WYO-BEN, INC.

TEN CLAIMS (WFO 2013) NEW PERMIT:

PROPOSED PITS (BENTONITE BEDS)	TOWNSHIP	RANGE	SECTION	PROPOSED DISTURBANCE AREA[1]	CLAIMS
TEN 1 (F2 BED)	T47N	R89W	20, 21, 22, 23, 25, 26	55.4	TEN 4, 6-9, 24-41, 44-47
TEN 2 (F3 BED)	T47N	R89W	20, 21, 22, 23, 25, 26	20.2	TEN 4, 6-10, 24-42, 44-48
TEN 3 (BEAVER BED)	T47N	R89W	20, 21, 22, 23, 25, 26	49.5	TEN 6-11, 24-48
TEN 4 (MOWRY A BED)	T47N	R89W	20, 21, 22, 23, 25, 26	55.7	TEN 6-12, 25-43, 45-50
TEN 5 (MOWRY B BED)	T47N	R89W	20, 21, 22, 23, 25, 26	25.5	TEN 6-13, 16, 17, 26-43, 45-50
C.O.P.[2], T.O.P[3], HIGHWALL REDUCTION	T47N	R89W	20, 21, 22, 23, 25, 26	22.2	TEN 6, 27–30, 36–38, 47-49
POTENTIAL DISTURBANCE AREA	T47N	R89W	20, 21, 22, 23, 25, 26	274.6	TEN 4, 6-13, 15-18, 24-50

1) Because the pits of this proposal are in very close proximity to each other, it is difficult to separate each pit disturbance area. A total proposed disturbance area is reported below, which includes the mine plan as shown on submitted maps and the extended disturbance limit above and below the proposed pit disturbance area. Some of the pit disturbance areas may reach an adjacent pit's disturbance, thus resulting in continuous disturbance between pits. In other cases, there will be islands of native vegetation between pit sequences; however, it is included in the total potential disturbance area. The extended disturbance limit allows a little extra room for Wyo-Ben, Inc to be able to expand their pits if the production of bentonite is discovered to be economically advantageous, or if additional stockpile area is needed. This will avoid the use of additional limited time to review additional submittals by the DEQ-LQD and BLM for post approval modifications.
2) C.O.P. = Contoured Overburden Pile – this area may include overburden stockpile area, temporary bentonite stockpiles, sub/topsoil stockpile areas, camp site, and will be reclaimed as a permanent contoured overburden area once mining is complete to reflect the surrounding topography.
3) T.O.P. = Temporary Overburden Pile – this area may include temporary overburden stockpile area, temporary bentonite stockpiles, sub/topsoil stockpile areas, camp site, and will be reclaimed similar to the original topography.

Proposed Haul Roads

New Haul Road HR 63 (Primary haul road for the west end of the Ten Claims Mining to the F2 bed with additional spurs going to the Mowry and Beaver beds. The road will intersect with US HWY 16.)

2,083 lineal feet x 60 feet wide = 2.9 acres

New Haul Road HR 63.1 (Access to the mining west of Little Cottonwood Creek, access all of the proposed pits. This road has a total length of 2,262 feet with 932 feet outside of the potential disturbance.) A 30 inch culvert will be required for this proposed new haul road on the northern end and a low water crossing is proposed for the southern crossing with the possibility of an 18" culvert if deemed necessary.

932 lineal feet X 60 feet wide = 1.3 acres

New Haul Road HR 63.2 (Access to the mining east of Little Cottonwood Creek, starts at Washakie County Road (aka Old Ten Sleep Road) and travels north to access all of the proposed pits. This road has a total length of 3,085 feet with 1,564 feet outside of the potential disturbance.)

1,564 lineal feet X 60 feet wide = 2.2 acres

New Haul Road HR 63.3 (Access to the mining from Washakie County Road (aka Old Ten Sleep Road) and travels north to access all of the proposed pits in the middle of the proposed mining. This road has a total length of 1,888 feet and is confined within the potential disturbance.)

New Haul Road HR 63.4 (Starts where the Castle Garden road comes off of the Washakie County Road (aka Old Ten Sleep Road) and travels south approximately ½ mile then travels east on a two track road to where it goes through the State of Wyoming Lands to connect back to the Old Ten Sleep Road. This road has a total length of 10,246 feet.

10,246 lineal feet x 60 feet wide = 14.1 acres

New Haul Road HR 63.5 (Intersects Haul Road 63.4 on the eastern end of the proposed mining. This road will provide access to our proposed mining on the eastern portion. This road has a total length of 1,099 feet with 232 feet outside of the potential disturbance.)

232 lineal feet X 60 feet wide = 0.3 acres

Summary of Proposed Disturbance

Total Proposed Pit Disturbance	**206.3 Acres**
C.O.P., T.O.P., and Highwall Reduction Areas	**22.2 Acres**
Potential Disturbance Area	**274.6 Acres**
Haul Roads Outside of Potential Disturbance*	**20.8 Acres**
Total Proposed Disturbance Area	**523.9 Acres**

* There is a total of 28.5 Acres of haul roads included in this proposal, only 20.8 acres are located outside of the Potential Disturbance Area. All other haul roads will be within the proposed disturbance boundaries. Wyo-Ben will also be hauling on the Washakie County Road (aka Old Ten Sleep Road) that is not included in the numbers above.

** Wyo-Ben will consider the installation of cattle guards on their haul roads as we deem necessary.

***Typical Haul Road Cross sections are located on page 3.1.

LAND OWNER: UNITED STATES GOVERNMENT, WORLAND FIELD OFFICE OF THE BUREAU OF LAND MANAGEMENT

TABLE OF CONTENTS

Page

Ten Claims New Permit Summary ……..……1
Surface Owner Consent …….…….…….……....6
Appendix A – Surface Ownership and Mineral Rights w/in New Permit ……..…8
Appendix A, B, C Map …… 8.1
Appendix B – I. Surface ownership w/in ½ mile ……..8
II. Other valid legal estates of record ……...…….. 10
Adjudicated Water Rights …… 10
Ground Water and Surface Water Map …… 10.1
Surface Water Rights ……..…….……... 10.2
Ground Water Rights ……..…….. 10.3
Appendix C – Form C-2 Bearing and Distance Descriptions …… 11
Form 1 – New Permit Application ….……..……14.1
Appendix E…….…….…… 15
Appendix E Map ..……...… 15.1
Appendix D …….…… …… 16
D-1 Land Use …… …… ……. 16
D-2 Brief History of the Area … …… ……. 16
D-3 Archaeology and Paleontology ……..……..... 16
D-4 Climatology ……..…….. 17
D-5 Geology and Overburden ….……..…… 19
Major Big Horn Basin Bentonite Formations ……...……. 19.1
Overburden Laboratory Analysis …….. 20
D-6 Hydrology ...…… 25
Hydrology Map …….. 25.1
Table D-6.1 Hydrologic Summaries ……....25
Table D-6.2 Culvert Sizing Table ……....26
Ten Claims Proposed Haul Roads Culvert Summary ……. 26
D-7 Soils……..…… 28
Soils Map 1, 2, & 3 ….....…… 28.1
Appendix D-7.1 Soil Pedon Descriptions …..…….. 42
Appendix D-7.2 Soil Laboratory Results ……...……... … 60
D-8 Vegetation…… 61
Vegetation Maps 1 , 2, & 3 ….…… 62.1
Threatened or Endangered Plant Species …… 64
Appendix D-8.1, Vegetation Summary Tables ……..…..……. 68
Vegetation Summary for each map unit…….. 68.1
Appendix D-8.2, Vegetation Field Data Sheets ……...……... 69
Appendix D-8.3, Shrub Belt Transect Data Summary Table ……. 70
Vegetation Summary for composite of all Map Units …… 70.1
Appendix D-8.4, Vegetation Aspect Photographs ……. 71

D-9 Wildlife……... 72
Exhibit D-9.1 (Wyoming Game and Fish Letter) ……... 72.1
Exhibit D-9.2 (US Fish & Wildlife Services) ……... 72.2
Wildlife Map …… …… ……. 72.3
Wildlife Anticipated & Observations …… 72.4
Wildlife Observations by CJ Grimes …… 72.5
US Fish & Wildlife Services Updated Correspondence (2015) ……. 72.6
Wildlife Protection Team Letter ……. 73
D-10 Wetlands…… 75
Exhibit D-10.1 (US Army Corp of Engineers letter) ……..… 75.1
Wetlands Map D-10.2 …...……. 75.2
Spill Management Plan ……76
Noxious Weed Management Plan For Federal Lands ……..… 76
Mine Plan……..……..…… 77
Figure MP-1 Material Flow Diagram ….……..…… 78.1
Figure MP-2 Cast Back Mining System Schematic ……. 78.2
Figure MP-3 Typical Steep Slope Highwall Reduction Schematic ..…… 78.3
Figure MP-3a Typical Gentle Slope Highwall Reduction Schematic …….. 78.3
Mine Plan Maps 1, 2, & 3……. 78.4
Contoured Overburden Piles – Descriptions …… …….. 80.1
Interim Management Plan ……. 82
Monitoring Plan …….. 82
Reclamation Plan ……..….… 82.1
Appendix for Reclamation Plan – Examples of Mining & Reclamation…… 82.2
Premine Landforms (disk & table) …….. 82.3
Drill Hole Plugging …….. 83
Feasibility of Pit Backfill ……. 83
Isolation and Control of Acid-Forming, Toxic, or Deleterious Material ……... 84
Post Closure Management …….. 84
Revegetation Techniques and Seed Mixtures …….. 84
Quality Assurances …… 85
Bond Calculations ……... 86

SURFACE OWNER CONSENT

FEDERAL DOMAIN LANDS

Federal public domain lands included in this proposal are managed by the Worland Field Office (WFO) of the Bureau of Land Management (BLM). These lands are covered by placer mining claims which, under federal law of the General Mining Act of 1872, give the applicant, Wyo-Ben, Inc., the right of access to extract the minerals claimed and to use the surface of the claim area in as careful and prudent manner as may be necessary to facilitate this extraction. The approval of this Plan of Operations (POO) through the signing of a Finding of No Significant Impact/Decision Record (FONSI) by the BLM, under the terms of 43 CFR 3809, and the Cooperative Agreement between the Bureau and the State of Wyoming, Department of Environmental Quality - Land Quality Division (DEQ-LQD), will constitute surface owner consent on those lands.

Table 1. BLM WMC Numbers

Proposed disturbance acreage by unpatented mining claim and ¼ ¼ legal description

Unpatented Claim Name	BLM Serial#	Division (1/4 1/4, lot or tract)	Section	Township/ Range	# Acres by Legal Description	Potential Disturbance Acres Proposed in Claim or ¼ ¼
Ten 6	273494	E2NWSE	20	47 - 89	20	14.6
Ten 7	273495	W2NESE	20	47 - 89	20	15.7
Ten 8	273496	E2NESE	20	47 - 89	20	15.2
Ten 9	273497	W2NWSW	21	47 - 89	20	14.5
Ten 10	273498	E2NWSW	21	47 - 89	20	12.3
Ten 11	273499	W2NESW	21	47 - 89	20	9.1
Ten 12	273500	E2NESW	21	47 - 89	20	4.8
Ten 13	273501	W2NWSE	21	47 - 89	20	0.8
Ten 15	273503	W2NESE	21	47 - 89	20	0.8
Ten 16	273504	E2NESE	21	47 - 89	20	1.9
Ten 17	273505	W2NWSW	22	47 - 89	20	2.1
Ten 18	273506	E2NWSW	22	47 - 89	20	1.1
Ten 24	273512	NESWSW, NWSESW	21	47 - 89	20	17.2
Ten 25	273513	E2SESW	21	47 - 89	20	14.2
Ten 26	273514	W2SWSE	21	47 - 89	20	16.3
Ten 27	273515	E2SWSE	21	47 - 89	20	16.3
Ten 28	273516	W2SESE	21	47 - 89	20	18.7
Ten 29	273517	E2SESE	21	47 - 89	20	15.3
Ten 30	273518	W2SWSW	22	47 - 89	20	16.8
Ten 31	273519	E2SWSW	22	47 - 89	20	17.7
Ten 32	273520	W2SESW	22	47 - 89	20	18.5
Ten 33	273521	E2SESW	22	47 - 89	20	19

Ten 34	**273522**	**W2SWSE**	**22**	**47 - 89**	**20**	**19.5**
Ten 35	**273523**	**E2SWSE**	**22**	**47 - 89**	**20**	**19.1**
Ten 36	**273524**	**W2SESE**	**22**	**47 - 89**	**20**	**17.9**
Ten 37	**273525**	**E2SESE**	**22**	**47 - 89**	**20**	**16.2**
Ten 38	**273526**	**W2SWSW**	**23**	**47 - 89**	**20**	**15.9**
Ten 39	**273527**	**E2SWSW**	**23**	**47 - 89**	**20**	**13.8**
Ten 40	**273528**	**W2SESW**	**23**	**47 - 89**	**20**	**12.2**
Ten 41	**273529**	**E2SESW**	**23**	**47 - 89**	**20**	**10.2**
Ten 42	**273530**	**W2SWSE**	**23**	**47 - 89**	**20**	**8.1**
Ten 43	**273531**	**E2SWSE**	**23**	**47 - 89**	**20**	**6.1**
Ten 45	**273532**	**NENWNE, NWNENE**	**26**	**47 - 89**	**20**	**16.3**
Ten 46	**273533**	**E2NENE**	**26**	**47 - 89**	**20**	**10.9**
Ten 47	**273534**	**W2NWNW**	**25**	**47 - 89**	**20**	**17.2**
Ten 48	**273535**	**E2NWNW**	**25**	**47 - 89**	**20**	**18.7**
Ten 49	**273536**	**W2NENW**	**25**	**47 - 89**	**20**	**17.1**
Ten 4	**306693**	**NESESE NWSWSW**	**20 21**	**47 - 89**	**20**	**7.8**
Ten 50	**306695**	**S2SESE**	**23**	**47 - 89**	**20**	**4.6**
Ten 44	**306694**	**NENENW NWNWNE**	**26**	**47 - 89**	**20**	**8.6**

TOTAL **503.1**

APPENDIX A

I. **Surface ownership within the proposed New Permit Area (Locations illustrated on Appendices A, B, C Map).**

Public Lands
C/O Bureau of Land Management
Worland Field Office
101 South 23rd Street
Worland, WY 82401

II. **Mineral ownership within the proposed New Permit Area (Locations illustrated on Appendices A, B, C Map).**

Public Lands
C/O Bureau of Land Management
Worland Field Office
101 South 23rd Street
Worland, WY 82401

APPENDIX B

Surface ownership within ½ mile of the proposed New Permit Area (Locations illustrated on Appendices A, B, C Map).

