
To: Mr. Peter Werner, PE – Mining Engineer, Custer Gallatin National Forest

Cc: Michael Hatten, PE – Project Manager, Tetra Tech

From: Jake Conver, PE – Civil Engineer, Tetra Tech

Date: February 6, 2023

Subject: Riley Pass Bluff B – Conceptual Design- Excavation and Natural Regrade– (Contract 12035518D0001, Task Order 22)

Riley Pass Uranium Mines Site (the Site) is located in the North Cave Hills area of the USDA Forest Service (USFS) Custer Gallatin National Forest in northwest South Dakota. The Site is approximately 25 miles north of Buffalo, South Dakota. Reclamation activities completed at the Site are generally being performed under US EPA guidance for conducting CERCLA Non-Time-Critical Removal Actions. The primary environmental issues at the Site are associated with impacts from mining activities conducted from the 1950s to the early 1960s. Hazards include high walls, unstable overburden, elevated radioactive materials, heavy metals (arsenic, molybdenum, thorium, and uranium) and mass transport by erosion. The purpose of this project work is to develop an overall conceptual design for Bluff B and to evaluate conceptual mass/haul volumes to accommodate excavated mine waste and natural regrade reclamation. This conceptual design will be used as guidance for future Bluff B design and construction projects.

Tetra Tech has prepared a conceptual design for the reclamation of Bluff B which includes the excavation of mine waste materials below the bluff and placing the mine waste materials in a repository above Bluff B, as shown in the attached figures, and using Geoflur® Natural Regrade reclamation techniques. In addition, this memo summarizes the design criteria and concepts used in the conceptual design and provides excavation, natural regrade, and cover soil estimated volumes.

Conceptual Excavation Design

Design Criteria for the excavation of mine waste were developed and presented in the *Excavation/Removal Criteria and Grading Criteria Memo* that was submitted January 11, 2022 to the Forest Service and revised April 29, 2022. The following is a bulleted list of the design criteria:

- Removal of all mine waste materials exceeding the site-wide cleanup requirements, detailed in the 2016 Riley Pass Action Memorandum (USDA Forest Service, 2016). The site-wide cleanup requirements were solely based on two contaminants of potential concern (COPCs) - arsenic and radium (Ra-226). Removal of mine waste exceeding the criteria below results in the remaining COPCs meeting their established cleanup goals.
 - Arsenic > 142 mg/kg
 - Radium > 30 pCi/g
- Recent contamination mapping from 2021 shows the surface areas exceeding the site-wide cleanup requirements are not as extensive as suspected. Contamination below the surface is based on data from borings and is not as comprehensive as the surface mapping.
- Mine waste exhibiting the highest concentrations of arsenic and radium will be placed in the deepest parts of the bluff consolidation area(s), above the sandstone bluffs and adjacent to the southeast highwall. The Bluff B Subsurface and Supplemental Surface Investigation Report (Tetra Tech, 2021) will be used to delineate the extents of mine waste exceeding site wide cleanup levels.

- A comparison of the existing ground surface to the surface developed from the pre-mined 1954 photogrammetry surface will be used to estimate the amount of mine waste that could be potentially excavated.
- The 1954 exposed sandstone bluff edge will be located and used to differentiate between the lower and upper natural landform grading. The sandstone bluff edge and face will be exposed to the full 1954 extent. The natural regrade landform will begin at the base of this feature.
- For excavation areas in close proximity to archaeological avoidance areas, alternative excavation methods will be developed and approved by the Forest Service to prevent disturbance to the archaeological area(s).

The excavated material (**Figure F-1**) will be placed on top of the bluff rimrock within consolidation areas at elevations that correspond with the conceptual natural landform grading and final grading (**Figure F-2**). In addition, some excavated mine waste will be incorporated into the landform design below the bedrock (**Figures F-2, F-3, and F-4**).

The conceptual excavation below the bluff edge was divided into fourteen separate excavation areas to accommodate excavating one or two areas per construction season. The total volume of mine waste excavation below the bluff edge is estimated at 1,141,350 cubic yards (CY). A breakdown of the excavation area volumes is provided in **Table 1**, below.

