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June 30, 2016

<u>Sent by U.S. Mail and Facsimile</u>
Ms. Jeanne Goodman, Chief Engineer
Department of Environment and National Resources
Water Rights Program
Foss Building
523 East Capitol
Pierre, SD 57501-3182

Re: *In the Matter of the Application of Croell Redi-Mix*
Application No. 2745-2

Dear Ms. Goodman:

Please find enclosed the original *Petitioners' Witness Disclosure* in the above-referenced matter. A copy of this document has been sent to Attorneys Brady and Mines Bailey which is intended as service by U.S. Mail and Facsimile.

If you have any questions or comments, please advise. Thank you.

Sincerely,

BANG, McCULLEN, BUTLER,
FOYE & SIMMONS, L.L.P.

Michael M. Hickey

MMH:bah
Enclosures
cc: Clients
Eric Gronlund
Thomas Brady
Ann Mines Bailey

STATE OF SOUTH DAKOTA
BEFORE THE WATER MANAGEMENT BOARD

IN THE MATTER OF THE APPLICATION OF CROELL REDI-MIX, APPLICATION No. 2745-2

Petitioners' Witness Disclosure

Pursuant to the *Order on Petitioners' Motion for Continuance*, dated June 20, 2016, Petitioners designate the following individuals as their witnesses and expert witness for the hearing scheduled for July 7, 2016:

1. Arden D. Davis, Ph.D., P.E. Dr. Davis is Petitioners' Expert Witness. See attached report titled *Groundwater Conditions in the Deadwood Aquifer near the Perli Quarry, Pennington County, South Dakota*, dated June 30, 2016.

2. Duane Abata.

3. Don Burger.

4. Barrett Wendt.

5. All witnesses designated by the Applicant.

6. Petitioners reserve the right to call additional witnesses to rebut any testimony which has not yet been disclosed.

Dated this 30th day of June, 2016.

BANGS, McCULLEN, BUTLER,
FOYE & SIMMONS, L.L.P

BY: _____
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ATTORNEYS FOR PETITIONERS

CERTIFICATE OF SERVICE

I certify that, on June 30, 2016, I served copies of this documents upon each of the listed people by the following means:

[X]	First Class Mail	[ ]	Overnight Mail
[ ]	Hand Delivery	[X]	Facsimile
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_____
MICHAEL M. HICKEY

Groundwater Conditions in the Deadwood Aquifer near the Perli Quarry, Pennington County, South Dakota

Arden D. Davis, Ph.D., P.E.
1014 Milwaukee Street
Rapid City, South Dakota 57701

June 30, 2016

Introduction

This report was prepared in regard to concerns of Dr. Duane Abata and other homeowners near the Perli Quarry, located in the SE ¼ of section 9, T. 1 S., R. 7 E, Pennington County, South Dakota (Figures 1 and 2). Croell Redi-Mix, Inc., has requested approval of a permit for expansion of the quarry near U.S. Highway 16, about 3½ miles east-northeast of Rockerville. The quarry is at an outcrop of the Minnekahta Limestone, a formation that is approximately 40 feet thick. Associated with the expansion of the quarry operations is Water Permit Application No.2745-2 for a well in the Deadwood aquifer that would pump a maximum of 0.33 cubic feet per second of groundwater, up to 19.6 acre-feet annually.

Deadwood Aquifer

The Deadwood aquifer underlies much of western South Dakota except where it has been removed by erosion in the central Black Hills. Its recharge area is exposed at outcrops of the Deadwood Formation on the flanks of the Black Hills, including a narrow band in the area near the Stratosphere Bowl, west of the quarry (Figure 3). The aquifer, at the site of

