

Long-Term Stewardship at a Former Uranium Mill Tailings Site in Riverton, Wyoming – 17090

William L. Dam, Site Manager

Dr. April Gil, Environment Team I Lead

U.S. Department of Energy Office of Legacy Management

Dr. Raymond H. Johnson, Sam Campbell – Navarro Research and Engineering, Inc., *LM Contractor*

Dr. John R. Bargar – SLAC National Accelerator Laboratory

Mary Picel – Argonne National Laboratory

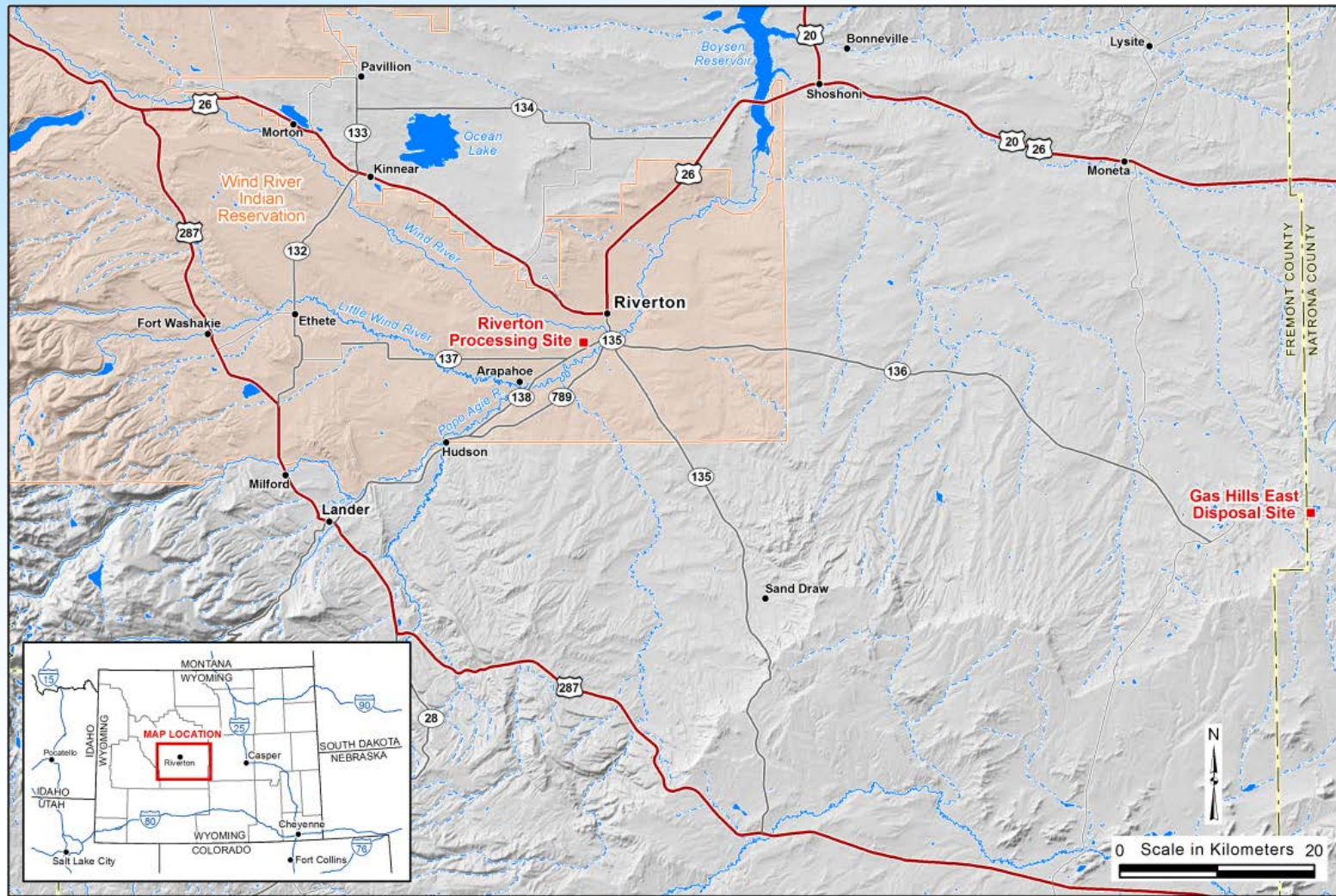
Waste Management Conference • March 2017



