Uranium Mining in the Edgemont District

Rapid City Common Council
Mark Hollenbeck – Project Manager

- Dewey Native
- Organic Rancher
- B.S. Chemical Engineering – SDSM&T
- Former Mayor of Edgemont
- Former SD State Legislator
- Background in Energy and Engineering Management
- Licensed Professional Engineer
Mark Hollenbeck
Dewey Native & Organic Rancher
Presentation Overview

- What is Uranium
- History of Uranium Mining in SD
- *In Situ* Recovery (ISR) Process
- Dewey–Burdock Project
- Regulatory Status
- Economic Benefits
What is Uranium?

- Naturally occurring radioactive element
- Part of Earth’s formation 4.5 billion years ago
- Fairly common element in Earth’s crust, groundwater & seawater
- As common as tin, tungsten, molybdenum
- A square mile of earth (640 acres), one foot deep, will typically contain about 4 tons of uranium
Food and water contain uranium

- We eat about 1-2 micrograms of natural uranium every day – amount depends on source
- We drink about 1.5 micrograms of natural uranium for every liter of water we drink – amount depends on source
What causes Cancer?
Radiation is not a big hitter!!!

WHO

- Cigarette smoke
- Diet & nutrition
- Chronic infection
- Occupational exposure
- Genetic
- Alcohol drinking
- Environmental factors including radiation
Sources of Ionizing Radiation
Collective effective dose as a percentage for all exposure categories in 2006

- Radon & Thoron (background) 37%
- Medical 48%
- Industrial <.1%
- Consumer 2%
- Occupational <.1%
- Space (background) 5%
- Terrestrial (background) 3%
- Internal (background) 5%

Source: NCRP report no. 160 (1).
Long Term Impacts of Contamination

The worst case surface soil radionuclide contamination scenario is a near ground burst of the item below.
Immediate Effects

The immediate effects are somewhat bleak
Later, however...

...a metropolis blossoms
Uses of Uranium & Byproducts

- Nuclear power
  - 20% of U.S. electricity
  - 104 operating plants
- Medical isotopes
  - Diagnostics
  - Therapies
- Smoke detectors
- Luminous watch dials
- Military armor and armament
- Counterweights on ships & aircraft
Uranium
The Planet’s Most Powerful Energy Source

- 2 million times more powerful than chemical energy (coal, natural gas)
- Small footprint
- No carbon dioxide emissions
- No emissions regulated by Clean Air Act
- Domestically supplied

One uranium fuel pellet – the size of the tip of your little finger

= 149 gallons of oil
= 1,780 pounds of coal
= 17,000 cubic feet of natural gas
Uranium
A Very Dense Source of Energy

It takes 75 train cars of coal to equal the energy produced from one drum of yellowcake.
The U.S. will need 26% more electricity between 2007 and 2030

Source: US DOE 2009 Annual Energy Outlook
http://www.eia.doe.gov/oiaf/aeo/electricity.html
Uranium Purchased
By Owners & Operators of U.S. Civilian Nuclear Power Reactors

Million Pounds
$U_3O_8$
Equivalent

Source: U.S. Department of Energy, Energy Information Administration
http://www.eia.doe.gov/cneaf/nuclear/umar/summarytable1.html
104 Operating U.S. Nuclear Power Plants

Source: Nuclear Energy Institute
http://nei.org/resourcesandstats/nuclear_statistics/usnuclearpowerplants/
Projected New Nuclear Power Reactors

Source: U.S. Nuclear Regulatory Commission
Nuclear Power – the Clean Choice

Carbon Footprint - Sources of Electricity
Life Cycle Assessment - Cradle to Grave

Source: UK Parliamentary Office of Science and Technology, Oct. 2006
Other Benefits of Nuclear Power

- Reliable – 24 / 7
  - Produces at night
  - Produces when cloudy
  - Produces when wind isn’t blowing

