Terrace Geochemistry at the Shiprock, New Mexico, Disposal Site – 17232

Initial Phase

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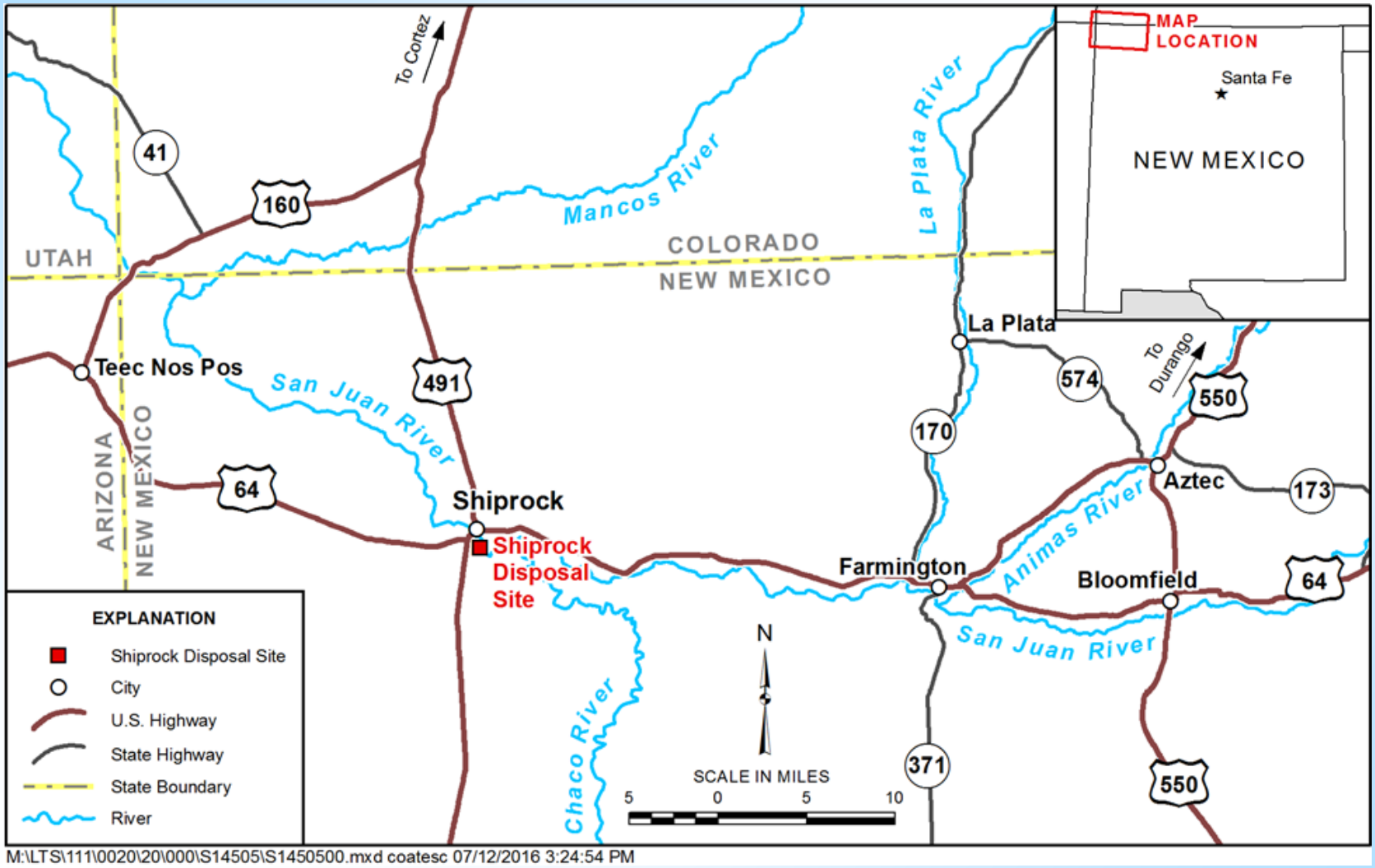
Presentation Topics

- Background
- Objective and Problems
- Definitions
- Methods
- Results
- Interpretation
- Conclusions