U.S. DEPARTMENT OF
ENERGY

Legacy
Management

Riverton Site Location Map



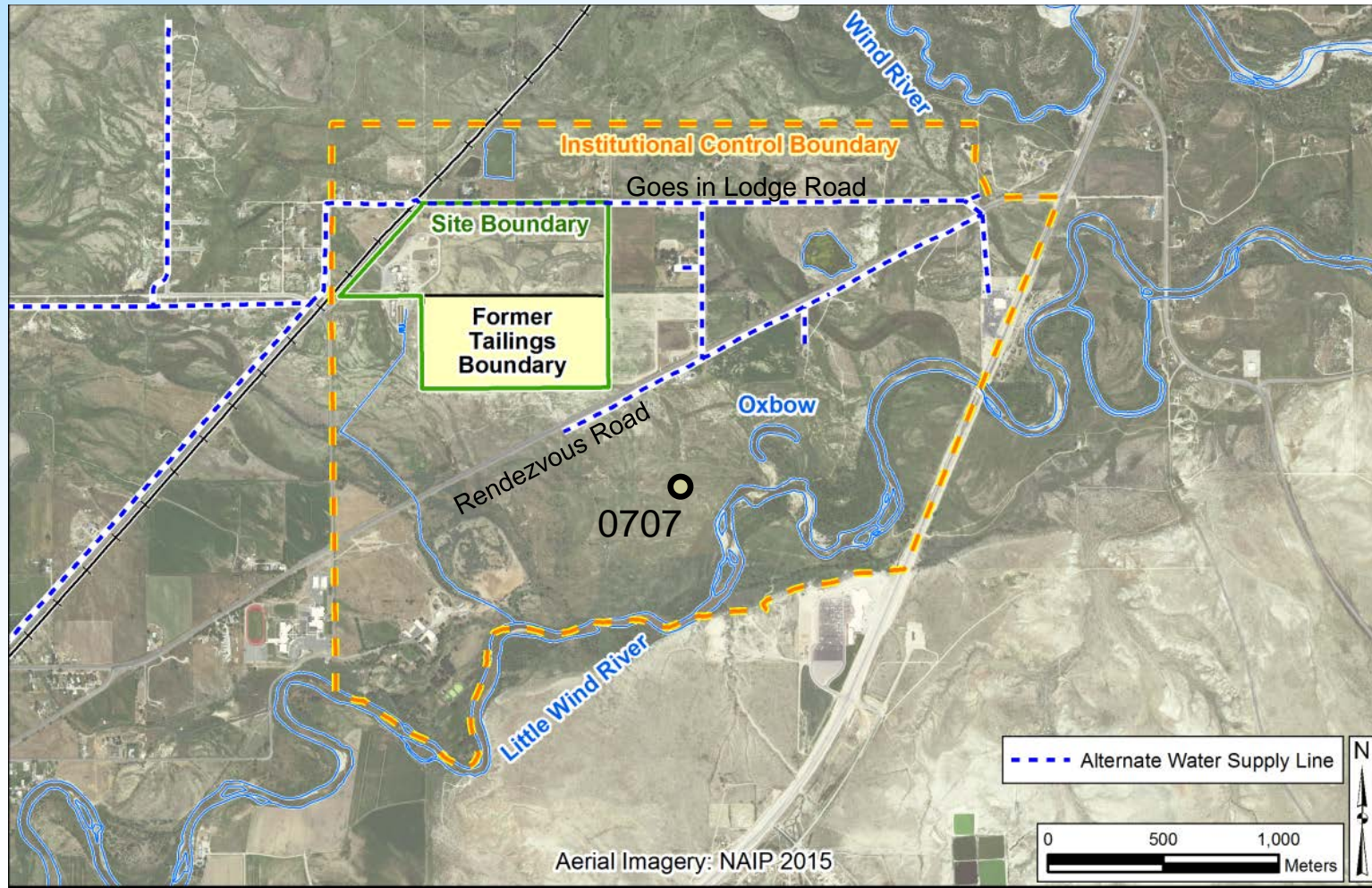
\\LMess\Env\Projects\EBM\LT\S\111\0001\40\000\S15142\S1514200.mxd smithw 10/26/2016 9:56:30 AM



U.S. DEPARTMENT OF
ENERGY

Legacy
Management

Riverton Institutional Control (IC) and Site Boundaries, and Alternate Water Supply System



\\LMess\EnvProjects\EBM\LT\S\111\0001\40\000\S15143\S1514300.mxd smithw 10/26/2016 10:26:17 AM



U.S. DEPARTMENT OF
ENERGY

Legacy
Management

Riverton Site Remediation (1989)



U.S. DEPARTMENT OF
ENERGY

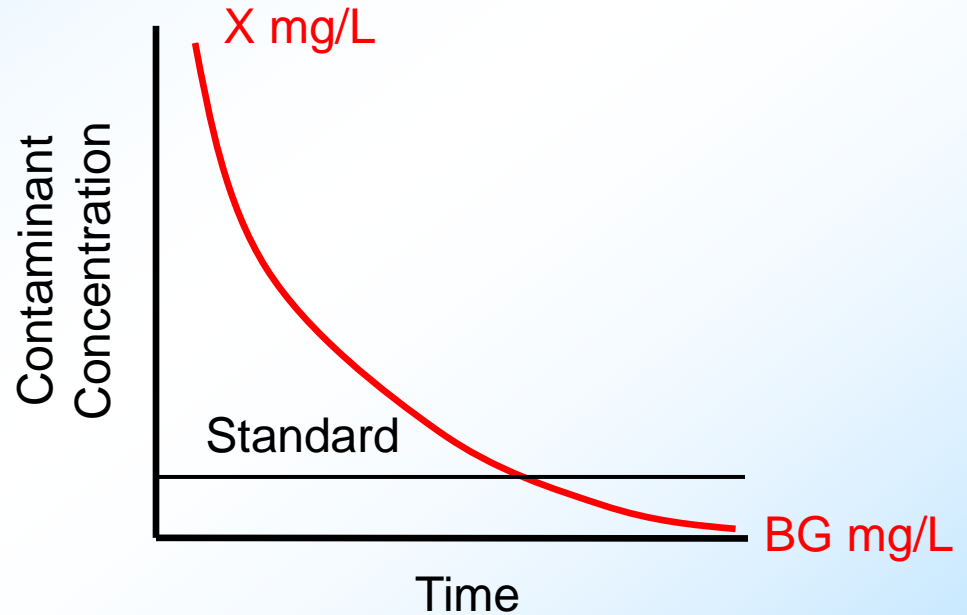
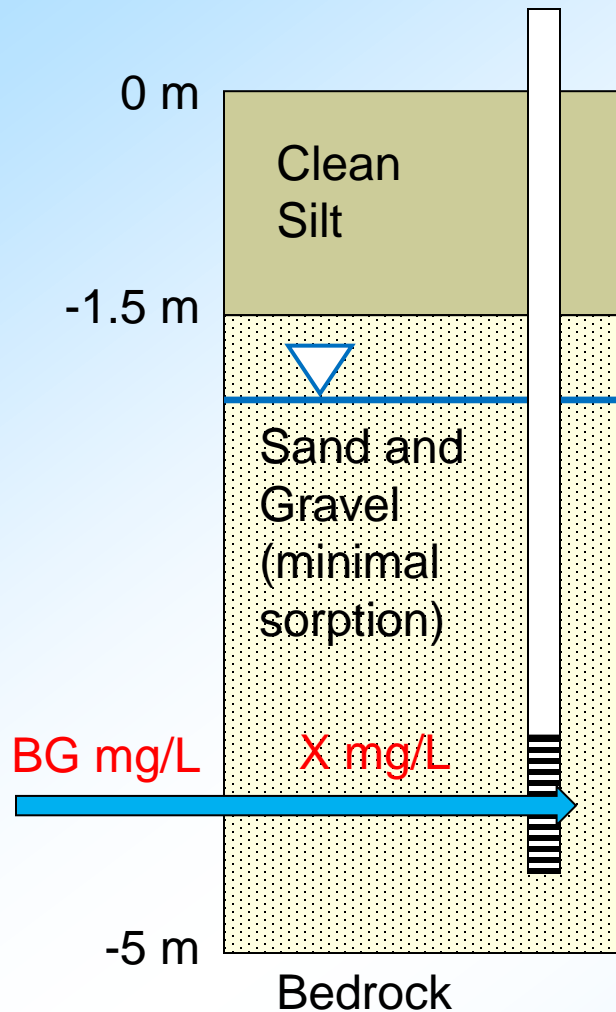
Legacy
Management