- Efficient
  - 20% of total electrical output but <10% of capacity

- Safe and Secure
  - Would have to live near a nuclear power plant for more than 2,000 years to get same radiation exposure as an x-ray (Clean and Safe Energy Coalition)
  - “Are probably our best defended targets,” (Center for Strategic and International Studies)
Early Uranium History

- 1789 - Discovered by German chemist Martin Klaproth
  - Used only as coloring agent for glass & ceramic glazes
- 1896 – Becquerel discovers uranium’s radioactivity
  - Uranium Discovered in Craven Canyon
- 1898 – Marie & Pierre Curie discover radium
  - Thought to be miracle cure for cancer
  - Rapid expansion in uranium mining until late 1930’s
- Curies’ work led study of uranium around the world
  - 1939 - First proven nuclear fission (Germany)
  - 1942 – First chain reaction by Enrico Fermi (U of Chicago)
  - 1945 – First nuclear weapons used (Hiroshima, Japan)
Mining in the Edgemont Area

- 1951 – June - Uranium discovered in Craven Canyon – Jerry Brennan
- 1952 – January first shipment of U to Rifle CO – Roy Chord
- 1954 – Mill was needed
- 1955 – March contract was issued to build new mill
DW Ck Govt Pd        Washington D C  654Pm      Mar 31, 1955

William Schoenmacher
Edgemont, S Dak.

Contract for uranium mill went to Mines Development Inc of
Golden to be located at Edgemont.

E Y Berry
537Pm
Above is pictured Governor Joe of the Mines Development Corp., as they are escorted through the main street of Edgemont, in a convertible driven by Roy. Miss Donna Rea Seppala, Miss Uranium, and Allen Gray, Vice-President and General Manager, are pictured with Mrs. Chord, as they are taken to the site of the uranium mill, preceding the ceremonies.
Edgemont Uranium Mill
Firm to Get Uranium From Dakota Lignite

DENVER — (AP) — Susquehanna-Western, Inc., announced Monday it is ready to buy and process uranium-bearing lignite ores in North and South Dakota.

The firm is a division of the Susquehanna Corp. of Chicago.

An official said in a statement that plant operations have solved metallurgical problems of extracting uranium concentrate from lignite in the production of uranium from this source.

The statement said Mines Development, Inc., a Susquehanna subsidiary, will buy all uranium-bearing materials from the Dakota plains mining district and guarantee a market through 1966.
Uranium Mines & Sites - Fall River County

128 Fall River County mines listed:

www.mindat.org/loc-44863.html

With names like Trail Wind, Apple Pie, Get Me Rich, Yellowcat, Green Slipper, PeeWee & Rip Snorter
Darrow Mine
ISR Well Field
Recovering Uranium

Cameco’s Crow Butte ISR, Crawford, NE
Spencer Richardson
New mining standards in place
In Situ Recovery History

- 1974 – First *in situ* uranium recovery permit issued (Texas)
- 1980’s
  - U.S. producers turned to in-situ recovery operations to extract uranium from ore
  - Oxygen technology for ISR perfected
- 2004 - 6 uranium extraction operations in U.S.
  - 3 conventional
  - 3 *in situ*
In Situ Treatment
In Environmental Remediation

Issue:
Groundwater treatment employs many different technologies. Conventional ex situ (removed from source) treatment methods, such as pump and treat, can have substantial operation and maintenance costs and may not achieve cleanup objectives within reasonable time frames, if at all. As an alternative, in situ (at source) processes treat soils and groundwater in place (without removal) with physical chemical or biological treatment technologies. This approach may be advantageous since the costs of materials handling and some environmental impacts, such as energy use and disruption of the surrounding area, may be reduced.

Scientific Objective:
The U.S. Environmental Protection Agency’s (EPA) Land Research Program in the Office of Research and Development (ORD) has made significant contributions to exploring innovative solutions to groundwater pollution problems and translating research results into practical applications. Scientists are evaluating the use of in situ treatment at hazardous waste sites and verifying innovative technologies. Research currently focuses on air sparging, thermal treatment, permeable reactive barriers, chemical treatment, bioremediation, phytoremediation, and monitored natural remediation. More information can be found at: www.frp.gov/optimization/treatment/in situ.htm or http://clu-in.org. Technologies are tested by scientists in laboratories and with pilot-scale demonstration projects.

