White Mesa Uranium Mill And Wind River UMTRA

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Outline

• USGS-EPA Tribal Water Quality Work
• White Mesa Uranium Mill
• Wind River Uranium Project
EPA-USGS-Tribal Cooperation

- Given 3-4 months per tribe to complete retrospective analysis
- One week visit to the reservation – meet with tribal environmental staff, tour reservation, meet with other state and federal agencies (BIA, IHS, USGS, BOR, NRCS, State Health Departments)
- Invite tribal staff to Denver in fall/winter to work with them one-on-one
EPA-USGS-Tribal Cooperation

- Uranium Study – White Mesa – Completed
- Uranium Study – Wind River Reservation – Ongoing
- Effects of Oil and Gas Drilling on Water Quality – Fort Berthold Reservation - Ongoing
Mill History

• Began operations in 1980
• As of September 2007 the Mill has recovered 29 million pounds of $\text{U}_3\text{O}_8$ and 33 million pounds of $\text{V}_2\text{O}_5$ processed from 3.8 million tons of ore
• Greater than 1.6 million pounds of $\text{U}_3\text{O}_8$ recovered from alternate feed materials
Exposure Pathways

- Volatilization to the atmosphere
- Wind and water distribution of fine material from the ore storage pads to surrounding areas
- Leakage to the surficial aquifer
- Water Table aquifer in the Dakota Sandston/Burro Canyon Formation
- Morrison Formation

- Tailings Cell
- Mill
- Drying oven
- Ore-storage pads
Sample Design

• Quarterly monitoring of wells and springs upgradient and downgradient of the Mill for field parameters, major ions, and total and dissolved metals

• Periodic sampling of springs and wells for uranium isotopes
Sample Design

• Soil survey with portable gamma radiation detectors
• Collection of stream sediment samples for analysis of metals from about 30 locations in the ephemeral stream channels draining the White Mesa
• Collection of sagebrush samples
NOTE:
1. THIS DRAWING IS NOT TO SCALE.
2. ALL THICKNESSES ARE APPROXIMATE.

STRATIGRAPHY OF WHITE MESA
PREPARED FOR
ENERGY FUELS NUCLEAR
DENVER, COLORADO

OTITAN Environmental
White Mesa Hydrology

• Springs in the Burro Canyon are used by tribal members; groundwater flow is from the Mill south toward the reservation.
• The Brushy Basin Member and the Summerville Formation act as aquitards that prevent the mixing of groundwater with the formations above and below them (Freethey and Cordy, 1991).
White Mesa Hydrology

- The Westwater Canyon, Recapture, and Salt Wash Members of the Morrison Formation are considered an aquifer by Freethey and Cordy (1991) but it is not used by tribal members.
- The Navajo Sandstone provides drinking water to the towns of White Mesa, Blanding, Bluff, and Montezuma Creek.
White Mesa Geochemistry

- Have measured some variability in the concentration of major ions and uranium among our sampling sites.
- Despite variability in major ion composition, uranium is expected to be mobile in White Mesa groundwater.
- Would expect low concentrations in groundwater (Johnson and Thordarson, 1966).
Average Major Ion Composition

Explanation
- Bayless Well
- Cow Camp Spring
- East Well
- Entrance Spring
- Lyman Well
- Mill Spring
- Oasis Spring
- PWN
- PWS
- Ruin Spring
- West Well
Uranium Distribution in Water

- **Oasis Spring**
- **Bayless Well**
- **Lyman Well**
- **Entrance Spring**
- **South Mill Stock Pond**
- **WM East Well**
- **Anasazi Pond**
- **Mill Spring**
- **Cow Camp Spring**
- **Ruin Spring**
- **WM West Well**

**TOTAL URANIUM, IN PARTS PER BILLION**

**EPA Drinking Water MCL**

**Median**

**North**

- **OASIS SP**
- **BAYLESS WELL**
- **LYMAN WELL**
- **ENTRANCE SP**

**Mill area**

- **MILL SP**
- **COW/CAMP SP**
- **S. MILL STK. POND**

**South**

- **RUIN SP**
- **WM MW EAST**
- **ANASAZI POND**
- **WM MW WEST**
Uranium Isotopes

