# AML PROJECT 160 – McINTOSH PIT EVAPORATIVE DEWATERING & BACKFILL

DEQ
WYOMING DEPARTMENT OF
ENVIRONMENTAL
QUALITY

## ASRS Laramie 2026

BRS
ENGINEERING

# Bottom Line Takeaways

## Backfill Management

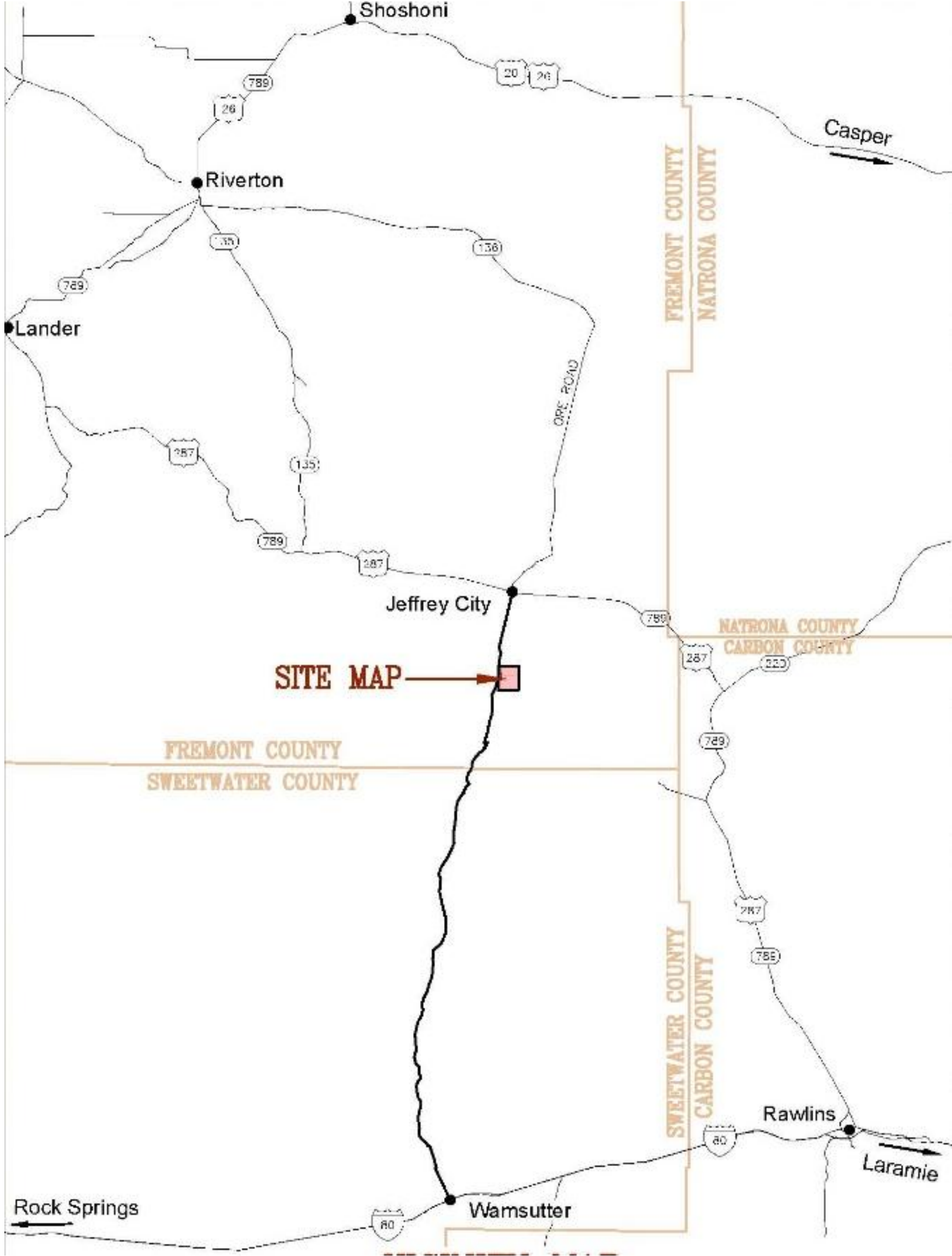
- Backfill material will segregate upon introduction to water body
  - Fill Stability Considerations
  - Slimes Accumulation
- Fill introduction rate is *ideally* performed to roughly match effective evaporation rate/volume
  - Phased work essential
- Phased interim grading surfaces must
  - Maintain fill stability
  - Manage internal drainage
  - Allow for Deployment and maintenance of Evaporative systems, allow for winterizing in off season

## Evaporative Dewatering

- System evaporation rate $\geq$Effective evaporation rate
  - Mine open pits are not closed systems
  - System operating parameters are rarely *ideal*
- $ Discharge Dewatering < $ Evaporative Dewatering (lined electrical power) < $ Evap. Dewatering (*Deisel Genset)*
- Evaporative dewatering is not effective in all seasons and all climates
  - Phase work essential
- Land vs. Water Deployed evap. arrays have tradeoffs (evaporation rate, erosion, access, footprint, maintenance etc.)

# McIntosh Location and History

- Project is located approximately 10 miles south of Jeffrey City, Wyoming
- Ore grade uranium discovered in Crooks Gap District in 1953
- Commercial production began 1957
- Production at McIntosh ceased 1982
- Ownership passed to current owner Energy Fuels in 2012



# McIntosh Pit Overview

- 30.3 acre water body
- Excavation Magnitude
  - ~20 million CY mine pit excavation
  - ~11.7 million CY reclamation backfill volume placed in pit
- ~1 billion gallons water in pit
- Up to 240 feet deep water body
- Up to 200 foot highwalls above water line