Public Lands
C/O Bureau of Land Management
Worland Field Office
101 South 23rd Street
Worland, WY 82414

Basin Bentonite Trust
Bank Of Commerce
PO Box 2007
Sheridan, WY 82801

Rice Ranch Inc.
2846A HWY 16E
Ten Sleep, WY 82442

Marvin Wyman Living Trust
PO Box 123
Ten Sleep, WY 82442

Clayton E. Smith
1240 West Teton Blvd Apt 5E
Green River, WY 82935

Virginia Holiday
2402 Cedar Court
Cody, WY 82414

Justin Smith
P.O. Box 128
Ten Sleep, WY 82442

State of Wyoming
Commissioner of Public Lands
Herschler Building
Cheyenne, Wyoming 82002

Cole D. & Carol L Smith
P.O. Box 28
Ten Sleep, WY 82442

David M. Schab
3715 Totem Drive
Lake Havasu City, AZ 96406

Kent R. Holiday
2402 Cedar Court
Cody, WY 82414

II. Other valid legal estates of record.

TCT West, Inc.
ROW – Fiber Optic Cable
P.O. Box 671
Basin, WY 82410

Washakie County
ROW – County Road
P.O. Box 260
Worland, WY 82401

ADJUDICATED WATER RIGHTS

Information regarding adjudicated surface water rights within one half mile from the proposed New Permit area was obtained from the Wyoming State Engineer's website (http://seo.state.wy.us/wrdb/PS_TnsRngSec.aspx). Several stock ponds and reservoirs are located adjacent to the New Permit area (See Ground and Surface Water Map). Wyo-Ben's mining activity will not affect any of these ponds or reservoirs.

Information obtained from the State Engineer's Office online database indicated several permitted water wells within three miles of the New Permit area (See Ground and Surface Water Map). There are many water wells within the 3 mile radius boundary with the closest well over 1 mile from our proposed disturbance area. Additionally, no ground water was encountered during developmental drilling of the pits of this New Permit. Thus, Wyo-Ben, Inc. mining activities should not affect any permitted water wells. No other surface or ground water impacts are expected.

Form C-1 **APPENDIX "C"**

This Appendix "C" represents the location of lands by legal subdivision, section, township, range, county, and municipal corporation, if any, (W.S. §35-11-406,(a),(vi)) and the number of acres in each description. No mining activity may take place on land for which there is not in effect a valid mining permit (W.S. §35-11-405). To include additional lands within a permit area it is necessary to amend the permit (W.S. §35-11-406,(a)(xii)), so care should be taken to include all lands necessary to the mining and reclamation operation as defined in W.S. §35-11-103,(e),(viii). All acreage figures should be obtained from official survey documents or recent surveys if available. An original U.S.G.S. topographic map with the permit area clearly outlined should accompany each permit application.

Division (1/4 1/4, lot or tract)	Section	Township/ Range	# Acres by Legal Description
N2SE	20	47 - 89	80
E2NESW	20	47 - 89	20
N24SESE	20	47 - 89	20
E2SENE	20	47 - 89	20
SE	21	47 - 89	160
N2SW	21	47 - 89	80
N2SWSW	21	47 - 89	20
SESW	21	47 - 89	40
SWNW	21	47 - 89	40
SW	22	47 – 89	160
NWSE	22	47 – 89	40
SWSE	22	47 – 89	40
SESE	22	47 – 89	40
S2NESE	22	47 – 89	20
S2SW	23	47 - 89	80
SWSE	23	47 - 89	40
S2SESE	23	47 - 89	20
S2SWSE	24	47 - 89	20
N2NW	25	47 – 89	80
NWNE	25	47 – 89	40
N2SWNW	25	47 - 89	20
SWNE	26	47 - 89	40
N2NE	26	47 - 89	80
NW	26	47 - 89	160
E2NE	27	47 - 89	80
N2NWNW	27	47 - 89	20
NENE	28	47 – 89	40
PERMIT TOTAL			1,500.0

COUNTY of Washakie Description Acres 1,500.0

Municipal Corporation NONE Permit (New Permit) Acres 1,500.0

Reviewed (compiled), DEQ/LQD Date Applicant Signature Date

Checked, DEQ, LQD Date Permit No. New Permit

Revised 4/1980 Page 2 of 2 TFN

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APPENDIX E

The Appendix E Map Illustrate:

- Proposed areas of disturbance:
  Roads, railroads, public and private right-of-ways and easements, utility lines, etc. within or adjacent to the proposed disturbance areas
- Drainage areas:
  Previously affected areas adjacent to the proposed pit areas including haul roads servicing existing pits
- Proposed New Permit Boundary

D-1. LAND USE

Historically, these lands have been used for livestock grazing, wildlife habitat, recreational hunting, and bentonite mining. Present land uses remain the same. The potential affected grazing permits include Castle Gardens #8 – O'Donnell and Rice, Big Cottonwood Creek #132 – Otter Creek Grazing Association, Little Cottonwood #21 – Bader Ranch, Wyman Draw #211 – Bryan O'Donnell, Homestead #151 – Rice Ranch, Signal Butte #212 – Cole Smith, and the Worland – Ten Sleep Stock Drive for this submittal.

D-2. BRIEF HISTORY OF THE AREA

The small ranching community of Ten Sleep is a true example of western lifestyle. Located at the base of the Big Horn Mountains, the area is rich in fertile soil and waterways which make it perfect for raising cattle and sheep.

Ten Sleep got its name by being ten sleeps (nights) between the Great Sioux Camps and the Platte River to the south, and the northern camp located near Bridger, Mont.

The area is full of history and is recognized as being the site of many historic battlegrounds between Indian tribes and the white man. Among those sites are the Bates Battlesite, an engagement in which the Arapahoe were defeated by a coalition composed of U.S. troops and the Shoshone. At the Dull Knife site, Dull Knife and Wild Hog were defeated leaving the Big Horn Mountains under the control of the white man. Located a few miles south of Ten Sleep is the famous site of the Spring Creek Raid. Here, cattle ranchers and sheep herders fought a bloody battle over grazing rights. The event eventually led to the end of the bitter rivalry between cattlemen and sheep ranchers.

Scenic wonders ranging from mountain ranges, canyon and pure mountain streams and lakes are everywhere. Expect to see abundant sightings of elk, moose, deer and other forest creatures.

To the southwest of Ten Sleep, Castle Gardens present unusual stone caricatures of animals, castles and other objects of interest. The Ten Sleep experience is timeless and terrific according to the Ten Sleep Chamber of Commerce site located at *http://www.worlandchamber.com/about_ten_sleep.htm*.

Oil and mining companies have been extracting natural resources that are available in this area such as bentonite and oil and gas for over 50 years.

Established roads in the area include US HWY 16, which runs east and west from Buffalo, Wyoming on the other side of the Big Horn Mountains to Worland, Wyoming to the west. The Washakie County Road (aka Old Ten Sleep Road) will provide additional access from US Hwy 16 to Wyo-Ben's proposed main haul roads that will provide access to the proposed pits of this New Permit. The Burlington Northern/Santa Fe railroad has a rail line that passes through the Town of Worland about 26 miles due west of Ten Sleep.

D-3. ARCHAEOLOGY AND PALEONTOLOGY

This submission will constitute notification to the BLM's Worland Field Office (Bureau) regarding the proposed disturbances. No surface disturbances will occur until a cultural resource clearance is received from the Bureau, nor will surface disturbances continue if cultural resources are discovered during operations until additional clearance has been issued by the Bureau as stated in their stipulated approval.

Mrs. JoAnna Mettler Chase of Mettler and Associates, Inc. has performed a Class III cultural survey of the proposed disturbance area and a report was submitted on February 6, 2012 to the Worland, Wyoming Field Office of USDOI/BLM attention of Marit Bovee for review.

D-4. CLIMATOLOGY

Although no site-specific climatic information is available for the Ten Claims Area, the following information was obtained for the Ten Sleep area, approximately 1 mile east of the proposed disturbance area. Average annual precipitation is 13.04 inches; and the average annual temperature is 48.0 degrees Fahrenheit (Table D-5.1). The climate of the area is typical of cold desert regions of the intermountain west. Over fifty percent of the yearly precipitation occurs in April, May, June and July. The annual average snowfall is 52.6 inches with an average of 125 frost-free days per year (University of Wyoming – Climate Atlas) http://www.wrds.uwyo.edu/sco/climateatlas/temperature.html.

No wind speed or direction information is available for this specific area. However, the average wind speed at the Worland Airport ASOS (KWRL), 25.5 miles west of Ten Sleep, has the average wind speed at 5.7 mph from 1998 – 2006 according to the website for automated stations (ASOS) at (http://www.wrcc.dri.edu/htmlfiles/westwind.final.html).

Table D - 5.1 – Average Monthly Climatic Information Precipitation Normals 1964 to 2012 Ten Sleep, Wyoming				
	Average Maximum Temperature Fahrenheit	Average Minimum Temperature Fahrenheit	Average Ave. Temp. Temperature Fahrenheit	Average Total Precipitation Inches
January	36.7	13.6	25.2	0.54
February	40.8	18.2	29.5	0.43
March	50.0	26.1	38.1	0.83
April	59.3	34.2	46.8	1.40
May	69.2	42.4	55.8	2.28
June	79.1	50.5	64.8	1.98
July	88.1	57.4	72.8	0.93
August	86.3	55.7	71.0	0.68
September	75.7	45.6	60.7	1.31
October	62.4	35.4	48.9	1.24
November	46.4	24.2	35.3	0.76
December	37.4	15.3	26.4	0.67
Annual Ave.	61.0	34.9	48.0	13.04

D-5. GEOLOGY AND OVERBURDEN

Mr. Rick Magstadt (Geologist, Wyo-Ben, Inc.) has prepared the following general geologic description of the Big Horn Basin, supplemented with a "stylized" geologic column of the major Big Horn Basin Bentonite formations, which highlights the beds to be mined with this submission (Fig D-5.1, page 19.1). Overburden associated with each of these beds was sampled in five-foot increments to the contact with the top of the bentonite. Sample results from Intermountain Laboratories in Sheridan, Wyoming are reported in Tables D-5.1 through D-5.8a (below). Overburden sample locations are illustrated on Soil Maps 1, 2, & 3.

Wyo-Ben uses a tiered overburden castback method that replaces material in roughly the same order as it was removed during the mining process. This castback system of moving material will be employed unless conditions dictate otherwise. Below is a discussion of material movement for each proposed bentonite bed

Frontier Formation (F2 & F3 Bed) & Beaver Bed – In this formation 2 overburden holes were drilled with the following summary, no suitable plant growth medium was identified in the sampled profiles of this bed and the second hole indicated that there is some salvageable soil in the lower horizons (15 – 25 feet). The data indicates that SAR levels are high from the surface to the bentonite bed and acidic soils in the upper zones (0 – 15 feet). Wyo-Ben, Inc. will utilize neutral overburden material (if available) from lateral castback mining on adjacent bentonite beds or within the profile as a buffer (minimum of 2 feet thick) between the acidic overburden and topsoil/subsoil.

Mowry Formation (A Bed & B Bed) – In the six overburden holes, tables indicate that there will be some soils that have an elevated SAR levels, acidic conditions (low pH), and some Acid Base Potential (ABP). The data indicate that the overburden will have marginal to no suitable plant growth medium. Wyo-Ben, Inc. will utilize neutral overburden material (if available) from lateral castback mining on adjacent bentonite beds or within the profile as a buffer (minimum of 2 feet thick) between the acidic overburden and topsoil/subsoil material.

A total of 8 overburden holes were sampled for the 5 proposed beds for this New Permit. In the sampled holes we saw a variation of soil conditions from elevated SAR levels, high acidic conditions, and high Acid Base potential. Wyo-Ben, Inc. will utilize neutral overburden material (if available) from lateral castback mining on adjacent bentonite beds or within the profile as a buffer (minimum of 2 feet thick) between potential deleterious soils overburden and topsoil/subsoil.

Regional Geology

The Big Horn Basin is an area bounded by Laramide mountain building to the northwest, north, and east, along with Absoraka volcanics to the west. The center of the basin is filled with flat-lying Eocene sediments, with progressively more complex folding and faulting in Mesozoic and Paleozoic strata as the flanks of the mountains are approached.

Economically important bentonite is limited to middle-lower Cretaceous, identified as the Frontier, Mowry, and Thermopolis Formations. The mining activity proposed with this application will eventually affect five separate bentonite beds in the Major bentonite bearing Formations of the Big Horn Basin, all of which have been successfully mined by Wyo-Ben, Inc. in the past.

The pre-mining topographic slope conditions can be viewed on the Ground and Surface Water Map. The New Permit area is located on the US Topographical map area of the Wild Horse Hill and Ten Sleep Wyoming maps. All geology holes have been located on the Soil Maps 1, 2, & 3 for easy reference.