The diagram illustrates the distribution of uranium isotopes, with data points representing different locations and activities. The x-axis represents the dilution factor (1/U x 1,000) of dissolved uranium, while the y-axis shows the activity ratio of 234U/238U. Various locations such as Cow Camp Sp, WM MW East, and others are plotted with distinct symbols, indicating their respective activity levels.
S & O ISOTOPES IN SULFATE

DELTA 18-O (SULFATE), IN PER MIL

DELTA 34-S (SULFATE), IN PER MIL

Perimeter wells & springs
Mill monitoring wells
Tailings cells
Wildlife ponds

DELTA 18-O (SULFATE), IN PER MIL

DELTA 34-S (SULFATE), IN PER MIL

COW CAMP SP
MW EAST
ENTRANCE SP
MILL SP
OASIS SP
MW WEST
RUIN SP
White Mesa Soils

• Measurements with portable gamma detectors along Highway 191 for 2 miles south of the Mill recorded levels of <3 pCi/g Ra-226 – equivalent to background levels for the area.

• However, we measured levels up to 50 pCi/g Ra-226 near Entrance Seep on the east side of Highway 191 opposite the entrance road to the Mill and the area around Entrance Seep.
Background Sites

White Mesa Uranium Mill

White Mesa Study Team
Uranium Concentration in Sediments

U concentration in ppm dry weight
Uranium concentration in Big Sagebrush
Conclusions

• Uranium introduced into the groundwater in the Dakota Sandstone/Burro Canyon Aquifer would be mobile.
• $^{234}\text{U}/^{238}\text{U}$ values indicate a natural source of uranium in the groundwater at all sampling sites with the possible exception of Entrance Seep.
• At Entrance Seep there is a decrease in the values of $^{234}\text{U}/^{238}\text{U}$ with an increase in concentration of dissolved uranium.
Conclusions

• S and O isotopes of sulfate – no tailing cell influence on Entrance Seep
• All these facts suggest that small sized particles are being blown off the ore storage pads and are dissolving in Entrance Seep
• Spatial patterns of uranium concentration in sediment and vegetation samples support this hypothesis
Lessons Learned

- Use of uranium concentration data only is not sufficient for identifying source(s) (background and/or offsite migration) of uranium in groundwater
- Localized nature of uranium deposits and natural processes (evaporation) can result in large spatial variations in the concentration of uranium in groundwater
Lessons Learned

- $^{234}\text{U}/^{238}\text{U}$ alpha activity ratios - useful in distinguishing sources of uranium (ore vs. natural weathering)
- $\delta^{34}\text{S}$ and $\delta^{18}\text{O}$ in sulfate - sulfuric acid in tailing cells has distinctive isotopic signature relative to sulfate in groundwater
Lessons Learned

- Uranium concentration data in soils and vegetation can confirm that spatial variations in uranium concentration in groundwater is due to off-site migration

- $^{235}\text{U}/^{238}\text{U}$ and $^{236}\text{U}/^{238}\text{U}$ ratios can be useful in monitoring other types of facilities (Ketterer and others, 2000; and Ketterer and others, 2003)
Wind River Reservation

• Began a project similar to the White Mesa Project but bigger in scope in 2011
• Groundwater contaminated with uranium and other metals headed toward the Little Wind River
• WREQC has asked for verification of DOE’s assessment of the situation
FIGURE 2.3
GEOLOGIC CROSS SECTION
RIVERTON, WYOMING, SITE

LEGEND

- SAND PACK
- SCREEN
- T.D. = TOTAL DEPTH
- SANDSTONE
- SHALE
- SANDSTONE
- SHALE
- SANDSTONE
- SHALE
- SANDSTONE

a) DH-2 DECOMMISSIONED 1987.
b) RVT-701 CORED TO 201.3 FT REAMED TO 228.0 FT GEOPHYSICALLY LOGGED TO 219.0 FT.
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