West Highwall and Pit Water Prior to Reclamation

# Backfill Sequence Photos

12-12-14 middle Phase 1

1-30-15 later Phase 1

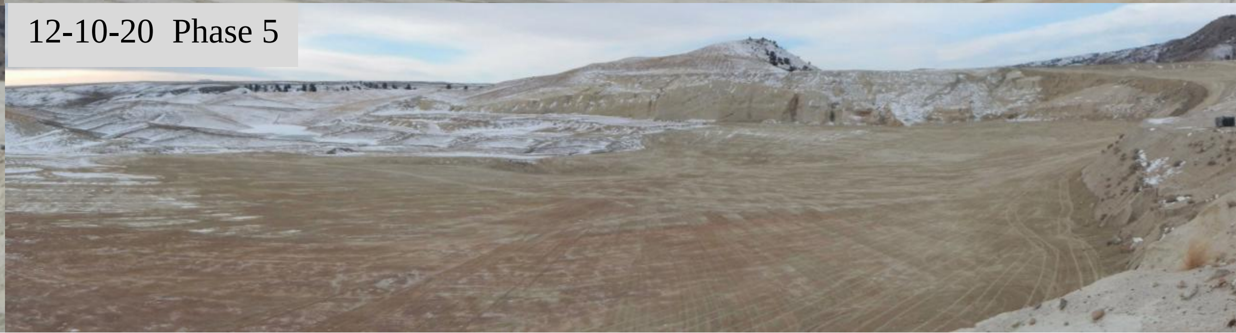
8-27-15 Phase 2

12-9-16 Phase 2C

11-6-17 Phase 3

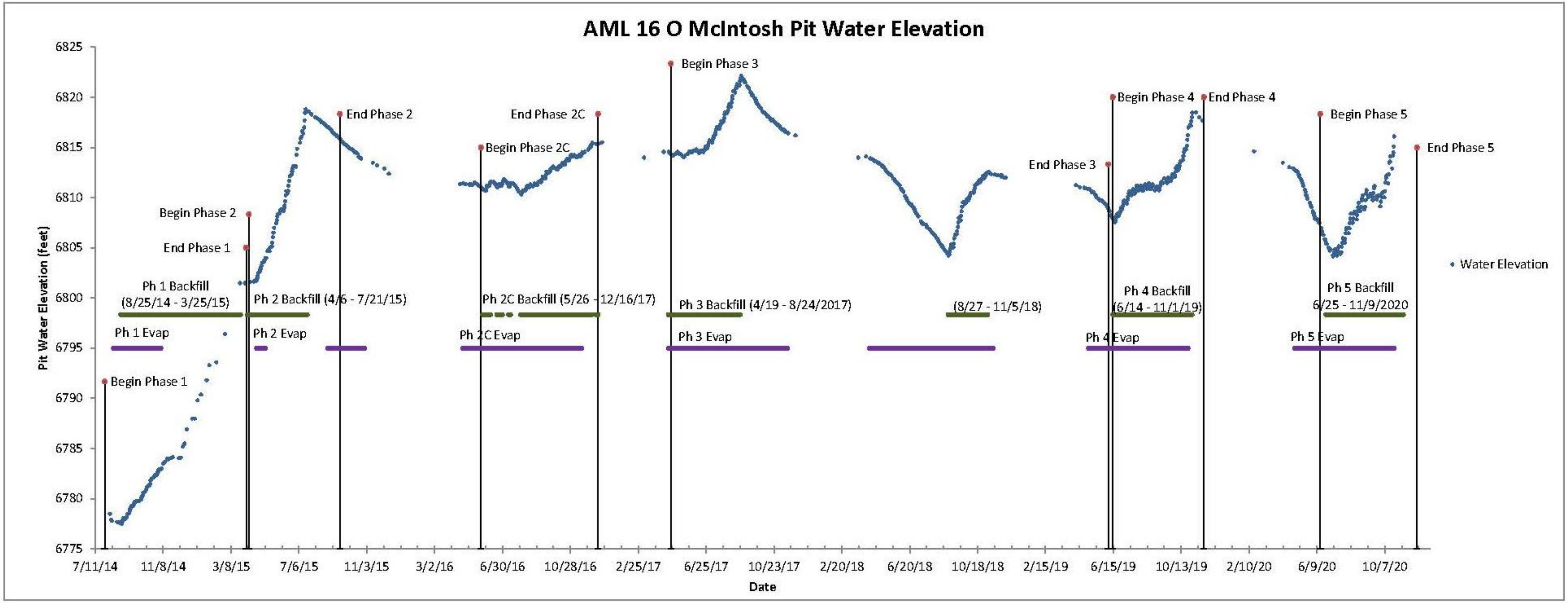
11-16-18 Phase 3

11-15-19 Phase 4

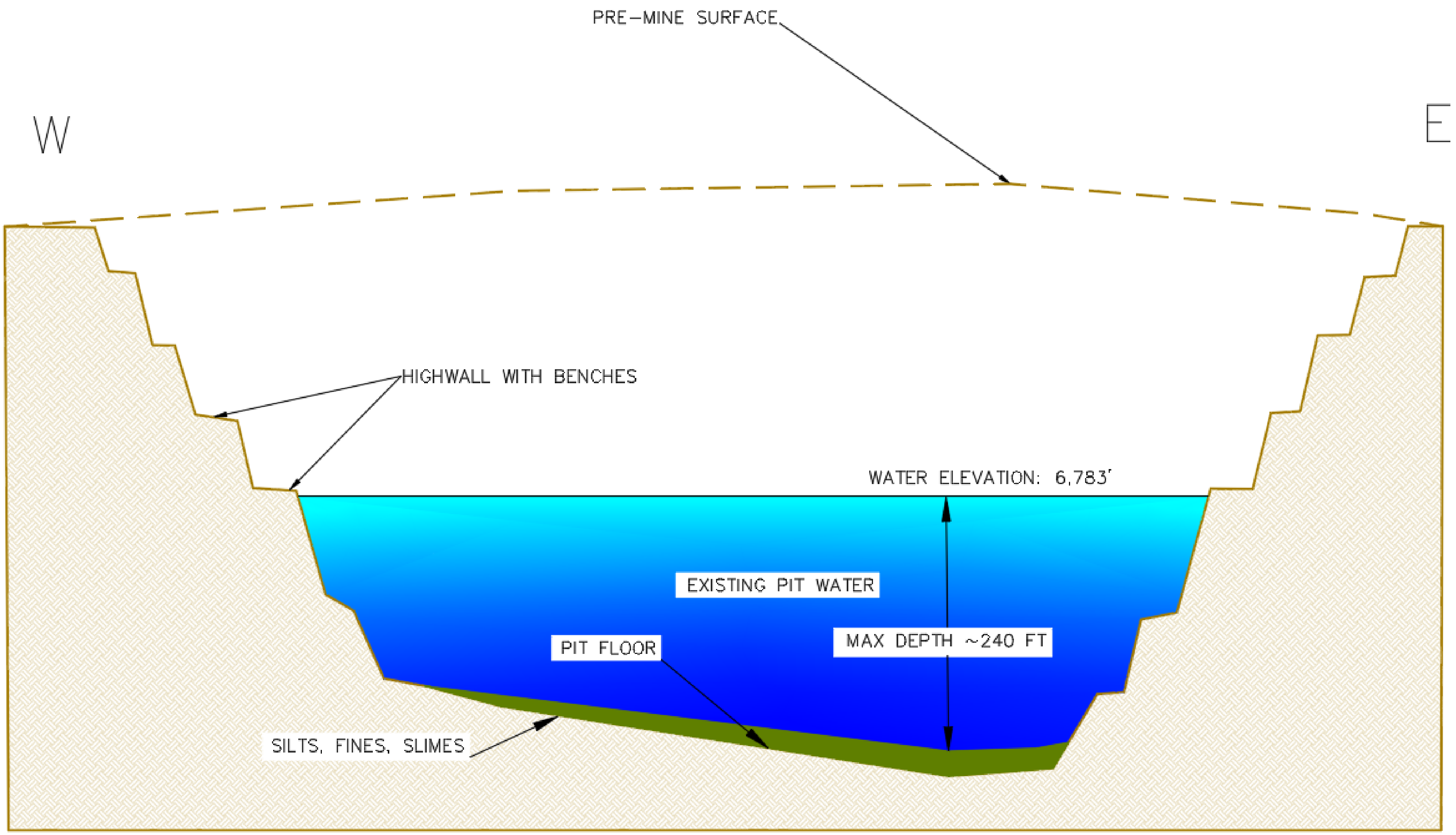


12-10-20 Phase 5

# Pit Water Elevation Timeline



# Pre-Reclamation Condition E-W View

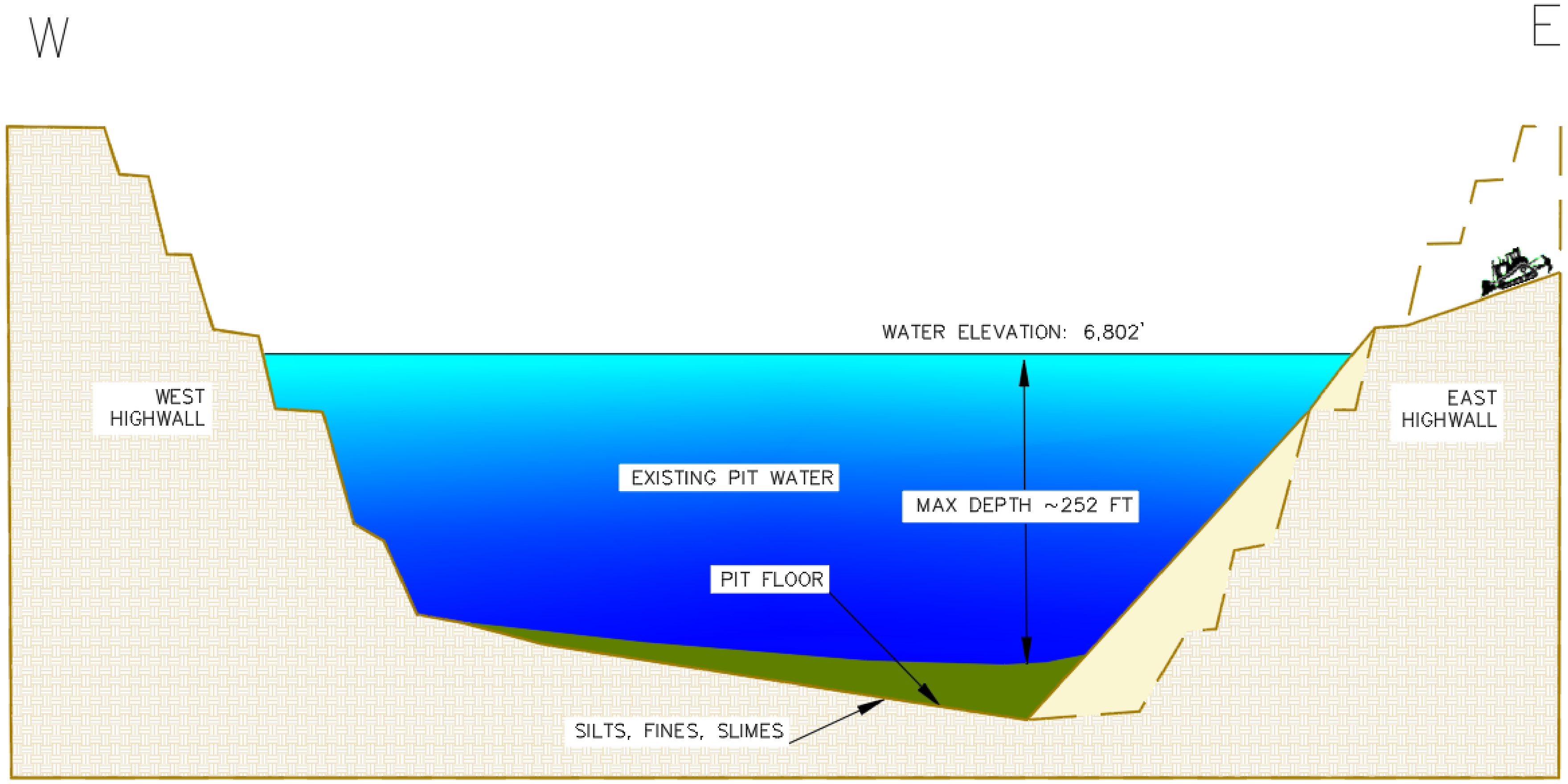


# Backfill Phase 1

Dozers Pushing Blasted Material From Highwall into the Pit