Evaluation of Overburden Suitability

*Based on Criteria listed in Table I-2 of Guideline No. 1, Wyoming DEQ/LQD Topsoil and Overburden

TABLE D-5.1. OVERBURDEN LABORATORY ANALYSIS—(F2 Bed) DS#412-153P4

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	Ca meq/L	Mg meq/L	Na meq/L	SAR	Sand	Silt	Clay	Texture
0-5	5.0	243	4.34	7.68	2.57	46.7	20.6	44	22	34	Clay Loam
5-10	5.1	134	5.39	13.10	3.70	62.7	21.6	54	21	25	Sandy Clay Loam
10-15	5.1	159	4.51	8.40	2.05	52.3	22.9	55	21	24	Sandy Clay Loam
15-20	6.5	199	3.40	3.21	1.07	38.9	26.6	37	29	34	Clay Loam
20-25	7.6	290	1.80	1.77	0.60	16.8	15.5	26	33	41	Clay
25-30	8.4	337	2.01	1.90	1.00	19.2	15.9	27	24	49	Clay
30-35	7.8	359	1.82	2.03	1.03	17.7	14.3	18	26	56	Silty Clay
35-40	8.8	326	1.75	1.93	0.63	16.4	14.5	20	26	54	Clay

*TABLE D-5.1a. Evaluation of Overburden Suitability—(F2 Bed) DS#412-153P4**

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	SAR	Texture	Overall Rating	Restrictive Features
0-5	M	M	S	U	S	U	Sodic
5-10	M	M	S	U	S	U	Sodic
10-15	M	M	S	U	S	U	Sodic
15-20	S	M	S	U	S	U	Sodic
20-25	S	M	S	U	M	U	Sodic
25-30	S	M	S	U	M	U	Sodic
30-35	S	M	S	U	M	U	Sodic
35-40	M	M	S	U	M	U	Sodic

TABLE D-5.2. OVERBURDEN LABORATORY ANALYSIS—(F2) Bed DS#412-156P75

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	Ca meq/L	Mg meq/L	Na meq/L	SAR	Sand	Silt	Clay	Texture
0-5	5.6	224	5.44	14.6	7.82	17.5	17.5	35	26	39	Clay Loam
5-10	4.6	279	3.75	8.10	3.70	15.9	15.9	41	25	34	Clay Loam
10-15	4.9	445	2.28	1.74	0.61	21.0	21.0	30	31	39	Clay Loam
15-20	7.1	228	3.45	12.4	3.89	10.8	10.8	42	25	33	Clay Loam
20-25	5.9	351	3.01	7.10	2.19	13.0	13.0	34	28	38	Clay Loam
25-30	8.8	311	1.92	1.86	1.14	14.5	14.5	26	29	45	Clay

*TABLE D-5.2a. Evaluation of Overburden Suitability—(F2 Bed) DS#412-156P75**

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	SAR	Texture	Overall rating	Restrictive Features
0-5	S	M	S	U	S	U	Sodic
5-10	U	M	S	U	S	U	Acidic, Sodic
10-15	U	M	S	U	S	U	Acidic, Sodic
15-20	S	M	S	M	S	M	None
20-25	S	M	S	M	S	M	None
25-30	M	M	S	U	M	U	Sodic

TABLE D-5.3. OVERBURDEN LABORATORY ANALYSIS—(Beaver Bed) DS#511-142P90

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	Ca meq/L	Mg meq/L	Na meq/L	SAR	ABP	Sand	Silt	Clay	Texture
0-5	7.9	58.0	5.02	23.1	11.9	42.3	10.1	12.3	24	32	44	Clay
5-10	8.0	61.1	6.13	19.7	20.3	55.2	12.4	24.7	26	35	39	Clay Loam
10-15	7.8	107	4.66	16.7	13.0	39.3	10.2	17.1	39	29	32	Clay Loam
15-20	7.0	78.5	3.66	9.13	6.30	31.3	11.3	7.30	50	22	28	Sandy Clay Loam
20-25	7.7	69.3	4.94	15.8	9.74	44.6	12.5	11.5	55	19	26	Sandy Clay Loam
25-30	7.4	113	3.80	11.0	8.52	33.2	10.6	6.06	48	25	27	Sandy Clay Loam
30-35	6.4	93.9	4.29	11.6	11.5	39.8	11.7	3.68	48	26	26	Sandy Clay Loam
35-40	7.8	73.6	5.49	13.9	13.4	55.7	15.1	30.7	52	24	24	Sandy Clay Loam
40-45	7.2	82.1	4.28	8.98	8.73	42.7	14.4	2.29	49	25	26	Sandy Clay Loam
45-50	7.0	77.5	5.04	11.3	8.84	54.1	17.1	4.58	54	22	24	Sandy Clay Loam
50-55	8.4	116	3.84	11.2	8.79	54	17.1	7.97	56	21	23	Sandy Clay Loam
55-58.5	8.7	103	1.31	1.26	0.87	12.8	12.4	24.3	57	21	22	Sandy Clay Loam

*TABLE D-5.3a. Evaluation of Overburden Suitability—(Beaver Bed) DS#511-142P90**

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	SAR	ABP	Texture	Overall rating	Restrictive Features
0-5	S	S	S	M	S	S	M	None
5-10	S	S	S	M	S	S	M	None
10-15	S	M	S	M	S	S	M	None
15-20	S	S	S	M	S	S	M	None
20-25	S	S	S	M	S	S	M	None
25-30	S	M	S	M	S	S	M	None
30-35	S	S	S	M	S	S	M	None
35-40	S	S	S	U	S	S	U	Sodic
40-45	S	M	S	M	S	S	M	None
45-50	S	S	S	U	S	S	U	Sodic
50-55	S	M	S	U	S	S	U	Sodic
55-58.5	U	M	S	M	S	S	U	Basic

TABLE D-5.4. OVERBURDEN LABORATORY ANALYSIS—(Beaver Bed) DS# 412-148P50

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	Ca meq/L	Mg meq/L	Na meq/L	SAR	Sand	Silt	Clay	Texture
0-5	7.5	85.6	4.33	20.6	8.46	37.7	9.89	44	25	31	Clay Loam
5-10	6.6	113	5.03	13.8	10.70	49.5	14.2	42	26	32	Clay Loam
10-15	7.0	205	1.60	2.04	1.00	13.5	10.9	38	30	32	Clay Loam
15-20	7.8	134	1.46	2.38	1.07	13.4	10.2	42	28	30	Clay Loam
20-25	7.8	135	1.77	2.15	0.81	15.1	12.4	37	29	34	Clay Loam
25-30	7.6	167	1.80	2.11	0.81	14.4	11.9	37	27	36	Clay Loam
30-37	9.1	320	0.87	0.96	0.36	7.88	9.73	18	33	49	Clay

*TABLE D-5.4a. Evaluation of Overburden Suitability—(Beaver Bed) DS#412-148P50**

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	SAR	Texture	Overall rating	Restrictive Features
0-5	S	M	S	S	S	M	None
5-10	S	M	S	M	S	M	None
10-15	S	M	S	M	S	M	None
15-20	S	M	S	M	S	M	None
20-25	S	M	S	M	S	M	None
25-30	S	M	S	M	S	M	None
30-37	U	M	S	S	M	U	Basic

TABLE D-5.5. OVERBURDEN LABORATORY ANALYSIS—(Beaver Bed) DS# 412-150P50

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	Ca meq/L	Mg meq/L	Na meq/L	SAR	Sand	Silt	Clay	Texture
0-5	7.9	63.4	4.96	21.7	5.53	49.1	13.3	58	20	22	Sandy Clay Loam
5-10	7.7	132	4.74	17	7.14	48.1	13.8	36	28	36	Clay Loam
10-15	7.6	148	2.76	3.43	1.49	28.1	17.9	46	28	26	Loam
15-20	7.2	140	3.76	4.8	1.88	39.5	21.6	44	30	26	Loam
20-25	7.1	123	3.93	4.31	1.62	42.3	24.6	44	30	26	Loam
25-30	6.4	121	4.75	6.44	2.85	56.0	26.0	44	26	30	Clay Loam
30-35	6.8	246	1.83	1.53	0.56	16.9	16.6	28	31	41	Clay
35-39	8.9	281	2.06	1.50	0.41	20.9	21.4	24	30	46	Clay

*TABLE D-5.5a. Evaluation of Overburden Suitability—(Beaver Bed) DS#412-150P50**

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	SAR	Texture	Overall rating	Restrictive Features
0-5	S	S	S	U	S	U	Sodic
5-10	S	M	S	U	S	U	Sodic
10-15	S	M	S	U	S	U	Sodic
15-20	S	M	S	U	S	U	Sodic
20-25	S	M	S	U	S	U	Sodic
25-30	S	M	S	U	S	U	Sodic
30-35	S	M	S	U	M	U	Sodic
35-39	M	M	S	U	M	U	Sodic

TABLE D-5.6. OVERBURDEN LABORATORY ANALYSIS—(Beaver Bed) DS# 412-152P57

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	Ca meq/L	Mg meq/L	Na meq/L	SAR	Sand	Silt	Clay	Texture
0-5	7.8	72.3	3.71	12.9	1.57	34.4	12.8	58	22	20	Sandy Clay Loam
5-10	8.0	85.6	4.76	11.7	2.67	52.1	19.4	60	22	18	Sandy Loam
10-15	7.7	89.7	4.86	10.0	3.48	54.3	20.9	56	22	22	Sandy Clay Loam
15-20	7.7	121	4.86	10.7	3.72	53.7	20.0	54	23	23	Sandy Clay Loam
20-25	7.8	163	3.68	8.50	2.10	40.6	17.7	48	24	28	Sandy Clay Loam
25-30	8.6	266	0.72	0.99	0.66	6.65	7.33	23	33	44	Clay

*TABLE D-5.6a. Evaluation of Overburden Suitability—(Beaver Bed) DS#412-152P57**

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	SAR	Texture	Overall rating	Restrictive Features
0-5	S	M	S	M	S	M	None
5-10	S	M	S	U	S	U	Sodic
10-15	S	M	S	U	S	U	Sodic
15-20	S	M	S	U	S	U	Sodic
20-25	S	M	S	U	S	U	Sodic
25-30	M	M	S	S	M	M	None

TABLE D-5.7. OVERBURDEN LABORATORY ANALYSIS—(Mowry A Bed) DS# 412-179P45

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	Ca meq/L	Mg meq/L	Na meq/L	SAR	Sand	Silt	Clay	Texture
0-5	3.8	49.4	6.05	18.8	10.5	61.3	16.0	42	29	29	Clay Loam
5-10	3.9	52.2	5.70	19.0	12.8	52.9	13.3	34	31	35	Clay Loam
10-15	3.6	46.3	4.98	14.8	15.5	35.0	9.01	39	32	29	Clay Loam
15-20	4.0	46.1	4.61	18.3	17.3	29.1	6.90	42	32	26	Loam
20-25	4.7	42.7	4.59	22.1	18.4	37.0	8.22	56	23	21	Sandy Clay Loam
25-30	8.3	116	1.90	2.45	0.90	17.4	13.5	44	30	26	Loam

*TABLE D-5.7a. Evaluation of Overburden Suitability—(Mowry A Bed) DS#412-179P45**

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	SAR	Texture	Overall rating	Restrictive Features
0-5	U	S	S	U	S	U	Acidic, Sodic
5-10	U	S	S	M	S	U	Acidic
10-15	U	S	S	S	S	U	Acidic
15-20	U	S	S	S	S	U	Acidic
20-25	U	S	S	S	S	U	Acidic
25-30	S	M	S	M	S	M	None

TABLE D-5.8. OVERBURDEN LABORATORY ANALYSIS—(Mowry A Bed) DS# 511-188P80

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	Ca meq/L	Mg meq/L	Na meq/L	SAR	ABP	Sand	Silt	Clay	Texture
0-5	4.0	34.4	0.42	0.70	0.35	2.45	3.38	-4.97	40	29	31	Clay Loam
5-10	3.7	39.9	0.63	1.29	0.51	3.44	3.63	-1.62	36	33	31	Clay Loam
10-15	3.5	38.4	2.05	9.66	3.46	5.13	2.00	-16.2	41	27	32	Clay Loam
15-20	4.0	43.2	3.25	17.7	11.7	9.70	2.53	-21.4	46	22	32	Sandy Clay Loam
20-25	5.9	42.0	3.32	20.1	10.1	18.5	4.77	-10.4	54	21	25	Sandy Clay Loam
25-30.5	8.2	86.3	1.30	1.64	1.18	12.0	10.1	7.66	49	24	27	Sandy Clay Loam

*TABLE D-5.8a. Evaluation of Overburden Suitability—(Mowry A Bed) DS#511-188P80**

Depth (Feet)	pH	Sat. (%)	EC@25°C mmhos/cm	SAR	ABP	Texture	Overall rating	Restrictive Features
0-5	U	S	S	S	S	S	U	Acidic
5-10	U	S	S	S	S	S	U	Acidic
10-15	U	S	S	S	U	S	U	Acidic, Acid Base Potential
15-20	U	S	S	S	U	S	U	Acidic, Acid Base Potential
20-25	S	S	S	S	U	S	U	Acid Base Potential
25-30.5	S	M	S	S	S	S	M	None

D-6. HYDROLOGY

The premine surface topography associated with the drainages to be affected by these proposed activities is illustrated on the Hydrology Map. No perennial or intermittent streams will be affected by the proposed disturbances.

Through drainage will be reestablished during final reclamation. Table D-6.1 summarizes characteristics of premine drainage basins. Significant ephemeral channels (drainage basins of greater than 5 acres) will be temporarily directed around open pits during active mining stages. Channel design for both temporary and permanent diversions will match premine channel gradients and cross-sectional shapes.

Temporary diversions will comply with Noncoal rules, chapter 3, section 2(e) (ii) (F) to allow passage of peak runoff from a 2 year, 6 hour precipitation event in a nonerosive manner. Permanent diversions (including reconstructed channels and adjacent topography) will comply with Noncoal rules, chapter 3, section 2(e)(iv), to be erosionally stable during the passage of the peak runoff from a 100 year, 6 hour precipitation event. If necessary, sediment control fabric fences will be installed at discharge points into natural channels. These structures will be moved periodically to accommodate active mining areas.

All hydrologic calculations were developed by Greg Sweetser using Carlson Software's SurvCADD 2006, Hydrology Module; Carlson Software, 102 West Second Street, Maysville, KY. Rainfall is based on SCS Type 11 Distribution. Latitude 44-20 Longitude 107-30-00. Precipitation reported in tenths of an inch.

2 Year 6 Hour = 1.00 Event used for temporary diversions.
10 Year 6 Hour =1.73 Event used for corrugated metal pipe (CMP) Road Crossings.
100 Year 6 Hour = 2.57 Event used for stability of permanent diversions.