Riverton Processing Site

- Mill site operated from 1958 to 1963
- U.S. Atomic Energy Commission bought ore from private firm
- Ore brought from Gas Hills, Wyoming, and tailings were returned in 1989
- Site surrounded by tribal and mission property
- Company still operates a sulfuric acid plant
- Alternative water supply system built in 1998
- Natural flushing compliance strategy for uranium and molybdenum within 100 years
- Numerous IC covenants, restrictions, and protections
- Site prone to flooding along two rivers



Pre-2009: Conceptual Model



**Natural Flushing
In 100 Years**

Riverton Baseflow and Flood Conditions on Little Wind River



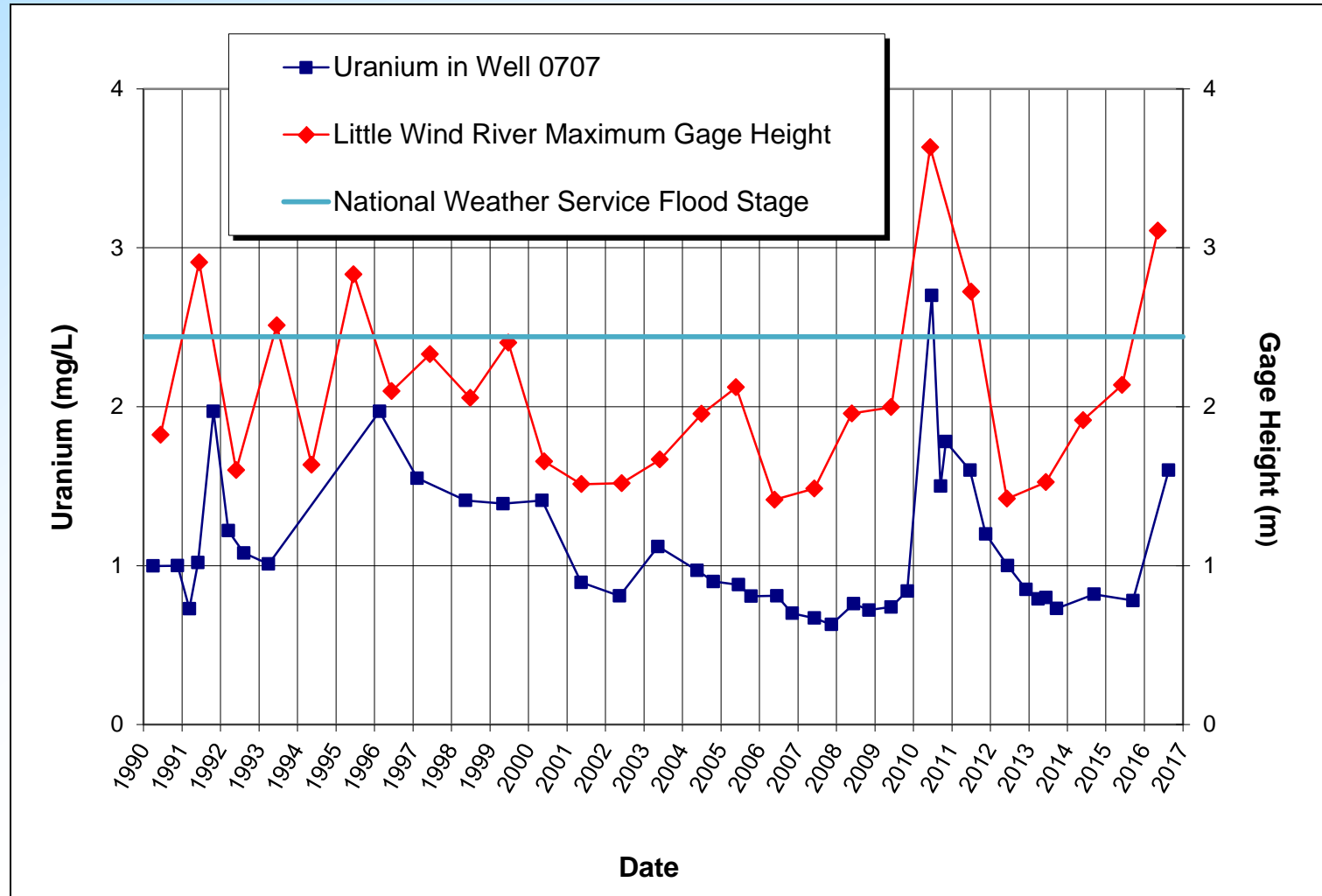
Well installed before 2010 flood



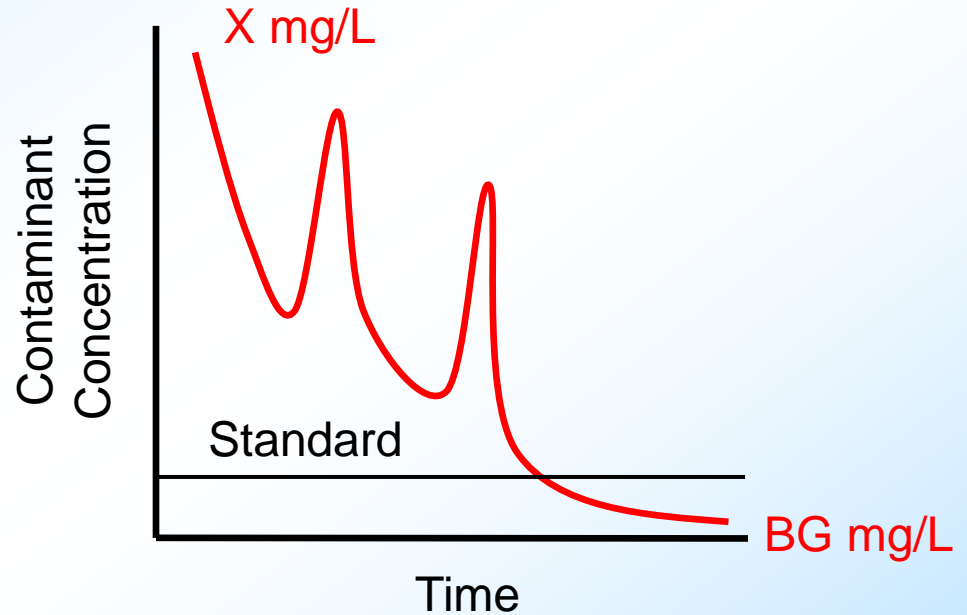