the Perli Quarry, appears to be under artesian conditions, based on information from the U.S. Geological Survey. The potentiometric surface of the Deadwood aquifer is at approximately 3500 to 3600 feet above sea level (Strobel et al., 2000), while the top of the Deadwood Formation (Carter and Redden, 1999) is approximately 3200 feet above sea level, indicating that the water levels in wells would stand above the top of the aquifer in this area. From this information, it appears that the head in the Deadwood aquifer is about 300 to 400 feet above the top of the Deadwood Formation. Based on a potentiometric map by Strobel et al. (2000), groundwater flow is generally eastward in the area. The total thickness of the Deadwood Formation is about 215 to 245 feet in the Rockerville area (Rahn, 1987), but the aquifer is contained mainly in the upper 80 feet of permeable sandstone, whereas the lower part of the formation is predominantly low-permeability shale, dolomite, and conglomerate (Lester and Rahn, 2001).

The Deadwood aquifer is not as productive as the Madison or Minnelusa aquifers in the Black Hills (Driscoll et al., 2002; Carter et al., 2002), but some wells have been drilled in the Deadwood where more abundant supplies from other formations are not available. Yields from wells in the Deadwood aquifer typically vary from about 10 to 40 gallons per minute in the Black Hills, with a median production of about 15 gallons per minute (Driscoll et al., 2002).

The recharge rate to sedimentary aquifers in this part of the Black Hills is about 1 to 2 inches per year (Driscoll et al., 2002). Flow in the Deadwood aquifer in this area generally is eastward, so the Deadwood Formation's outcrop immediately west of the area should be considered here. As shown on Figure 3, the outcrop of the Deadwood Formation, where recharge would occur, is exposed in a very narrow band. It appears that this

outcrop typically is about 300 feet wide. In the band of outcrop extending for three miles in a north-south direction, west of the quarry, about 100 acres of recharge area would be exposed. A recharge rate of 2 inches per year (1/6 foot per year) would result in about 17 acre-feet of groundwater that is recharged locally. According to SDCL 46-6-3.1, "No application to appropriate groundwater may be approved if, according to the best information reasonably available, it is probable the quantity of water withdrawn annually from a groundwater source will exceed the quantity of the average estimated annual recharge of water to the groundwater source." Thus, it appears that the requested appropriation of 19.6 acre-feet per year of groundwater would exceed this local recharge, especially when existing Deadwood wells in the area are considered.

Few estimates of aquifer properties are known for the Deadwood. The only pumping test for which information is available in the Black Hills was conducted and analyzed by Valder (2006), who determined a transmissivity (T) of about 70 ft^2/day and a storage coefficient (S) of about 0.001.

On the basis of aquifer properties and projected pumping rates, predictions can be made about likely drawdowns from proposed pumping of the Deadwood aquifer at the Perli Quarry. The Theis equation (Theis, 1935) is widely used for calculating drawdown. It has the following form:

$$s = (Q / 4 \pi T) W(u)$$

where s = drawdown, Q is the pumping rate, T is transmissivity, and W(u) is the well function of u. The dimensionless parameter, u, is expressed as:

$$u = (r^2 S / 4 T t)$$

where r is the distance from the pumped well to the point of interest, S is storage coefficient, T is transmissivity, and t is time. Standard values for W(u) vs. u can be found in groundwater textbooks by authors such as Freeze and Cherry (1979).

The aquifer properties for the Deadwood aquifer can be used with the Theis equation to predict drawdown at various distances from the Perli Quarry. A transmissivity of 70 ft^2/day, a storage coefficient value of 0.001, a pumping rate of 0.33 ft^3/sec (equivalent to about 150 gallons per minute), and a pumping time of 30 days would result in a calculated drawdown of more than 500 feet at the pumped well. This indicates that the drawdown could be great enough to dewater the aquifer at the quarry, because the head in the Deadwood aquifer is about 300 to 400 feet above the top of the aquifer, raising concerns about potential effects on existing water wells nearby.

