

UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

BEFORE THE ATOMIC SAFETY AND LICENSING BOARD

In the matter of)	
)	
POWERTECH (USA) INC.)	Docket No. 40-9075-MLA
)	ASLBP No. 10-898-02-MLA-BD01
(Dewey-Burdock In Situ Uranium)	
Recovery Facility))	

OPENING WRITTEN TESTIMONY OF DR. HANNON LAGARRY

EXPERT OPINION REGARDING THE CONSOLIDATED INTERVENERS' CONTENTION 3: *The DSEIS Fails to Include Adequate Hydrogeological Information to Demonstrate Ability to Contain Fluid Migration and Assess Potential Impacts to Groundwater*, PROPOSED DEWEY-BURDOCK PROJECT ISL MINE NEAR EDMONT, SOUTH DAKOTA

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INTRODUCTION

In early 2010 I was contacted by the Western Mining Alliance Network to provide an expert opinion regarding the proposed construction the Dewey-Burdock Project ISL facility near Edgemont, South Dakota. I had previously provided an expert opinions to the Western Nebraska Resources Council (among others) regarding Crow Butte Resources' ISL uranium mining near Crawford, Nebraska. Since that time, I have offered expert opinions on Crow Butte Resources' proposed expansions, and initiated or participated in several scientific studies intended to further clarify the issues I raised in those written opinions. I am offering this additional expert opinion regarding the consolidated interveners' contention 3 regarding the Dewey Burdock Project because I am concerned that issues regarding the lack of lixiviant containment raised in earlier opinions also apply to the consolidated petitioners' contention in this case. My goal in offering this

expert opinion is not to protest uranium mining, but rather to express my concerns regarding threats to the region's diminishing water supplies, and the future inhabitability of southwestern South Dakota and adjacent Nebraska. In this document I will briefly explain the basis for my concerns.

PROFESSIONAL BACKGROUND

I have 25 years' experience studying the geology of northwestern Nebraska and adjacent South Dakota. Following dissertation work on the regional geology from 1988-1995, from 1996-2006 I led teams of geologists from the Nebraska Geological Survey that mapped in detail the geology of most of northwestern Nebraska (a total of 80 1:24,000 quadrangles). The completion of this work frequently required detailed study of equivalent strata in adjacent Fall River, Shannon, and Todd counties in South Dakota. These maps, including digital versions (ArcInfo) and supporting field notes, are available from the University of Nebraska-Lincoln School of Natural Resources (contact Dr. Matthew Joeckel, Director). As a direct consequence of this mapping, I have published peer-reviewed articles on the Chadron Formation (Terry & LaGarry 1998), the Brule Formation (LaGarry 1998), the mapping of surficial deposits (Wysocki & others 2000, 2005), and local faults (Fielding & others 2007). From 2006-2008 I continued this work as an Adjunct Professor of Geology at Chadron State College (CSC) in Chadron, Nebraska. During this time I worked with and advised students studying the region's groundwater, surface water, and faults (Balmat & others 2008, Butterfield & others 2008). Since 2008 I have worked as an Instructor and Researcher in the Department of Math, Science, & Technology at Oglala Lakota College (OLC MST), serving the department as Co-Chair from 2009-2012 and Chair from 2012-2013. I have been working with students and faculty to study the geology, groundwater, surface water, and heavy metal contaminants of southwestern South Dakota and the Pine Ridge Reservation. For the past 6 years our research has been funded by the National Science Foundation's Tribal Colleges and Universities Program and Experimental program for Stimulating Competitive Research, and the USDA National Institute for Food and Agriculture Tribal College Equity Program. We have formed partnerships with Chadron State College, the South Dakota Geological Survey, the South Dakota School of Mines and Technology, South Dakota State University, the University of Illinois Urbana-Champaign, the University of Illinois Center for Advanced Materials Purification of Water Systems, the Department of Health Physics at the University of Michigan School of Nuclear Engineering, the University of Washington Native American

Research Center for Health, and the Technological University of Darmstadt, Germany. I have authored or co-authored reports detailing the preliminary results of studies describing toxic heavy metal contamination of drinking water (Salvatore & others 2010, Botzum & others 2011), characteristics of local aquifers (Gaddie & LaGarry 2010, LaGarry & others 2012), potential uranium contamination risk to communities on the Pine Ridge Reservation (LaGarry & Yellow Thunder 2012), and the transmission of uranium-contaminated water along regional faults (Bhattacharyya & others 2012).

THE CONCERNS

My concerns regarding the Dewey-Burdock Project are the lack of confinement resulting from secondary porosity in the form of faults, joints, existing test holes old bore holes, the problem of artesian flow, and the horizontal flow of water within the uranium-bearing strata. It is beyond the scope of this opinion to review the entire scientific literature for the region, but I provide the most readily available recent research. Where appropriate, I also refer to specific sections of Powertech's environmental report to the US Nuclear Regulatory Commission (NRC) for the construction of the Dewey-Burdock Project, and the final draft of the U.S. Nuclear Regulatory Commission's Environmental Impact Statement (Office of Federal and State Materials and Environmental Management Programs 2014).

