Cost Analysis of Uranium Mining in the Grants Mining District, New Mexico, 1955-1989

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INTRODUCTION

New Mexico was the dominant producer of uranium in the U.S. for almost three decades starting in the mid-1950's and currently has the 2nd highest reserves in the U.S. From 1951-1980, the Grants uranium district in northwestern New Mexico yielded more uranium than any other mining district in the United States, amounting to just under 350 million pounds of U3O8 or 37.5% of total U.S. production over the 1947-2002 period (McLemore, 2007).

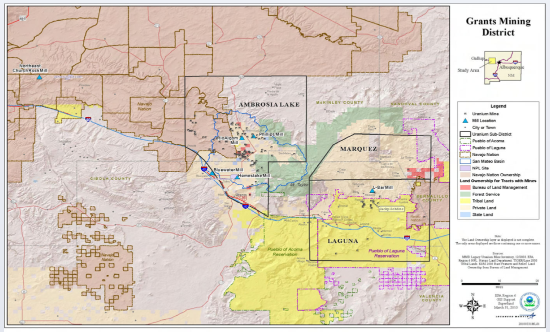

Figure 1. Grants Mining District, New Mexico

While there are several studies looking at the economic benefits of past and proposed uranium mining in New Mexico, no study to-date has compiled the economic costs of past uranium production in the Grants district. The legacy of uranium mining in New Mexico is still felt today with active mine and mill reclamation at dozens of sites across the state. In addition, past exposures to radon gas in underground uranium mines continues to take its toll on former miners in terms of lung cancer and debilitating respiratory illnesses (Boice et al, 2008). We are the first to provide cost estimates of past, on-going, and projected reclamation and remediation costs as well as estimates of the costs associated with unintended premature deaths for miners in the Grants district over 1955-1989 (all mining ceased in 1989).

We compile a present value estimate of the overall costs borne by the mining companies, Tribal Nations, the state of New Mexico and the Federal government.

OBJECTIVES

- Estimate present value mill & mine reclamation and remediation costs; 1981-2070
- Calculate person-years of life lost (PYLL) among underground uranium miners due to radon exposure; 1955-1989
- Using PYLL results, estimate for aggregate Grants miners:
  - Indirect costs to society of premature loss of life (value of lost utility and net savings at time *t*)
  - Direct medical costs of lung cancer diagnosis and treatment
- Perform a sensitivity analysis to develop a lower-bound and an upper-bound estimate of present value costs

Figure 2: DOE notice at former Ambrosia Lake mill

RESULTS

Table 1: Number of excess lung cancer deaths among Grants miners

	Lower-bound	Benchmark	Upper-bound
Excess Lung Cancer Deaths	446.04	687.12	933.85
% of unique miners	1.42%	1.79%	2.02%

Table 2: Present value reclamation & remediation costs of Grants mining (2012$)

	Lower-bound	Benchmark	Upper-bound
Reclamation & Remediation Costs	$374 million	$417 million	$473 million
$/lb. U3O8[i]	$1.13	$1.26	$1.43

[i]Based on estimate of 330,453,000 lbs. of U3O8 produced in Grants district over 1955-1989 (McLemore, 2007)

Table 3: Present value human health costs of Grants uranium mining (2012$)

	Lower-Bound	Benchmark	Upper-Bound
Indirect (Value of PYLL)	$638 million	$2.56 billion	$6.15 billion
Direct (Medical Costs)	$101 million	$156 million	$212 million
TOTAL (Indirect + Direct):	**$739 million**	**$2.72 billion**	**$6.36 billion**
$/lb. U3O8[i]	$2.24	$8.23	$19.26

[i]Based on estimate of 330,453,000 lbs. of U3O8 produced in Grants district over 1955-1989 (McLemore, 2007)

Combined environmental and human health cost estimates range from $1.1 billion to $6.8 billion with a point-estimate of $3.1 billion (2012$).

DATA & METHODS

DATA: Reclamation & remediation costs compiled from DOE, EIA, EPA, NRC, and mining company reports. PYLL extrapolated from cohort studies by Samet et al. (1991) and Boice et al. (2008). Value of Life Year (VLY) taken from Cutler et al. (2002) and Murphy & Topel (2006). Medical cost data from Mariotto et al. (2011).

METHODS: Reclamation & remediation costs are converted to present value using the BLS CPI (U.S. city average) and a 7% discount rate (following OMB Circular A-94). When uncertainties exist in the cost data, median values are used for benchmark estimates. Long-term surveillance costs are included when available.

The "Number of Excess Lung Cancer Deaths" are calculated as:

$$Excess\ Lung\ Cancer\ Deaths = (\#UniqueMiners) * \left(\frac{51.2}{1735}\right)$$

Second term comes from Boice et al. (2008) who study Homestake miners. Number of unique miners calculated using data from Samet et al. (1991).

The "Value of PYLL" is calculated as:

$$Value\ of\ PYLL = (\#\ ExcessDeaths * VLY) * |DeathAge - E[DeathAge]|$$

Expected age of death based on life table data for a person of give age, sex and race. This is done for the median Grants district uranium miner using CDC lifetables and previous cohort studies.

CONCLUSIONS

- Reclamation & remediation costs are likely lower-bounds on actual costs due to incomplete data and uncertainty on future costs
- Most site reclamation will be complete by 2022. Future clean-up costs will be due to remediation and site surveillance by DOE
- Indirect human health costs provide a measure of the negative externality to society created by uranium mining; $638 million to $6.15 billion
- Wide ranges in health costs driven by VLY ($100,000-$300,000) and number of excess lung cancer deaths

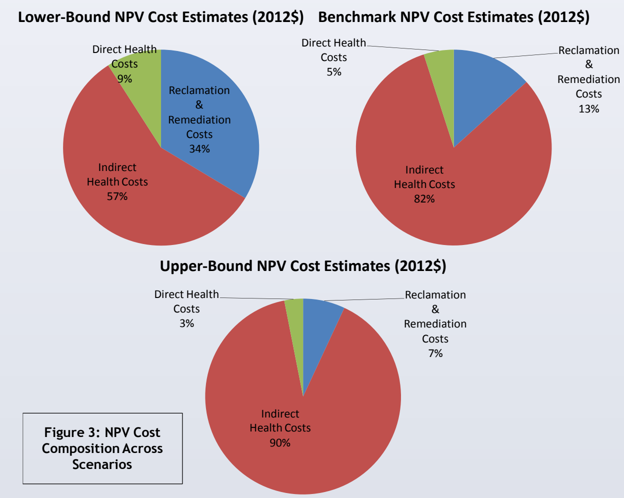

Figure 3: NPV Cost Composition Across Scenarios

- Combined health and clean-up costs (benchmark case) represent about $9.50/lb. of U3O8 produced in NM over 1955-1989
- Average U3O8 market price over 1955-1989 was $29.95/lb. Thus, uranium mining still potentially a net benefit to society
- However, any renewed uranium production in New Mexico is likely to have lower human health effects due to technological improvements and more regulatory oversight of the industry

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