



From Model to Field: Constructible Soil Planning

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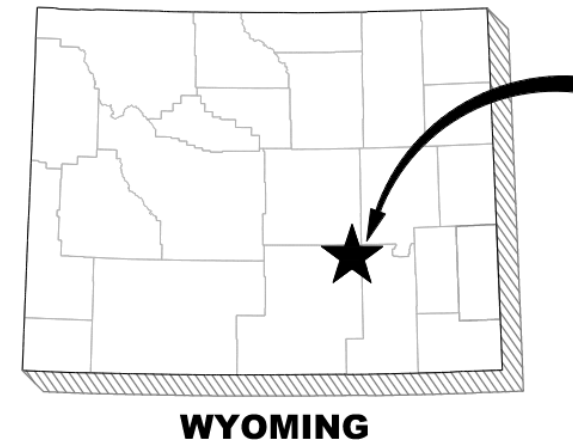


Site Location and History



Shirley Basin, WY

- Approximately 40 miles SE of Casper, WY
- Shirley Basin Tour on 6/11
- Uranium mining back in the 1960s
- Original reclamation conducted in the 1990s
- Recent reclamation started in 2021
 - 400 Pile (completed 2022)
 - 500 Pile (starting in 2026)



Project Goals



400 Pile (2021)



400 Pile (2023)



Past Challenges and Planning Approach



Challenges

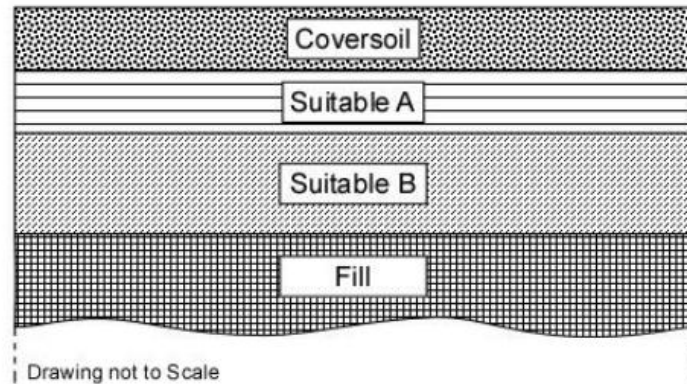
- Limited cover soil available for revegetation efforts
- Limited subsurface investigation on the 400 Pile
- Unexpected significant pockets of good and bad materials noticed during construction

Adjustments

- Expanded soil classification for cover soil alternatives
- Expanded drilling plan with downhole gamma logging, and focused in areas of high interactivity
- Subsurface quantity estimation via modeling



Soil Classification



- Enhanced soil classification parameters help further sort materials present at the site
- Expansion of suitable materials classification helps for vegetation growth
- Need to simplify for field implementation

Parameter	Suitable	Marginal	Fill	Unsuitable
pH	>5.5 <8.5	5.0 - 5.5 8.5 - 9.0	3.0 - 5.0 9.0 - 10.0	<3.0 >10.0
Radium 226 (pCi/g)	≤ 20	-	-	>20
Acid Base Potential (CaCO ₃ equivalent/1000 tons)	> 0	≤ 0 > -5	≤ -5	*
NP/AP Ratio	> 3:1	≤ 3:1 ≥ 1:1	< 1:1	*
Texture	Loam, Silty Loam, Silty Clay Loam, Sandy Loam, Sandy Clay Loam, Silt, Clay Loam, Loamy Sand	Sandy Clay, Silty Clay	Clay, Sand	-
SAR	0-10	10-12	>12	-
SAR (Clay)	0-10	10-15	>15	-
EC (mmhos/cm)	0-8	8-12	>12	-
Coarse Frag (% vol) *	<25	25-35	>35	-
Arsenic (ppm)	≤ 12.0	-	> 12.0	-
Molybdenum (ppm)	≤ 5.0	-	> 5.0	-
Selenium (ppm)	≤ 2.0	-	> 2.0	-

*Insufficient data available to determine site specific unsuitable criteria for ABP and NP/AP Ratio. Classification criteria will be re-evaluated based on ongoing exploration and sampling.