TABLE D-6.1. TEN CLAIMS HYDROLOGIC SUMMARIES
SCS CN Number ------- 86; Hydrologic Soils Group --------- C; Typical Hydrology Information Point

	Basin Area (Acres)	Relief FT	Watercourse Length	2 Year, 6 Hour Vol. (ac-ft.)	2 Year, 6 Hour Q (cfs)	10 Year, 6 Hour Vol. (ac-ft.)	10 Year, 6 Hour Q (cfs)	100 Year, 6 Hour Vol. (ac-ft.)	100 Year, 6 Hour Q (cfs)
A	33.9	190	2,441	0.28	0.44	1.24	2.67	2.8	6.5
B	5.3	80	769	0.04	0.13	0.19	0.94	0.44	2.32
C	501.1	373	12,864	4.09	3.96	18.4	18.93	41.44	44.69
D	1419	460	17,082	11.58	11.21	52.13	53.62	117.37	126.59
E	61.5	330	3,383	0.5	0.74	2.26	4.39	5.09	10.7
F	3.4	120	679	0.03	0.13	0.12	0.75	0.28	1.86

G	19.7	170	1,649	0.16	0.34	0.72	2.34	1.63	5.69
H	2.3	120	776	0.02	0.22	0.08	0.46	0.19	1.13
I	801	320	14,544	6.54	6.33	29.42	30.26	66.26	71.46
J	525.7	250	10,881	4.29	4.15	24.49	19.86	43.48	46.9
K	38	20	2,184	0.31	0.31	1.4	1.49	3.14	3.52
L	9	140	1,068	0.07	0.2	0.33	1.48	0.74	3.63
M	421	160	7,337	3.43	3.33	15.46	15.91	34.82	37.56

Drainage Cross Sections and Channel Designs

Due to the width of proposed disturbance in the drainages of the Ten Claims New Permit pits (in most cases less than 200 feet) and the acreage of drainage basins from the hydrologic divide to the lower portion of disturbance (< 40 acres), drainage cross sections and channel designs will not be required. Based on review of the drainages for the Ten Claims Project, there will be no channels that have a disturbance over 200 feet in length.

TABLE D-6.2 CULVERT SIZING TABLE

FLOW Cubic Feet/Second		Single Culvert Diameter 60 Feet Long	
9	cfs	18	inch
18	cfs	24	inch
31	cfs	30	inch
49	cfs	36	inch
83	cfs	48	inch
150	cfs	60	inch
230	cfs	72	inch
330	cfs	84	inch
470	cfs	96	inch
810	cfs	120	inch

Ten Claims Proposed Haul Road Culverts Summary

Of the 5 haul roads proposed for this New Permit, one will require a culvert (HR 63.1). Based on hydrology calculations for a 10 year/ 6 hour event, and the culvert sizing table below provided by the WDEQ/LQD using FHA HY-8 software, the drainage crossing of proposed haul road HR-63.1 will require a 30-inch culvert. Low-water crossings may be used in place of CMP where deemed appropriate (i.e. drainages that are less than 4-foot in

depth). There are existing culverts in the County road (aka Old ten Sleep highway) that are adequately sized based on our calculations. At the crossing of Little Cottonwood Creek there is an existing 10 foot culvert that is in good condition and will not be replaced. In regards to proposed HR 63.4 (Cattle Stock Driveway), there are two existing culverts that will need to be replaced and Wyo-Ben would be willing to replace these culverts and make the roadway safe for the best interest of the public and access for moving equipment. We would be able to keep the existing disturbance and would not require any additional disturbance to this road

Drainages reported in B, F, G, H, and L are representations of typical drainages that traverse proposed pits on the Frontier formation that originate from the steep slope to the north and drain to the south.

The culvert sizing table below is intended for corrugated metal culverts at 60 feet long. Inlet and outlet will be projected beyond side slopes of road surface. Culverts will be set at a 2% slope or set on the bottom of the channel based on BLM Section 9113.

Information obtained from the State Engineer's Office online database indicated several permitted water wells within three miles of the New Permit (See Ground Water and Surface Water Map on page 10.1). There are many water wells within the 3 mile radius boundary with the closest well over 1 mile from our proposed disturbance area. Additionally, no ground water was encountered during developmental drilling of the pits of this New Permit. Thus, Wyo-Ben, Inc. mining activities should not affect any permitted water wells. No other surface or ground water impacts are expected.

D-7. SOILS

INTRODUCTION

A soil resource inventory for the Ten Claims New Permit area was conducted by Matthew Call and Joe Sylvester of Wyo-Ben in the fall of 2011. An Order II soil survey was conducted on areas proposed to be affected by mining activities and corresponds to the proximity of the bentonite beds. A more general level Order III survey was conducted on adjacent areas planned for haul roads, and areas that are less likely to be disturbed by mining but are in close proximity to bentonite beds. The total area inventoried consisted of approximately 1,200 acres. Soil maps 1, 2, & 3 show soil map units and recommended soil salvage depths for each unit. Also in this report are descriptions of soil pedons and soil map units, laboratory results of 56 soil pedons, and an assessment of topsoil suitability for each map unit.

Objectives

The objectives of the soil inventory are to provide mining and reclamation specialists and regulators with essential soil data, namely topsoil data, for project and reclamation planning. The specific tasks for the soil resource inventory were to:

- Identify and delineate soil map units.
- Define the physical and chemical characteristics of the soils.
- Develop soil map units.
- Determine suitability depth of topsoil for each soil that will be affected by mining activities.

STUDY AREA

Wyo-Ben's Ten Claims New Permit area is located in Washakie County, Wyoming. The study area sits in the east central part of the Bighorn Basin and is characterized as having dry shrub and subshrub communities with the mean annual precipitation between 10 and 14 inches. The elevation of the site ranges from about 4500 feet on the lowest portion of the Frontier formation of the survey area to about 4700 feet on the highest portion of the Mowry Formation.

The landscape is dominated by steep to gentle slopes vegetated with annual grasses, big sagebrush and Junipers on the Thermopolis shale formation to moderate to steep slopes dissected by deep ephemeral drainages on the Mowry formation vegetated with sparse big sagebrush and Junipers in mixed shrub communities(MSC). The Frontier formation includes topographies that are gentle to moderately steep and vegetated with big sagebrush, Junipers, and rubber rabbitbrush .

METHODS

Compilation of Available Information

The soil inventory was a refinement of the ongoing, preliminary mapping by the Natural Resource Conservation Service (NRCS). Minimal soil mapping by the NRCS had been conducted in the survey area; therefore, general soil series were available. Soils were mapped to the family level using keys to soil taxonomy 8th edition, and were further defined based on field observations and laboratory results.

Field Methods

Field work was conducted in accordance with the standards of the National Cooperative Soil Surveys (USDA, 1981 and 1983) at a scale of 1 inch = 400 feet. Field mapping was carried out using a spade shovel, Montana Sharp-Shooter shovel, and auger during the 2011 field season.

Typical pedons of the soils occurring within the proposed affected area were described and sampled by soil horizons at a sampling rate according to Wyoming Department of Environmental Quality's "Guidelines for Topsoil and Overburden" (WDEQ, 1994). A total of 66 soil pedons were described and 15 observations were made and their locations are shown on the soil maps. 56 of these pedons were sampled and analyzed for topsoil suitability parameters.

Soil horizons were identified according to criteria in *Keys to Soil Taxonomy* (Soil Survey Staff, 1975, 1999) and described according to U.S. Department of Agriculture standards (USDA, 1981). Pedons were described on a modified NRCS pedon description form. Features documented for each horizon include: depth, color, mottles, texture, structure, reaction to hydrogen chloride, boundary, roots, clay films, coarse fragments, and consistence. In addition to horizon characteristics, site features were also documented and include, parent material, physiography, slope, aspect, relief, drainage, and rock outcrop.

Laboratory Analysis

Soil samples were submitted for analysis to Inter-Mountain Laboratories, Inc. in Sheridan, Wyoming. The analytical parameters and analytical methods employed are in Table D-7.1. The methods utilized include American Society of Agronomy (ASA) and USDA methods. Laboratory results are presented in Appendix D-7.2.

TABLE D-7.1 PARAMETERS AND METHODS OF SOIL ANALYSES

Parameter	Method
pH, Saturated Paste	Method 9-3.1.2, ASA Monograph Number 9, Part 2
Electrical Conductivity (EC)	Method 9-3.1.2 ASA Monograph Number 9, Part 2
Saturation Percent	Method 10.2.3, ASA Monograph Number 9, Part 2
Calcium	Method 10-2.3.1, ASA Monograph Number 9, Part 2
Magnesium	Method 10-2.3.1, ASA Monograph Number 9, Part 2
Sodium	Method 10.3.3, ASA Monograph Number 9, Part 2
Sodium Adsorption Ratio (SAR)	Method 2, 3a, USDA Handbook 60
Texture	Method 43-5, ASA Monograph Number 9, Part 1

Black, C.A. 1965. Methods of Soil Analysis, Part 1. American Society of Agronomy, Monograph No. 9; Second Edition; American Society of Agronomy.
Richards, L.A. ed. 1954. Diagnosis and Improvement of Saline and Alkaline Soils. U.S. Salinity Laboratory Staff. USDA Agricultural Handbook No. 60.
Page, A.L. 1982. Methods of Soil Analysis, Part 2. American Society of Agronomy Monograph No. 9; Second Edition; American Society of Agronomy.

SOILS

The soils of the study area have formed in residuum, colluvium, and slopewash of shale and sandstone, and from alluvium in drainages. They are generally well to moderately well drained soils. Most of the soils contain a suit of neutral salts, such as the sulfates, carbonates, and chlorides of sodium and calcium. In addition, some have a considerable amount of exchangeable sodium, and with the salts they are classified as saline-sodic soils.

Alluvial soils are generally deep (greater than 40 inches) and have coarse to loamy textures. Soils derived from sedimentary rocks have a clay texture and are generally very shallow (less than 10 inches) and shallow (less than 20 inches). The soils in each map unit are classified below followed by descriptions of the soil map units.

Soil Classification

Soils were classified to the family level using *Keys to Soil Taxonomy* (Soil Survey Staff, 1999). TableD-7.2 lists the soils by their classification at the family level.

TABLE D-7.2 CLASSIFICATION OF THE SOILS

Soil Name	Classification
Youngston	Fine-loamy, mixed, superactive, calcareous, mesic Typic Torrifluvents
Clayey Lithic Torriorthent	clayey, mixed, mesic, Lithic Torriorthents clayey, calcareous, mixed, mesic, Lithic Torriorthents
Loamy Lithic Torriorthent	fine-loamy, mixed, mesic, Lithic Torriorthents
Persayo	sandy, mixed, mesic, Typic Torriorthents fine-loamy, mixed, mesic, Typic Torriorthents
Sodic Haplocambids	clayey, mixed, mesic, Sodic Haplocambids fine-loamy, mixed, mesic, Sodic Haplocambids
Lithic Haplocambids	clayey, mixed, mesic, Lithic Haplocambids fine-loamy, mixed, mesic, Lithic Haplocambids
Typic Haplocambids	clayey, mixed, mesic, Typic Haplocambids fine-loamy, calcareous, mixed, mesic, Typic Haplocambids coarse-loamy, mixed, mesic, Typic Haplocambids
Typic Haplocalcids	clayey, calcareous, mixed, mesic, Typic Haplocalcids
Lithic Torripsamments	sandy, mixed, mesic, Lithic Torripsamments

Description of the Soils and Soil Map Units

This section provides a description of the soils and map units occurring within the survey area. Descriptions of the typical soil pedons for each soil map unit are included with soil map unit narratives. Pedon descriptions and observations that are not included in

the soil map unit descriptions are presented in Appendix D-7.1. All soil colors presented in the soil descriptions are of moist soil.

Eighteen soil map units were delineated within the survey area and are based on three general soil groups (Torrifluvents, Sodic Haplocambids, Lithic Haplocambids, Typic Haplocambids, Lithic Torriorthents, Typic Torriorthents, and Lithic Torripsamments) and slope. Soil map units are listed in Table D-7.3.

For haul Roads 63.3 and 63.4 an order III Survey was completed and the description of the map units are included on page 31.1.

The last number of the map units denotes the thickness of usable topsoil according to the following scheme:

0 = 0 inches of usable topsoil
1 = 2 - 3 inches of usable topsoil
2 = 4 - 5 inches of usable topsoil
3 = 6 - 7 inches of usable topsoil
4 = 12+ inches of usable topsoil

Slope ranges for the map units are designated by letters from A to F, A being the shallowest slopes and F the steepest. The assigned letter for each map unit represents the steepest slopes in that unit but may include slopes shallower than the letter represents.

Slope (%)	Class
0-5	A
6-15	B
16-25	C
26-40	D
41-60	F

TABLE D-7.3 SOIL MAP UNITS

Soil Map Unit Code	Soil Map Unit Name
Deep Soils Derived from Alluvium	
10A-4	Typic Torrifluvents, 1 to 5 percent slopes (Youngston)
Deep Soils Derived from Residual Shale and Slopewash	
20B-2	Sodic Haplocambids, 0 to 15 percent slopes
20D-3	Sodic Haplocambids, 26 to 40 percent slopes
24B-3	Typic Haplocambids, 6 to 15 percent slopes
46B-3	Typic Torriorthents, 0 to 15 percent slopes
Very Shallow Soils Derived from Sandstone	
48C-3	Lithic Torripsamments, 16 to 25 percent slopes
Very Shallow and Shallow Soils Derived from Residual Shale, Sandstone and Colluvium	
22B-2	Lithic Haplocambids, 6 – 15 percent slopes
22D-3	Lithic Haplocambids 26 – 40 percent slopes
22F-1	Lithic Haplocambids, 40 – 65 percent slopes
24C-3	Typic Haplocambids, 16 – 25 percent slopes

24F-2	Typic Haplocambids, 40 – 65 percent slopes
26B-3	Typic Haplocalcids, 6 – 15 percent slopes
42B-1	Clayey Lithic Torriorthents, 6 – 15 percent slopes
42C-1	Clayey Lithic Torriorthents, 16 – 25 percent slopes
42D-1	Clayey Lithic Torriorthent, 26 – 40 percent slopes
42F-1	Clayey Lithic Torriorthent, 40 – 65 percent slopes
44B-1	Loamy Lithic Torriorthent, 6 – 15 percent slopes

Miscellaneous Map Units

51F-0	Barren Shale lands, 0 to 65 percent slopes

Alluvial Soils

- Map Unit 10A-4—fine-loamy, mixed, super-active, calcareous, mesic Typic Torrifluvents, 0 to 15 percent slope

This map unit occurs mostly in the deep drainage that dissects all three formations of the proposed project. These soils are deep and suitable down to at least 50 inches. Mixed shrubs including big sagebrush and greasewood and annual grasses are the dominant vegetation of this map unit.