It is important to note that the aquifer properties of the Deadwood aquifer are variable and could be less than the values used in the calculations above. Because of geologic variability, it is reasonable that the values of transmissivity and storage coefficient for a groundwater reservoir such as the Deadwood aquifer could vary by one order of magnitude or more. This should be considered in predicting effects from long-term pumping of the Deadwood aquifer. For example, if the transmissivity is 10 ft^2/day and the storage coefficient is 0.0002, with a pumping rate of 12.2 gallons per minute (equivalent to 19.6 acre-feet per year), the calculated drawdown at the pumped well would be about 385 feet at a time of twenty years. This also would result in a calculated drawdown of about 150 feet at an observation point 530 feet from the well. At a distance of about 1900 feet from the well, the predicted drawdown would be 100 feet. At a distance of about 7000 feet

from the well, the calculated drawdown would be more than 50 feet. Drawdown contours from these calculations are shown on Figure 4.

Because of uncertainties about the hydraulic properties of the Deadwood aquifer, and because Deadwood wells typically are not capable of yielding 100 gallons per minute or more, it is recommended that a pumping test be conducted before withdrawals of the proposed scale are permitted.

Radium and Radon in Groundwater of the Deadwood Aquifer

Radium and radon concentrations in the Deadwood aquifer are a health concern. Rounds (1991) documented a ^{226}Ra concentration of 66 pCi/L in groundwater from the Deadwood aquifer at Countryside Estates, near Sheridan Lake Road north of the Perli Quarry. In a U.S. Geological Survey publication, Williamson and Carter (2001) reported a mean concentration for ^{226}Ra of 6.0 pCi/L in the Deadwood aquifer. The public drinking-water limit for combined ^{226}Ra and ^{228}Ra is 5 pCi/L. A daughter product of radioactive decay of radium is radon, which is a concern because of air quality. Rounds (1991) found a ^{222}Rn concentration of 6600 pCi/L in a Deadwood well near Lead in the northern Black Hills. Williamson and Carter (2001) determined a mean concentration for ^{222}Rn of 1,971 pCi/L in the Deadwood aquifer. The U.S. Environmental Protection Agency has recommended 4 pCi/L as the action level for radon gas in homes (U.S. Environmental Protection Agency, 2013).

If pumped water from a Deadwood well is stored in a surface-water reservoir at the quarry site, it appears that radium and radon could be a problem because of the likelihood that the water would contain these contaminants in high concentrations, and because of the potential for accidental releases of water from the site. It is recommended that a plan

should be formulated to deal with radium and radon from pumped water at the site.

Conclusions

Proposed groundwater withdrawals from a well in the Deadwood aquifer at the Perli Quarry could dewater the aquifer at the proposed site and could cause drawdowns of 50 feet or more at a distance of more than one mile from the quarry, potentially affecting nearby homeowners. It also appears that the requested appropriation of 19.6 acre-feet per year of groundwater could exceed the local recharge rate to the Deadwood aquifer, potentially causing long-term problems for owners of Deadwood wells in the area. It is recommended that a pumping test be conducted before withdrawals of the proposed scale are attempted.

Radium concentrations in groundwater of the Deadwood aquifer are a concern that should be addressed, particularly if the pumped water is stored in an exposed reservoir at the quarry site, where releases to the environment could occur. A plan should be formulated to deal with radium and radon in groundwater from the well.