Shiprock, New Mexico, Disposal Site



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Background

- Milling activities occurred from 1954 through 1968
- Groundwater on terrace exists in alluvium and Mancos Shale
- Compliance strategy
  - Pump remaining mill-related groundwater out of alluvium and weathered Mancos Shale
  - Dry terrace seeps
- Terrace water levels have decreased in response to remedial pumping and discontinued irrigation

Objective and Problems

Objective

- Identify groundwater sources that presently exist on terrace, to differentiate mill-related vs. non-mill-related water

Problems

- Better understanding of origin of groundwater presently on terrace is needed
- Contributions of non-mill water to the terrace inhibits extraction effectiveness

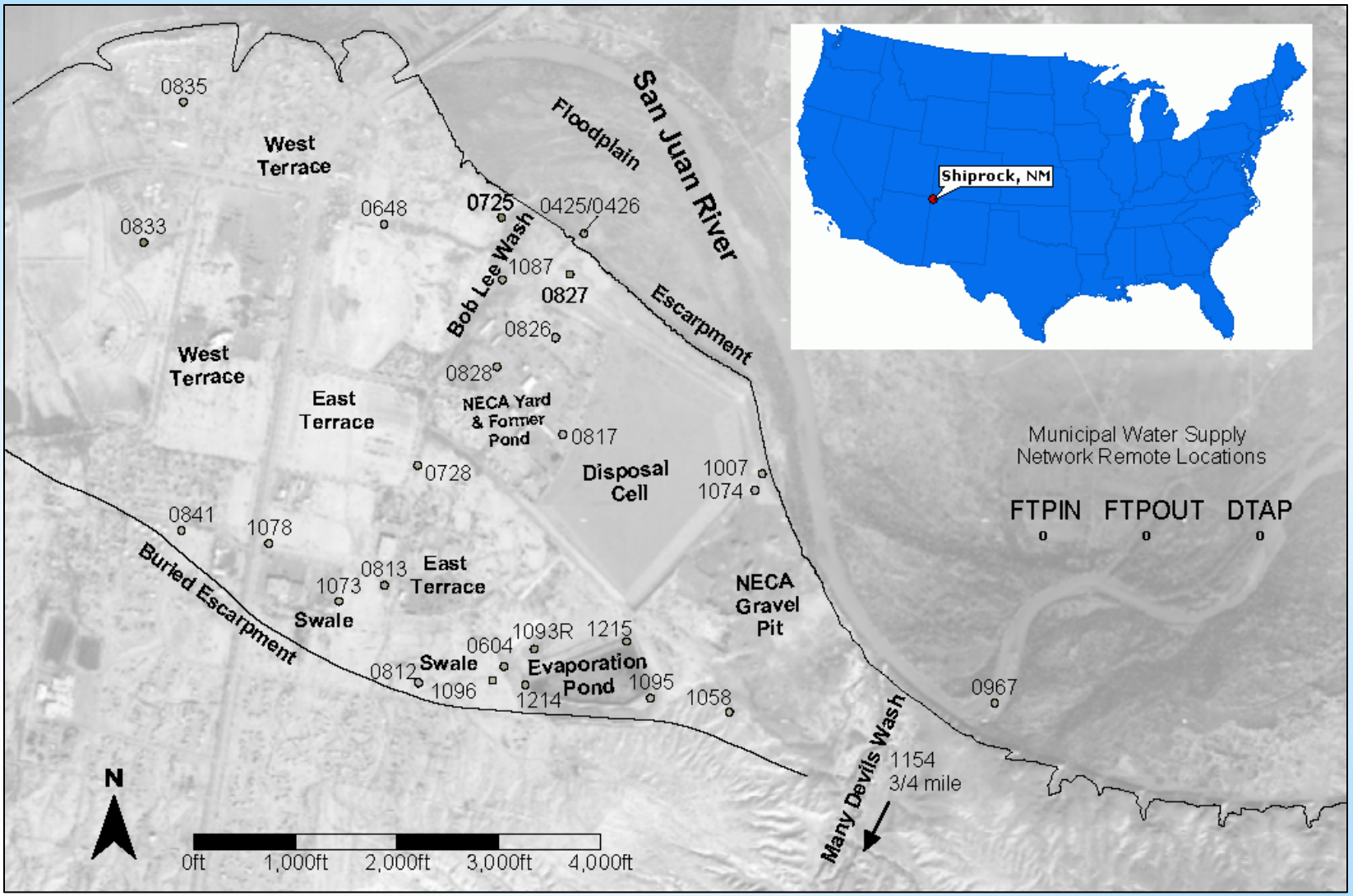
Definitions

- Mill water (mill-affected water)
  - San Juan River water used by mill to extract uranium from ore
- Non-mill water
  1. Precipitation
  2. San Juan River
     - West terrace irrigation
  3. San Juan River
     - Dust suppressant
  4. Animas River
     - Municipal supply via distribution lines
- No attempt made to distinguish precipitation from other non-mill water sources