In situ processes can be used in combination with each other and with more conventional ex situ treatments to enhance their effectiveness. Removal rates and extent vary on the basis of contaminants and site-specific characteristics; contaminant distribution and concentration; co-contaminant concentrations; indigenous microbial populations and reaction kinetics; and soil parameters. Many of these factors are site dependent and can be difficult to manipulate. As a result, in situ treatment may not be uniform throughout the treatment area.

Application and Impact:
ORD’s evaluation of new technologies and collaboration with EPA’s regional offices has reduced remedial costs and improved effectiveness. Research contributions include:

- ORD scientists are continuing to investigate the fundamental and applied aspects of In Situ Chemical Oxidation (ISCO). ISCO introduces a chemical oxidant into the subsurface to transform groundwater or soil...
Origin of Uranium Roll Front Deposits

Rain Water

Volcanic Ash

O₂ & CO₂

Oxidizing H₂O

Confining Layer

Uranium Ore (Roll Front)

Reducing H₂O

Clay
In-Situ Recovery
Temporarily Reverses the Natural Deposit Process
Typical ISR Wellfield Layout

- Ore Zone
- Buffer Zone
- Permit Boundary
- Aquifer Exemption Boundary
- Monitor Well Ring
  < 400’ from Nearest Part of Wellfield
- Ore Zone
Cone of Depression Created

- Slightly more water is extracted from the ore-bearing formation than is re-injected
- “Bleed” produces cone of depression in mining area
- Cone of depression controls fluid flow – confining it to the mining zone
Groundwater Usage in ISR

- Native to ore formation
- Contains uranium and other radionuclides
- Not suitable for drinking water, livestock or agriculture
- Augmented with $\text{O}_2$, $\text{CO}_2$
- Recirculated
- Bleed stream is typically 0.5 - 3%
- Agreement with County on wells

Photo courtesy of Crow Butte Resources
End of Production

- Groundwater quality restored to prior use
- Wells plugged
- Pipelines removed
- Surface re-vegetated
- Leased land returned to landowner
Dewey-Burdock Reserves
(Nearly 11 Million Pounds of Uranium Oxide)

Enough Energy to Power South Dakota for over 15 years
Located about 12 miles northwest of Edgemont, South Dakota
A South Dakota corporation
Project office Edgemont
Corporate office Greenwood Village, CO
Almost all employees work and live in U.S.
Subsidiary of Powertech Uranium Corp.
Cross-Section of Uranium Occurrences
Black Hills Uranium District
Simplified Hydrologic Setting of the Black Hills Area

Potential Well Field Areas
Natural Features

(Concern #1)

- Geological confinement of ore zone
- Natural precipitation of uranium out of groundwater in oxygen deficient environments
Operational Features
(Concern #1)

- **Wellfield Design:** Injection and extraction pressures keep the solution moving through the ore.

- **Bleed Pressure:** Slightly more water withdrawn than re-injected. Gradient results in a flow toward production wells, not away from them.

- **Monitor Wells:** Measure groundwater levels and chemistry, allowing adjustments of injection, extraction and bleed rates to balance wellfield.

Wellfield Control
Dewey-Burdock Project Approach

- State Permits
- NRC License
- EPA Permit

Background & Project Specific Data
Baseline Studies & Project Specific Data Collection Completed - Fall 2008

- Site Characterization
- Meteorology
- Geology and Seismology
- Hydrology
- Environmental Justice
- Radiological Characteristics
- Cultural Resources
- Ecology (soils, vegetation, fish & wildlife)

- Description of Proposed Facility and Operations
- Effluent Control System
- Groundwater Restoration, Surface Reclamation, and Decommissioning
- Environmental Effects
- Socio / Economic Cost-Benefit Analysis
- Alternatives
# Groundwater Sampling Results