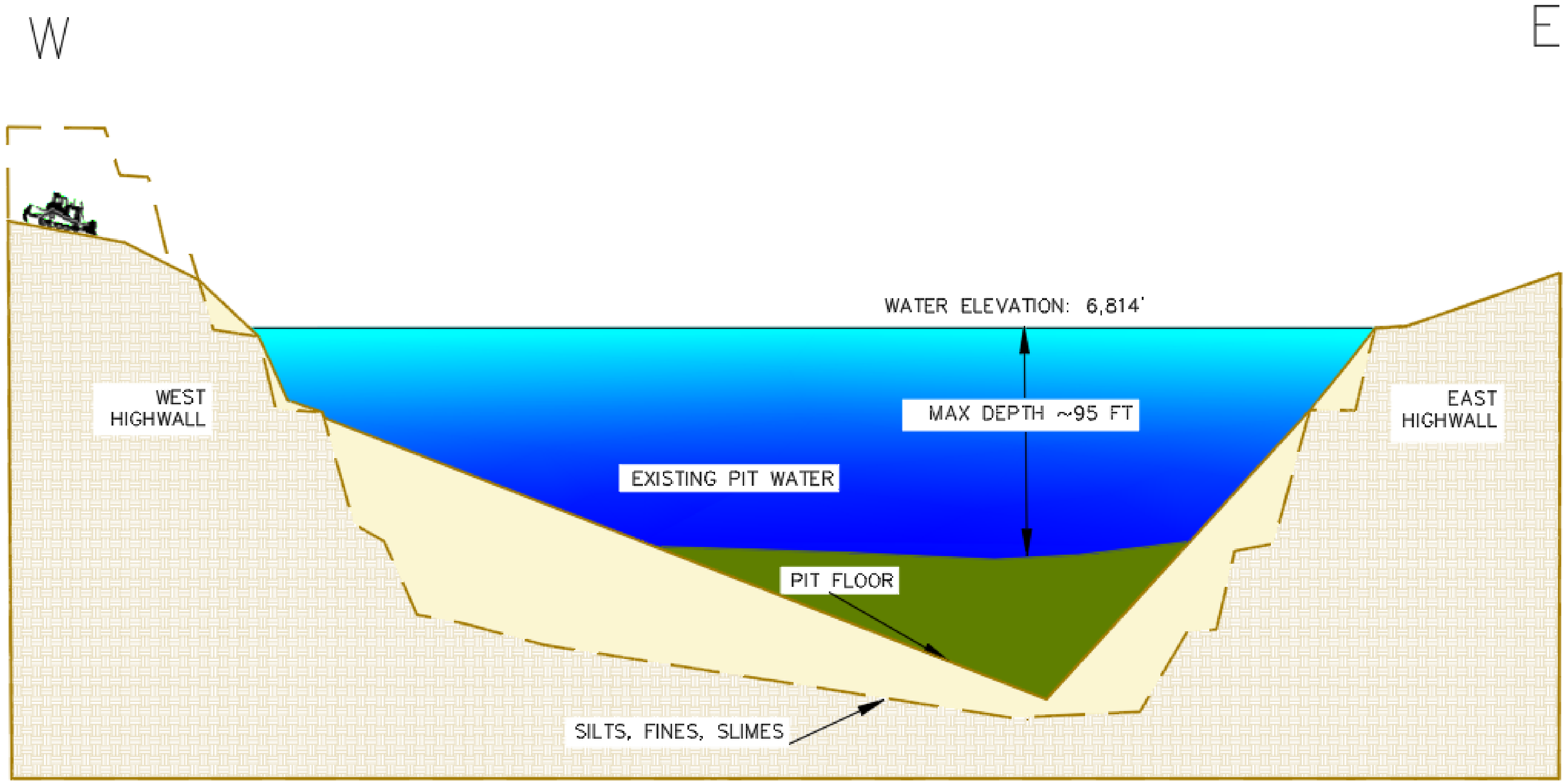
# Backfill Phase 1

- Phase 1 blasted and dozed rocky spoils into water filled pit
- Fines settled into a layer in the bottom of the pit
- Minimal change in surface area of pit water body at end of phase
- Max depth of water ~252 ft



# Backfill Phase 2

- Phase 2 continued to blast and doze rocky spoils into water filled pit
- Fines again settled into a layer in the bottom of the pit
- Minimal change in surface area of pit water body at end of phase
- Max water depth reduced to ~95 ft