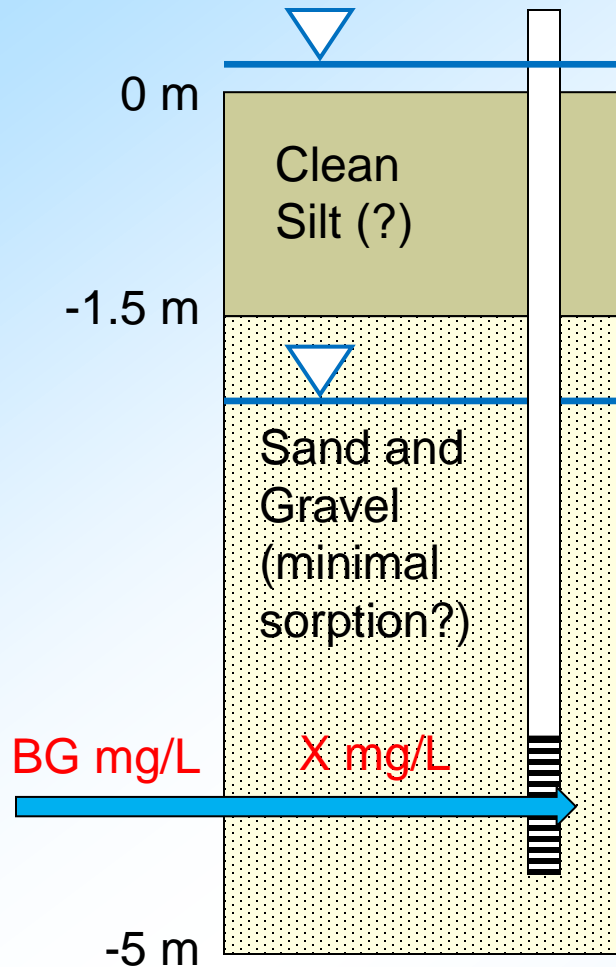
U.S. DEPARTMENT OF
ENERGY

Legacy
Management

Hydrograph for the Little Wind River with Uranium Concentrations at Well 0707



2010: Revised Conceptual Model



**Natural Flushing In
100 Years (?) with
Flood Spikes**

Actions Resulting from 2010 Flood

- Detailed plume mapping with direct-push drilling in 2012
- New conceptual model with plume persistence issues due to unknown contaminant sources
- More testing to determine where additional contaminant sources exist, including
 - Sonic drilling, trenching, and hand augering for core collection and solid-phase analyses
 - Multilevel well installations with seasonal monitoring
 - Collection and analyses of surficial evaporite deposits and naturally reduced zones



Naturally Reduced Zones (NRZs)