These soils are derived from alluvial deposition in drainages of the project area and contain moderate to fine-loamy material in all horizons. The soils are well drained and permeability is fast.

One soil pedon was described in the fine-loamy, mixed, super-active, calcareous, mesic Typic Torrifluvent. Pedon 48 is described below. This map unit will be minimally affected by mining activities.

Description of pedon 48: fine-loamy, mixed, super-active, calcareous, mesic Typic Torrifluvents. This sample was taken on the Frontier Formation.

A	0 to 1 inches; dark grayish brown (2.5 Y 4/2) loam; weak fine Granular structure; loose, slightly sticky and slightly plastic; few fine-medium roots; non effervescent; abrupt smooth boundary.
Bk	1 to 9 inches; light olive brown (2.5Y 5/4) loam; medium moderate subangular blocky structure; moderately hard, sticky and moderately plastic; few fine roots; strong effervescent; clear wavy boundary.
Ck	9 to 15 inches; light olive brown (2.5Y 5/4) loam; massive; moderately hard, very sticky and plastic; few very fine roots; strong effervescent.
C2	15 - 30 inches; grayish brown (2.5Y 5/2) loam; massive; moderately hard, very sticky, slightly plastic; no roots; strong effervescent.
C3	30 – 50 inches; grayish brown (2.5Y 5/2) sandy loam; massive; moderately hard, very sticky, slightly plastic; no roots; strong effervescent

Deep Soils Derived from Residual Shale and Slopewash

- Map Unit 20B-2 – clayey, mixed, mesic, Sodic Haplocambids
- Map Unit 20D-3 – fine-loamy, mixed, mesic, Sodic Haplocambids
- Map Unit 24B-3 – fine-loamy, mixed, mesic, Typic Haplocambids
- Map Unit 46B-3 – fine-loamy, mixed, mesic, Typic Torriorthents

This map unit occurs on all geologic formations proposed for mining in this New Permit including the Frontier, Mowry and Thermopolis Shale. These soils are very shallow

to shallow, sodic affected in the B horizons, and occur mostly on gentle (0 to 15 degree slope) to moderately steep slopes (26 – 40 degree slope). The vegetation is a Mixed Shrub Community (MSC) with Wyoming Big Sagebrush as the most common shrub of the map unit, but small areas of Greasewood, Juniper, and Annual grasses also occur in this map unit.

Two separate qualities of Sodic Haplocambids occur throughout the survey area. One is a poorer quality soil that is salt and sodic affected at or below 12 inches. The other quality is sodic affected deeper in the profile thus resulting in a greater soil salvage depth recommendation up to 18 inches. Vegetation species for this soil map unit is a Mixed Shrub Community (MSC).

Soils of these map units are derived from residual sodic shale and slopewash and are well drained. Permeability is slow to moderate and runoff is slow to fast in the steeper mapping units.

This map unit is in the clayey to fine-loamy, mixed, mesic, Sodic Haplocambids family. Eight soil pedons were described in the clayey, mixed mesic Sodic Haplocambids map units, and pedon 62 is described below. Three soil pedons were described in the fine-loamy mixed mesic Sodic Haplocambids. Pedon 35 is described below. These map units will be affected by mining activities.

Description of pedon 62: clayey, mixed, mesic Sodic Haplocambids – MSC Unit (ARTR)

- A 0 to 2 inches; dark grayish brown (2.5 Y 4/2), loam; slight crust over weak fine Granular structure; loose, moderately sticky and slightly plastic; many fine roots; non effervescent; abrupt smooth boundary.
- Bw1 2 - 6 inches; olive brown (2.5Y 4/4) loam; moderate medium subangular blocky structure; hard, very sticky and plastic; common fine to medium roots; slight effervescent; gradual wavy boundary.
- Bw2 6 – 13 inches; olive brown (2.5Y 4/4) clay; strong medium prismatic structure; very hard, sticky, plastic; few fine to medium roots; violent effervescent.
- C1 13 to 22 inches (Augured); dark grayish brown (2.5Y 4/2) clay; massive; hard, slightly sticky, very plastic; approx. 1 inch of disseminated gypsum as 21 inches depth; no roots; slight effervescent.
- C2 22 – 31 inches (Augured); very dark grayish brown (2.5Y 3/2) clay; massive; hard, moderately sticky, plastic; 5% gypsum masses; no rots; noneffervescent.

Description of pedon 35: fine-loamy mixed mesic Sodic Haplocambids- The vegetation is a MSC with dominate Sagebrush with Greasewood and some Junipers on a 20% slope.

- A 0 to 1 inches; olive brown (2.5y 4/4) <1% surface rock; sandy loam; slight crust over weak fine Granular structure; loose, nonsticky and slightly plastic; few fine roots; strong effervescent; abrupt smooth boundary.
- Bw 1 to 14 inches; olive brown (2.5Y 4/4) sandy loam; strong to medium strength, medium to very coarse prismatic structure; moderately hard, sticky and moderately plastic; common few to medium roots; strongly effervescent; clear wavy boundary.
- C1 14 to 22 inches; light olive brown (2.5Y 5/4) sandy clay loam; massive; moderately hard, sticky and moderately plastic; very few very fine roots; strongly effervescent.
- C2 22 to 32 inches; dark grayish brown (2.5Y 4/2); clay loam; massive structure; slightly hard, sticky and plastic; no roots; strongly effervescent.

- Map Unit 24B-3 – Typic Haplocambids

This map unit occurs on the Frontier and Mowry Formations. The vegetation on this map unit is a Mixed Shrub Community with sagebrush as the dominate species. The slopes range from gentle up to 15 degree slopes with varying aspects.

Soils of this map unit are derived from residual weathered shale and are high in clay content. Permeability is slow and runoff is slow to moderate based on the slope of the soil hole.

This map unit is in the clayey, mixed, mesic Typic Haplocambid family. Ten soil pedon were described and sampled. Pedon number 28 is described below.

Description of pedon 28: clayey, mixed, mesic, Typic Haplocambids This soil was described on a 5 % slope within a MSC and Big Sagebrush on the Frontier and Mowry formation.

A 0 to 3 inches; grayish brown (2.5Y 5/2) clay; weak fine Granular structure with 1/8" crust; loose, moderately sticky and moderately plastic; 2% rock fragments; many fine roots; noneffervescent; abrupt smooth boundary.

Bw 3-13 inches; grayish brown (2.5Y 5/2) clay; moderate medium subangular blocky structure; moderately hard, moderately sticky and moderately plastic; few fine roots; strong effervescent; gradual wavy boundary.

C1 13 to 28 inches; dark grayish brown (2.5Y 4/2) clay; massive; very hard, sticky and plastic; no roots; noneffervescent.

C2 28 to 34 inches; dark grayish brown (2.5Y 4/2) clay; massive; very hard, sticky and plastic; 4 inch string of gypsum from 27 to 31 inches; slight effervescent; no roots.

- Map Unit 46B-3 – Persayo - Typic Torriorthents

This map unit occurs on the Frontier and Mowry Formations. The vegetation on this map unit is a Mixed Shrub Community with sagebrush as the dominate specie. The slopes range from gentle up to 15 degree slopes with varying aspects.

Soils of these map units are derived from residual sodic shale and slopewash and are well drained. Permeability is slow to moderate and runoff is slow to moderate in the steeper samples.

This map unit is in the fine-loamy, mixed, mesic Typic Torriorthents family. Two soil pedon were described and sampled. Pedon number 47 is described below.

Description of pedon 47: fine-loamy, mixed, mesic, Typic Torriorthent. This soil was described on a 5 % slope with MSC and Big Sagebrush on the Frontier formation.

A 0 to 3 inches; very dark grayish brown (2.5Y 3/2) sandy loam; weak fine Granular structure; loose, nonsticky and slightly plastic; <1% rock fragments; many fine roots; noneffervescent; abrupt wavy boundary.

C1 3 to 9 inches; very dark grayish brown (2.5Y 3/2) sandy clay loam; massive structure; hard, moderately sticky and slightly plastic; few fine roots; noneffervescent; gradual smooth boundary.

C2 9 to 18 inches; dark grayish brown (2.5Y 4/2) sandy loam; massive; moderately hard, sticky and slightly plastic; no roots; noneffervescent.

C3 18 to 36 inches; olive brown (2.5Y 4/4) sandy clay loam; massive; moderately hard, moderately sticky and plastic; strong effervescent; no roots.

C4 36 to 50 inches; dark grayish brown (2.5Y 4/2) sandy clay loam; massive with 3% lime nodules; moderately hard, moderately sticky and plastic; slight effervescent; no roots.

Very Shallow Soils Derived from Sandstone

- 48C-3-sandy, mixed, mesic, Typic Torripsamments:

This map unit occurs on a limited basis on a moderately sloped bench below the Peay Sandstone formation with a southern aspect in the west portion of the proposed project. The vegetation is mixed with grasses and sparse Juniper trees.

This map unit consists of sandy, mixed, mesic, Typic Torripsamments. Soils are shallow, well drained, and formed in residual sandstone rock parent material and slopewash. Permeability is moderate, and runoff is fast. One soil pedon was described and analyzed for topsoil parameters.

A representative profile of the sandy, mixed, mesic, Typic Torripsamments is pedon 59. This soil was described on a 25 percent slope.

A 0 to 6 inches; grayish brown (2.5Y 5/2) sand; weak fine Granular structure; loose, nonsticky and nonplastic; <1% rock fragments; few fine roots; noneffervescent; abrupt wavy boundary.

R 6 – 10+ inches; consolidated sandstone; very few fine roots; noneffervescent

Very Shallow and Shallow Soils Derived from Residual Shale, Sandstone and Colluvium

- Map Unit 22B-2 – fine-loamy, mixed, mesic Lithic Haplocambids, 0 to 15 percent slopes.
- Map Unit 22D-3 – clayey, mixed, mesic Lithic Haplocambids, 15 to 40 percent slopes.
- Map Unit 22F-1 – clayey, mixed, mesic Lithic Haplocambids, 40 – 60 percent slopes.

These map units occur to a great extent as bands on all three Geologic Formations that are proposed for disturbance; Frontier, Mowry, and Thermopolis Shale Formations. Three general qualities of soils occur in this map unit, one being shallower and of a poorer quality than the others, the second one has better deposition and more salvageable topsoil, and the third has 6 – 7 inches of suitable topsoil. The poorer quality soil has developed from residual shale and has a shallow A horizon that is somewhat acidic in some holes and some clay textured, and has been assigned map unit 22F-1 on the soil map. The better quality soil (22D-3) is located on the Mowry formation and has influence from residual sandstone parent material of the Peay sandstone formation. This better quality soil is deeper to lithic parent material than the other soils of this map unit. These soils have a more neutral pH and a more sandy texture compared to the poorer quality soil of 22F-1.

Indicator vegetation for map unit 22F-1 is sparse Junipers with little other vegetation due to the qualities of the soil. Map unit 22D-3 and 22B-2 generally occur along the Mowry Formation. Indicator vegetation map units 22D-3 and 22B-2is a mixed shrub community with Wyoming big sagebrush and Juniper trees with some Rubber rabbitbrush and cheatgrass noted on some of the samples.

- Map Unit 22B-2 – fine-loamy, mixed, mesic Lithic Haplocambids, 0 to 15 percent slopes.

Eleven soil pedons were described in the fine-loamy, mixed, mesic Lithic Haplocambids map unit, and number 33 is described below.

A 0 to 1 inches; olive brown (2.5Y 4/4) sandy clay; weak fine Granular structure; loose, moderately sticky and plastic; 2% small rock fragments; few fine roots; noneffervescent; abrupt smooth boundary.

Bw 1 to 8 inches; olive brown (2.5Y 4/4); strong medium subangular blocky; very hard moderately sticky plastic; few fine to medium roots; noneffervescent; clear smooth boundary.

C 8 to 14 inches; olive brown (2.5Y 4/4); massive structure with 3% lime masses; very hard, sticky, plastic; few fine to medium roots; slight effervescent.

Cr 14+ inches Peay Sandstone

- Map Unit 22D-3 – clay, mixed, mesic Lithic Haplocambids, 15 to 40 percent slopes.

One soil pedon was described in the clay, mixed, mesic Lithic Haplocambids map unit, and number 43 is described below.

A 0 to 1 inches; grayish brown (2.5Y 5/2) clay loam; weak fine Granular structure; loose, moderately sticky and moderately plastic; 20% small rock channers; few fine roots; noneffervescent; abrupt smooth boundary.

Bw 1 to 5 inches; grayish brown (2.5Y 5/2) clay; strong fine to medium sub angular blocky with <1% rock fragments; moderately hard, sticky, plastic; few fine roots; noneffervescent; abrupt smooth boundary.

Cy 5 to 9 inches; light brownish gray (2.5Y 6/2) sandy clay; massive structure with <1% rock fragments and 60% gypsum; moderately hard, sticky, plastic; very few fine roots; noneffervescent; gradual wavy boundary.

C1 9 to 16 inches; light olive brown (2.5Y 5/4) sandy clay; massive structure with 15% gypsum; moderately hard, moderately sticky, plastic; very few fine roots; noneffervescent.

R 16+ inches; Peay Sandstone.

- Map Unit 22F-1 – clay, mixed, mesic Lithic Haplocambids, 40 to 60 percent slopes.

One soil pedon was described in the clay, mixed, mesic Lithic Haplocambids map unit, and number 81 is described below.

A 0 to 2 inches; very dark grayish brown (2.5Y 3/2) clay; weak fine Granular structure; loose, slightly sticky and plastic; <1% small rock channers; many fine roots; noneffervescent; abrupt wavy boundary.