Table 1. Bluff B Conceptual Excavation Volumes

AREA	CY	AREA	CY
2A	97,700	5A	102,760
2B	87,150	5B	105,770
3A	23,340	5C	100,630
3B	60,950	5D	100,550
4A	97,000	5E	104,820
4B	102,280	5F	63,900
4C	48,200	6	46,300
TOTAL CY	1,141,350		

Conceptual Natural Landform and Final Grading

Design Criteria for the conceptual Natural Landform and Final Grading were developed and presented in the *Excavation/Removal Criteria and Grading Criteria Memo* that was submitted on January 11, 2022 to the Forest Service and revised on April 29th, 2022. The following outlines the overall final natural landform grading criteria for Bluff B, following excavation:

- The grading area will cover the extents of the excavation areas and the extents of disturbance from historical mining activities and incorporate the latest post excavation construction contract surface.
- Mine waste from the excavation areas will be placed and compacted in consolidation areas, conforming to the specifications, and graded to natural landform design elevations. The final reclaimed slope of any mine waste left in place below the bluff edge, and regraded as part of a landform, will replicate nearby undisturbed slope angle(s).
- Mine waste exhibiting the highest concentrations of arsenic and radium will be placed in the deepest parts of the bluff consolidation area(s), above the sandstone bluffs and adjacent to the southeast highwall. The Bluff B Subsurface and Supplemental Surface Investigation Report (Tetra Tech, 2021) will be used to delineate the extents of mine waste exceeding site wide cleanup levels.
- Boulders will be placed in the deep erosion channels in the northeast corner of Bluff B during excavation to help stabilize the channels prior to regrading below the bluff.
- An attempt to reestablish pre-mining major drainage channels into the natural landform will be made using the 1954 photogrammetric surface. Landform grading on top of Bluff B will follow historic pre-mine drainage patterns. The location of the toe of the landforms near the top edge of the bluff shall mimic nearby areas by

having the landform toe on the edge of the bluff and match drainages below the bluff or leaving a flat transitional zone between the toe of the landform on which dispersed sheet flow would occur.

- The grading design will follow the fluvial geomorphic approach using Carlson Geofluv® Natural Regrade software and site survey measurements from the Riley Pass Natural Regrade Survey Site Visit Memorandum (Tetra Tech, 2015). **Table 2**, below, presents the parameters from field measurements and landform characteristics of upland areas and ephemeral, intermittent, and perennial stream channels that will be evaluated using the Geofluv® Natural Regrade software.
- All grading areas will be covered with a minimum 18-inches of vegetative soil, with the final grade tying into the undisturbed land surface, matching existing elevations and grades. The ridge on the south end of Bluff B will be covered with vegetative soil following the excavation of mine waste above the bluff.
- Not all mine waste material exceeds the clean-up threshold levels for Ra-226 and arsenic. Mine waste material not exceeding the threshold values may be left in place to construct the natural landforms for the final reclamation surface.
- The stability and strength of all mine waste material left in place, along with the sediment repository used for landform construction, will be evaluated.
- Construction activities in close proximity to archaeological avoidance areas will be developed and approved by the Forest Service to prevent disturbance to the archaeological area(s).

Table 2. Geofluv® Natural Regrade Parameter

Parameter	Value
Drainage Density	92 ft/ac
Max Ridge-to Head of Channel	91 ft
Sinuosity	1.13
Channel Reach Length	106 ft (average)

The conceptual natural landform grading for both above and below the bluff was developed using the natural major drainages from the 1954 surface model. The natural regrade conceptual design was separated into 17 different drainage areas across Bluff B, with seven areas above the bluff edge and nine areas below the bluff edge. In addition to the natural regrade areas, there are six areas that will be regraded, but were not identified as major drainages; minor grading is anticipated. The natural regrade areas and additional grading areas are shown in **Figure F-2**. **Figures F-3** and **F-4** provide cross sections of the natural regrade design.

The net volume of fill for the natural landform grading is estimated at 1,062,515 CY. The volume comparison from the excavation volume to the fill areas is currently adjusted for a 6% shrinkage. The exact shrink/swell factor of the material has varied between previous construction projects at Riley Pass; shrink/swell factor shall be evaluated as Bluff B reclamation continues. Each landform area will be adjusted to account for the remaining material, as construction progresses through each phase. A breakdown of natural landform grading volumes is provided in **Table 3**, the natural landform and final grading is presented in **Figure F-2**

Table 3. Bluff B Conceptual Regrade Volumes

Area	Cut (CY)	Fill (CY)	Net (CY)		Area	Cut (CY)	Fill (CY)	Net (CY)	
			(CUT)	FILL				(CUT)	FILL
A	28,433	208,303	179,870	26,617	L	12	417,574	417,562	15,810
B	68,398	15,517	(52,881)	18,052	M	4,374	48,663	44,289	8,251
C	7,936	67,458	59,522	24,121	N	2,512	26,916	24,404	6,300
D	5,750	57,575	51,825	13,147	O	3,715	63,449	59,734	10,225
E	1,604	23,667	22,063	6,684	P	2,592	100,763	98,171	10,237
F	108,156	39,672	(68,484)	11,867	Q	897	92,650	91,753	8,517
G	5,460	14,070	8,610	8,061	R	4,397	875	(3,522)	8,737
H	1,373	4,374	3,001	3,705	S	23,814	2,591	(21,223)	4,877
I	373	4,898	4,525	2,946	T	21,732	8,954	(12,778)	5,970
J	3,024	64,434	61,410	15,021	U	206	21,865	21,659	4,216
TOTAL								1,062,515	222,526