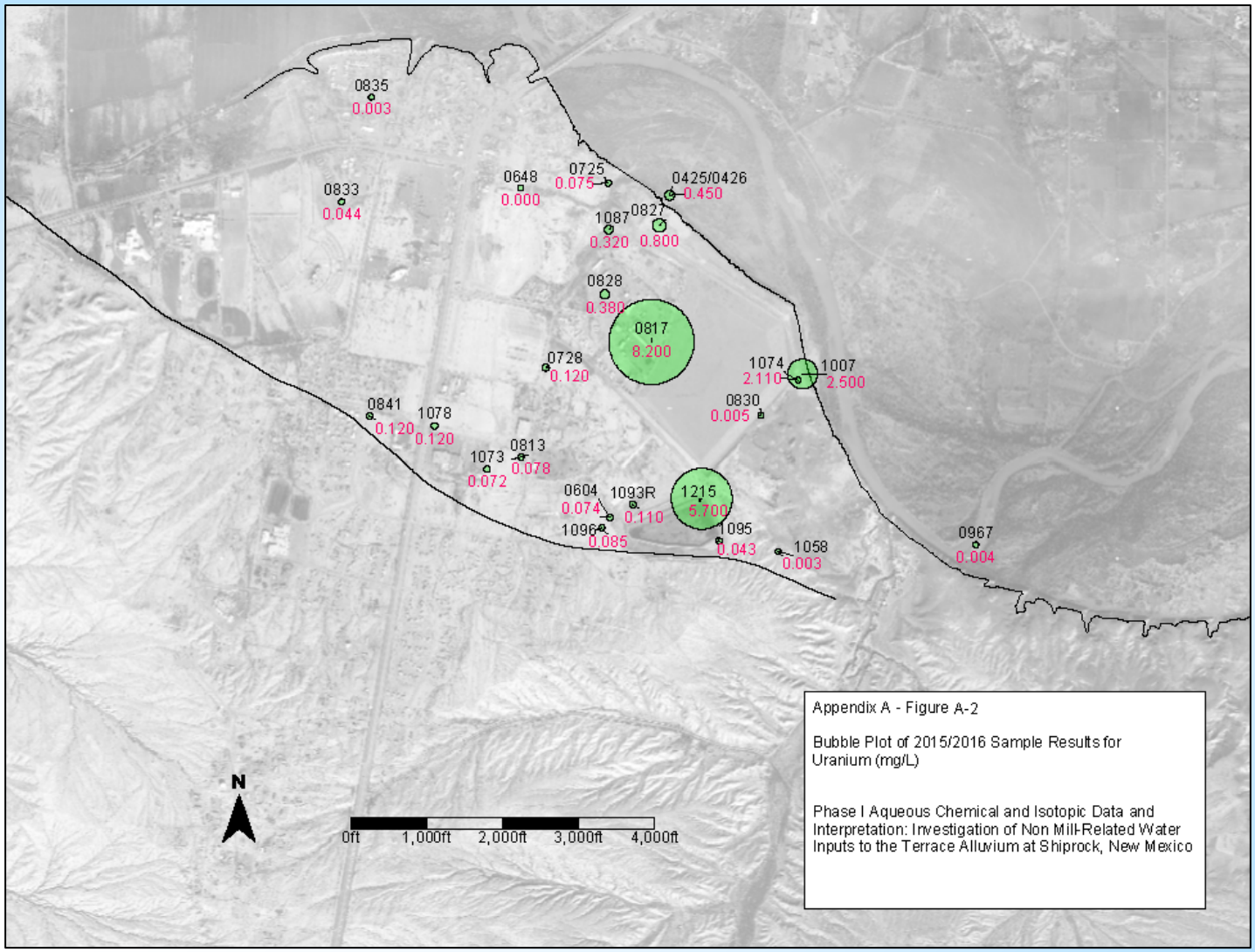
Methods

- Measurements made in groundwater throughout terrace consisted of:
  - Uranium concentration and $^{234}U/^{238}U$ activity ratio (AR)
  - Sulfate concentration and $\delta^{34}S_{sulfate}$
  - $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$
  - Tritium concentration
- Preference for assigning groundwater source to each well given to $^{234}U/^{238}U$ AR