B 2 to 17 inches; very dark grayish brown (2.5Y 3/2) clay; strong medium to coarse prismatictic to subangular blocky <1% rock fragments with 40% white gypsum masses; moderately hard, sticky, plastic; common fine to medium roots; noneffervescent; abrupt wavy boundary.

C 17+ Bentonite

- Map Unit 24C-3- clayey, mixed, mesic Typic Haplocambids, 15 – 25 percent slope
- Map Unit 24F-2- clayey, mixed, mesic Typic Haplocambids, 40 – 65 percent slope

This map unit occurs on all geologic formations proposed for mining in this New Permit including the Frontier, Mowry and Thermopolis Shale. This map unit contains several distinct qualities of soils. The poorer quality soil is identified vegetatively in areas that contain sparse juniper and Wyoming big sagebrush. These soils are heavy clay soils

with elevated pH and SAR level in the 24F-2 map unit. The moderate soil quality 24C-3 map unit occurs mostly on the Thermopolis Shale formation and will have limited disturbance. This soil map unit is identified vegetatively with the presence of Mixed Shrub Community with Junipers and Wyoming big sagebrush. Soils in this map unit are moderately deep with heavy clays below 6 inches of topsoil.

Soils of these map units are derived from residual shale, sandstone, and colluvium slopewash and are well drained. Permeability is moderate to fast and runoff is moderate to fast depending on the slope of the area.

- Map Unit 24C-3- clayey, mixed, mesic Typic Haplocambids, 15 – 25 percent slope

Two soil pedons were described in the clayey, mixed, mesic Typic Haplocambids map unit, and pedon 77 is described below.

Description of pedon 77: clayey, mixed, mesic Typic Haplocambids

A 0 to 2 inches; very dark grayish brown (2.5Y/3/2) clay; weak fine Granular structure with 5% small channers; loose, slightly sticky and plastic; common fine and medium roots; noneffervescent; clear wavy boundary.

Bw 2 to 12 inches; dark grayish brown (2.5YR 4/2) clay; strong, medium subangular to prismatic structure with a seam of 5% channers around 3 inches; hard, slightly sticky and plastic; few fine roots; noneffervescent,; clear wavy boundary.

C 12 to 17 inches; dark grayish brown (2.5YR 4/2) clay loam; massive structure with 5% channers; hard, sticky, plastic; very few fine roots; noneffervescent.

- Map Unit 24F-2- clayey, mixed, mesic Typic Haplocambids, 40 – 65 percent slope

Description of pedon 40: clayey, mixed, mesic Typic Haplocambids

A 0 to 1 inches; olive brown (2.5Y 4/4); clay; weak fine Granular structure; loose, slightly sticky and plastic; few fine roots; noneffervescent; clear smooth boundary.

Bw 1 to 7 inches; dark grayish brown (2.5Y4/2) clay; weak medium subangular blocky structure; slightly hard, moderately sticky, plastic; many few to common roots; noneffervescent; clear smooth boundary.

C 7 - 12 inches; light olive brown (2.5Y 5/4) clay; massive structure with 60% lime as masses and bentonite intermixed; violently effervescent.

R 12+ solid shale stone.

- Map Unit 26B-3- clayey, calcareous, mixed, mesic Typic Haplocalcids, 6 – 15 percent slope. One soil pedon was described in the clayey, calcareous, mixed, mesic Typic Haplocalcids map unit, and pedon 4 is described below.

This map unit occurs on the Mowry formation on the eastern third portion of the proposed mining in this New Permit. This map unit contains a distinct quality of high concentrations of lime. The primary vegetative cover is a Mixed Shrub Community with Wyoming big sagebrush as the dominate species. These soils increase in clay concentrations the deeper you go in the profile. Soils in this map unit are shallow and there is 6 inches of suitable topsoil for and 6 inches of subsoil to be salvaged for this soil map unit 26B-3.

Soils of these map units are derived from residual shale, sandstone, and colluvium slopewash and are well drained. Permeability is moderate to fast and runoff is moderate.

Description of pedon 4: clayey, calcareous, mixed, mesic Typic Haplocalcids

A 0 to ½ inches; light olive brown (2.5Y 5/4) sandy clay loam; weak fine Granular structure with 10% small rock fragments; loose, slightly sticky and slightly plastic; few fine roots; slightly effervescent; abrupt smooth boundary.

Bk 1/2 to 6 inches; dark grayish brown (2.5YR 4/2) sandy clay loam with 10% lime concentrations and 5% stones; moderate, medium subangular structure; hard, slightly sticky and moderately plastic; common fine to medium roots; violent effervescent,; clear wavy boundary.

Ck 6 to 17 inches; dark grayish brown (2.5YR 4/2) loam with 40% lime concentrations; massive structure; hard, slightly sticky, slightly plastic; few fine roots; violent effervescent.

- Map Unit 42B-1- clayey, mixed, mesic Lithic Torriorthents, 6 - 15 percent slope
- Map Unit 42C-1- clayey, mixed, mesic Lithic Torriorthents, 16 - 25 percent slope
- Map Unit 42D-1- clayey, mixed, mesic Lithic Torriorthents, 26 – 40 percent slope
- Map Unit 42F-1- clayey, mixed, mesic Lithic Torriorthents, 40 – 65 percent slope

This map unit occurs on all geologic formations proposed for mining in this New Permit including the Frontier, Mowry and Thermopolis Shale. The soil quality is identified by the vegetation in areas that contain sparse juniper and sparse Wyoming big sagebrush. These soils are shallow with heavy clay soils. There will be moderate disturbance with the Frontier and Mowry mining.

Soils of these map units are derived primarily from residual shale with minimal influence from sandstone, and colluvium slopewash and are well drained. Permeability is moderate to fast and runoff is slow to fast depending on the slope of the area.

- Map Unit 42B-1 clayey, mixed, mesic Lithic Torriorthents, 6 - 15 percent slope
  Four soil pedons were described in the clayey, mixed, mesic Lithic Torriorthents map unit, and pedon 30 is described below.

Description of pedon 30: clayey, mixed, mesic Lithic Torriorthents

A 0 to 2 inches; dark grayish brown (2.5Y 4/2) clay; weak fine Granular structure with 5% small channers; loose, slightly sticky and plastic; few fine roots; noneffervescent; abrupt boundary.

R 2+ inches; fracture shale rocks

- Map Unit 42C-1—clayey, mixed, mesic Lithic Torriorthents, 16 – 25 percent slope
  Four soil pedons were described in the clayey, mixed, mesic Lithic Torriorthents map unit, and pedon 15 is described below.

Description of pedon 15: clayey, mixed, mesic Lithic Torriorthents

A 0 to 3 inches; dark grayish brown (2.5Y 4/2) clay; weak fine Granular structure; loose, sticky and plastic; 10% shale chips; few fine roots; noneffervescent; abrupt wavy boundary.

R 3+ inches; black fractured shale chips.

- Map Unit 42D-1—clayey, mixed, mesic Lithic Torriorthents, 26 – 40 percent slope
  Eight soil pedons were described in the clayey, mixed, mesic Lithic Torriorthents map unit, and pedon 8 is described below.

Description of pedon 8: clayey, mixed, mesic Lithic Torriorthents

A 0 to 2 inches; dark grayish brown (2.5Y 4/2) clay; weak fine Granular to subangular blocky structure; loose, slightly sticky and moderately plastic; 20% channers; few fine roots; noneffervescent; abrupt smooth boundary.

R 2 – 9+ inches; 90% small shale channers with weathered shale; few fine to medium roots.

- Map Unit 42F-1—clayey, mixed, mesic Lithic Torriorthents, 41 – 60 percent slope
  Two soil pedons were described in the clayey, mixed, mesic Lithic Torriorthents map unit, and pedon 72 is described below.

Description of pedon 72: clayey, mixed, mesic Lithic Torriorthents

A 0 to 2 inches; very dark grayish brown (2.5Y 3/2) silty clay; weak fine Granular structure; loose, slightly sticky and plastic; 10% channers; common fine roots; noneffervescent; clear wavy boundary.

Cr 2 – 15+ inches; very dark grayish brown (2.5Y 3/2) clay loam; massive structure; 60% sandstone gravel; loose, slightly sticky, plastic; common fine roots; noneffervescent.

- Map Unit 44B-1- fine-loamy, mixed, mesic, Lithic Torriorthents, 6 – 15 percent slope

This map unit occurs on the geologic Frontier and Mowry Shale formations. The vegetation on this map area varies from sparse Mixed Shrub Community of juniper and Wyoming big sagebrush with some annual vegetation. These soils are very shallow. There will be moderate disturbance with the Frontier and Mowry mining.

Soils of these map units are derived primarily from residual shale with influence from sandstone, and colluvium slopewash and are well drained. Permeability is moderate and runoff is slow to moderate.

- Map Unit 44B-1 fine-loamy, mixed, mesic Lithic Torriorthents, 6 - 15 percent slope
  Five soil pedons were described in the fine-loamy, mixed, mesic Lithic Torriorthents map unit, and pedon 1 is described below.

Description of pedon 1: fine-loamy, mixed, mesic Lithic Torriorthents

A 0 to 1 inches; light yellowish brown (2.5Y 6/4) sandy loam; weak medium Granular structure with < 1% rock fragments; loose, nonsticky and nonplastic; few fine to medium roots; noneffervescent; smooth clear boundary.

C1 0 to 12 inches; light olive brown (2.5Y 5/4) sandy loam; massive structure with 10% gravel; hard, nonsticky and slightly plastic; common medium to coarse roots; slightly effervescent; abrupt smooth boundary.

R 12+ inches; sandstone rock.

Topsoil Suitability

Topsoil suitability was determined for soils within the affected areas and suitability was based on criteria established by the Wyoming Department of Environmental Quality (WYEQ, 1994). These criteria are shown in Table D-7.4. Sample analysis did not include boron and selenium. Suitable topsoil depths and volumes for each map unit within the affected area are shown in Table D-7.5.

Table D-7.4 Criteria to Establish Suitability of Topsoil

Parameter	Suitable	Marginal	Unsuitable
pH	5.5-8.5	5.0-5.5	<5.0
EC (conductivity) mmhos/cm	0-8	8-12	>12
Saturation Percent	25-80	<25, >80	
Texture		Clay, silty clay, sand	
SAR (Sodium Adsorption Ratio)	0-10	10-12• 10-15	>15
Coarse Fragments (% vol.)	<25	25-35	>35

- for fine textured soils (clay > 40%)

Table D-7.5 Topsoil Summary

Map Unit	Composition of Map Unit (%)	Depth of Topsoil (inches)	Salvage Depth of Topsoil/ Subsoil (inches)	Limitations
10A-4 Typic Torrifluvents	100	50	12/38	No limitations to 50 inches
20B-2 Sodic Haplocambids	100	50	5/6	SAR > 13 in the C Horizon, but EC is generally not high until below 12 inches.
20D-3 Sodic Haplocambids	100	36	6/11	SAR>13 in the C horizon below 18 inches.
22B-2 Lithic Haplocambids	100	12	4/5	33 has high saturation levels below 6 inches, and 36 is acidic with no salvage value.
22D-3 Lithic Haplocambids	100	16	6/10	Elevated SAR in 1st 5 inches.
22F-1 Lithic Haplocambids	100	17	2/0	Heavy clays below 6 inches
24B-3 Typic Haplocambids	100	32	6/6	Heavy clay soils throughout the horizon
24C-3 Typic Haplocambids	100	17	6/3	Heavy clays below 6 inches
24F-2 Typic Haplocambids	100	10	4/6	Acidic soils and elevated SAR below 18 inches
26B-3 Typic Haplocalcids	100	18	6/6	Clay soils increase the deeper you get in the horizon
42B-1 Clayey Lithic Torriorthents	100	2	2/0	High clay soils, very shallow soils, bedrock below 2 inches
42C-1 Clayey Lithic Torriorthents	100	3	3/0	High clay soils, very shallow soils, bedrock below 3 inches
42D-1 Clayey Lithic Torriorthent	100	2	2/0	High clay soils, very shallow soils, bedrock below 2 inches
42F-1 Clayey Lithic Torriorthent	100	2	2/0	High clay soils and high pH levels on sample 72
44B-1 Loamy Lithic Torriorthents	100	10	3/7	Low pH in one of the samples.

46B-3 Typic Torriorthents	100	50	6/12	Sodic conditions below 18 inches on soil hole 12
48C-3 Lithic Torripsamments	100	6	6/0	High is sands 80%+
51F-0 Miscellaneous	100	0	0/0	Does not support vegetation probably due to high SAR and EC

TABLE D-7.6 PROJECTED TOPSOIL AND SUBSOIL STOCKPILE VOLUMES AND AVERAGE SOIL REPLACEMENT DEPTHS.

PIT No.	Total Affected Acres	Stockpile Volume Topsoil B.C.Y.	Stockpile Volume Subsoil B.C.Y.	Average TS/SS Replacement Depth in Inches	Total TS/SS to be removed in cubic yards
Ten 1 (F2)	55.8	2,750 yd^3	4,100 yd^3	4”/ 6”	30,010 yd^3/ 45,010 yd^3
Ten 2 (F3)	20.6	950 yd^3	1,600 yd^3	4”/ 7”	11,080 yd^3/ 19,390 yd^3
Ten 3 (Beaver)	49.9	2,250 yd^3	3,900 yd^3	4”/ 7”	26,835 yd^3/ 46,960 yd^3
Ten 4 (MA)	56.1	2,750 yd^3	3,850 yd^3	5”/ 7”	37,710 yd^3/ 52,800 yd^3
Ten 5 (MB)	25.9	800 yd^3	800 yd^3	4”/ 4”	13,925 yd^3/ 13,925 yd^3
COP/TOP/HW	24.0	1,440 yd^3	3,960 yd^3	4”/ 11”	12,900 yd^3/ 35,500yd3

Topsoil and Subsoil Handling

Wyo-Ben will save all available soil for reclamation during the initial stripping part of mining. Soils will be saved by one of two methods. Soils will be stockpiled with topsoil and subsoil being stockpiled separately and signed to distinguish the two qualities. Alternatively, soils may be spread directly on a previously backfilled and contoured phase of mining, behind the current phase, when a new phase of mining is being opened (spreading soils live in a castback sequence).