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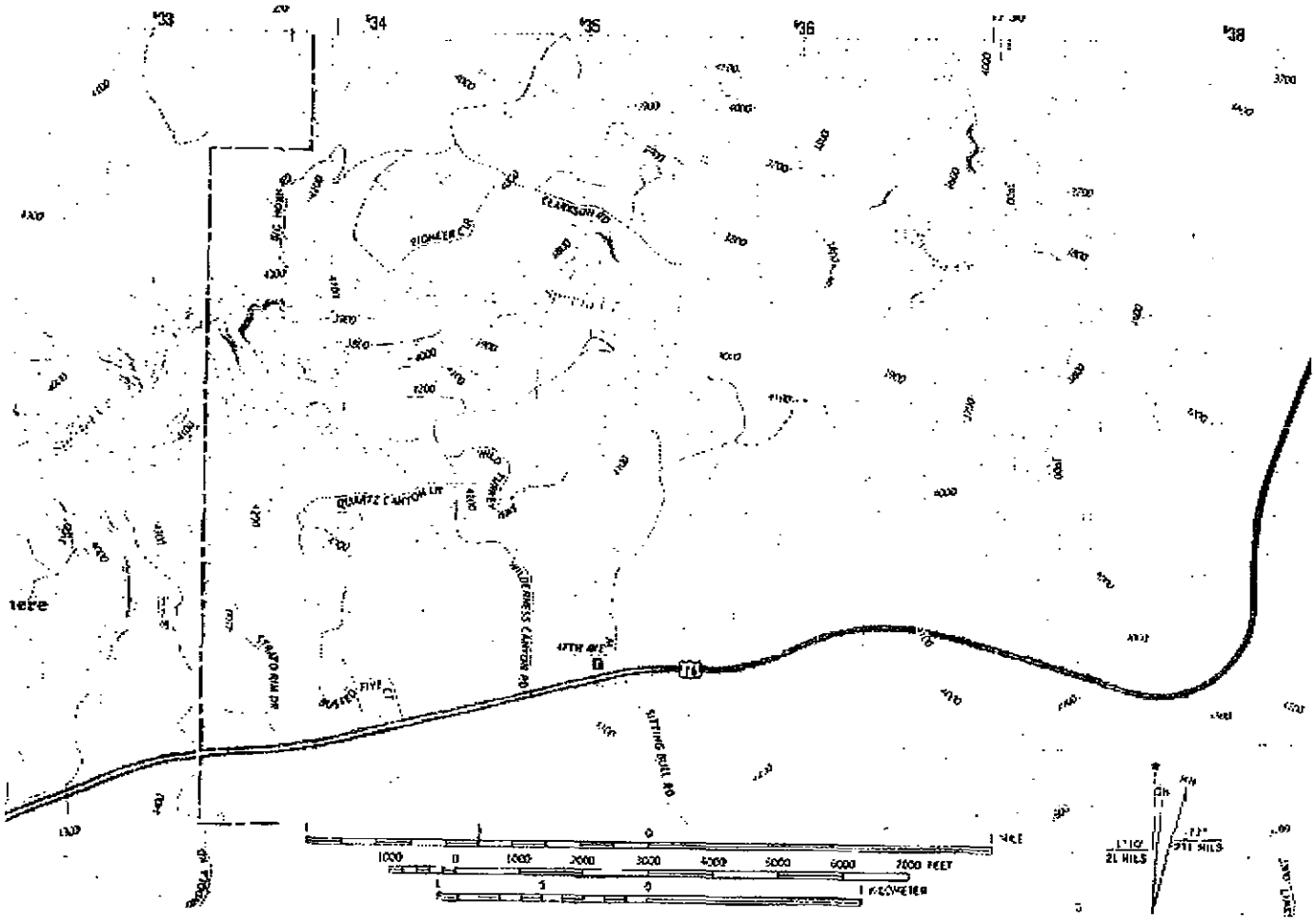

Figure 1. Topographic map of part of the U.S. Geological Survey's 1:24,000-scale Rockerville quadrangle. The Perli Quarry is in the southeastern part of the map, northwest of the large curve in U.S. Highway 16.