The problem of secondary porosity

In order for ISL mining to be considered safe, the mined uranium-bearing strata must be isolated from rocks above and below by confining layers. Confining layers must be continuous, unfractured, and unperforated in order for containment to exist. There are three principal pathways through which contaminated water could migrate away from the uranium-bearing strata through adjacent confining layers (described in detail below): 1) secondary porosity in the form of joints and faults, 2) thinning or pinching out of confining layers, and 3) perforations made by improperly cased or capped wells.

Faults and joints - Secondary porosity, in the form of intersecting faults and joints, is common in all of the rocks north, east, and south of the Black Hills Dome and along the Pine Ridge Escarpment (see Swinehart & others 1985). These faults and joints are generally oriented NW- SE and SW-NE, and are a result of the ongoing uplift of the Black Hills of southwestern South Dakota. Although many people consider the Black Hills uplift to have ended by the late Cretaceous Period (~65

Ma), the Black Hills were tectonically active in the late Eocene (Evans & Terry 1994), and continued to fault, fracture, and fold the rocks of northwestern Nebraska and southwestern South Dakota into the middle Miocene (Fielding & others 2007). Based on numerous small earthquakes along the Sandoz Ranch-Whiteclay Fault, the area is still tectonically active (McMillan & others 2006). These earthquakes are relatively mild, and don't significantly damage surface infrastructure. However, even small earthquakes represent shifting and flexing of the earth's crust, and are continuously creating, closing, and redistributing the secondary porosity of the region's rocks and changing the flow pathways of the region's groundwater. This means that joints incapable of transmitting water one day may be able to transmit water at a later date. These faults and fractures transect all major bedrock units of the region. These faults connect the uranium-bearing strata to adjacent aquifers as well as modern river alluvium.

Preliminary studies of the interaction of local these faults with surface waters in the region show that creeks that provide municipal water supplies can be entirely consumed and redirected by the region's secondary porosity. Chadron Creek, the stream that supplies water to the city of Chadron, Nebraska, went dry for the first time in the city's history. Subsequent study of the creek's water flow rates by Chadron State College students suggested that normal amounts of water are flowing from springs, but the water is disappearing into deeper alluvium or into fractures in the rock (Balmat & others 2008, Butterfield & others 2008). Following these observations, a Chadron State College graduate student studied the lineaments of northwestern Nebraska and southwestern South Dakota using data collected by high-flying aircraft, satellites, and the space shuttle, and showed that these represent widespread faults (Balmat & Leite 2008). Many of the faults in northwestern Nebraska and southwestern South Dakota persist for tens of miles (Diffendal 1994, Fielding & others 2007). Also, many of the ancient river deposits of the Tertiary strata, along with the alluvium deposited by modern rivers such as the Cheyenne River, the White River, and Hat Creek, follow fault zones because fractured rock erodes more easily.

Powertech's application asserts that although fault zones are known both north and south of the project area, there are no known faults within the project area and that there is little or no secondary porosity. However, according to the final environmental impact statement (Office of Federal and State Materials and Environmental Management Programs 2014), the Dewey Fault is located approximately 1.6 km north of the proposed Dewey-Burdock permit area. A review of the scientific literature shows that faults and joints are well-known in rocks surrounding the Black Hills, and are known to interconnect major aquifers and the land surface (Swinehart & others 1985, Peters & others 1988, Fielding & others 2007). In earlier expert opinions, I predicted that faults and joints would be

capable of transmitting uranium-contaminated waters from depth onto the land surface. In 2012 my colleagues and I reported preliminary research showing uranium-contaminated artesian springs along the Sandoz Ranch-Whiteclay Fault in Fall River and Shannon counties (Bhattacharyya & others 2012), supporting my earlier assertions. Based on the numerous studies reported here, the absence of joints and faults in the vicinity of the proposed mine is likely a false perception, because joints and faults are ubiquitous in this region. Despite being obvious when viewed from Earth's orbit, however, these joints and faults are difficult to observe when covered by Holocene surficial deposits.

Thinning of confinement layers - The thickness of a geological stratum depends of several factors, including how it was deposited onto the ancient landscape, the lateral limits of the depositing environment, and whether or not it was partly eroded by subsequent geological activity. Such an assessment is difficult in the subsurface, and requires extensive drilling or seismic refraction techniques to determine. Despite these difficulties, Powertech conceded its initial application that the upper confining layers thin and that breaches exist. Based on this admission, confinement does not exist at the site.