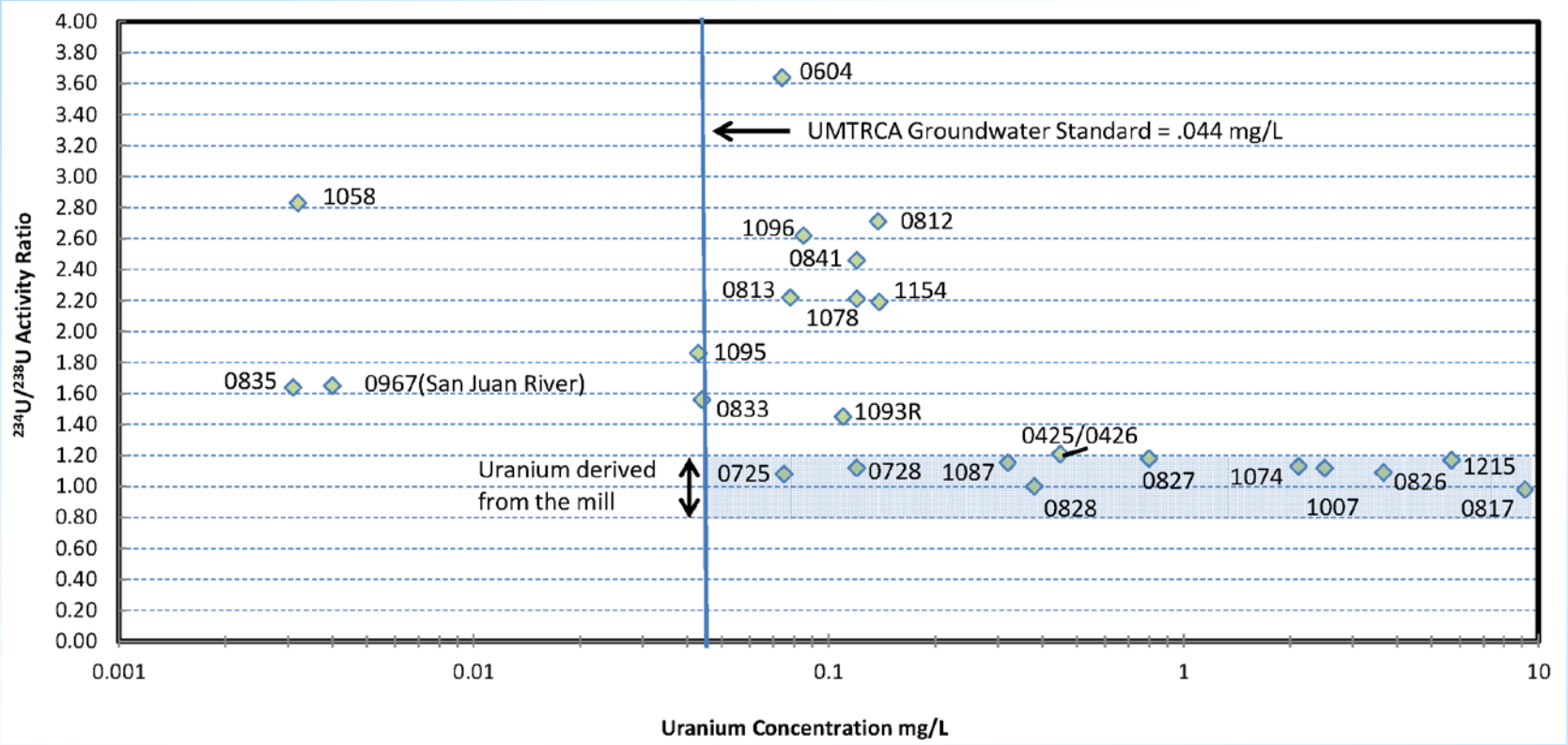
Terrace Sampling Locations