Cover Soil

Per the Action Memorandum (USDA 2016), following natural landform grading, cover soil will be placed at a total depth of 18-inches throughout the entire disturbed reclaimed site. The disturbance area of the remainder of Bluff B (not including the 2023 Bluff B Reclamation Bid Package) is approximately 91.6 acres that requires cover soil. With a cover soil depth of 18-inches, that equates to 222,526 CY of cover soil required for the remainder of Bluff B. A breakdown of cover soil volumes per reclamation area is provided in **Table 4**. Three regrade areas, one located on the far west of Bluff B and two located farthest to the south, are not included in this cover soil volume and total approximately 15 acres. The additional volume of covered soil would need to be added to this total if it is determined these three areas require covered soil.

Table 4. Conceptual Cover Soil Volumes

Area	Cover Soil (CY)
A	26,617
B	18,052
C	24,121
D	13,147
E	6,684
F	11,867
G	8,061
H	3,705
I	2,946
J	15,021
K	9,164
L	15,810
M	8,251
N	6,300
O	10,225
P	10,237

Area	Cover Soil (CY)
Q	8,517
R	8,737
S	4,877
T	5,970
U	4,216
TOTAL	222,526

Path Forward/Design Considerations

The conceptual design approach has estimated an over-cut/fill balance with a 6% shrink of excavated material. The shrink/swell factor will be calculated after each construction season and natural regrade areas can be adjusted to balance the cut/fill as the construction progresses. Other design considerations include the following:




1. The existing sediment pond above the bluff edge is in the deepest fill section of the natural regrade areas. The current sediment pond drains to the northeast. As the natural regrade areas are constructed, they will change the runoff characteristic of the existing pond. Options to consider in dealing with the runoff above the bluff include:
 - a. Staging construction of natural regrade landforms from south to north keep the current drainage pattern until the final landform construction.
 - b. Use pumps to dewater the pond as needed for the construction of the landforms. Water would be pumped into existing drainages below the bluff.
 - c. Temporarily divert the stormwater runoff collected by the pond to the south or east.
2. Seven of the ten natural regrade areas below the bluff will require a net fill to construct the landforms. To prevent hauling excavated material out of the area during excavation and hauling it back in during landform construction, consideration should be given to the construction of a portion of landforms in the excavation area to prevent unnecessary hauling of material. Additionally, the material could be stockpiled in the area for landform construction later.