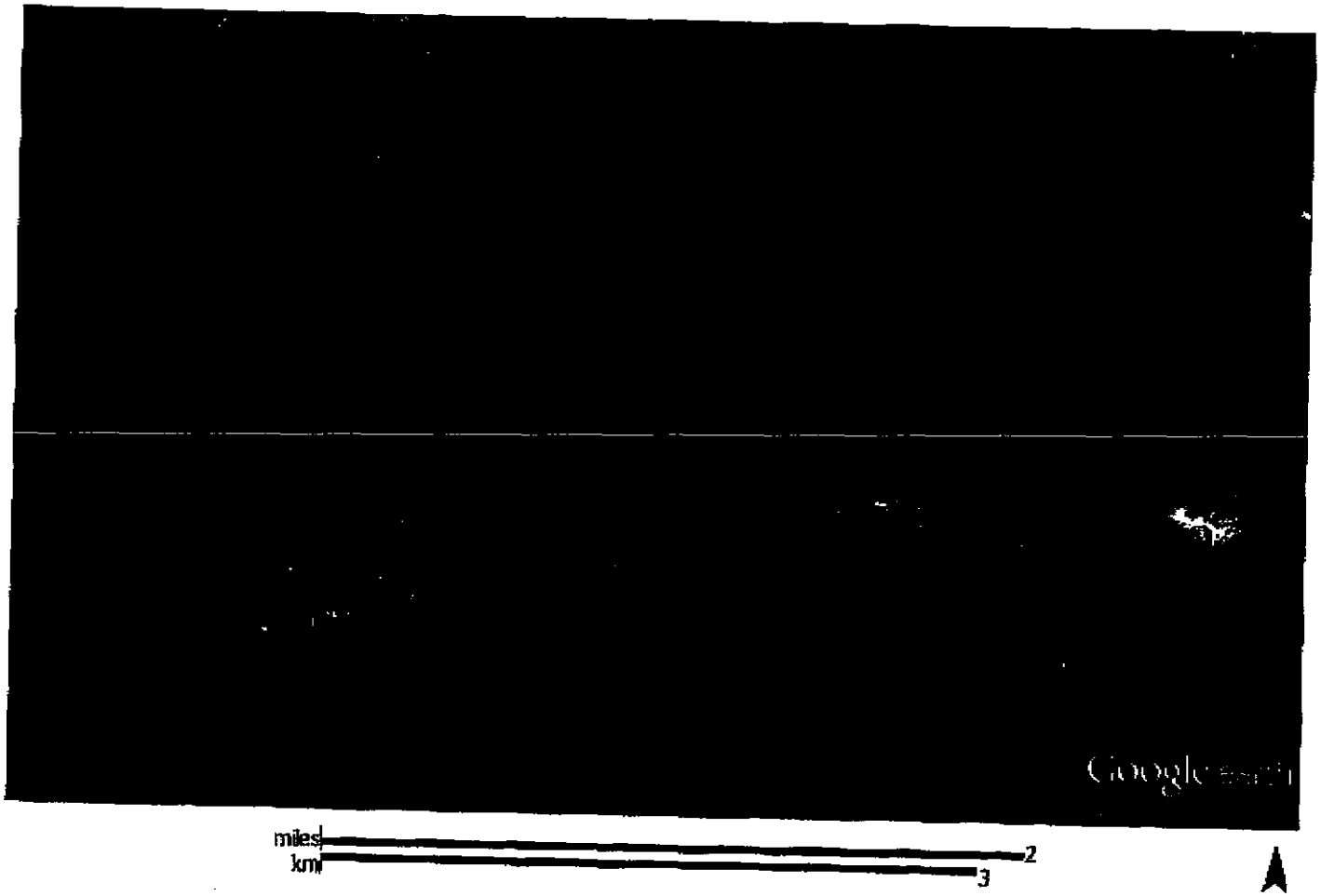

Figure 2. Aerial view of the Perli Quarry and nearby homes (from Google Earth, 2016). The Perli Quarry is the tan-colored area in the southeastern part of the image.

Figure 3. Geologic map of part of the Rockerville quadrangle (from Lester and Rahn, 2001). The Deadwood Formation is the narrow band labeled OC_d near the western edge of the map.