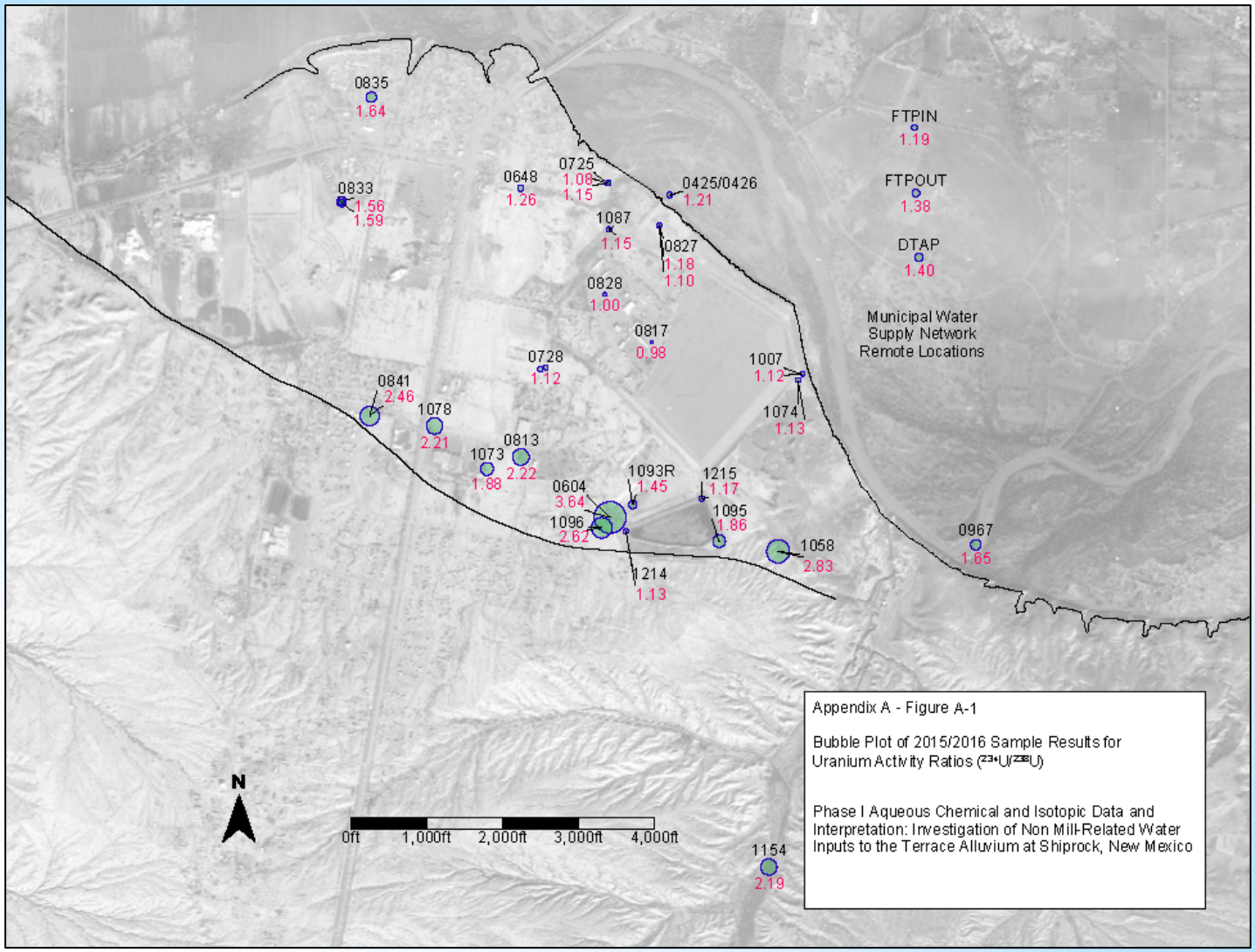
Results: Uranium Concentration



