Acknowledgements

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- Community partners and participants in population-based health studies on the Navajo Nation and Pueblo of Laguna

Land Acknowledgement Statement: The University of New Mexico sits on the traditional homelands of the Pueblo of Sandia. The original peoples of New Mexico have deep connections to the land and have made significant contributions to the broader community statewide. We honor the land itself and those who remain stewards of this land and acknowledge our committed relationship to Indigenous peoples.

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Cover photo of Quivira Churchrock I Mine waste dump and homes in Red Water Pond Road Community, Coyote Canyon Chapter, Navajo Nation
The Big Picture: Mining Impacts on Indigenous Americans

U.S. Western States

- 161,000 abandoned hard rock mines
- >500,000 sites
- 40% of watershed headwaters in West thought to be contaminated from these mines (USEPA)
- >1/2 of US Indigenous population
- >600,000 Native Americans live within 10 km of abandoned mines

Potential for higher sensitivity to toxicity among Native Americans

- reliance on local resources
- understudied genetic, epigenetic metabolic, distribution differences
- Tied to land – relocation away from mine sites not always an option to reduce exposures

Lewis, Hoover, & MacKenzie (2017), Current Environmental Health Reports.
Navajo Nation Abandoned Uranium Mines Superfund Cleanup Sites

Monument Valley Area
- Skyline Mine

Cove / Mesa Area
- 2 Transfer Stations
  - Mesa Mines
  - Cove Wash

Tachee AUMs
Added to NN Orphan AUM list in 2015

Cameron Area
- 20 Cameron Area Mines
  - Tuba City Open Dump

Puerco River Valley/
New Lands Area
(upstream mining
discharges)

Exposures:
According to USEPA, people live within a quarter mile of 14% of the 524 AUMs on the Navajo Nation

DiNEH Project Study Area

Map courtesy USEPA Region 9, modified by SRIC
Navajo Uranium Legacy: By the Numbers

<table>
<thead>
<tr>
<th>524</th>
<th>Abandoned uranium mines (AUMs), plus &gt;1,100 mine “features”</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>Fully remediated AUMs</td>
</tr>
<tr>
<td>4</td>
<td>Interim AUM remedial actions to contain wastes</td>
</tr>
<tr>
<td>96</td>
<td>AUM site radiation screening reports</td>
</tr>
<tr>
<td>130</td>
<td>Removal Site Evaluations (RSEs) expected to be completed by end of 2022</td>
</tr>
<tr>
<td>10-15</td>
<td>EE/CAs* expected to be completed by end of 2022</td>
</tr>
<tr>
<td>$1.7 billion</td>
<td>Money USEPA says it has available for remediating ~40% AUMs through Tronox bankruptcy, settlements with mining companies, federal contributions</td>
</tr>
<tr>
<td>57 (52%)</td>
<td>Navajo Chapters w/ 1-3 uranium exposure sources (AUMs, water sources, contaminated structures)</td>
</tr>
</tbody>
</table>

*EE/CA = Engineering Evaluation/Cost Analysis
Community questions about exposures have driven UNM environmental health research

**DiNEH Project, 2002-2012**
- Does U in drinking water increase risk of kidney disease?
- Do multi-pathway exposures to metals in mine wastes increase risks of chronic disease?
- Community-based trainings to develop study design, implementation methods, consents

**Navajo Birth Cohort Study, 2010-present**
- Do exposures to U mine waste affect child health, development?
- Do exposures to metals in mine wastes increase chronic disease?
- Extensive trainings to develop EH capacity among community members hired by UNM, SRIC and NNDOH

**METALS SRP, 2014-present**
- Do mixed-metal U mine wastes contribute to air, water and farmland contamination?
- Do exposures to U wastes result in immunologic, cardiovascular, pulmonary effects?
- Status of remediation?
- Community defines research
Common Characteristics of AUM-impacted Native Communities

- Mine wastes replete with hazardous substances, especially metals
- Chronic exposures to contaminants in water, land, vegetation, livestock
- Communities use citizen science to address concerns
Indeed, uranium does not grow on trees! It’s finite...

- Naturally occurring metal and radioactive element found throughout the Earth’s crust in concentrations averaging about 2.5 milligrams per kilogram (or parts per million)
- Technologically Enhanced Naturally Occurring Radioactive Materials, or TENORM – what humans have done to liberate uranium from its host rock
- Uranium first produced in the Southwest from vanadium mines in the Monument Valley area of AZ and UT in 1942
- Gov’t only purchaser of U between 1949 and 1971
- AEC production incentives, 1950s to 1965
- Privatization of U market began in 1971
- Mining, milling, conversion, enrichment, fuel fabrication, and waste transportation are carbon emitters – only the reactors don’t release carbon
Regulatory Process for Remediation of Abandoned U Mines

History

- 1960-61 – AEC declined to regulate conventional uranium mining, i.e., the recovery of “source material” (defined as 0.05% U, or 500 ppm) from its place in nature
- 1978 – Passage of Uranium Mill Tailings Remediation Control Act: authorized regulation of uranium processing at “active” mill sites (N=28) and remediation of tailings at “inactive” mill sites (N=24)
- States such as New Mexico adopted hardrock mining laws, regulations in the 1990s
- “Mine wastes” v. “mill tailings” – know the difference
- EPA determined CERCLA only federal statute available to regulate hazardous substances at AUM sites
- National Priority List sites (e.g., Jackpile Uranium Mine, UNC-Churchrock uranium mill tailings, Homestake-Barrick Gold Milan (NM) uranium mill, among others)
- Most AUMs assessed under time-critical and non-time critical removal actions

CERCLA Process for non-NPL sites

- Site Evaluation (RSE)
- Engineering Evaluation/Cost Analysis (equivalent to Remedial Investigation/Feasibility Study for NPL sites)
- Public comment, meetings, hearings on preferred alternative
- “Action Memo” is decision document
- Disposal options – cap-in-place, consolidation of wastes from multiple sites, off-site removal – suffers from a lack of regional disposal facilities

Graphic courtesy of USEPA, June 2023
Multi-generational, chronic exposures from living close to abandoned mines

Interim removal

Quivira Churchrock Mine

Homes in Red Water Pond Road Community, Coyote Canyon

Claim 28 Mine in Blue Gap-Tachee

Jackpile Mine, Pueblo of Laguna, Village of Paguate

Cameron Area AUMs
### UNM Population-based EH studies to ascertain exposures and health outcomes

<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Population</th>
<th>Target Health Outcomes</th>
</tr>
</thead>
</table>
| DiNEH Project, Navajo Uranium Assessment   | Cross-sectional; iterative, multi-pathway analysis | Phase I – 1,304 participants in 20 chapters of ENA; Phase II – 267 participants in blood and urine collections | ▪ Chronic kidney disease  
    ▪ Cardiovascular disease  
    ▪ Autoimmunity |
| Kidney Health                              |                                       |                                                                                                      |                                                                                        |
| Navajo Birth Cohort Study                  | Longitudinal cohort                   | More than 1,800 mothers, fathers, babies in 3 phases across Navajo Nation                           | ▪ Child development  
    ▪ Metals and pre-term births  
    ▪ Upper airway effects |
| Thinking Zinc                              | Clinical trial                        | 52 volunteers from Churchrock and Blue Gap-Tachee communities                                         | ▪ Zn supplementation to repair metals-induced damage to DNA repair mechanisms          |
| METALS Superfund Research Center           | Laboratory animals                    | Community members exposed to dust from AUMs                                                          | ▪ Cardiopulmonary effects of exposure to metals-laden “nanoparticles”                  |