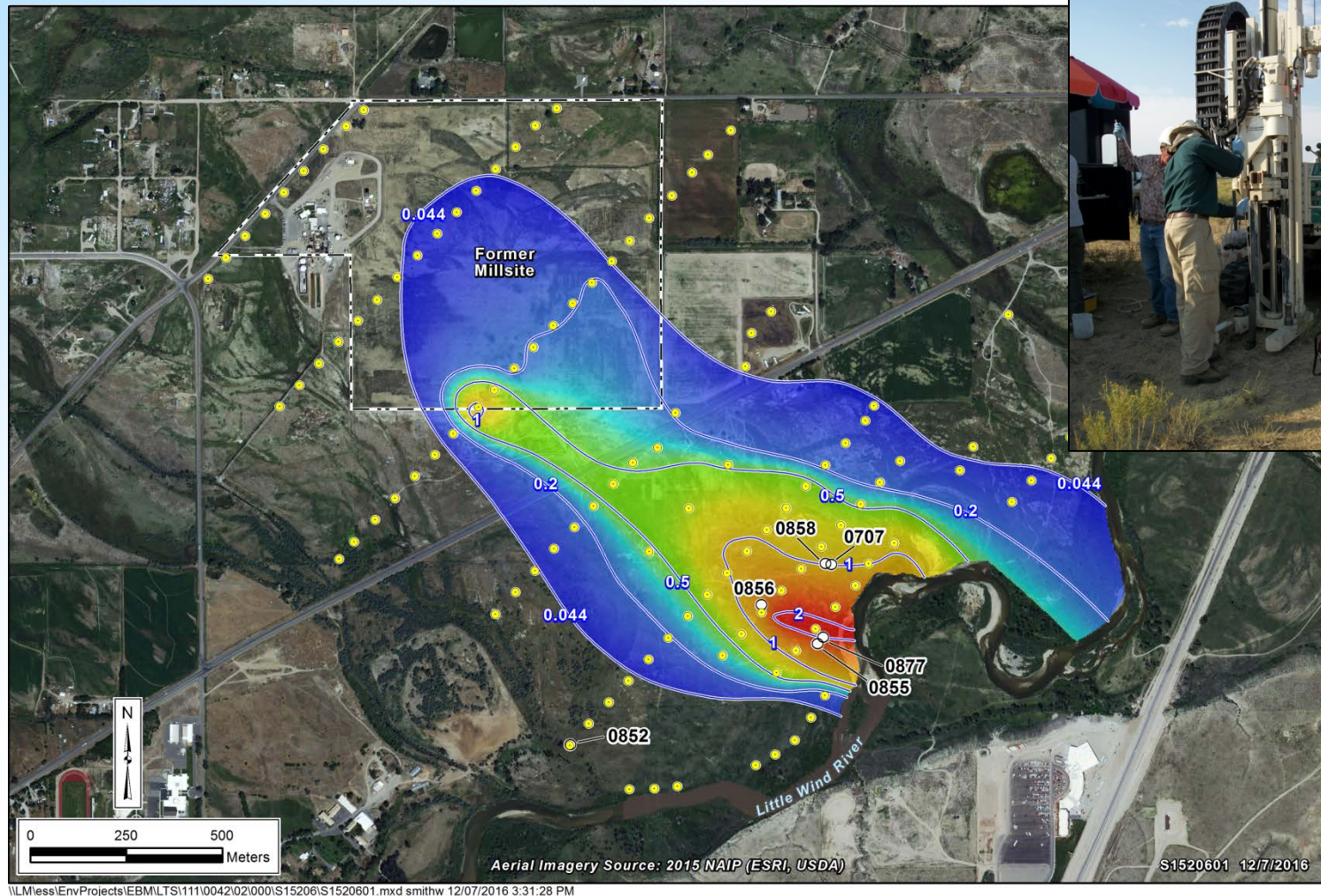
Hand-augered core in oxbow sediments



Shallow trench along river bank



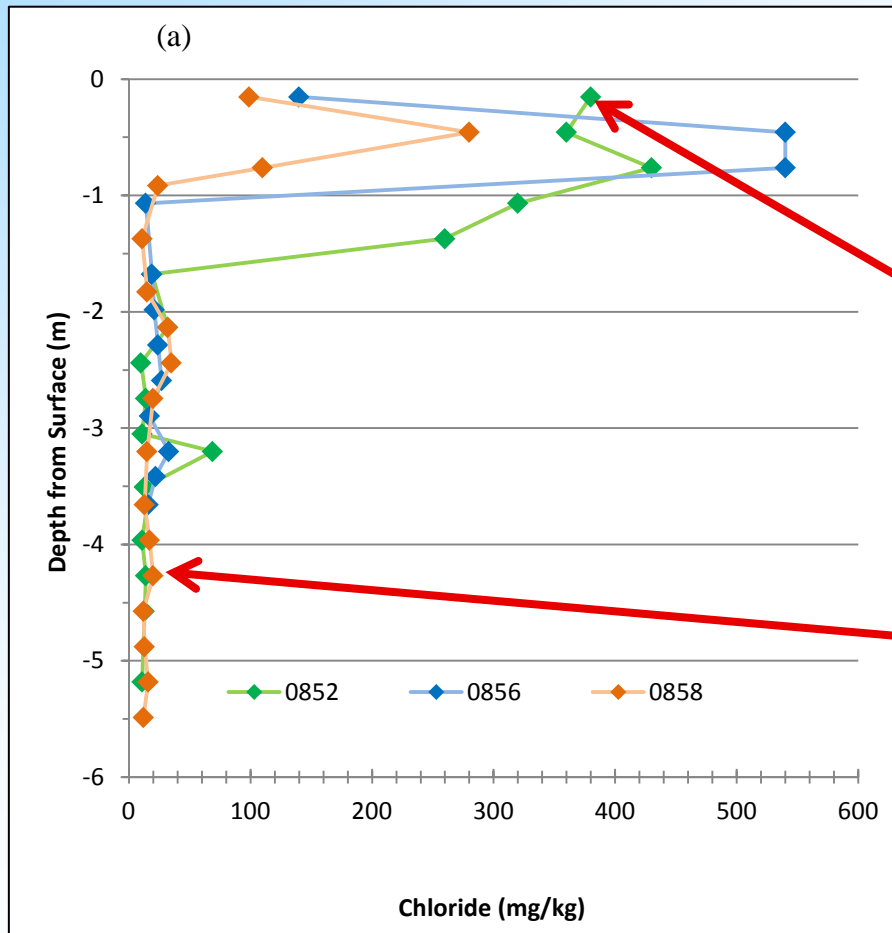
Uranium Plume (mg/L) Based on 2012 and 2015 Direct-Push Drilling