<table>
<thead>
<tr>
<th>Location</th>
<th>Gross Alpha-Dissolved (pCi/L)</th>
<th>Radium 226-Total (pCi/L)</th>
<th>Radon 222-Total (pCi/L)</th>
<th>Solids-Total Dissolved TDS @ 180 C (mg/L)</th>
<th>Uranium-Dissolved (mg/L)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ranch A</td>
<td>37.45</td>
<td>17.4</td>
<td>1090</td>
<td>785</td>
<td>0.0014</td>
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<tr>
<td>Ranch B</td>
<td>5.05</td>
<td>2.2</td>
<td>674</td>
<td>1100</td>
<td>ND</td>
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<tr>
<td>Ranch C</td>
<td>373</td>
<td>79.7</td>
<td>132000</td>
<td>950</td>
<td>0.0237</td>
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<tr>
<td>Ranch D</td>
<td>8.2</td>
<td>1.1</td>
<td>305</td>
<td>890</td>
<td>ND</td>
</tr>
<tr>
<td>Burdock PT</td>
<td>4090</td>
<td>1192.7</td>
<td>143000</td>
<td>2400</td>
<td>0.172</td>
</tr>
<tr>
<td>Dewey PT</td>
<td>656</td>
<td>430.9</td>
<td>462000</td>
<td>930</td>
<td>0.0117</td>
</tr>
</tbody>
</table>

[1] Radium 226 and 228 (combined)  
[2] Proposed MCL  
[3] “Secondary” guideline value above which use of water may give rise to complaints
Groundwater Sampling Results

- Gross Alpha-Dissolved (pCi/L)
- Radon 222 Total (pCi/L)
- Radon 222 Dissolved (pCi/L)
- Dissolved Radon 222 (pCi/L)
- Uranium-Dissolved (mg/L)
- EPA MCL

Graph showing various radionuclide levels and their concentrations in groundwater samples.
Groundwater Sampling Results w/o Radon

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Burdock Ore Body</th>
<th>Dewey Ore Body</th>
<th>EPA MCL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gross Alpha-Dissolved (pCi/L)</td>
<td>4300</td>
<td>1200</td>
<td>400</td>
</tr>
<tr>
<td>Radium 226-Total (pCi/L)</td>
<td>200</td>
<td>100</td>
<td>100</td>
</tr>
<tr>
<td>Solids-Total Dissolved TDS @ 180 C (mg/L)</td>
<td>1000</td>
<td>200</td>
<td>300</td>
</tr>
<tr>
<td>Uranium-Dissolved (mg/L)</td>
<td>50</td>
<td>10</td>
<td>50</td>
</tr>
</tbody>
</table>

Burdock Ore Body
Dewey Ore Body
EPA MCL
Inyan Kara Water Use

170 gpm Maximum Consumption
8,500 gpm Recycled

Drawdown at Boundary (Powertech Engineers)
- 10’ Lakota (approximately 450’ available)
- 12’ Fall River (approximately 300’ available)
- Recover to 1’ - 2’ after one year post mining

DENR
- 1,400 acre feet of recharge in the area
- Other users using 327 acre feet
- Dewey-Burdock to use 274.2 max acre feet
Madison Water Use

551 gpm Maximum Consumption

Drawdown 5 miles from Boundary (Powertech Engineers)
- 8.5’
- Edgemont has 200’ above ground at 16 miles

DENR
- At 1,000 feet - 35’ of head reduction
- Approximately 2800’ of head available
46-5-32. Assignment of application, permit, or license. Subject to the limitations provided in §§ 46-5-33 and 46-5-34, any application, permit, or license to appropriate water, including a permit issued under § 46-5-8.1, may be assigned, but no assignment is binding, except upon the parties thereto, unless filed for record with the chief engineer. No assignment may carry with it the right to use the water for any purpose or in any manner other than that specified in the application, permit, or license without the approval of the Water Management Board. Transfer of an application to appropriate water does not confer any right to use of water. The evidence of the right to use water from any works constructed by the United States, or its duly authorized agencies, shall in like manner be filed with the chief engineer, upon assignment. A sale, grant, conveyance, assignment, lease, or other transfer of a permit or license issued under § 46-5-8.1 may be assigned only in accordance with the terms of the contract or instrument of conveyance between the district and the energy industry user.
46-6-3.1. Annual withdrawal of groundwater not to exceed recharge--Exception for water distribution systems.