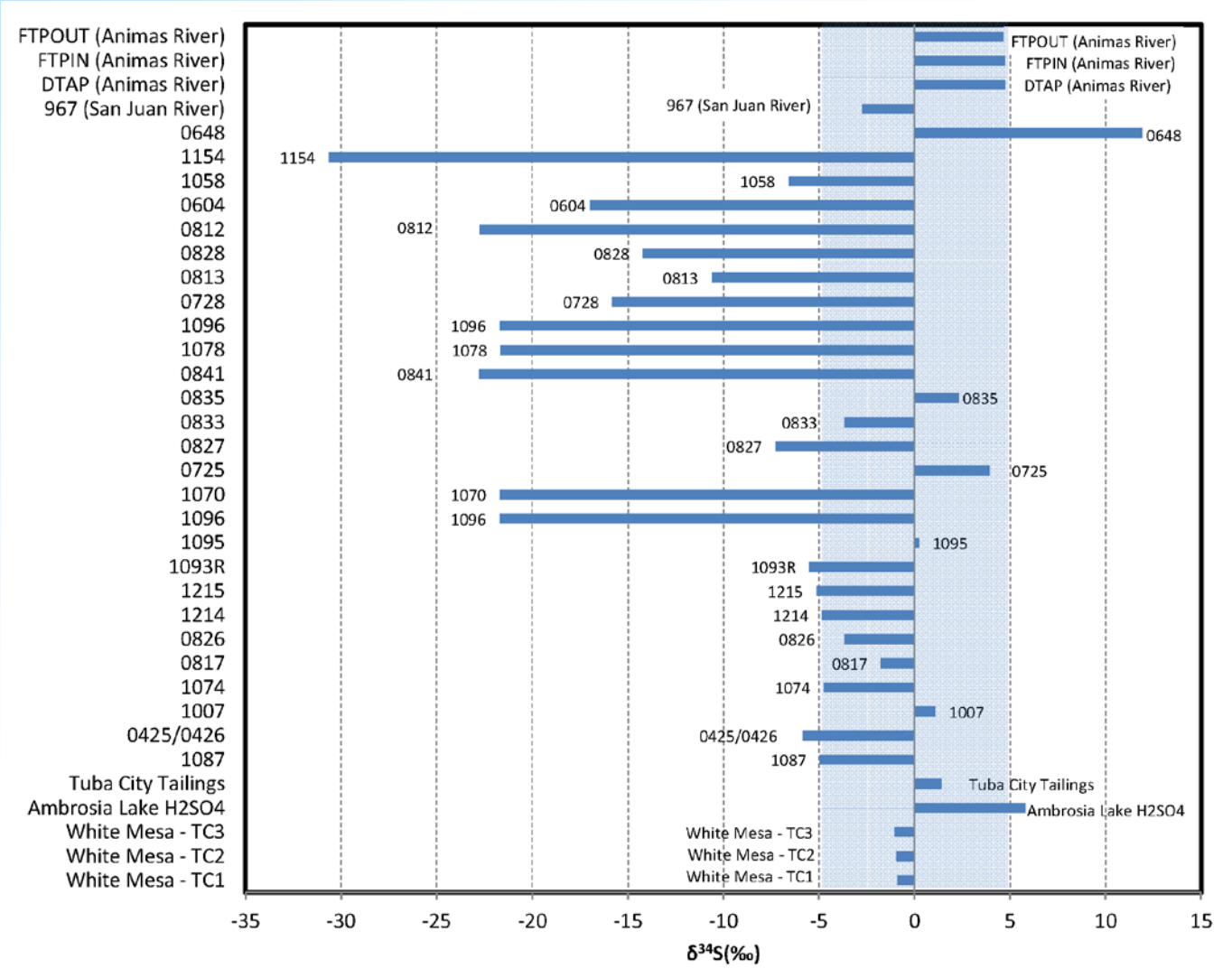
Results: $^{234}U/^{238}U$ Activity Ratio