Soil Groups

- Five soil groups were identified based on the materials observed during drilling
- Identifiable by 3 characteristics:
 - Texture
 - Color & Mottling Pattern
 - pH (visual components expressed)
- Designed for efficiency during construction oversight

Material Classification	Salvage Depth (ft bgs)	Soil Groups
Coversoil	≤ 2	1 ; 2 ; 3
Suitable A	> 2	1 ; 2 ; 3
Suitable B	Any	Any
Fill	Any	Any
Unsuitable	Any	Any

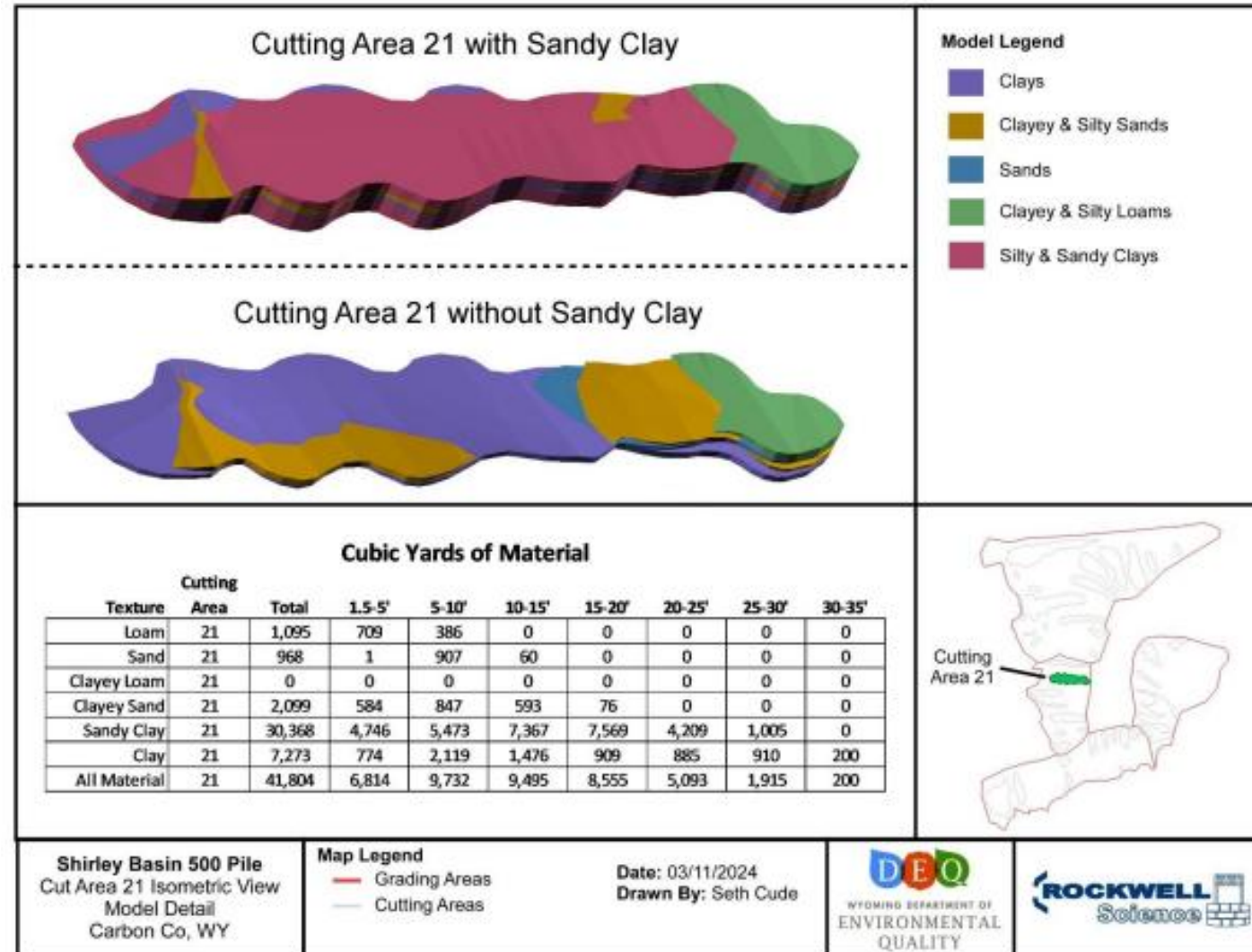


		Soil Groups				
pH (s.u.)		1	2	3	4	5
	Mean	6.7	6.7	5.9	6.0	4.6
	Max	9.0	8.9	9.4	8.5	8.4
	Min	2.80	4.30	2.50	2.50	2.30