No application to appropriate groundwater may be approved if, according to the best information reasonably available, it is probable that 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. An application may be approved, however, for withdrawals of groundwater from any groundwater formation older than or stratigraphically lower than the greenhorn formation in excess of the average estimated annual recharge for use by water distribution systems.
Maximum Drawdown
Fall River / Chilson
Southern Hills Cross Section
Comparable Water Rights

- Rapid City – 97.3 cfs
- Hot Springs – 9.2 cfs
- Custer – 5.8 cfs
- Edgemont - 1.9 cfs
- Dewey Burdock – 1.6 cfs
Rainfall vs Project Consumption

Project Annual Rainfall
Annual rainfall of 1.35 ft x 325,831 gal/acre ft x 11,800 acres

\[
\begin{align*}
&= 5,210,031,639 \text{ gal}
\end{align*}
\]

Project Annual Water Consumption
551 GPM

\[
\begin{align*}
&= 289,605,600 \text{ gal}
\end{align*}
\]

Project Consumption = .056 of Annual Rainfall

Annual Rainfall = 18 x Project Water Consumption
Grazing Value vs Mining Value

**Gross Annual Grazing Value**

11,800 acres @ 40 acres/calf = 295 calves

295 calves @ $900 each = **$265,500**

**Gross Annual Mineral Value**

$800,000 lbs U308 @ $50 = **$40,000,000**

**Gross Mining Value = 151 x Gross Grazing Value**
Agriculture & Uranium Extraction

We don’t have to make a choice.
US Nuclear Regulatory Commission
Supplement to the GEIS
Dewey-Burdock Project
Comparing Early Conventional Mining to Modern ISR
Is Like Comparing

A flight with the Wright brothers
to

A modern flight on a 747
Economic Benefits

State of South Dakota
- Severance Tax
- Conservation Tax
- Sales & Use Tax

Local Governments
- Severance Tax
- Sales & Use Tax
- Property Tax
- Employment
Running on empty

By Jason Ferguson

For Cherish Baker, running Baker's Bakery during the winter months doesn't make a lot of sense. Mostly because if she is lucky, it only makes a few cents. Baker is one of many Custer business owners who close up their store in the winter, opting for a few months of vacation rather than scraping by, usually in the red, during months when she says there aren't enough people in town to make keeping her restaurant open viable.

Whether it's a restaurant, a grocery store or a mechanic, business owners struggle to keep their heads above water when tourism season winds down.

"Unfortunately, there aren't enough people in this town to sustain (staying open)," Baker said. "It's just not worth it."

Now in her seventh year of owning the bakery, Baker said she stayed open over the winter for the first three years, but quickly figured out there was little, and usually no, money to be made in the winter.

"It's gotten worse and worse as the years have gone on," she said.

"It would be great and I would love to stay open, even if it was just to break even."

Baker said on the average day, 30 people would come into the bakery in the winter, compared to 300 in the summer. Expenses also rise in the winter, such as the cost of propane and electricity.

"I just opened my electric bill, and it was over $1,000, and that was with the place shut down," she said.

Steve Sallee, now in his third year as owner of Rushmore Automotive, can relate.
Estimate of Economic Benefits
- Local Governments -

- $50 million - Payroll
- $250 million - Other direct expenditures
- $185 million - Indirect expenditures
- $10 million - Severance taxes
- Additional $ for property taxes
Estimate of Economic Benefits
- State of South Dakota -

$7.6 million – Sales tax
$10 million – Severance tax
$1.1 million – Conservation tax
Hollenbeck Ranch Life

The Cheyenne River is a quality of life as well as the swimming hole of choice for the Hollenbeck kids.
Mark Hollenbeck
Project Manager

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