Many of the soils in the New Permit area contain a thin surface layer that is marginally suitable as topsoil. Some subsoils are generally unsuitable due to high exchangeable sodium (high SAR) and some have a high amount of salts that are more soluble than gypsum (high EC). Most of the unsuitable subsoils with a high SAR are saline-sodic which means that they contain appreciable quantities of neutral salts and enough sodium ions to seriously affect most crops. Based on chemical data alone, most of the recommended salvage depths listed above are greater than what WDEQ guideline 1 would suggest. However, due to the limited amount of soil resources in this area, subsoil will be saved separately from topsoil to allow a buffer between topsoil and the more chemically detrimental overburden material. This is shown in table D-7.5-topsoil summary.

REFERENCES

Soil Survey Staff. 1999. Keys to Soil Taxonomy. Eight Edition. Pocahontas Press, Inc. Blacksburg, Virginia.

United States Department of Agriculture (USDA). 1981/1993. Soil Survey Manual, Chapter 4, Examination and Description of Soils in the Field. Manuscript (430-V-SSM, May 1981).

Wyoming Department of Environmental Quality. November, 1984. Guideline No. 1, Topsoil and Overburden.

APPENDIX D-7.1

PEDON DESCRIPTIONS

Pedon Key:

Structure:

1 = weak, 2 = moderate, 3 = strong;

vf= very fine, f = fine, m = medium, c = coarse, vc = very coarse

AB = angular blocky, SAB = subangular blocky, PRIS = Prismatic, PLAT = Platy,

Reaction to 10% HCl:

Eo = noneffervescent, Evsl = very slightly effervescent, Esl = slightly effervescent;

Estr = strongly effervescent, Ev = violently effervescent

Coarse Fragments

Chan = Channers

Grav = Gravels

Visible Salts

Gyp = Gypsum

Lime = Lime

Vegetation

MSC = Mixed Shrub Community

Map Unit 10A-4: Youngston (Typic Torrifluvents), 1 to 5 percent slopes

Pedon 48: Fine-loamy, mixed, superactive, calcareous, mesic Typic Torrifluvent. This soil was described on a major drainage that dissects all 3 formations. The sample was taken on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Loam	2.5Y 4/2	1f Granular	>1%	none	Eo
Bk	1-9	Loam	2.5Y 5/4	2 m SAB	>1%	none	Estr
Ck	9-15	Loam	2.5Y 5/4	Massive	>1%	none	Estr
C2	15-30	Loam	2.5Y 5/2	Massive	>1%	none	Estr
C3	30-50	Sandy Loam	2.5Y 5/2	Massive			Estr

Map Unit 20B-2: (Sodic Haplocambids), 0 to 15 percent slopes, soils described on the Thermopolis Shale Formation unless noted in the Pedon description.

Pedon 25: Sodic Haplocambid. The vegetation is mainly Greasewood and annuals on a 5% grade.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5 Y 4/4	1 f Granular	>1%	None	Eo
Bw1	1–5	Clay	2.5 Y 4/2	2 m sab	>1%	None	Eo
Bw2	5–10	Clay	2.5 Y 4/2	2 m-vc, PRIS-SAB	>1%	5% Gyp	Eo
C1	10–18	Clay	2.5 Y 4/2	Massive	>1%	None	Eo
C2	18-30	Silty Clay	2.5 Y 3/0	Massive	>1%	None	Eo

Pedon 27: Sodic Haplocambid. The vegetation is mainly Greasewood and annuals on a 3% grade near a drainage.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
1Bw	0-4	Clay Loam	2.5Y 4/2	2 m sab	None	None	Estr
1C	4-12	Clay Loam	2.5Y 4/2	Massive	None	None	Estr
2BW	12-26	Sandy Clay Loam	2.5Y 4/2	2 c – vc PRIS	None	5% Lime	Estr
2C	26-36	Clay loam	2.5Y 3/2	Massive	None	None	Estr
Cr	36+			Black Shale Chips		None	

Pedon 54: Sodic Haplocambid. The vegetation is a sagebrush dominate MSC with a 15% slope. The soil is located on the upper Frontier Formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Sandy Clay Loam	2.5Y 5/2	1 f Granular	2%	None	Estr
Bk	1-12	Sandy Clay Loam	2.5Y 4/2	3 m AB	1%	15% Lime	Estr
C1	12-17	Sandy Clay Loam	2.5Y 4/4	Massive	>1%	10% Lime	Estr
C2	17-30	Sandy Clay Loam	2.5Y 4/2	Massive	None	10% Gyp	Eo
C3	30-48	Sandy Clay Loam	2.5Y 4/2	Massive		None	

Pedon 62: Sodic Haplocambid. The vegetation is a sagebrush dominate MSC with 15% slope.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Loam	2.5Y 4/2	1 w Granular	None	None	Eo
Bw1	2-6	Loam	2.5Y 4/4	2 m SAB	None	None	Estr
Bw2	6-13	Clay	2.5Y/4/4	3 m PRIS	None	None	Ev
C1	13-22	Clay	2.5Y 4/2	Massive	None	10% Gyp	Estr
C2	22-31	Clay	2.5Y 3/2	Massive		5% Gyp	Ev

Pedon 64: Sodic Haplocambid. The vegetation is a sagebrush/juniper dominate MSC with a 10% slope.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 5/2	1 w Granular	2%	None	Estr
Bw	1-9	Clay	2.5Y 4/2	3 c-vc SAB	None	None	Ev
C1	9-14	Clay	2.5Y 4/2	Massive	5% Chan	5% Lime	Ev
C2	14-29	Clay	2.5Y 4/2	Massive	5% Chan	10% Lime	Ev
R	29+	Clay Loam		Rock		None	

Pedon 70: Sodic Haplocambid. The vegetation is a Greasewood with annuals on a 15% slope.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 5/2	1 f Granular	None	None	Eo
Bw	1-10	Clay	2.5Y 5/2	4 c PRIS	None	5% Gyp	Eo
C	10-19	Silty Clay	2.5Y 4/2	Massive	2% Grav	None	Eo

Pedon 73: Sodic Haplocambid. The vegetation is a MSC with Sagebrush and Greasewood dominate species on a 5% slope.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
B	0-9	Clay Loam	2.5Y 4/2	1/8 inch crust over 2 m-vc, SAB-PRIS	2% Chan	None	Eo
C1	9-14	Clay	2.5Y 3/2	Massive	20% Shale	None	Eo
C2	14-25	Clay Loam	2.5Y 3/2	Massive	10% Large Chan	None	Eo

Pedon 75: Sodic Haplocambid. The vegetation is a MSC with dominate Sagebrush on a 5% slope.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Clay Loam	2.5Y 4/4	1 f Granular	10% M Chan	None	Eo
Bw	2-14	Clay	2.5Y 5/6	3 vc SAB	1%	None	Estr
C1	14-23	Clay Loam	2.5Y 3/2	Massive	1%	5% Gyp	Eo
C2	23-36	Clay Loam	2.5Y 3/0	Massive	2%	5% Gyp	Eo

Map Unit 20D-3: (Sodic Haplocambids), 15 to 40 percent slopes, soils described on the Thermopolis Shale Formation unless noted in the Pedon description.

Pedon 35: Sodic Haplocambid. The vegetation is a MSC with dominate Sagebrush with Greasewood and some Junipers on a 20% slope.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Sandy Loam	2.5Y 4/4	1f Granular	>1%	None	Estr
Bw	1-14	Sandy Loam	2.5Y 4/4	2-3 m-vc PRIS	>1%	None	Estr
C1	14-22	Sandy Clay Loam	2.5Y 5/4	Massive	>1%	5% Lime	Estr
C2	22-32	Sandy Clay Loam	2.5Y 4/2	Massive	>1%	None	Estr

Pedon 68: Sodic Haplocambid. The vegetation for this soil hole was a MSC with dominate Juniper on a steep 40% slope.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Clay Loam	2.5Y 4/2	1 f Granular	5% Stones & Cobbles	None	Estr
Bw	3-6	Clay Loam	2.5Y 4/2	1m SAB	>1%	10% Lime	Ev
C1	6-20	Clay loam	2.5Y 5/4	Massive	>1%	30% Lime	Ev
C2	20-40	Clay Loam	2.5Y 4/2	Massive	>1%	5% Lime	Estr

Pedon 74: Sodic Haplocambid. The vegetation at this soil hole was a MSC with Sagebrush, Greasewood, and Juniper on a 20% slope.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Clay	2.5Y 4/4	1f Granular	>1%	None	Esl
B	2-8	Clay	2.5Y 4/2	3 m SAB	>1%	30% Lime	Estr
C1	8-20	Clay Loam	2.5Y 4/4	Massive	>1%	40% Gyp	Esl
C2	20-42	Clay	2.5Y 4/2	Massive	>1%	None	Eo

Map Unit 22B-2: (Lithic Haplocambids), 0 - 15 percent slopes, soils described are on all three Formations (Frontier, Mowry, and Thermopolis Shale) as noted in the pedon description.

Pedon 3: Lithic Haplocambid. This soil was described on a 10 % slope with big sagebrush and Juniper on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Silty Clay	2.5Y 4/2	1 f Granular	None	None	Eo
Bw	1-12	Clay Loam	2.5Y 5/2	3 m SAB-PRIS	>5%	>1% Gyp	Eo
C	12-17	Clay	2.5Y 4/2	Massive	None	None	Eo
R	17+	Clay					

Pedon 5: Lithic Haplocambid. This soil was described on a 15 % slope with Big Sagebrush and Juniper on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay Loam	2.5Y 4/2	1 f Granular	80% Chan	None	Eo
B	1-6	Clay Loam	2.5Y 3/2	2 m SAB	None	None	Eo

Pedon 6: Lithic Haplocambid. This soil was described on a 12 % slope in a sparse vegetative area with MSC and Junipers on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 3/2	1 f Granular	20% Grav	None	Eo
Bw	1-3	Clay	2.5Y 3/2	2 m SAB	None	None	Eo
C	3-6	Clay	2.5Y 3/2	Massive	None	None	Eo
R	6+	Black Shale					

Pedon 21: Lithic Haplocambid. This soil was described on a 10 % slope with big sagebrush and Juniper on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Sandy Loam	2.5Y 4/4	1 f Granular	<1%	None	Esl
Bw1	1-10	Sandy Loam	2.5Y 4/4	3 c AB-PRIS	<1%	None	Eo
Bw2	10-18	Sandy Loam	2.5Y 4/4	3 c AB-PRIS	<1%	5% Lime	Ev
Ck	18-24	Sandy Loam	2.5Y 5/4	Massive	<1%	40% Lime	Ev
Cr	24+	Soft Sandstone		Massive	<1%		

Pedon 22: Lithic Haplocambid. This soil was described on a 10 % slope in a MSC with Juniper on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Sandy Clay Loam	2.5Y 5/2	1 f Granular	<1%	None	Eo
Bw	2-10	Clay	2.5Y 4/4	3 m AB	<1%	5% Gyp	Eo
C	10-21	Sandy Clay	2.5Y 4/4	Massive	<1%	15% Gyp	Eo
R	21+						

Pedon 24: Lithic Haplocambid. This soil was described on a 10 % slope in a MSC with big sagebrush on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Clay	2.5Y 4/4	1 f Granular	<1% Chan	None	Eo
Bw	3-11	Clay Loam	2.5Y 4/4	2 m SAB	<1%	15% Lime	Estr
C1	11-22	Clay Loam	2.5Y 4/4	Massive	5% Stone	15% Lime	Estr
C2	22-40	Clay Loam	2.5Y 4/4	Massive	<1% Chan	15% Lime	Estr

Pedon 26: Lithic Haplocambid. This soil was described on a 15 % slope in a MSC with big sagebrush and cheatgrass on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
Bw1	0-5	Clay	2.5Y 4/2	¼" crust over 3 m-c SAB	<1%	5% Gyp & Lime	Eo
Bw2	5-11	Clay	2.5Y 4/2	3 c-vc PRIS-SAB	<1%	None	Eo
C	11-24	Clay	2.5Y 3/2	Massive	<1%	None	Eo

Pedon 32: Lithic Haplocambid. This soil was described on a 3 % slope in a sparse vegetation cover with Junipers on the with Gardner saltbush on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
Bw	0-2	Clay Loam	2.5Y 4/2	2 f AB	10% Chan	None	Eo
R	2-6	Fractured Shale					

Pedon 33: Lithic Haplocambid. This soil was described on a 5 % slope with big sagebrush and Juniper on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Sandy Clay Loam	2.5Y 4/4	1 f Granular	2%	None	Eo
Bw	1-8	Sandy Clay Loam	2.5Y 4/4	3 m SAB	1%	None	Eo
C	8-14	Clay	2.5Y 4/4	Massive	None	3% Lime	Esl
Cr	14+	Peay Sandstone					

Pedon 36: Lithic Haplocambid. This soil was described on a 5 % slope with Rubber Rabbitbrush on the Thermopolis shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 4/2	1 f Granular	>1%	None	Eo
Bw	1-6	Clay	2.5Y 4/2	3 m SAB	>1%	None	Eo
Cr	6-11+	Black Shale	2.5Y 3/2	Massive	>1%	None	Eo

Pedon 50: Lithic Haplocambid. This soil was described on a 5 % slope with big sagebrush in a MSC on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Sandy Loam	2.5Y 4/2	2 f PLAT	>1%	None	Eo
Bw	3-11	Sandy Clay Loam	2.5Y 4/2	3 m AB	>1%	10% Lime	Estr
C	11-20	Sandy Clay Loam	2.5Y 4/2	Massive	>1%	None	Estr
Cr	20+	Soft sandstone					

Map Unit 22D-3: (Lithic Haplocambids), 26 - 40 percent slopes, soils described are on the Mowry formation.