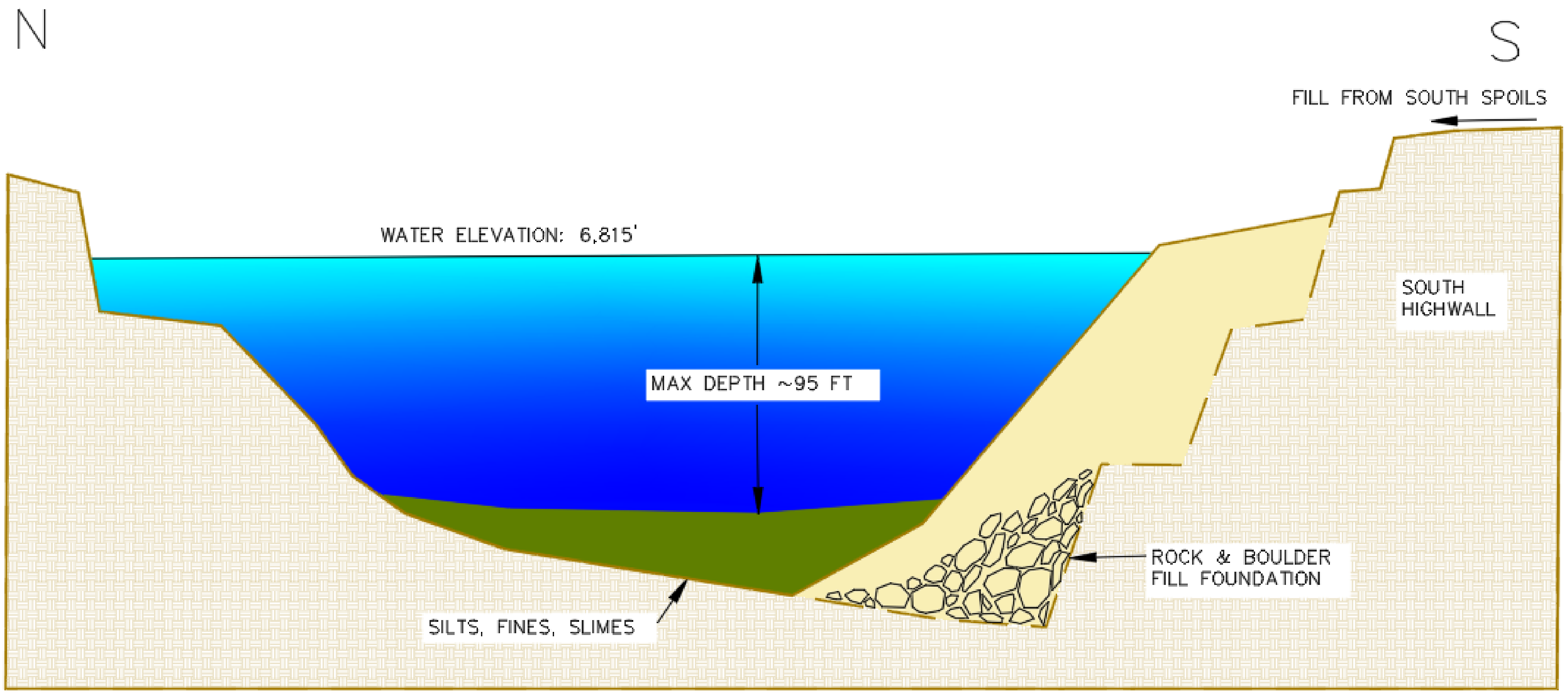


# Backfill Phase 2

Dozers Reducing West Highwall

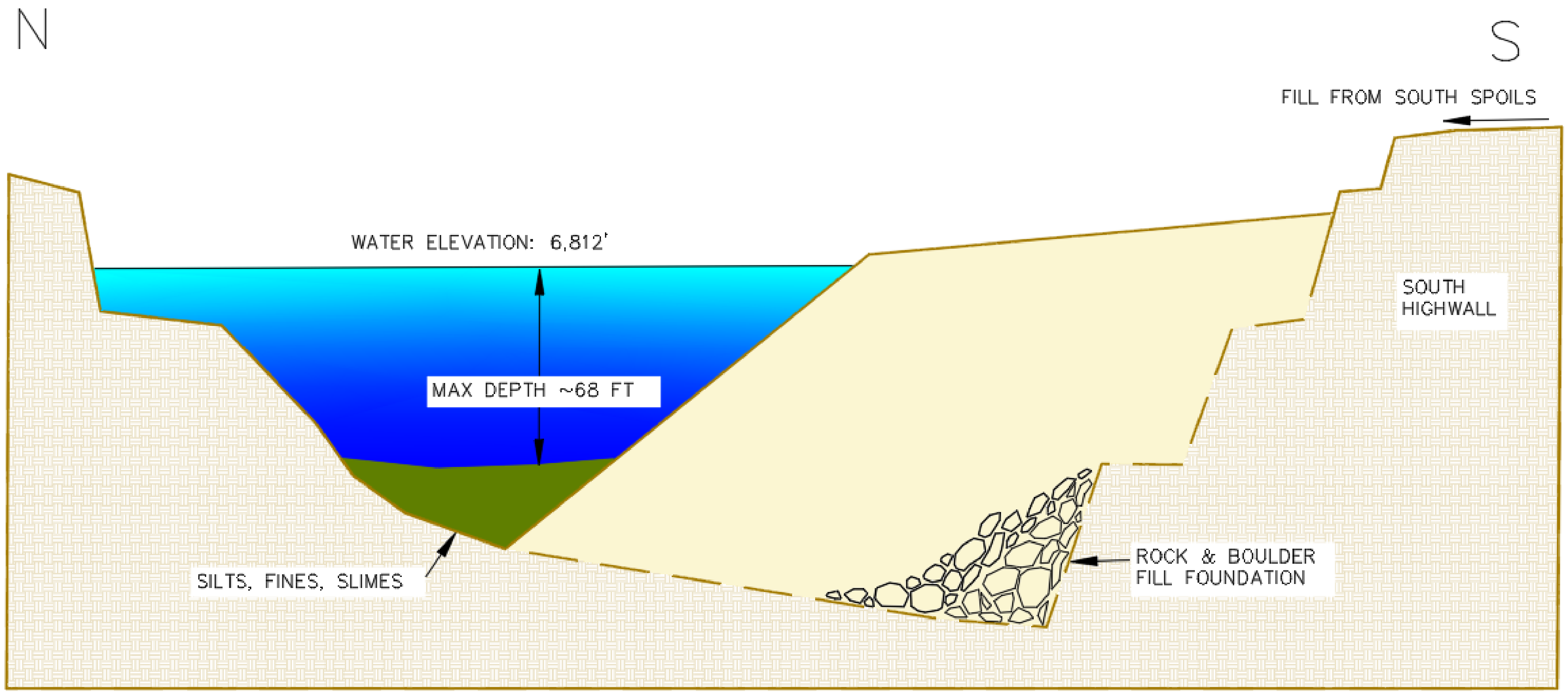
# Backfill Phase 2C

- Phase 2C dozed spoils into water filled pit on top of rock foundation from prior phases
- Water began to be crowded north as surface area of water body shrank
- Max water depth remained ~95 ft



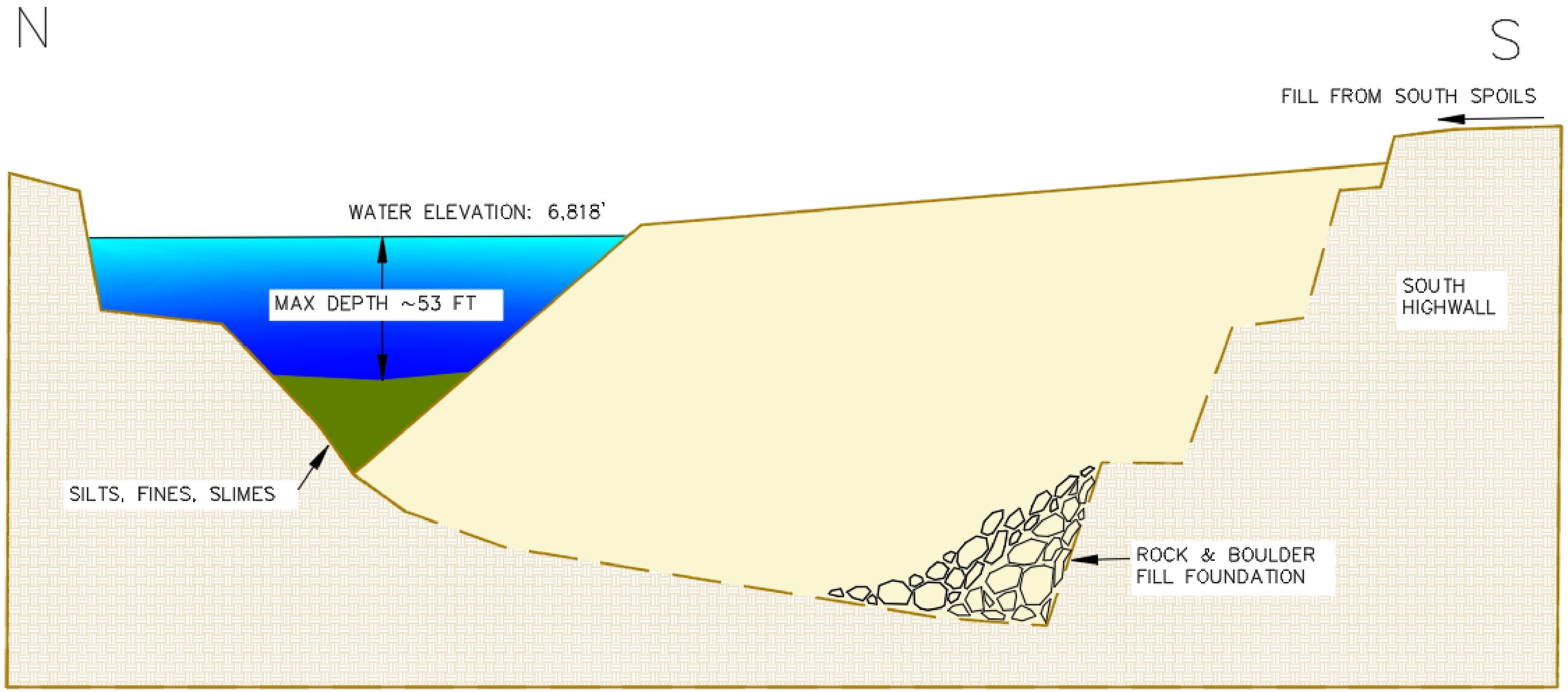
# Backfill Phase 3

- Phase 3 dozed additional spoils into water filled pit on top of rock foundation from prior phases
- Water continued to be crowded north as surface area of water body shrank
- Max depth reduced to ~68 ft