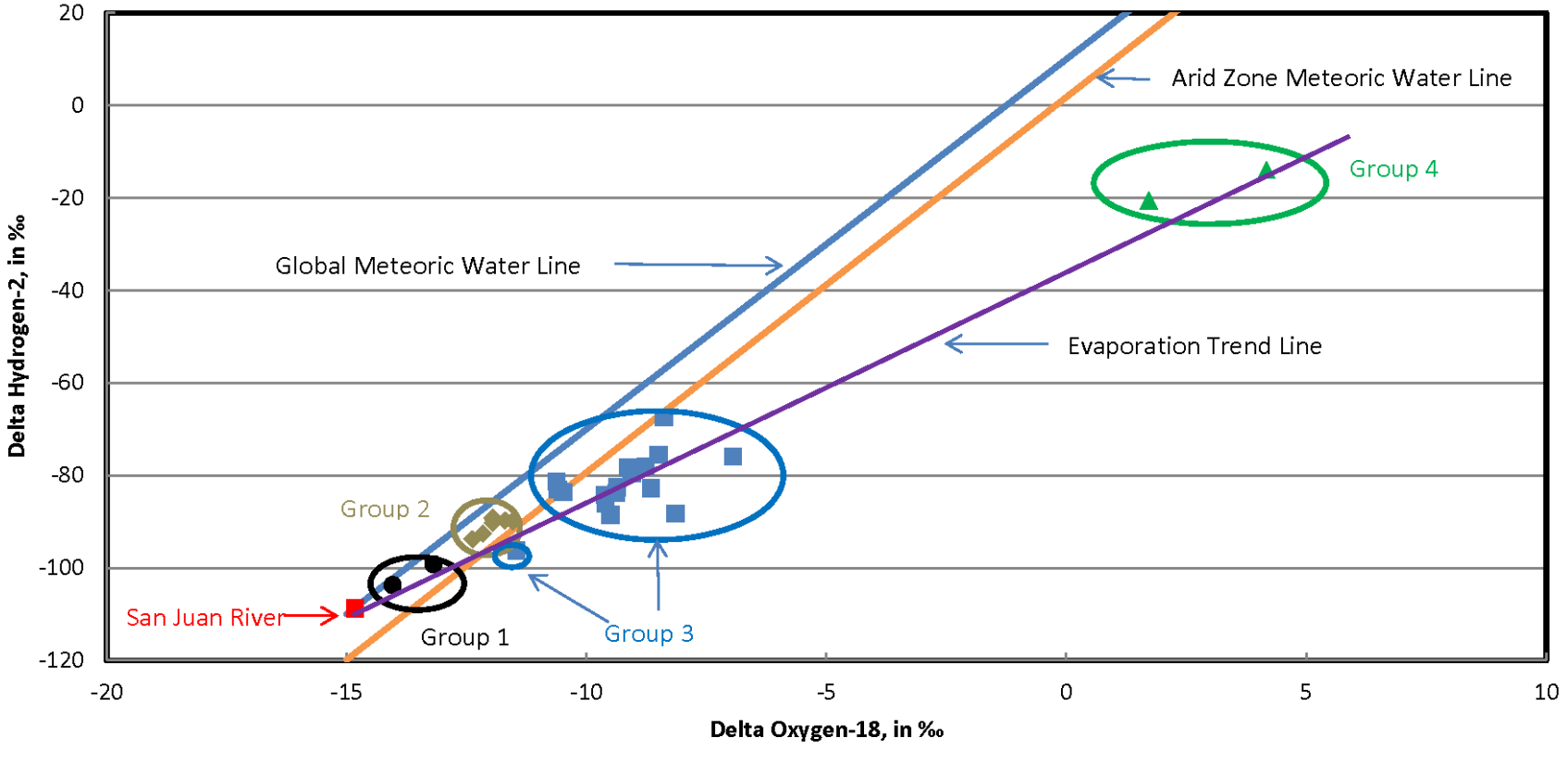
Results: $^{234}U/^{238}U$ Activity Ratio