Subsurface Modeling



- Subsurface modeling assists us in estimating quantities of various subsurface materials
 - Earthwork sequencing
 - Identifying available material types
 - Planning around unsuitable materials
- Model reconciliation after construction phases
 - Adjustments to the model and future planning will be made based on reconciliation results



Dosage Correlation



STANDARD
DEQ Clean-up Criteria 20 pCi/g



INVESTIGATION
Downhole gamma logging (cps)



FIELD
Ludlum Model 19 ($\mu\text{R/hr}$)



Core samples were kept during drilling and sent to a soil lab for analysis

- cps to pCi/g

Target ranges from logging were identified and excavated to in the field

- pCi/g to $\mu\text{R/hr}$

Values were plotted and compared to establish a correlation curve

Construction Screening



- Provides practical, real-time guidance
- Focus is to balance operational efficiency while guiding soil placement based on quality
- Screening results are compared to parameters identified for material classification and soil groups
- In-field screening methods:
 - Radiometric
 - pH/EC
 - Texture
 - Visualization

Parameter	Material Classification - Field			
	Suitable A	Suitable B	Fill	Unsuitable
pH	>5.5	5.0 - 5.5	3.0 - 5.0	<3.0
	<8.5	8.5 - 9.0	9.0 - 10.0	>10.0
Ludlum model 19 measurement (MicroR/hr)	> 0	-	-	100
EC (mmhos/cm)	0-8	8-12	>12	-
Coarse Frag (% vol)	<25	25-35	>35	-
Texture **	L, Si, SiL, SL, CL, SiCL, SCL	S, C, LS, SC, SiC	-	-

** L = loam, Si = Silt, S = Sand, C = Clay, SiL = Silty Loam, SiCL = Silty Clay Loam, SL = Sandy Loam, SCL = Sandy Clay Loam, CL = Clay Loam, SC = Sandy Clay, SiC = Silty Clay, LS = Loamy Sand

Radiometric Measurements

- Ludlum Model 19 used to acquire dosage measurements
- Materials above the DEQ clean-up criteria of 20 pCi/g will be categorized as unsuitable material
- Cannot be assessed visually
- Not correlated to pH at the site
- All soil types can have elevated radioactivity



pH and EC Measurements

- Hanna HI98130 pH/EC meter used to acquire measurements
- Materials with a pH of 3.0 or less are considered unsuitable
- Some visual assessment correlates to pH
 - Low pH soils will often be black or very dark in color
 - Low pH soils commonly have orange mottling
- Not correlated to radioactivity at the site
- Elevated EC was only observed in two samples, which were designated as fill and unsuitable due to pH
 - EC alone cannot place a material into unsuitable designation



Visual Identification and Texture

- This will be the primary method for determining soil group assignment
- Soil groups identified provide information on textures, colors, and patterns to look for
- Visual assessment of texture and coarse fragments
 - Hand texturing to supplement as needed
- Visuals provide some correlation with pH, no correlation to radioactivity



Material Blending



- Materials will be blended as soils are picked up and moved via construction equipment
 - Scrapers hold ~26-30 CY soil
- Oversight personnel will follow material placement locations to ensure blending was sufficient
- Checking extents of area where elevated measurements are taken
- Large quantity of materials being moved



Summary



- We have a lot of great data acquired from investigation and modeling
- We have a lot of material to move during the construction phases of this project
- Enhanced soil classification, based on observed materials at the site provides us with an approach to expanding cover soil limitations to promote vegetation establishment
- Soil groups have been established to assist with visual assessment of soils during construction oversight
- The use of tools in the field must be done in a manner that maintains operational flow
- Soil modeling provides us with estimates on our expected material types and locations, which will be reconciled upon completion of this season to adjust the model and planning approach

Thank you! Questions?



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Shirley Basin Site Tour Brochure



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