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Subject: Solution Mining for Brine

Introduction and Summary

The 40 CFR Part 194 criteria require that performance assessments for the Waste Isolation Pilot Plant (WIPP) Compliance Certification Application (CCA) include an analysis of the effects on the disposal system of any activities that occur in the vicinity of the disposal system prior to disposal or are expected to occur in the vicinity of the disposal system soon after disposal. These activities include boreholes that are used for fluid injection activities or boreholes that may be used for fluid injection activities in the near future[1]. One activity of potential concern is solution mining of halite, which is undertaken to produce brine for oil- and gas-field drilling operations. This document provides an analysis of the likelihood and potential effects on the WIPP disposal system of brine production operations in the Delaware Basin.

In summary, existing and planned brine solution wells are too far from the WIPP site to affect conditions in the disposal system. Even if solution mining for brine is assumed to occur near the WIPP land withdrawal boundary in the near future, such activities will be of low consequence to the performance of the disposal system.

Consistent with 40 CFR §194.33(d) performance assessments need not analyze the effects of techniques used for resource recovery subsequent to the drilling of a borehole in the future[2]. Therefore, future brine production from within and outside the controlled area has been eliminated from performance assessment calculations on regulatory grounds.

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1 Near-future human activities are those activities that may be expected to occur based on existing plans and leases. The DOE assumes that all such activities will occur and will continue until their completion, potentially at some time after disposal.

2 Future human activities are those that occur within or outside the controlled area subsequent to repository closure, for which there are no existing plans and leases. Such activities are limited by 40 CFR §194.32(a) to drilling and mining.

Brine Extraction in the Delaware Basin

Solution mining to produce brine typically involves the circulation of fresh water through an artificially fractured section of rock between two boreholes. A fracture is induced in order to increase the effective permeability between the boreholes such that the required brine production rate is achieved. As water is pumped along the surface of the fracture it becomes salt saturated through dissolution of the halite. The dissolution process results in the formation of a cavern between the boreholes.

Leonard (1996) reported the results of a recent survey of existing and planned brine solution wells in the Delaware Basin within New Mexico. Three active wells and one inactive, temporarily abandoned well were identified within 4 miles (6.4 kilometers) of Carlsbad, over 20 miles (32 kilometers) from the WIPP site. A permit has been filed to drill a brine well in Lea County, New Mexico (Section 32, Township 23 South, Range 33 East), about 14 miles (22 kilometers) southeast of the WIPP site. There are no pending applications for brine solution wells in Eddy or Lea County, New Mexico.

Potential For Collapse and Subsidence Resulting from Brine Extraction Operations

A concern associated with solution mining is the potential for collapse of the dissolution cavern and resulting subsidence. Hickerson (1991) considered the potential for subsidence resulting from operation of the Carlsbad Eugenie Brine well, where fresh water is injected into a salt section at a depth of 583 feet (178 meters) and brine is recovered through a borehole at a depth of 587 feet (179 meters), with a borehole separation of 327 feet (100 meters). Hickerson noted that the circulating fresh water, being less dense than brine, tends to move upwards, causing the dissolution cavern to grow preferentially upwards. Thus, the dissolution cavern at the Carlsbad Eugenie Brine well is approximately triangular in cross-section, being bounded by the top of the salt section and larger near the injection well. Hickerson estimated that brine production from 1979 until 1991 had created a cavern of about 3.4×10^6 cubic feet (9.6×10^4 cubic meters) (350 feet [107 meters] by 153 feet [47 meters] at the upper surface of the cavern with a depth of 127 feet [39 meters]).

Gray (1991) investigated the potential for collapse and subsidence at the Carlsbad Brine Well. Gray quoted earlier analyses that show cavity stability is relatively high if the cavity has at least 50 feet of overburden per million cubic feet of capacity (538 meters of overburden per million cubic meters of capacity). Based on estimated production at the Carlsbad Brine Well between 1976 and 1991, approximately 3.4×10^6 cubic feet (9.6×10^4 cubic meters) of salt have been dissolved. The well depth is 710 feet (216 meters) and thus there are about 210 feet of overburden per million cubic feet of capacity (2,250 meters of overburden per million cubic meters of capacity). Gray (1991) estimated that the critical ratio of 50 feet of overburden per million cubic feet of cavity

The most likely conditions under which radionuclide travel times through the Culebra might decrease as a result of subsidence associated with brine production are those in which the hydraulic head gradient in the Culebra increased. This might be achieved if subsidence occurred north of the WIPP site and provided an interconnection for fluid flow from the Magenta to the Culebra. The Culebra hydraulic head would be raised at this point. The increase in hydraulic head gradient caused by such an event would be less than that caused by long-term flow from a deep overpressurized unit to the Culebra through an abandoned borehole. Analysis by Wallace (1996) showed that flow from a deep overpressurized unit to the Culebra will be of low consequence to the performance of the disposal system. Thus, by comparison, the effects of subsidence resulting from the collapse of a dissolution cavity will be of low consequence to the performance of the disposal system.

In summary, even if solution mining for brine is assumed to occur near the WIPP land withdrawal boundary in the near future, such activities will be of low consequence to the performance of the disposal system. Note that, consistent with 40 CFR §194.33(d), performance assessments need not analyze the effects of techniques used for resource recovery subsequent to the drilling of a borehole in the future. Therefore, performance assessments need not analyze the effects of future brine production from within or outside the controlled area.

References

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