References

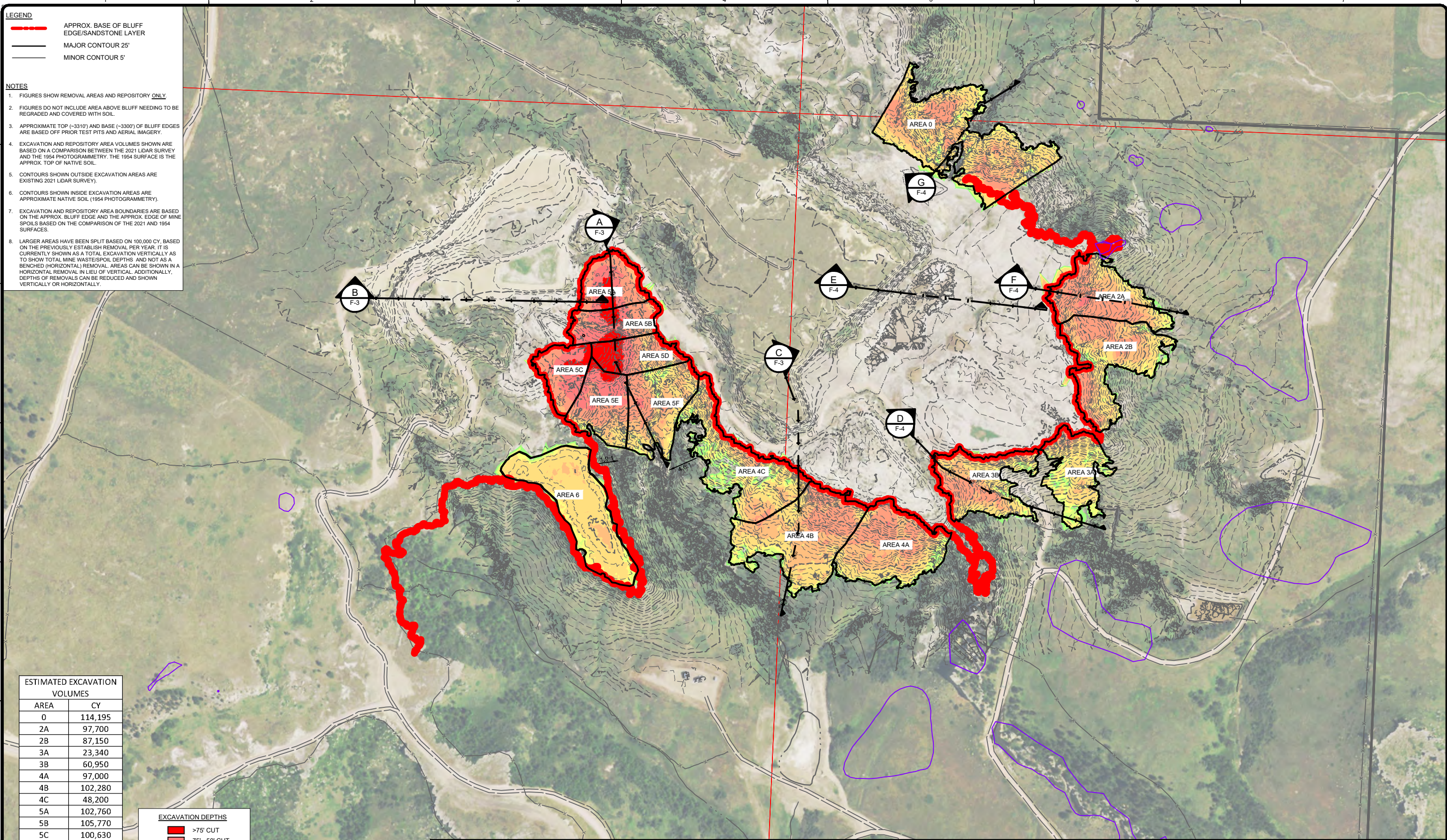
- Tetra Tech, 2015. Riley Pass Natural Regrade Survey Site Visit, Memorandum, Prepared for USFS, Custer National Forest. Dated, June 8, 2015
- Tetra Tech, 2021. Bluff B Subsurface and Supplemental Surface Investigation Report, Riley Pass Uranium Mines Site, North Cave Hills Land Unit, Custer Gallatin National Forest – Sioux Ranger District, Harding County, South Dakota, July.
- Tetra Tech, 2022. Riley Pass Bluff B – Excavation/Removal Criteria and Grading Criteria, Riley Pass Uranium Mines Site, North Cave Hills Land Unit, Custer Gallatin National Forest – Sioux Ranger District, Harding County, South Dakota, April.
- USDA Forest Service, 2016. Action Memorandum, Riley Pass Uranium Mines Site Removal Action, Riley Pass Uranium Mines Site, North Cave Hills Land Unit, Custer Gallatin National Forest – Sioux Ranger District, Harding County, South Dakota, April.

FIGURES

LEGEND

	APPROX. BASE OF BLUFF EDGE/SANDSTONE LAYER
	MAJOR CONTOUR 25'
	MINOR CONTOUR 5'









- NOTES**
- FIGURES SHOW REMOVAL AREAS AND REPOSITORY ONLY.
 - FIGURES DO NOT INCLUDE AREA ABOVE BLUFF NEEDING TO BE REGRADED AND COVERED WITH SOIL.
 - APPROXIMATE TOP (~3310') AND BASE (~3300') OF BLUFF EDGES ARE BASED OFF PRIOR TEST PITS AND AERIAL IMAGERY.
 - EXCAVATION AND REPOSITORY AREA VOLUMES SHOWN ARE BASED ON A COMPARISON BETWEEN THE 2021 LIDAR SURVEY AND THE 1954 PHOTOGRAMMETRY. THE 1954 SURFACE IS THE APPROX. TOP OF NATIVE SOIL.
 - CONTOURS SHOWN OUTSIDE EXCAVATION AREAS ARE EXISTING 2021 LIDAR SURVEY).
 - CONTOURS SHOWN INSIDE EXCAVATION AREAS ARE APPROXIMATE NATIVE SOIL (1954 PHOTOGRAMMETRY).
 - EXCAVATION AND REPOSITORY AREA BOUNDARIES ARE BASED ON THE APPROX. BLUFF EDGE AND THE APPROX. EDGE OF MINE SPOILS BASED ON THE COMPARISON OF THE 2021 AND 1954 SURFACES.
 - LARGER AREAS HAVE BEEN SPLIT BASED ON 100,000 CY, BASED ON THE PREVIOUSLY ESTABLISH REMOVAL PER YEAR. IT IS CURRENTLY SHOWN AS A TOTAL EXCAVATION VERTICALLY AS TO SHOW TOTAL MINE WASTE/SPOIL DEPTHS AND NOT AS A BENCHED (HORIZONTAL) REMOVAL. AREAS CAN BE SHOWN IN A HORIZONTAL REMOVAL IN LIEU OF VERTICAL. ADDITIONALLY, DEPTHS OF REMOVALS CAN BE REDUCED AND SHOWN VERTICALLY OR HORIZONTALLY.



