 • Olympia, Washington 98504-7827

November 6, 1995

Stephanie J. Baker
Manager, Environmental Services
Western Nuclear, Inc.
200 Union Blvd., Suite 300
Lakewood, Colorado 80228

Dear Ms. Baker:

Our hydrogeologists, Dorothy Stoffel and John Riley, have completed their review of Appendix P of the December 1994 Sherwood Project Tailing Reclamation Plan. On September 28 and 29, 1995, they met with you and your consultants to discuss their questions and comments related to Appendix P and the ground water monitoring system proposed for the Sherwood facility. Their review of other aspects of the closure plan has produced the following additional ground water questions and comments, which must be addressed before the approval process can be finalized:

1. Appendix P, page 6.2, states that the tailings are presently in a reduced state. Please provide information that supports this conclusion. Have chemical analyses been conducted on the solids that establish the chemistry of the sulphur minerals present in the tailings? Is there evidence that indicates presence of iron as Fe+2 versus Fe+3?

2. How does the proposed thick cover help to keep the tailings reduced? Information that describes the redox potential trend at depth could provide additional justification for the utilization of the thick cover design. Explain how the redox state of the tailings will be affected if the liner fails, and the pore water drains, and if the vegetative cover pulls moisture from the tailings. What is the water holding capacity of the tailings, and what is the likely mobility of oxygen under these conditions? Is it likely that oxygen diffusion will occur from the sides or bottom of the impoundment? How will these conditions affect the previous ground water modeling for water quality impacts?

3. Additional information is needed that describes the tailings material that was used in the columns for the leaching test. What was the origin of the material? Was the material composited prior to placement into the columns? Describe the test methodology.

4. What is the behavior of sulfate over time during the column tests? Does the behavior suggest that column results are kinetically limited?

5. Please provide justification for the use of 50-foot thickness for the conductive bedrock zone. The text should make it clear that the conductive bedrock zone does NOT equate to the weathered bedrock.

6. Please present results of the baseline water quality testing that has been completed for the new monitoring wells. This information will allow for completion and establishment of the baseline testing standards, and revision of Tables 6.2 and 6.3.

7. Figure C.2.1 should be revised to include the following: a notation that complete fracture data are presented in Table C.2-1; a notation that strikes and dips on the figure are representative and that there are other structures with strike and dip measurements that have been recorded; and delineated areas that were identified on the seismic profiles as areas where Low Velocity Zones were encountered.

8. Please present generalized cross-sections showing the relationship between the hydrostratigraphic units, monitoring well static water levels, bottom profile of the tailing impoundment, and bottom profile of the solution holding pond.

9. The contour intervals on Figure 3.4 indicate a level of detail that is not supported by the seismic information. Elimination of the 20-foot contour interval on the figure could better represent the bedrock surface. It should be noted that the bedrock contours in the vicinity of seismic line F were based on outcrops. (Seismic line F could not be interpreted.) The text could also be enhanced by documenting that the bedrock surface contour indicated by seismic lines A and B was confirmed when the new downgradient monitoring wells were installed. This is significant, considering the need to have good control at the Point of Compliance downgradient from the tailings impoundment.

10. Figure 15 of the seismic profiles is incorrect. The SE and NW appear to be reversed and should be corrected.

11. A computation error needs to be corrected on page E-14, in converting ft/min to cm/sec. Please clarify in the text, page E-14, that pump test data from wells 8 and 10 were not used in the integrated site model. The physical constraints of the aquifer prohibited an adequate stress test of the aquifer and the drawdown may only represent dewatering of the borehole. Therefore, data from previously performed packer tests were used in the integrated site model.

12. The text associated with the long-term limitations of yield in any dewatering program could be enhanced. A description of the lenticular, discontinuous coarse-grained layers that are limited in areal extent, and bounded by fine-grained layers in the tailings impoundment, indicate that the effectiveness of long-term pumping, associated with dewatering, would probably diminish over time as "negative boundaries" are encountered. This information should be included at page 4-12 and in the new Executive Summary.

13. The information presented in Appendix P represents a very comprehensive approach to evaluating the ground water underlying the area. The information could be effectively summarized in a new document, a Technical Integration Report document, that would be more readable for the non-hydrogeologist and provide a road map/guide to relevant topics found in appendices other than Appendix P. The Technical Integration Report document could also provide the additional information requested in the items listed above.

14. The text associated with ground water monitoring should be revised to reflect additions and modifications to the ground water monitoring program that have been developed since December 1994 (i.e., addition of intermediate phase of ground water monitoring between leak detection monitoring and compliance monitoring).

Please submit responses to questions associated with #1, 2, and 6 to the department by November 15, 1995.

If you have any questions related to comments and questions outlined above, you may contact me at (360) 753-3459, or our hydrogeologists directly, John Riley, at (208) 773-5223, or Dorothy Stoffel at (509) 456-3166. For project-related questions, contact John Blacklaw at (360) 753-3350.

Sincerely,

Gary Robertson, Head
Waste Management Section

GR:krf

cc: Lou Miller, SMI
Warren Seyler, Spokane Tribe of Indians
Mary Verner, Spokane Tribe of Indians
Alfred Peone, BIA - WA
Stanley Speaks, BIA - OR
Jerald LaVassar, WDOE