# Backfill Phase 4

- Phase 4 dozed additional spoils into water filled pit
- Water continued to be crowded north as surface area of water body decreased
- Max depth reduced to ~53 ft

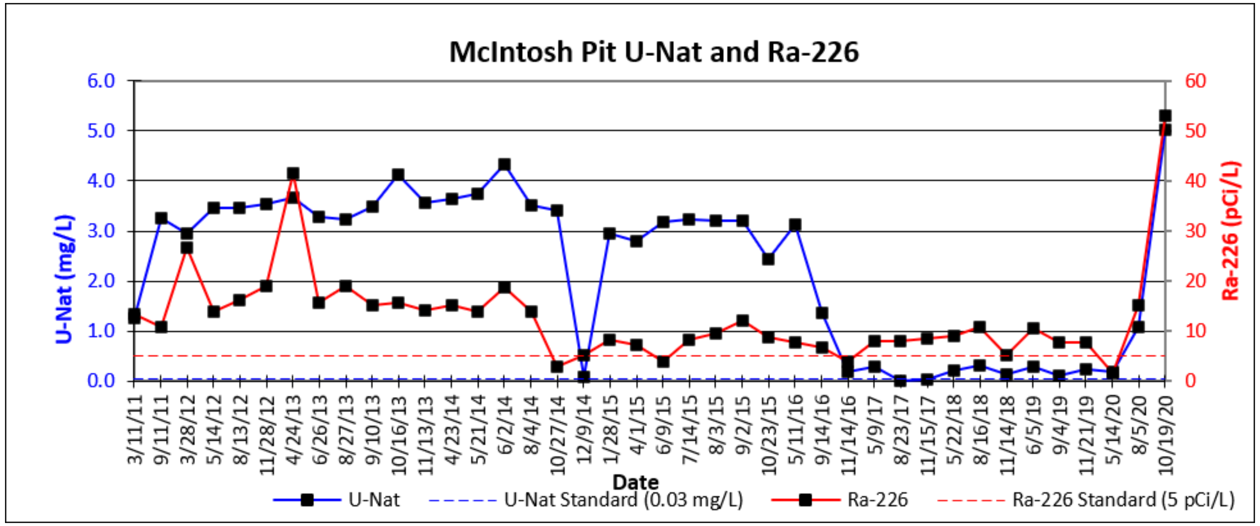


# Backfill Summary

| Phase | Pit Water Elevation (Feet) | Maximum Depth of Water (Feet) | Deepest Pit Elevation (Feet) | Depth to Average Pit Bottom (Feet) | Average Pit Bottom Elevation (Feet) |
|---|---|---|---|---|---|
| Pre-Project | 6,783 | 244 | 6,539 | 173 | 6,610 |
| Post Phase 1 | 6,801.5 | 251.5 | 6,550 | 171.5 | 6,630 |
| Post Phase 2 | 6,813.8 | 94.8 | 6,719 | 92.8 | 6,721 |
| Post Phase 2C | 6,815.4 | 95.4 | 6,720 | 85.4 | 6,730 |
| Interim Phase 3 | 6,816.4 | 75.4 | 6,741 | 70.4 | 6,746 |
| Post Phase 3 | 6,812.1 | 68.1 | 6,744 | 61.1 | 6,751 |
| Post Phase 4 | 6817.7 | 52.7 | 6,765 | 38.7 | 6,779 |
| Post Phase 5 | COMPLETE | | | | |

# Dewatering Parameters Overview

- Initial Maximum Water depth >240’
- ~1 billion gallons water
- Offsite discharge **not** permittable by Wyoming DEQ




- Evaporative Dewatering Needed

- Initial Evaporation rate designed to approximate equal displacement due to backfill

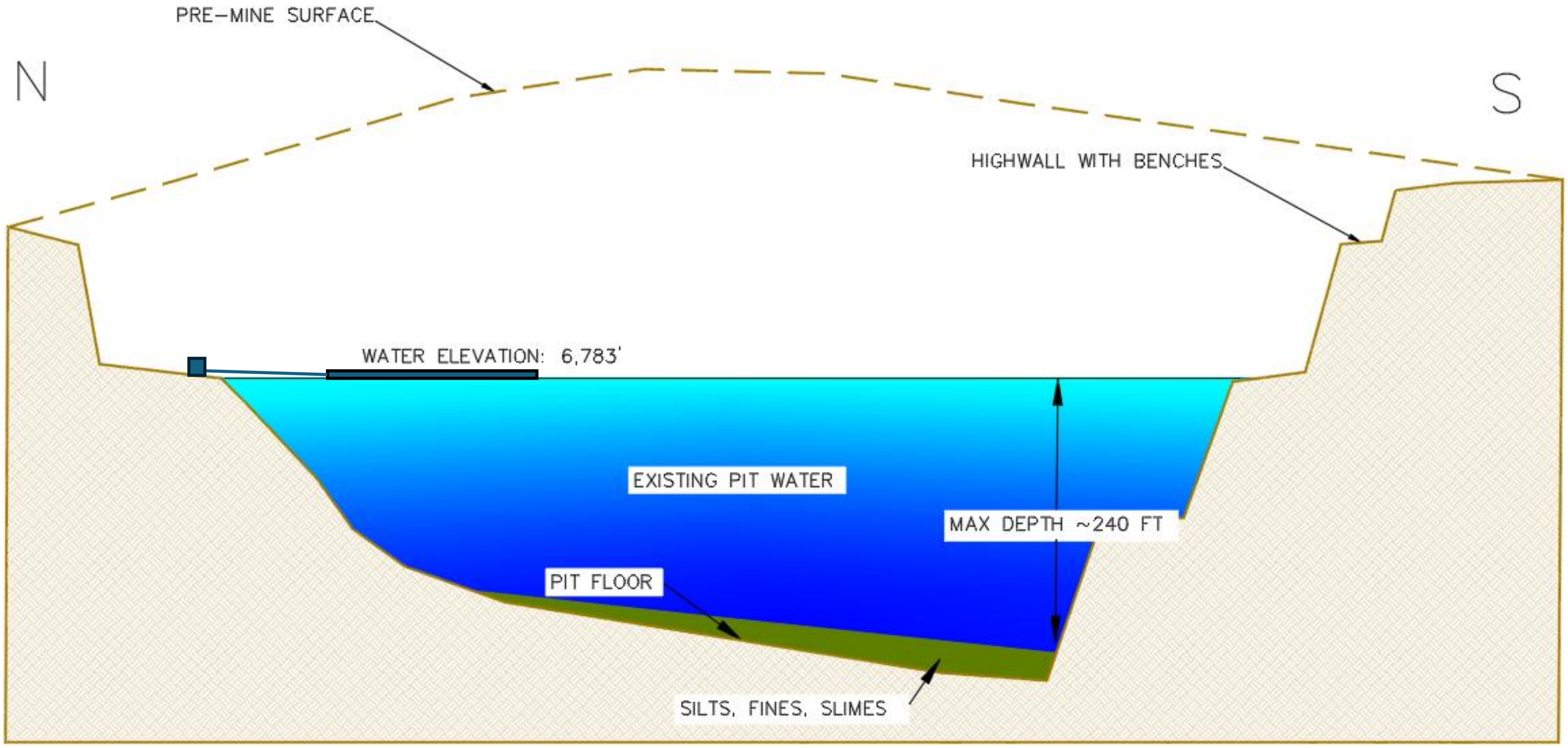
West Highwall and Pit Water Prior to Reclamation

# Initial System Design

- Evaporative dewatering system proposed to remove 800 gpm, 24h/d, 7d/wk during six highest evaporation months (April-September)
  - Evaporative array floated on pit water surface due to lack of access
  - Vendor estimated 10-25% evaporation rate
  - Highest net effective evaporation rate for water and land arrays was 7.3%