ESTIMATED EXCAVATION VOLUMES

AREA	CY
0	114,195
2A	97,700
2B	87,150
3A	23,340
3B	60,950
4A	97,000
4B	102,280
4C	48,200
5A	102,760
5B	105,770
5C	100,630
5D	100,550
5E	104,820
5F	63,900
6	46,300
TOTAL	1,255,545
REPOSITORY	739,620

EXCAVATION DEPTHS

	>75' CUT
	75' - 50' CUT
	50' - 25' CUT
	25' - 15' CUT
	15' - 5' CUT
	5' - 3' CUT
	3' - 1' CUT
	1' - 0' CUT

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RILEY PASS BLUFF B
 CUSTER GALLATIN NATIONAL FOREST
 HARDING COUNTY, SOUTH DAKOTA
ESTIMATED EXCAVATION VOLUMES OVERVIEW

Project No.:	
Designed By:	JSS
Drawn By:	JSS
Checked By:	JC
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Bar Measures 1 inch

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LEGEND

- ▬ NATURAL REGRADE AREA
- ▬ ADDITIONAL REGRADE AREA
- ▬ GEOFLUV CHANNEL
- ▬ GEOFLUV SUB-VALLEY
- ▬ GEOFLUV PRIMARY RIDGE
- ▬ SENSITIVE AREA - NO DISTURBANCE

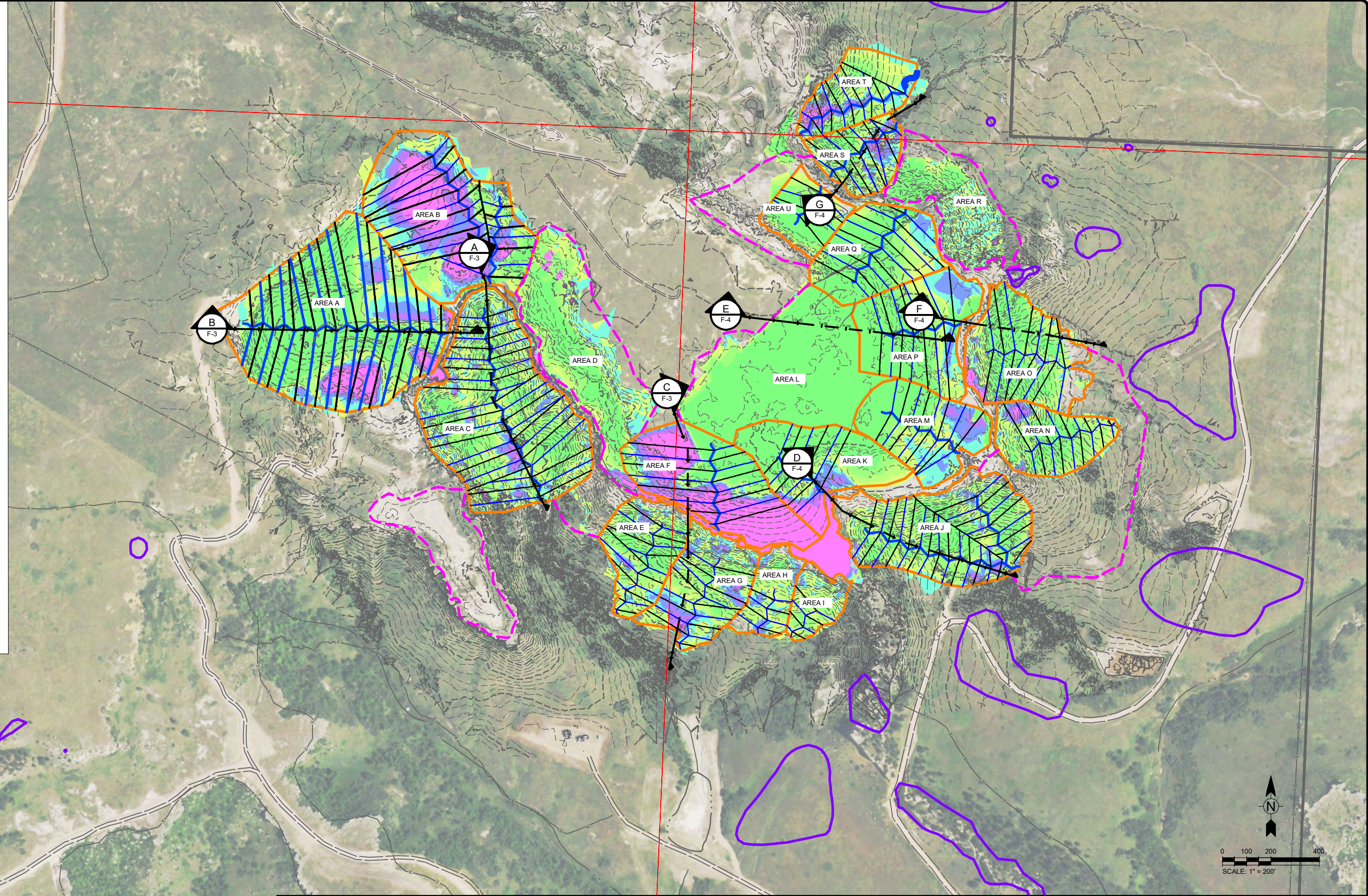
DEPTH DIFFERENCES

- >10ft CUT
- 5-10ft CUT
- 2-5ft CUT
- 0-2ft CUT
- 0-2ft FILL
- 2-5ft FILL
- 5-10ft FILL
- >10ft FILL