Results: $\delta^{34}S_{sulfate}$



Results: δ^2H_{water} and $\delta^{18}O_{water}$



Interpretation: Mill Water

- Groundwater in wells adjacent to disposal cell, 0817, 0826, 1007, and 1074, and evaporation pond sites 1214 and 1215
  1. $^{234}U/^{238}U$ ARs between 1.00 and 1.20 and $\delta^{34}S_{sulfate}$ values between –5‰ and +5‰ indicate mill-derived water as a source of uranium and sulfate at these wells
  2. $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$ isotopes indicate San Juan River water as water source (Group 3) and tritium concentration indicates recharge occurred in early 1960s

Interpretation: Non-Mill Water

- Groundwater in swale wells 0604, 0812, 0813, 0841, 1070, 1078, and 1096, and well 1058
  1. $^{234}U/^{238}U$ ARs greater than 1.20 and $\delta^{34}S_{sulfate}$ values less than –5‰ indicate non-mill water as a source of uranium and sulfate at these wells
  2. $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$ isotopes indicate San Juan River water as water source (Group 3) but tritium concentration indicates recharge occurred after1970, after the mill ceased operating

Interpretation: Challenges

- West Terrace wells – 0833 and 0835
  1. $^{234}U/^{238}U$ ARs greater than 1.20 but $\delta^{34}S_{sulfate}$ values between –5‰ and +5‰
  2. However, $\delta^{34}S_{sulfate}$ for 0833 matches that of San Juan River water and $\delta^{34}S_{sulfate}$ for 0835 matches that of Animas River water
  3. $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$ isotopes for both wells match Animas River water (Group 2) and tritium concentration indicates recharge occurred since 1969, after mill ceased operating
  4. Definitely non-mill water, but perhaps different sources of sulfate to each well
  5. Location of irrigation and leaking municipal water lines overlap in this area

Interpretation: Challenges (continued)

- Well 0728
  1. $^{234}U/^{238}U$ AR of 1.12 and $\delta^{34}S_{sulfate}$ value of -15.82‰
  2. $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$ isotopes for both wells match Animas River water (Group 2) and tritium concentration indicates recharge occurred since 1969, after mill ceased operating
  3. Perhaps mill water once flowed in this area and mill derived uranium that adsorbed to alluvium is now desorbing as groundwater of a different chemistry encounters alluvium

Interpretation: Challenges (continued)

- Seep 0425 and 0426
  1. $^{234}U/^{238}U$ AR of 1.21 and $\delta^{34}S_{sulfate}$ value of -5.86‰
  2. $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$ isotopes for both wells match Animas River water (Group 2) and tritium concentration indicates recharge occurred since 1969, after mill ceased operating
  3. Perhaps mill water once flowed in this area and mill derived uranium that adsorbed to alluvium is now desorbing as groundwater of a different chemistry encounters alluvium

Interpretation: Challenges (continued)

- Bob Lee Wash well 0725
  1. Recharged to some degree by 0648 – an artesian well in the Morrison Formation
  2. $^{234}U/^{238}U$ AR of 1.08 and $\delta^{34}S_{sulfate}$ value of 3.91‰
  3. $\delta^{34}S_{sulfate}$ value is similar to sulfuric acid used by mill and to that of Animas River water
  4. $\delta^{2}H_{water}$ and $\delta^{18}O_{water}$ isotopes of well 0725 and 0648 are very similar (Group 1) and tritium concentrations for both wells indicate old groundwater—recharge occurred prior to 1953
  5. Perhaps mill water once flowed in this area and mill derived uranium that adsorbed to alluvium is now desorbing as groundwater of a different chemistry encounters alluvium
  6. Perhaps there is some mixing with Animas River water

Conclusions