Disel Pump and Tank Powering Floating Arrays

# Pre-Reclamation Condition N-S View



# Phase 1

- Rental equipment
- Two Godwin Dri-Prime HL225M Diesel Pumps
- Two floating arrays
  - 6-inch HDPE
  - 76 feet x 276 feet
  - 75 nozzles / array
  - 4-foot risers
  - 55 psi at nozzle
- Began operation August 2014
- Operated to November
- Winterized by removing from water

Two Floating Arrays Operating in 2014

# Lessons Learned and Improvements

- Rapid increase in water elevation during Phase 1 winter backfill
  - August 2014: 6,778 feet
  - April 2015: 6,802 feet
- Significant downtime for diesel pump fueling, maintenance, mechanical issues
- Electric pumps estimated to save >$1 million compared to diesel
- Powerlines and two 200 HP Godwin Dri-Prime WT225M electric pumps installed for Phase 2
- Added floating array for Phase 2
  - Same design with 6-foot risers

Electric Power for Dewatering Arrays

# Phase 2

- Damage was sustained to pumps and arrays from highwall blasting in May 2015 (Shot 1)
  - Repaired by June 5
- June 30 and July 10 (Shots 5 & 6) blasting caused more array damage
  - Repaired by September 1
- Significant downtime increased pit water level
  - April 2015: 6,802 feet
  - July 2015: 6,819 feet

Shot 1 on 5/8/2015

Shot 6 on 7/10/2015

# Phase 2C

- One floating array removed
- One land-based evaporation array added
  - Two parallel 1000-foot, 12-inch HDPE lines
  - 80 nozzles at 25 feet spacing
  - One 400 HP Godwin Dri-Prime HL250M electric pump
- Water level successfully managed by upgraded system during the Phase
  - April 2016: 6,811 feet
  - December 2016: 6,815 feet
- Underwater survey showed pit bottom raised 8 feet during Phase due to backfill

Land Based Evaporation Array

# Phase 3 Upgrades

- In the 2017 season backfilling operations began significantly shrinking surface area of the pit water
  - Vertical displacement became more rapid due to decreased surface area
  - Six Pole Cat turbine evaporators added
    - 75 HP high pressure HL100M booster pump

Six Turbine Evaporators and Floating Arrays Operating

# Phase 3 (2017)

- Phase began April 2017
- Evaporation unable to match displacement due to backfill
  - April 2017: 6,814 feet
  - August 2017: 6,822 feet
- AML issued Stop Work Order August 2017
  - Contractor moved equipment to nearby job
- Only evaporation performed for remainder of 2017
  - November 2017: 6,816 feet
- No further upgrades made to system

Pit Backfilling Just Before Stop Work Order

# Phase 3 (2018)

- Start Work Order issued August 2018
- Evaporation unable to match displacement due to backfill
  - August 2018: 6,804 feet
  - November 2018: 6,812 feet

All Dewatering Systems Operating at the Start of 2018

# Phase 4

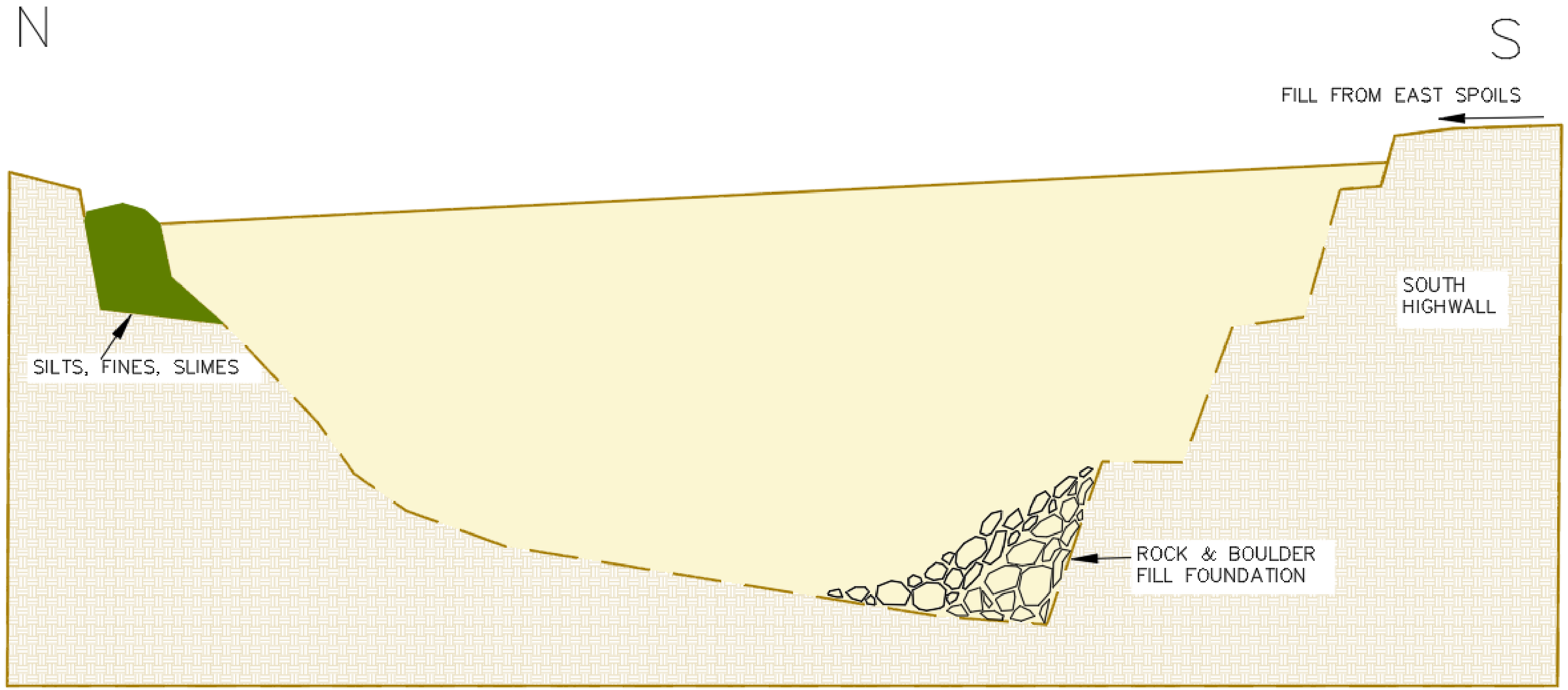
- Rising water levels necessitated raising fill around the pit
  - June 2019: 6,808 feet
  - November 2019: 6,818 feet
- August 2019 failing HL250 pump replaced with Vertical Industrial Turbine (VIT) on a floating barge
  - Higher flow of VIT pump caused flooding and erosion of Pole Cat bench
  - Water diverted away and pump rpm decreased

Rebenching to Raise the Elevation of a Pump

Floating Barge with VIT

# Backfill Phase 5

- Phase 5 dozed additional spoils into water filled pit
- Water was fully entrained
- Slimes either encapsulated or handled and spread to dry



# Phase 5

- Final Phase of backfill into water body
- Floating evaporative dewatering arrays operated until removal required to complete backfill
- Pit water elevation on October 15, 2020 (end of dewatering): 6,814 feet
- Turbine evaporators and land evaporators operated until impractical
- Remaining pit water pumped to McIntosh Reservoir No. 1
- No water remained by end of 2020

Mud Displaced by Fill along East Side of Pit

# Mud Handling

- Mud handling was conducted in Phases 5 & 6 upon completion of dewatering

- Phase 5 removed 15,000 CY mud and spread it for drying with the remainder being encapsulated in fill

- Mud left to dry at end of Phase 5 was still saturated at the beginning of Phase 6

- Excavated spoils were mixed with mud to dry it for compaction and stabilization

- Total Mud Handling Cost $74,882.50

Encapsulation of Remaining Mud at end of Phase 5

# Backfill Phase 5

Fill From Spoils Advancing into the McIntosh Pit

# Decommissioning

- Reusable equipment and materials removed from site for resale
- Non-reusable materials disassembled and properly disposed
- Decommissioning completed in 2022

