

Basic Seismological Characterization for Pathfinder Mines Corporation Shirley Basin Mill Tailings Site

by

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Background

The U.S. Nuclear Regulatory Commission generated the "Final Standard Review Plan" to guide the reclamation of uranium mill tailings sites. The review plan is meant to clarify federal regulations 10 CFR 40 Appendix A and 10 CFR 100 Appendix A. The Final Standard Review Plan has three steps that are to be completed in order to generate a seismotectonic stability analysis of a site. The steps are as follows:

- 1) Determination of the Maximum Tectonic Province Earthquake (Floating Earthquake)
- 2) Identification of Capable Faults
- 3) Designation of Maximum Credible Earthquake

In order to satisfy the requirements of the NRC as set forth in the "Final Standard Review Plan", I have generated a basic analysis of the following items:

- 1) Deterministic Analysis on Nearby Active Faults (Capable Faults) with a Surface Expression
- 2) "Floating Basin Earthquake" Analysis for a Regional Tectonic Province
- 3) Designation of Maximum Credible Earthquake (Larger of Items 1 or 2)

Deterministic Analysis

In 1988, Geomatrix Consultants, Inc., completed a report titled "Seismotectonic Evaluation of the Wyoming Basin Geomorphic Province. The report area includes the Shirley Basin and Pathfinder's Shirley Basin

Mill Tailings Site. Geomatrix assembled available information on known active faults in addition to conducting field investigations on poorly studied faults. Based upon the Geomatrix study as well as unpublished information and reports at the Wyoming State Geological Survey, I have concluded that the

active fault system that could cause the greatest accelerations at the Shirley Basin Site, assuming that the fault activates, is the Seminole Mountain Segment of the South Granite Mountain Fault System. The nearest point on the fault is located approximately 53 kilometers west-southwest of the Pathfinder Shirley Basin Mill Tailings Site.

Geomatrix did not find evidence of late-Quaternary movement on the Seminole Mountain Segment of the South Granite Mountain Fault System, and scarps that were present were found to be fault-line scarps due to differential erosion. The Seminole Mountain Segment, however, is an extension of other segments of the South Granite Mountain Fault System that have been shown to be active in the late-Quaternary and recurrently active over the last 500,000 years. The other segments of the South Granite Mountain Fault System are located to the west of the Seminole Mountain Segment, and are all further from the mill tailings site.

Based upon the above analysis, I feel that the selection of the Seminole Mountain Segment of the South Granite Mountain System as the active fault nearest to the mill tailings site, is very conservative. Geomatrix did not assign a maximum magnitude earthquake to the Seminole Mountain segment, in large part because of poor exposure of the fault, lack of measurable surface offsets, and uncertainty in the actual length of the segment. Geomatrix estimated the length of the Seminole Mountain Segment to be 36 kilometers. Such a fault length would result in a magnitude 6.85 earthquake if the entire length ruptured (Wells and Coppersmith, 1994). All other active segments of the South Granite Mountain Fault System, however, have been assigned a maximum magnitude of 6.5 to 6.75. Due to the uncertainties associated with the Seminole Mountain Segment, I feel that a maximum earthquake of magnitude 6.75 is more reasonable than one of magnitude 6.85.

A magnitude 6.75 earthquake, located 53 kilometers from the Pathfinder Shirley Basin Mill Tailings Site, should result in a peak horizontal acceleration of approximately 0.05g (Campbell, 1987) at the site. This acceleration is conservative, considering the uncertainties associated with the Seminole Mountain Segment.

Floating Basin Earthquake for a Regional Tectonic Province

NRC's Final Standard Review Plan requires that "For those earthquakes not associated with known tectonic structures (i.e., "floating" earthquakes) the largest event that has occurred in each of the tectonic provinces expected to influence the seismicity of the site should be identified". In other words, the largest event that has occurred and has not been tied to a specific fault system, or related structure, should be considered to be the "floating" earthquake for the tectonic province. The "floating" earthquake may be larger than the largest historic earthquake, and should be the largest "random" earthquake thought to have occurred in the last 35,000 - 50,000 years.

Once the "floating" earthquake has been determined for a tectonic province, it must be arbitrarily placed at a certain distance from a site in order to estimate what accelerations may be felt at the site if

such an earthquake occurs. NRC's Final Standard Review Plan defines the site-to-source distance for "floating" earthquakes as 15 kilometers.

Lawrence Livermore National Laboratory (Bernreuter and others, 1994) included the Shirley Basin in a "Central Wyoming Seismic Zone", defined by 109.7° West longitude on the west, 105.5° West longitude on the east, 41.5° North latitude on the south, and 43.0° North latitude on the north. This "Central Wyoming Seismic Zone" is within an even larger tectonic province, defined by Geomatrix (1988), called the "Wyoming Foreland Structural Province". The "Wyoming Foreland Structural Province" is approximately defined by the Idaho-Wyoming Thrust Belt on the west, 104° West longitude on the east, 40° North latitude on the south, and 45° North latitude on the north.

Geomatrix (1988) estimated that the largest "floating" earthquake that may occur in the "Wyoming Foreland Structural Province" would have a magnitude in the 6.0 -6.5 range, and used a magnitude 6.5 earthquake in their analysis. The average of the range of magnitudes suggested by Geomatrix for a "floating" earthquake in the "Wyoming Foreland Structural Province" is magnitude 6.25. A magnitude 6.25 "floating" earthquake is what Lawrence Livermore National Laboratory suggested for the "Central Wyoming Seismic Zone."

A magnitude 6.25 "floating" earthquake place 15 kilometers from the Pathfinder Shirley Basin Mill Tailings Site