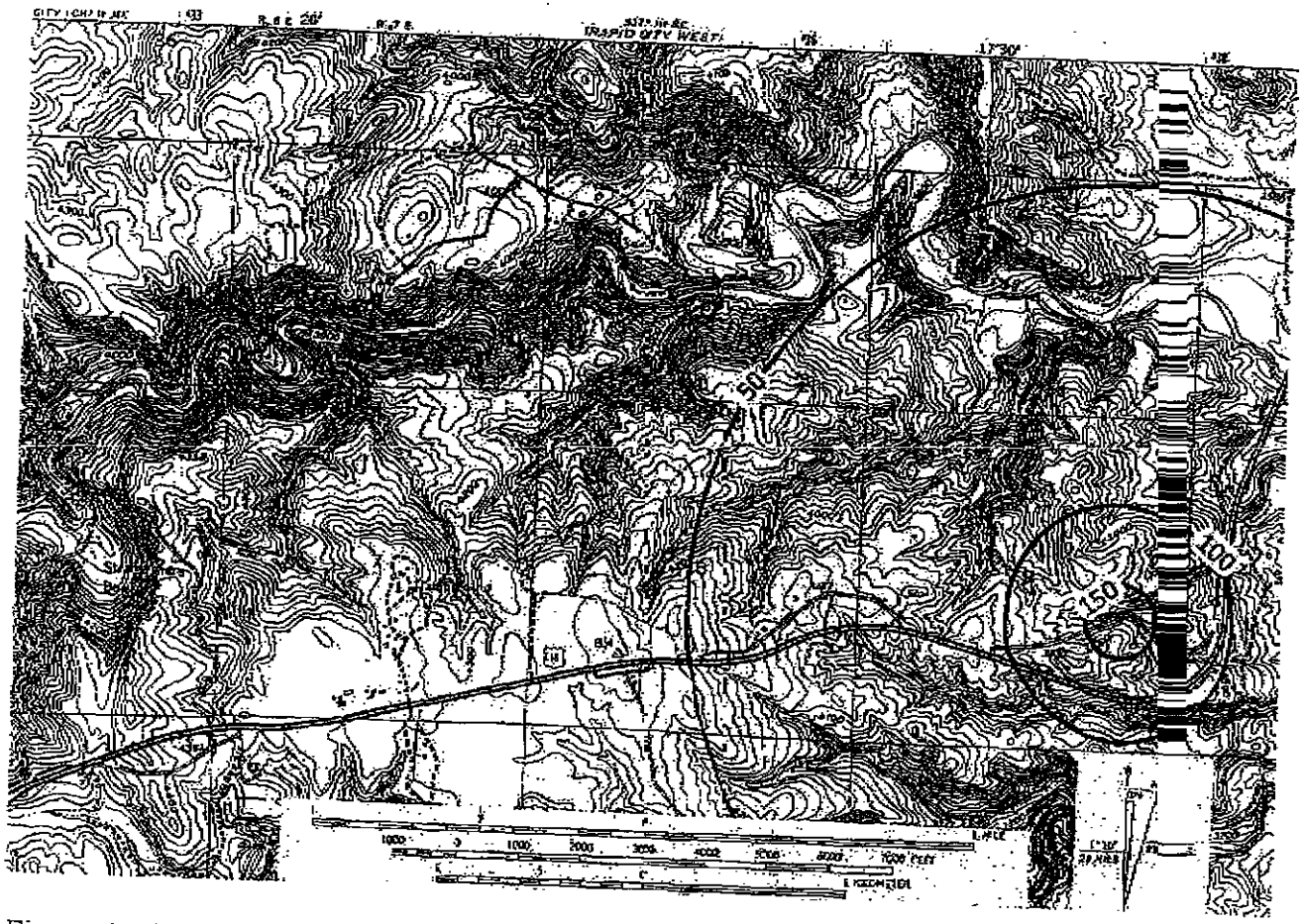

Figure 4. Calculated drawdown contours (in feet) from pumping 12.2 gallons per minute for twenty years in a Deadwood aquifer well at the Perli Quarry, with a transmissivity of 10 ft^2/day and a storage coefficient of 0.0002. Base map from the U.S. Geological Survey's 1:24,000-scale Rockerville topographic map.