NOTES:

1. DEPTHS SHOWN ARE A COMPARISON BETWEEN THE 2022 EXISTING SURFACE AND THE CONCEPTUAL FINAL GRADE.
2. REGRADE AREA SHOWN IS APPROXIMATELY 106.6 ACRES.

Area	Cut (CY)	Fill (CY)	Net (CY) (CUT) FILL	Coversoil (CY)
A	28,433	208,303	179,870	26,617
B	68,398	15,517	(52,881)	18,052
C	7,936	67,458	59,522	24,121
D	5,750	57,575	51,825	13,147
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N	2,512	26,916	24,404	6,300
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U	206	21,865	21,659	4,216
TOTAL			1,062,515	222,526



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CONCEPTUAL REGRADE OVERVIEW

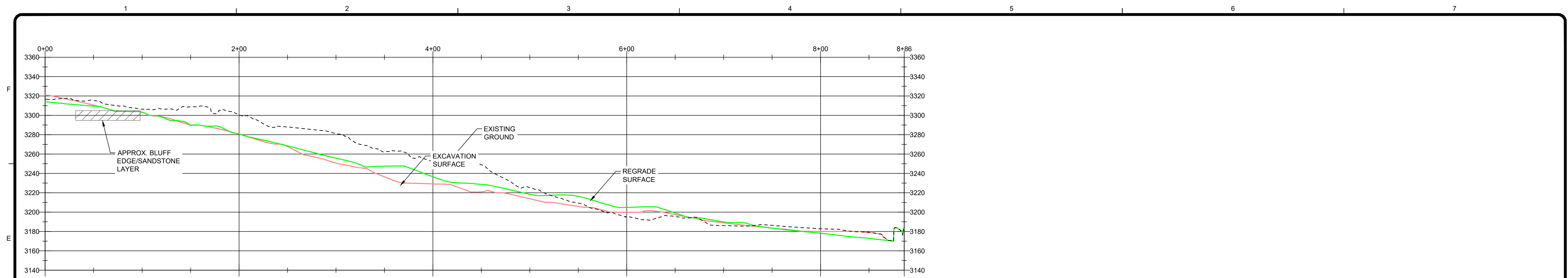
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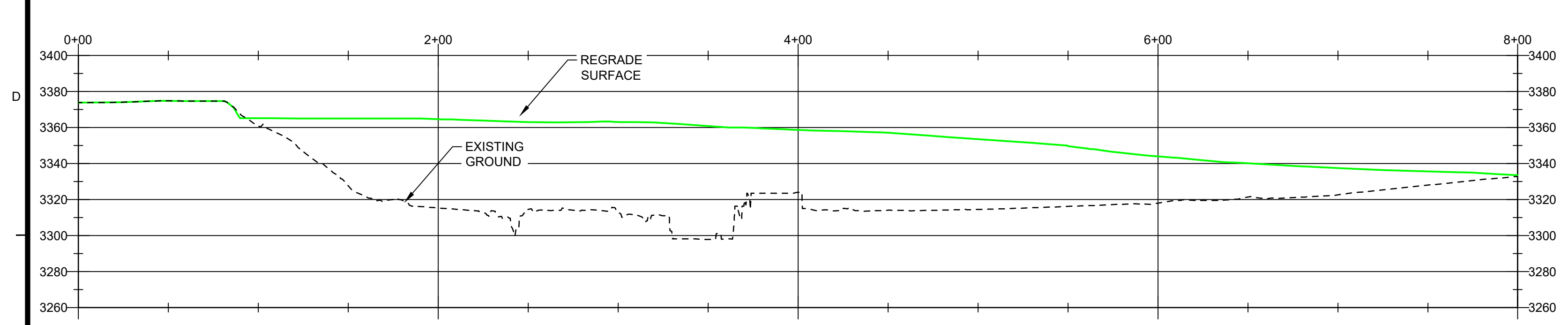
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Bar Measures 1 inch