Perforations by new and existing wells - The third pathway for mine fluids to breach containment is through. In Powertech's application, they repeatedly mention "thousands of exploratory wells," along with wells that supply drinking water (the uranium-bearing strata are a local drinking water supply) and water for livestock. In addition, many of these wells are abandoned and most likely improperly plugged. Once mining begins, and minerals are being extracted, flow pathways within the uranium-bearing rocks will change, potentially creating circumstances in which any one of these wells could allow lixiviant to breach confinement. Once into adjacent water-bearing strata or the land surface, contaminants can enter rivers and flow downstream with each successive rain event, or flow down gradient into other water supplies.

According to the final environmental impact statement (Office of Federal and State Materials and Environmental Management Programs 2014), there are 4,000 exploration drill holes representing historic exploration activities. Also, Powertech drilled approximately 115 exploration holes, including 20 monitoring wells. According to the environmental impact statement, Powertech cannot confirm that all historic borings were properly plugged and abandoned. However, an infrared map of a portion of the Burdock area shows an alkali pond area that Powertech concedes was formed as a result of unplugged borings. The environmental impact statement also confirms that aquifer pumping tests and a numerical groundwater model developed by the applicant using site-specific

geologic and hydrologic information show a hydrogeological connection between the Lakota and Fall River Formations through the intervening Fuson Shale in the Burdock area resulting from improperly installed wells or improperly abandoned exploration holes completed in the Fall River and Lakota Formations. Based on this assessment of the impact of boreholes at the site, there is no confinement and transmission of lixiviant into the environment surrounding the site is extremely likely.

The problem of artesian flow

Artesian flow occurs when there is a hydrologic connection, through faults or highly permeable strata, between groundwater sources high on the landscape and the land surface lower down. The weight of water in overlying strata exerts pressure downward into water within the uranium-bearing strata, which can then be released as artesian water flow (like a fountain) where the topographically lower uranium-bearing strata is exposed at the surface, or where it is punctured by drilling. Artesian flow was observed or predicted by Powertech in their Dewey-Burdock Project proposal, and was observed directly at the Black Hills Army Depot less than 10 miles to the south (U.S. Army Corps of Engineers 1992). Artesian flow is most likely where the upper confining layer is perforated by secondary porosity, poorly constructed or improperly sealed exploration wells, or thinning or absence of upper confining layers. Artesian flow could transmit lixiviant, the most toxic mineral-laden of waters, onto the land surface (and into Cheyenne River, White River, or Hat Creek alluvium) and discharge large amounts of contaminants into aquifers or faults in a very short time. In order for artesian flow to occur at the Black Hills Army Depot, the water must originate topographically higher in the Black Hills and pass through the Dewey-Burdock area. Were this to happen with oxidant-charged lixiviant, contaminated groundwater would rust any metal-contained ordnance and release its contents into the environment.

The problem of horizontal flow

Confining layers adjacent to uranium-bearing strata limit the unwanted spread of contaminants from an ISL site. However, horizontal flows within the uranium-bearing strata are also of concern. Such flow can rapidly redirect lixiviant or mine waste away from the mine site and into unexpected breaches in the confining layers. In their application to the NRC, Powertech reports horizontal flows within the uranium-bearing strata (the Inyan Kara Group) of up to 35.5 meters/day (Chilson Member) based on local conditions, and of up to 6,000 ft/day elsewhere

in the Black Hills region. Even if secondary porosity, artesian flow, or lack of confinement did not contaminate nearby water supplies, down gradient flow along the Cascade and Chilson anticlines (Rothrock 1931a, 1931b, 1948) would transmit contaminants to the major, mapped faults north of the Pine Ridge in Nebraska in less than 5 years (using the smaller value).

CONCLUDING REMARKS

Based on the arguments presented above, it is my expert opinion that ISL mining in the Edgemont, South Dakota cannot be adequately contained. Published reports of artesian flow, the acknowledged and prevalent potential lack of confinement due to secondary porosity and drilling, along with potentially high horizontal flow in the uranium-bearing strata indicate that during the course of its operation the Dewey-Burdock ISL Project will most likely contaminate the region with unconfined lixiviant. This contamination will pollute and render unusable groundwater and surface water southwards into Nebraska and surface waters within the Cheyenne River drainage eastwards into greater South Dakota. It's very likely that the oxidants used to free the uranium will also cause the destruction of underground storage containers and release their contents into the area's ground and surface waters. Also, based on my reading of the draft environmental impact statement, no comprehensive review of the geologic literature was conducted. In my view, the use of outdated scientific literature, or in this case, a general lack of review of recent study, should not be seen as an opportunity to operate in a knowledge vacuum. Much of the Great Plains region was studied prior to the 1980's and the general acceptance of Plate Tectonics Theory, and therefore generally misrepresents the geologic setting of the region. This was true of the geologic literature used to justify ISL mining near Crawford, Nebraska, and is also true of the data used to justify proposed mining near Edgemont, South Dakota. It is incumbent upon potential ISL operators, as it is with any natural resource extractors, to seek out the most recent research and expert opinions on the geological settings in which they propose to operate.

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Dated this 20th day of June, 2014.

/s/ Hannon LaGarry