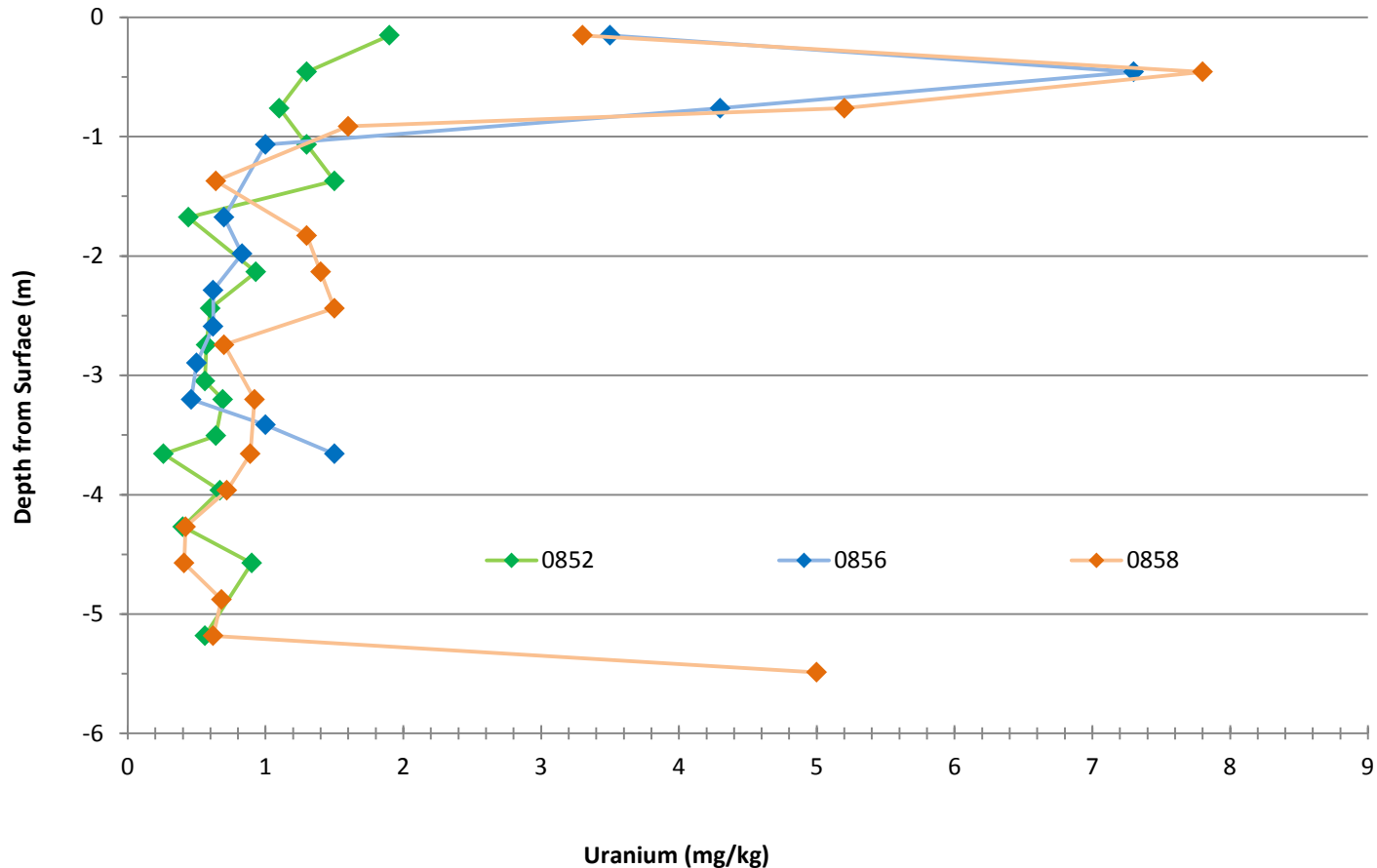
U.S. DEPARTMENT OF
ENERGY

Legacy
Management

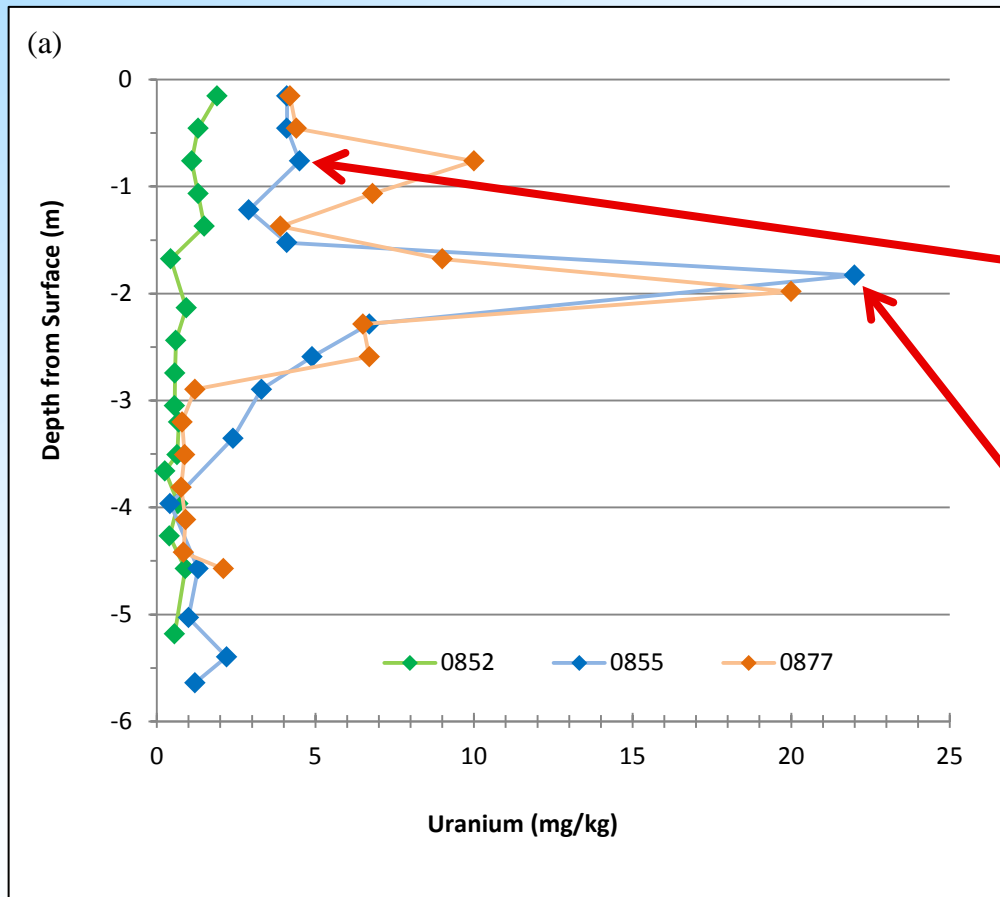
Solid-Phase Chloride with Depth



Solid-Phase Uranium with Depth



Solid-Phase Uranium with Depth



U.S. DEPARTMENT OF
ENERGY

Legacy
Management

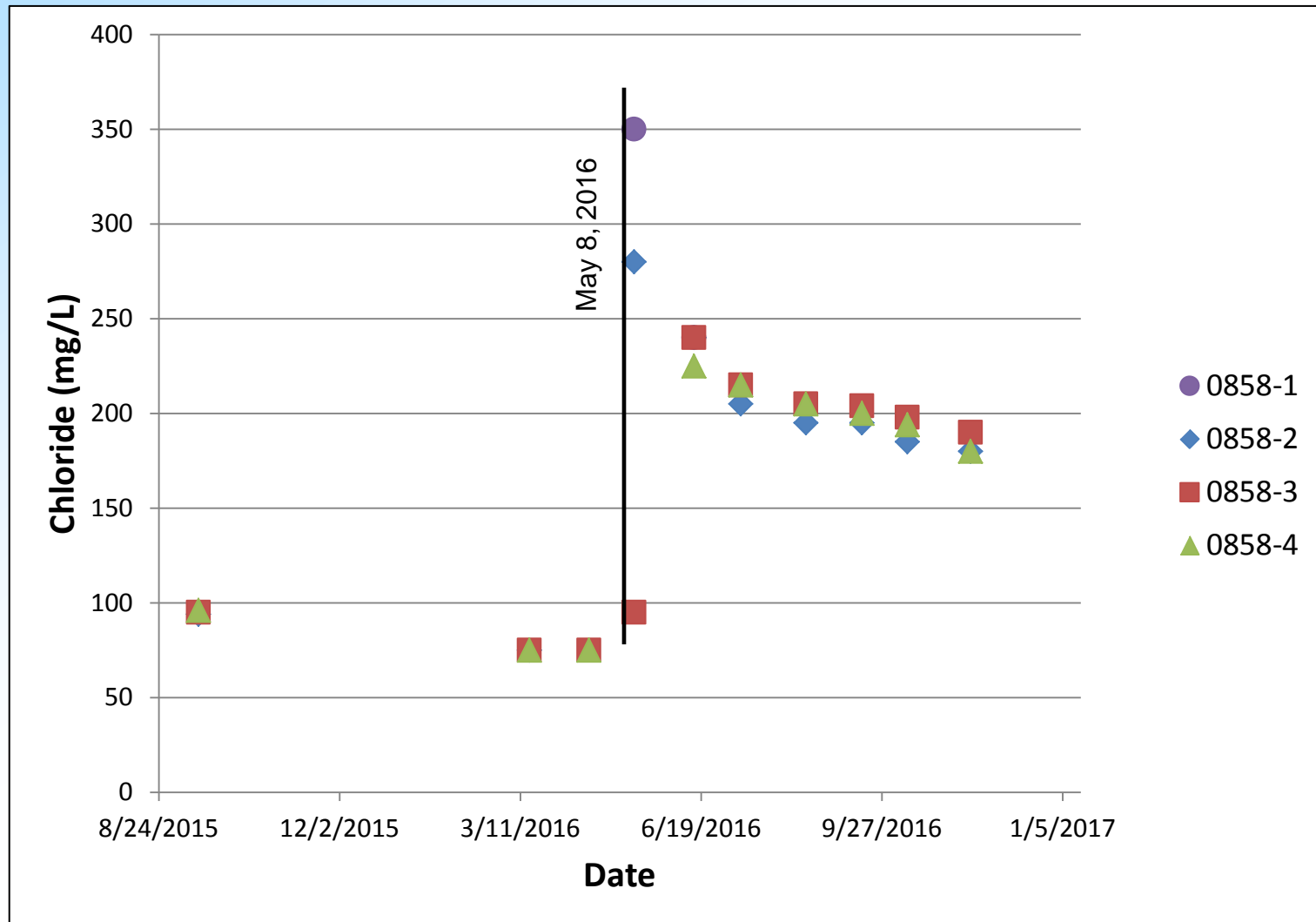
May 2016 Flood



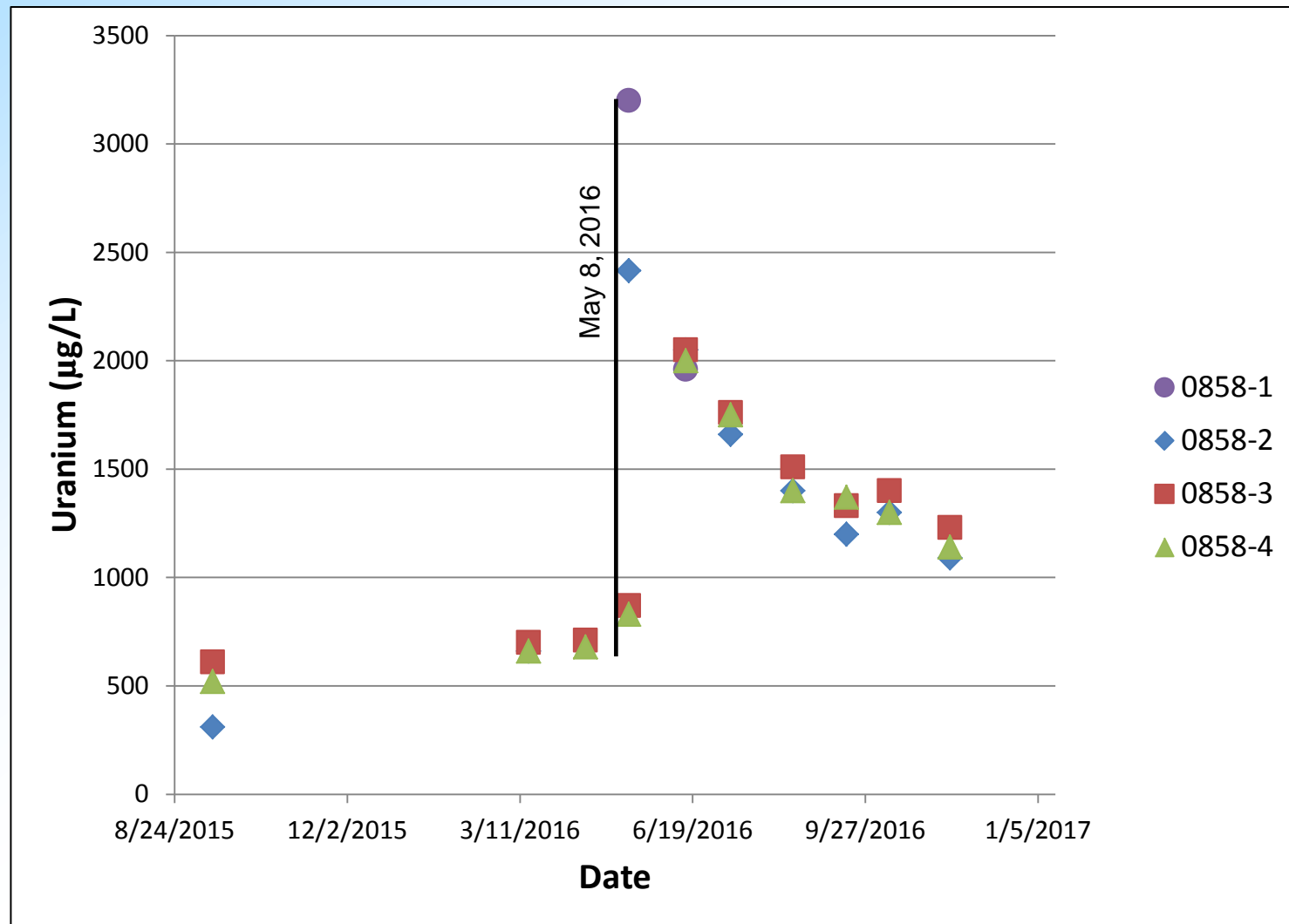
U.S. DEPARTMENT OF
ENERGY

Legacy
Management

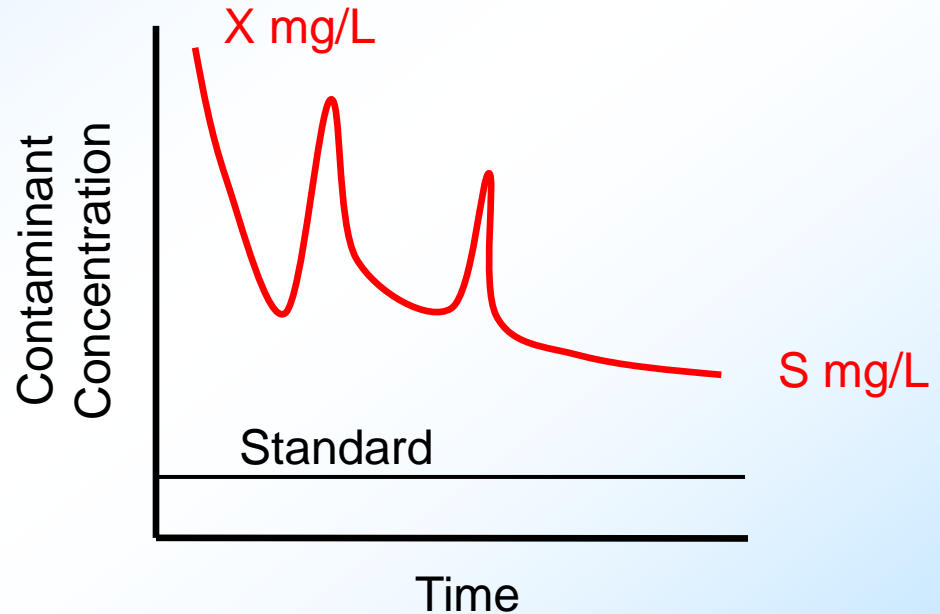
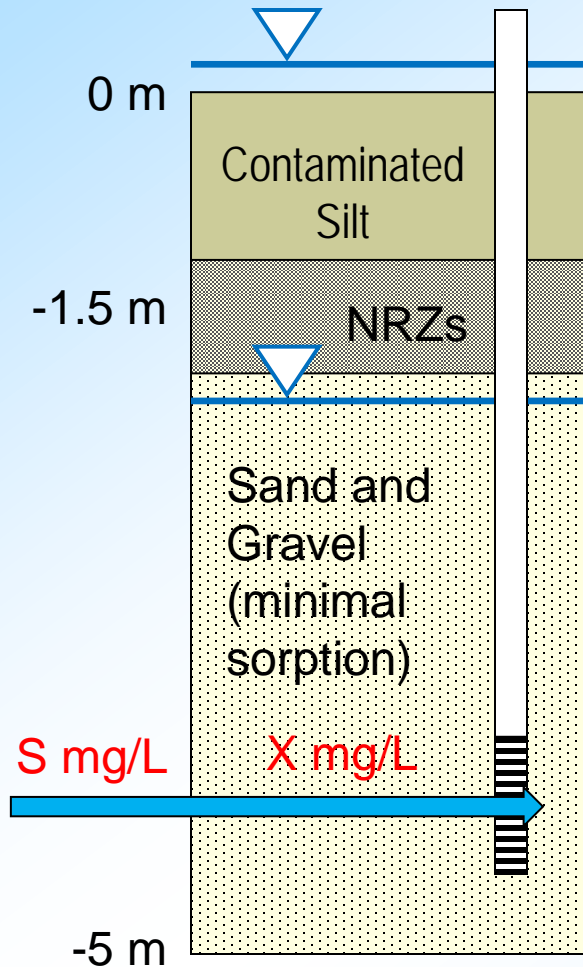
Chloride in Multilevel Well 0858



Uranium in Multilevel Well 0858



2016: Revised Conceptual Model



**Natural Flushing (?)
with Flood Spikes and
Ongoing Source**

Ongoing LTS&M Activities at Riverton

- Continue support of Wind River Tribes for oversight
- Evaluate and share the extensive data and interpretations
- Update conceptual models and plume snapshots
- Continue multilevel well sampling on a regular basis
- Annual sampling at monitoring locations
- Continue collaborations (SLAC, U.S. Geological Survey, etc.)
- Revise human health and ecological risk assessments



Summary and Conclusions

- Mill tailings were removed at Riverton
- Periodic flooding of rivers create transient contaminant increases
- Additional solid phase sampling and multilevel groundwater sampling led to new conceptual models with remaining contamination in:
 - Evaporites
 - Naturally reduced zones
 - Ongoing source zone
- These remaining contaminants can influence groundwater quality, especially after flooding events
- Long-term surveillance and maintenance includes continual conceptual model updates with science integration, including biogeochemistry and revised environmental risk assessments