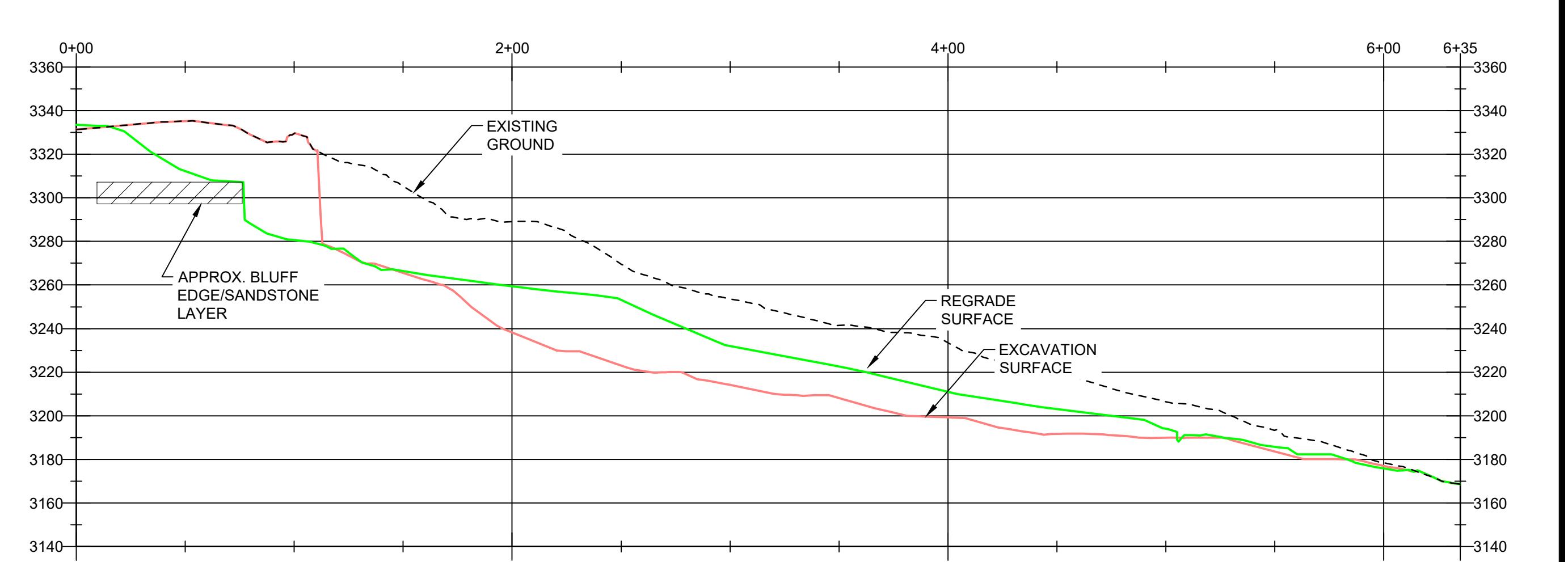
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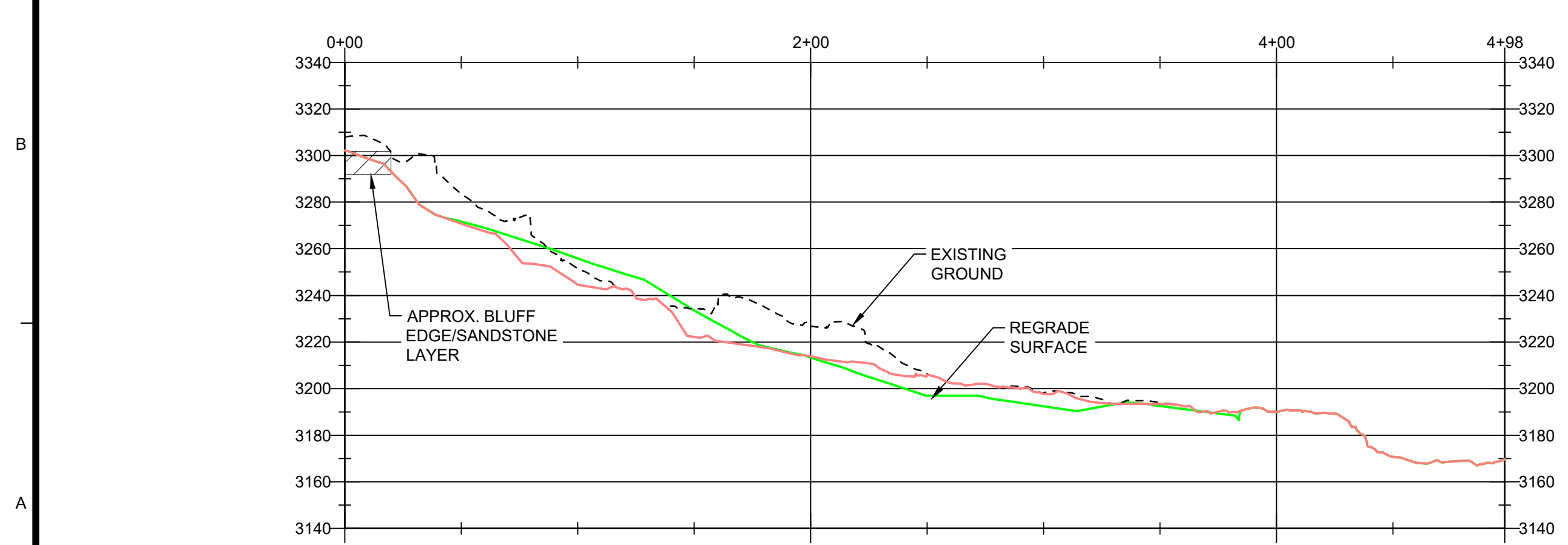
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E SECTION E
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F SECTION F
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G SECTION G
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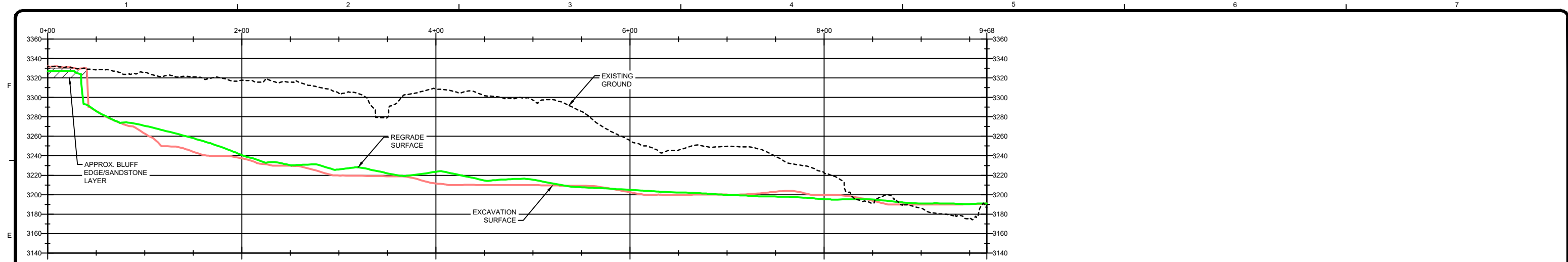
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SECTIONS