Dry McIntosh Pit with Equipment Being Decommissioned

# Evaporative Dewatering Summary

| Phase | Start Date | End Date | Total Volume Pumped (million gallons) | Calculated Evaporation (million gallons) | Effective Evaporation Rate | Annual Costs |
|---|---|---|---|---|---|---|
| 1 | 8/12/2014 | 11/4/2014 | 619.5 | 21.1 | 3.4% | $1,171,077.85 |
| 2 | 8/26/2015 | 10/30/2015 | 577.7 | 33.6 | 5.8% | $87,368.01 |
| 2C | 4/21/2016 | 11/17/2016 | 1,878.0 | 127.5 | 6.8% | $301,303.36 |
| 3 (2017) | 4/19/2017 | 11/16/2017 | 1,912.5 | 116 | 6.1% | $814,908.45 |
| 3 (2018) | 4/10/2018 | 11/15/2018 | 1,848.0 | 108.9 | 5.9% | $482,401.90 |
| 4 | 5/2/2019 | 10/25/2019 | 1,704.2 | 101.6 | 6.0% | $351,273.07 |
| 5 | 5/1/2020 | 10/23/2020 | 1,575.5 | 114.7 | 7.3% | $333,438.27 |
| 6 | n/a | n/a | n/a | n/a | n/a | $11,530.00 |
| 7 | n/a | n/a | n/a | n/a | n/a | $44,550.00 |
| Total | | | 10,115.4 | 623.4 | 6.2% AVG. | $3,597,670.91 |

# Evaporation Overview

- Initial pit water volume:
  - ~1 billion gallons
- Actual evaporation volume:
  - 623.4 million gal (62.3%)
- Net effective evaporation rate:
  - Initial Estimate: 10-25%
  - Actual/Effective: 6.2%
  - Pit **Not** a closed system
- Effective evaporation rate
  - Observed Water level
    - Ground water flow
    - Precipitation/runoff
- Actual evaporation > effective evaporation for 16O project

Land Array in Phase 4

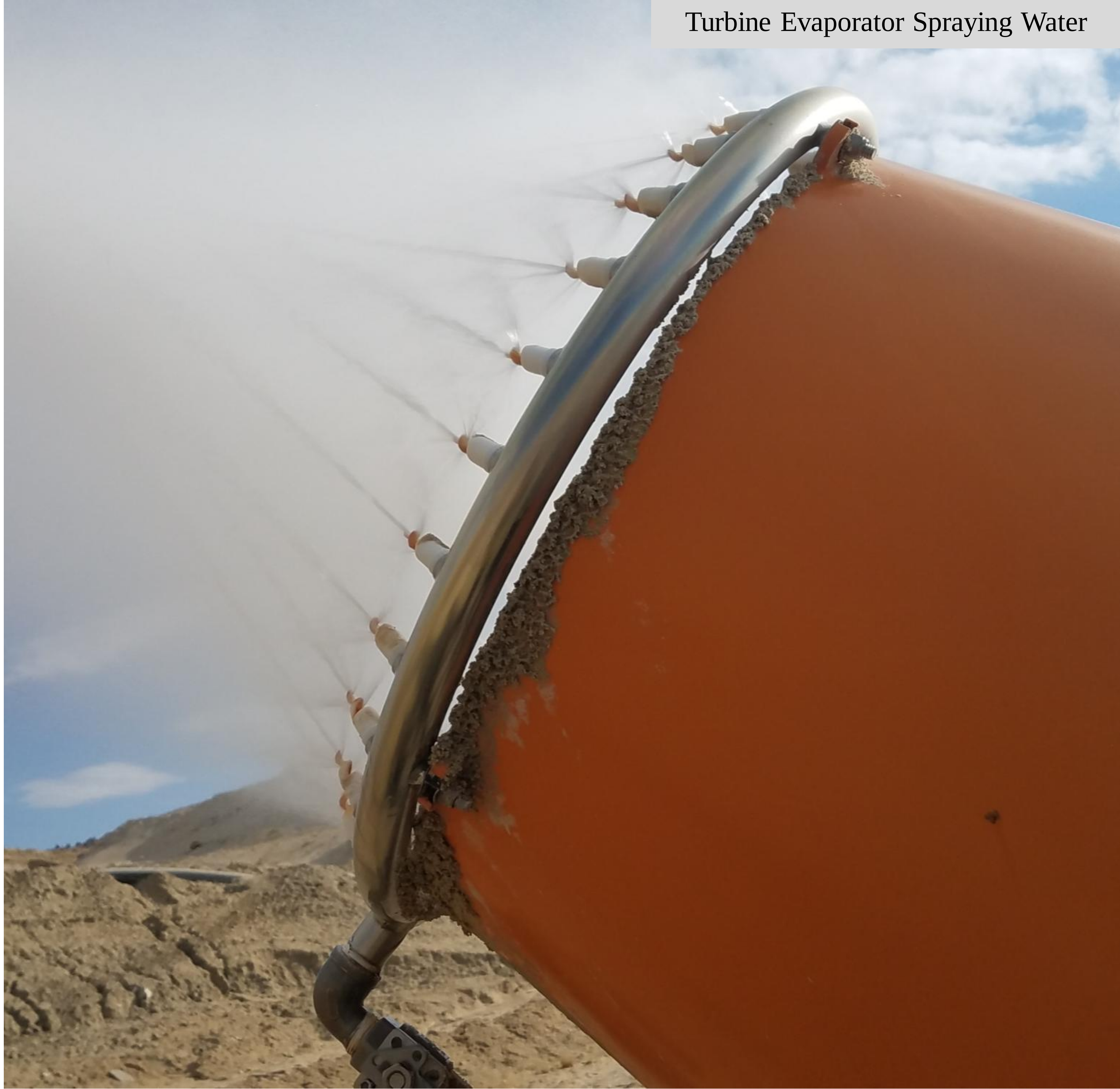
# Evap. System Challenges

- Raising pump benches and moving land pumps in response to water elevation changes
- Net effective evaporation rate lower than theoretical max rate
- Mechanical failures
- Blasting damage risk
- Erosion mgmt
- Waterbody Safety
- Freezing winter weather
- Electrical issues

Erosion undercutting water array system

# Array Comparison

- Floating array advantages:
  - Limited working space
  - Smaller pumps
  - No erosion or land saturation
- Land array advantages:
  - Ease/safety of maintenance
  - Better evaporation rate
    - 5.8% for water arrays
    - 11.2% for land arrays
  - Less wind/water damage
- Turbine evaporators – Not possible to separate performance from land and floating arrays due to limited use


Turbine Evaporator Spraying Water

# Challenges and Iterations

- Volume:10.1 billion gallons pumped total
  - 623.4 million gallons evaporated
  - 3,200 gallon/min pump rate
- Equipment:
  - Initial/Vendor estimated 2 arrays
  - Actual/Project required 4 arrays
- Time:
  - Estimated: 5 years pumping
  - Actual: 7 years pumping

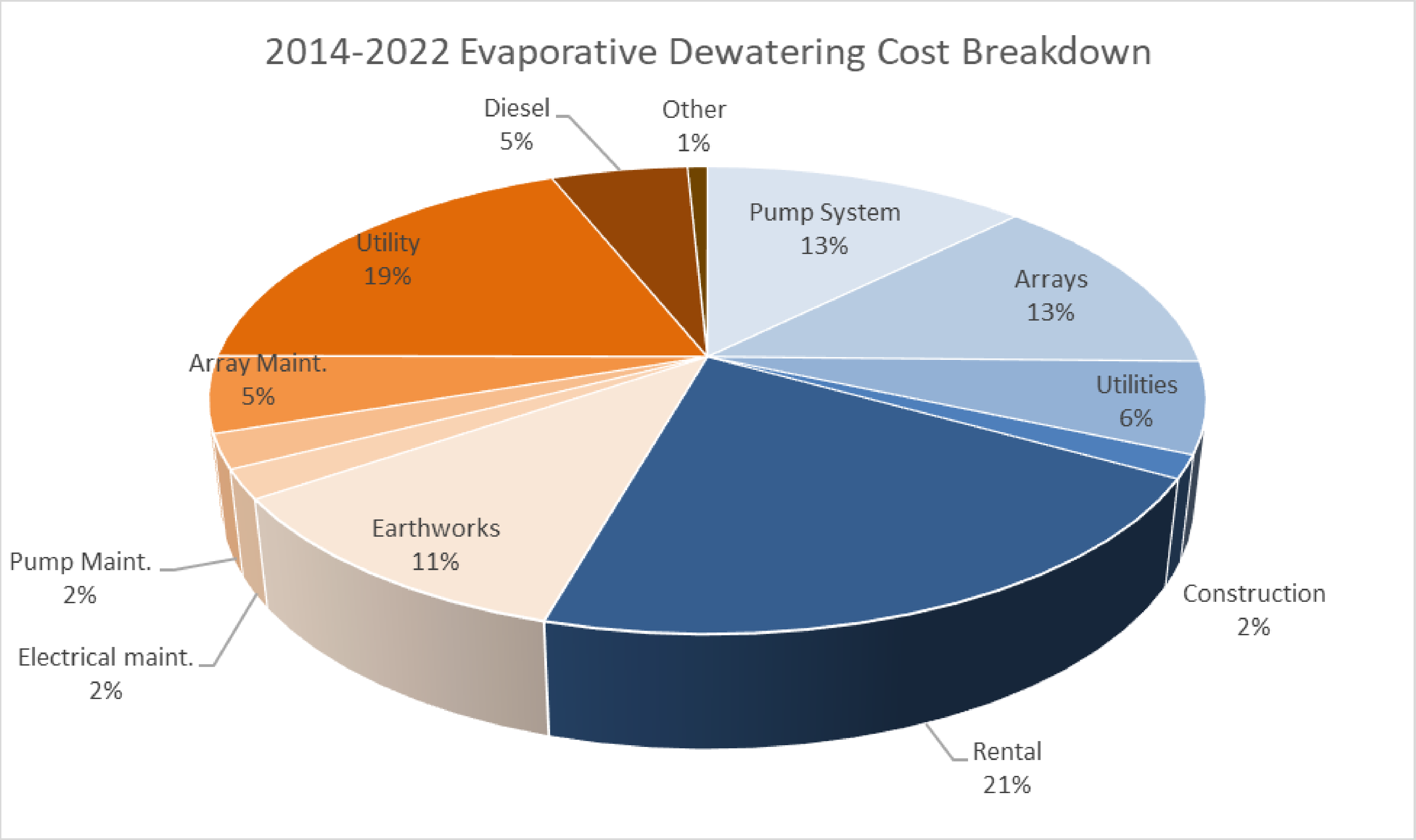
Water Array Phase 4

# Budget

- Original Cost Estimate: $3,674,000.00
- Actual Cost: $3,597,670.91
  - Savings: 2.1%
- General Breakdown
  - Capital costs: $1,957,491.68
  - Operating Costs: $1,640,179.23


Land and Water Arrays in Phase 2C

# Evaporative Dewatering Cost Breakdown



# Evaporative Dewatering Summary

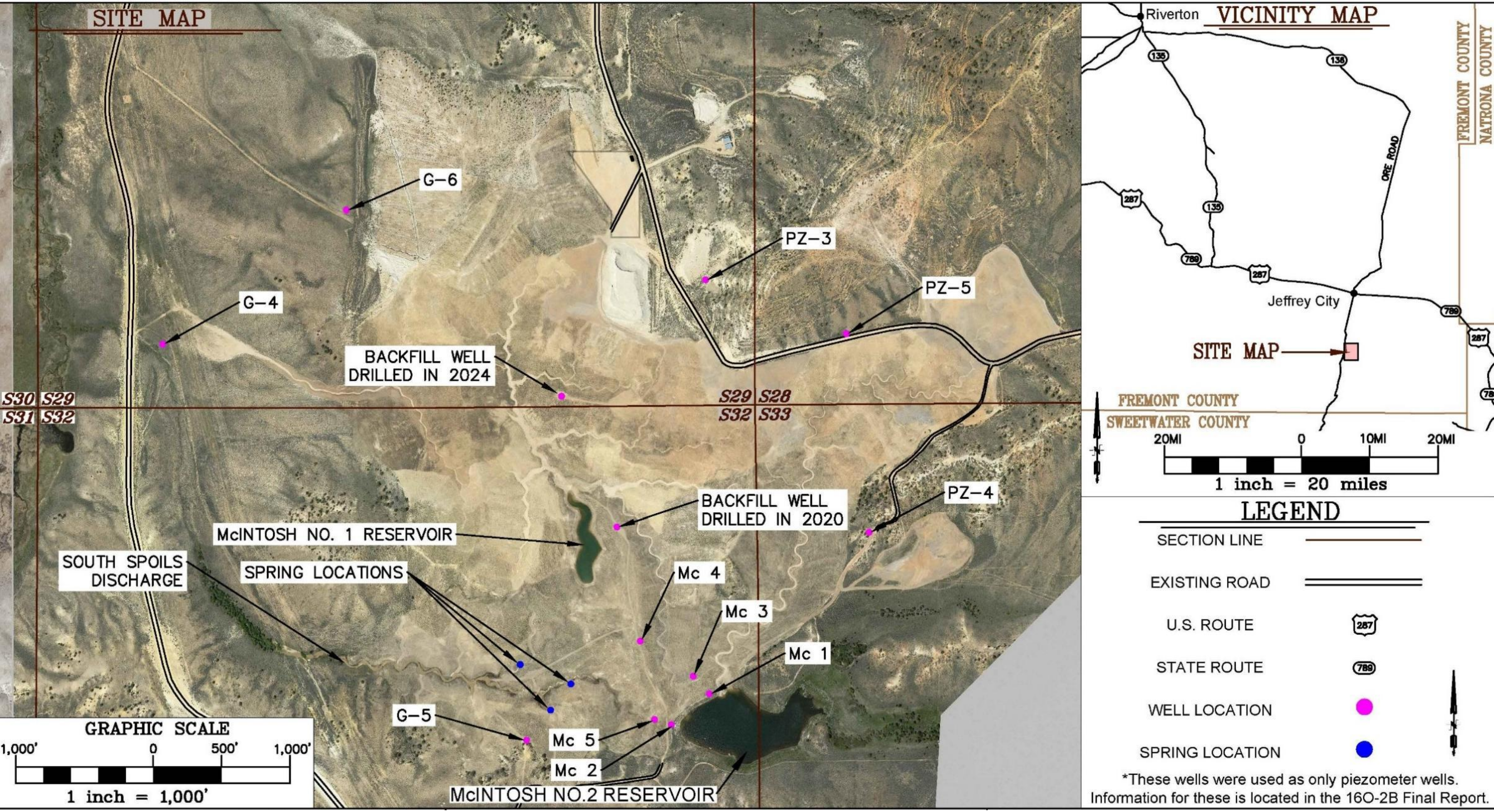
- Electric pump savings
  - No rebuilding or replacement
  - Greater reliability
  - Diesel pump cost:
    ~$30,000 / month
  - Electric pump cost:
    ~$6,000 / month
  - Savings: ~$2,400,000 versus diesel pumps
- Offsite discharge comparison
  - McIntosh evaporative dewatering: $5.77 / 1000 gal
  - Day Loma offsite discharge: $1.68 / 1000 gal

Pole Cat Turbine Evaporators

# Final McIntosh Pit condition => Reservoir No. 1

- Clean surface water impoundment constructed in pit fill during Phases 4 & 5
- Backfill of pit created an artificial aquifer
- Productive water well drilled into backfill 2020 in south and 2024 into the artificial aquifer
- Water Monitoring concluded by AML in 2025

Reservoir No. 1 in 2023


SITE MAP
G-6
G-4
PZ-3
PZ-5
BACKFILL WELL DRILLED IN 2024
S30 S29
S31 S32
S29 S28
S32 S33
BACKFILL WELL DRILLED IN 2020
PZ-4
McINTOSH NO. 1 RESERVOIR
SOUTH SPOILS DISCHARGE
SPRING LOCATIONS
Mc 4
Mc 3
Mc 1
G-5
Mc 5
Mc 2
McINTOSH NO.2 RESERVOIR
GRAPHIC SCALE
1,000' 0 500' 1,000'
1 inch = 1,000'
VICINITY MAP
Riverton
135
136
ORE ROAD
287
789
Jeffrey City
SITE MAP
FREMONT COUNTY
NATRONA COUNTY
FREMONT COUNTY
SWEETWATER COUNTY
20MI 0 10MI 20MI
1 inch = 20 miles
LEGEND
SECTION LINE
EXISTING ROAD
U.S. ROUTE
STATE ROUTE
WELL LOCATION
SPRING LOCATION
*These wells were used as only piezometer wells.
Information for these is located in the 16O-2B Final Report.

# Questions?