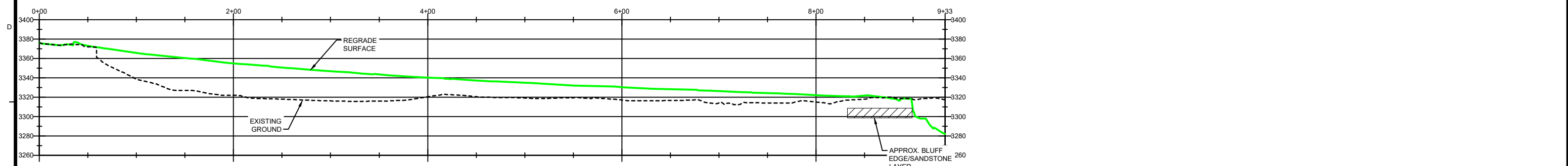
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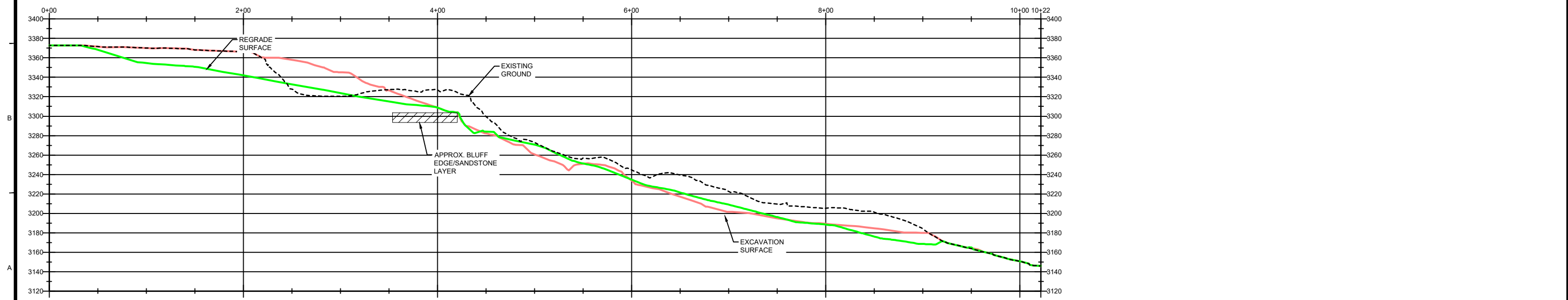
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A SECTION A
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B SECTION B
SCALE: VERT. 1" = 50' HORIZ. 1" = 50'



C SECTION C
SCALE: VERT. 1" = 50' HORIZ. 1" = 50'

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