Pedon 43: Lithic Haplocambid. This soil was described on a 40 % slope with Junipers in an MSC on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay Loam	2.5Y 5/2	1 f Granular	20%	None	Eo
Bw	1-5	Clay	2.5Y 5/2	3 f-m SAB	>1%	None	Eo
Cy	5-9	Sandy Clay	2.5Y 6/2	Massive	>1%	60% Gyp	Eo
C	9-16	Sandy Clay	2.5Y 5/4	Massive	None	15% Gyp	Eo
R	16+	Peay sandstone					

Map Unit 22F-1: (Lithic Haplocambids), 40 - 50 percent slopes, soils described are on the Thermopolis Shale formation.

Pedon 81: Lithic Haplocambid. This soil was described on a 45 % slope with sparse Junipers in an MSC on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Silty Clay	2.5Y 3/2	1 f Granular	>1%	None	Eo
B	2-17	Clay	2.5Y 3/2	3 m-c PRIS-SAB	>1%	40% Gyp	Eo
C	17+	Bentonite					Eo

Map Unit 24B-3: (Typic Haplocambids), 0 - 15 percent slopes, soils described are on the Frontier and Mowry formation.

Pedon 2: Typic Haplocambid. This soil was described on a 5% slope in a MSC with big sagebrush on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay Loam	2.5Y 4/2	1 f Granular	<1%	None	Eo
Bw	1-13	Clay Loam	2.5Y 3/2	3 m SAB	<1%	5% Gyp	Eo
C1	13-20	Sandy Clay Loam	2.5Y 4/4	Massive	5% Grav	None	Eo
C2	20-47	Clay Loam	2.5Y 5/2	Massive	<1%	None	Eo

Pedon 10: Typic Haplocambid. This soil was described on a 10 % slope with MSC vegetation on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Clay	2.5Y 4/2	1 f Granular	5%	None	Eo
B1	3-12	Clay	2.5Y 4/2	3 m AB-PRIS	2% Chan	None	Eo
B2	12-18	Clay	2.5Y 3/2	3 m SAB	2%	None	Esl
Cy	18-33	Clay	2.5Y 4/2	Massive	5%	50% Gyp	Eo

Pedon 11: Typic Haplocambid. This soil was described on a 5 % slope in a MSC vegetation unit on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Clay Loam	2.5Y 4/2	1 f Granular	15% Chan	none	Eo
Bw	2-8	Clay Loam	2.5Y 4/2	1 m AB	5% Chan	None	Eo
C1	8-13	Clay Loam	2.5Y 4/2	Massive	2% Chan	None	Eo
C2	13-32	Clay Loam	2.5Y 4/2	Massive	3% Chan	None	Eo
C3	32-48	Clay Loam	2.5Y 4/2	Massive	>1%	None	Eo

Pedon 28/29: Typic Haplocambid. This soil was described on a 5 % slope with MSC and Big Sagebrush on the Frontier and Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Clay	2.5Y 4/2	1/8" crust over 1 f Granular	2%	None	Eo
Bw	3-13	Clay	2.5Y 5/2	2 m SAB	None	None	Estr
C1	13-28	Clay	2.5Y 4/2	Massive	None	4" of Gyp	Eo
C2	28-34	Clay	2.5Y 4/2	Massive	None	None	Esl

Pedon 34: Typic Haplocambid. This soil was described on a 15 % slope in an MSC unit on the Mowry Formation.

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Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 4/2	1 f Granular	5% Chan	None	Eo
B	1-11	Silty Clay	2.5Y 4/2	3 m SAB	>1% Chan	3% Lime	Esl
C	11-17	Sandy Clay Loam	2.5Y 3/2	Massive	40% Chan	None	Eo
Cr	17+						

Pedon 55: Typic Haplocambid. This soil was described on a gentle 5% slope in an MSC with big sagebrush one the Frontier Formation.

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Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
Bw1	0-7	Sandy Loam	2.5Y 4/2	3 f-m SAB	>1%	None	Eo
Bw2	7-11	Sandy Loam	2.5Y 4/2	2 m SAB	>1%	None	Eo
C1	11-15	Sandy Loam	2.5Y 4/2	Massive	>1%	2% Lime	Eo
C2	15-30	Sandy Loam	2.5Y 4/2	Massive	>1%	2% Gyp	Eo
C3	30-40	Sandy Loam	2.5Y 4/2	Massive	>1%	1% Gyp	Eo

Pedon 56: Typic Haplocambid. This soil was described on a 10 % slope in an MSC unit with Rubber Rabbitbrush and Sagebrush on the Frontier Formation.

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Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
Bw	0-7	Clay	2.5Y 3/2	2 m-c SAB	>1%	None	Eo
C	7-16	Clay	10YR 3/3	Massive	50% Shale	None	Eo

Pedon 60: Typic Haplocambid. This soil was described on a 15 % slope with big sagebrush and Gardner saltbush on the Mowry Formation.

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Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Loamy Sand	2.5Y 4/2	1 f Granular	None	None	Eo
Bw1	2-8	Loamy Sand	2.5Y 4/2	3 m AB	None	None	Eo
Bw2	8-14	Loamy Sand	2.5Y 4/2	3 m SAB	None	None	Eo
C	14-18	Sandy Clay Loam	2.5Y 4/2	Massive	None	None	Eo

Pedon 63: Typic Haplocambid. This soil was described on a 15 % slope with and Gardner saltbush on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Silty Clay	2.5Y 4/4	1 f Granular	>1%	None	Esl
Bw	2-12	Clay	2.5Y 4/4	3 m-vc SAB-PRIS	>1%	None	Estr
C	12-23	Clay	2.5Y 4/2	Massive	>1%	5% Gyp	Eo

Pedon 79/80: Typic Haplocambid. This soil was described on a 5 % slope with big sagebrush in a MSC on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Sandy Loam	2.5Y 4/4	1 w Granular	>1%	None	Eo
B1	2-7	Sandy Loam	2.5Y 4/4	1 m PLAT	>1%	None	Eo
B2	7-12	Sandy Clay Loam	2/5Y 4/3	2 m-c SAB	>1%	None	Eo
C1	12-28	Clay loam	2.5Y 4/2	Massive - PLAT	>1%	20% Lime	Ev
C2	28-41	Sandy Clay Loam	2.5Y 5/2	Massive	>1%	None	Eo

Map Unit 24C-3: (Typic Haplocambids), 15 - 20 percent slopes, soils described are on the Frontier and Mowry formation.

Pedon 20: Typic Haplocambid. This soil was described on a 20% slope in a Juniper dominated MSC on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5 Y 4/2	1 f Granular	>1%	None	Eo
Bw1	1-7	Clay	2.5Y 5/2	3 m PRIS	>1%	None	Eo
Bw2	7-11	Clay	2.5Y 4/2	2 m SAB	>1%	10% Gyp	Eo
Cy	11-18	Clay	2.5Y 4/2	Massive	>1%	30% Gyp	Eo

Pedon 77: Typic Haplocambid. This soil was described on a 20 % slope in a big sagebrush dominated MSC on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Silty Clay Loam	2.5Y 3/2	1 f Granular	5% Chan	None	Eo
Bw	2-12	Clay	2.5Y 4/2	3 m SAB-PRIS	5%	None	Eo
C	12-17	Clay	2/5Y 4/2	Massive	5% Chan	None	Eo

Map Unit 24F-2: (Typic Haplocambids), 40 - 65 percent slopes, soils described are on the Frontier and Mowry formation.

Pedon 40: Typic Haplocambid. This soil was described on a steep 40% slope with sparse vegetation of Juniper and sagebrush on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 4/4	1 f Granular	None	None	Eo
Bw	1-7	Clay	2.5Y 4/4	1 m SAB	None	None	Eo
C	7-12	Clay	2.5Y 5/4	Massive	None	60% Lime	Ev
R	12+	Black Shale					

Pedon 78: Typic Haplocambid. This soil was described on a steep 40% slope with sparse vegetation of Juniper and sagebrush on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Sandy Clay Loam	2.5Y 4/2	1 f Granular	>1%	None	Eo
Bw	1-10	Sandy Clay Loam	2.5Y 4/4	3 m SAB-PRIS	>1%	None	Eo
C1	10-18	Clay loam	2.5Y 5/4	Massive	>1%	5% Gyp	Eo
C2	18–30	Clay loam	2.5Y 4/4	Massive	20% Shale	None	Eo
C3	30-42	Clay Loam	2.5Y 4/4	Massive	30% Shale	None	Eo

Map Unit 26B-3: (Typic Haplocalcids), 6 - 25 percent slopes, soils described on the Mowry formation.

Pedon 4: Typic Haplocalcids. This soil was described on a 7 % slope in an MSC community on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1/2	Sandy Clay Loam	2.5Y 5/4	1 f Granular	10%		Estr
Bk	1/2-6	Sandy Clay Loam	2.5Y 4/2	2 m SAB	5% Stone	10% Lime	Ev
Ck	6-17	Clay	2.5Y 4/2	Massive	None	40% Lime	Ev

Map Unit 42B-1: (Clayey Lithic Torriorthent), 0-15 percent slopes, soils described on the Mowry and Thermopolis Shale formations.

Pedon 7: Clayey Lithic Torriorthent. This soil was described on a 5 % slope in a Rubber rabbitbrush and wild buckwheat on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 5/4	1 f Granular	50% Chan	None	Eo
R	1+	Shale Stone			90% Fractured		

Pedon 9: Clayey Lithic Torriorthent. This soil was described on a 5 % slope in big sagebrush with Juniper vegetation unit on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Silty Clay	2.5Y 3/2	1 f Granular	15% Chan	None	Eo
Cr	2-9	Silty Clay			60% Chips		

Pedon 19: Clayey Lithic Torriorthent. This soil was described on a 10% slope in big sagebrush and Juniper vegetation unit on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Silty Clay	2.5Y 4/2	1 f Granular	<1%	None	Eo
Cr	1-10	Shale Chips					

Pedon 30: Clayey Lithic Torriorthent. This soil was described on a 2 % slope in a sparse big sagebrush on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Clay Loam	2.5Y 4/2	1 f Granular	5%	None	Eo
R	2+	Shale rock					

Map Unit 42C-1: (Clayey Lithic Torriorthent), 16-25 percent slopes, soils described on the Mowry and Thermopolis Shale formations.

Pedon 15: Clayey Lithic Torriorthent. This soil was described on a 20 % slope in a big sagebrush and Juniper area on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Clay	2.5Y 4/2	1 f Granular	10%	None	Eo
R	3+	Shale Chips					

Pedon 31: Clayey Lithic Torriorthent. This soil was described on a 20 % slope in a Juniper dominate area on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Clay	2.5Y 4/2	1 f Granular	5%	None	Eo
R	3-7	Shale Chips					Esl

Pedon 42: Clayey Lithic Torriorthent. This soil was described on a 20% slope in a Juniper dominate area on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 3/0	1 f Granular	10%	None	Eo
R	1+	Shale Chips					

Pedon 61: Clayey Lithic Torriorthent. This soil was described on a 20% slope in a Rubber rabbitbrush dominate area on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 3/2	1 f Granular	20%	None	Eo
R	1+	Shale					Eo

Map Unit 42D-1: (Clayey Lithic Torriorthent), 26-40 percent slopes, soils described on the Mowry and Thermopolis Shale formations.

Pedon 8: Clayey Lithic Torriorthent. This soil was described on a 30% slope in a Juniper, big sagebrush, and Rubber rabbitbrush area on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Clay Loam	2.5Y 4/2	1 f Granular – 1 f SAB	20% Chan	None	Eo
R	2-9	Shale Channers			90% weathered		Eo

Pedon 13: Clayey Lithic Torriorthent. This soil was described on a 30 % slope in a MSC area dominate with big sagebrush the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Clay	2.5Y 5/2	1 f Granular – 1 f SAB	30% Chan	None	Eo
R	2+	Shale Stone			90% Fractured		

Pedon 14: Clayey Lithic Torriorthent. This soil was described on a 30 % slope in a Juniper and big sagebrush area on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Clay	2.5Y 4/2	1 f Granular	40%	None	Eo
R	3+	Shale Stone			90% Fractured		

Pedon 39: Clayey Lithic Torriorthent. This soil was described on a 40% slope in a Juniper and big sagebrush area on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Clay	2.5Y 3/2	1 f Granular	15% Chan	None	Eo
R	2+	Shale Stone					

Pedon 65: Clayey Lithic Torriorthent. This soil was described on a 30% slope in a sparse Juniper and big sagebrush area on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Silty Clay	2.5Y 3/2	1 f Granular	10% Chan	None	Eo
R	2+	Shale Chips					

Pedon 66: Clayey Lithic Torriorthent. This soil was described on a 35 % slope in a Juniper area on the Thermopolis Shale formation. This soil sample has some structure in the B horizon but it is surrounded by Clayey Lithic Torriorthent 37 feet southwest and 50 feet northeast of this sample . This area will not be disturbed with the current mine plan.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay	2.5Y 4/2	1 f Granular	5% Chan	None	Eo
Bw	1-7	Clay	2.5Y 4/2	3 f-c SAB	>1%	5% Gyp	Eo
C	7-13	Silty Clay	2.5Y 5/2	Massive	>1%	None	Eo
R	13+	Shale Stone					

Pedon 67: Clayey Lithic Torriorthent. This soil was described on a 20 % slope in a sparse Juniper area on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Clay	2.5Y 4/2	1 f Granular	10% Chan	None	Eo
R	1+	Shale			Fractured Channers		

Pedon 69: Clayey Lithic Torriorthent. This soil was described on a 40% slope in a MSC with big sagebrush and Juniper area on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-6	Clay Loam	2.5Y 4/2	1 f SAB	5% Gravel	None	Esl
R	6+	Sandstone			Fractured		

Map Unit 42F-1: (Clayey Lithic Torriorthent), 41-65 percent slopes, soils described on the Thermopolis Shale formations.

Pedon 71: Clayey Lithic Torriorthent. This soil was described on a 45 % slope in a MSC with big sagebrush and Juniper on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay Loam	2.5Y 4/2	1 f Granular	>1%	None	Estr
C1	1-6	Clay	2.5Y 4/2	1 m SAB	>1%	15% Lime	Estr
C2	6-18	Clay	2.5Y 4/2	Massive	>1%	15% Lime	Estr
C3	18-24	Bentonite Stringer					Eo

Pedon 72: Clayey Lithic Torriorthent. This soil was described on a 65% slope in a MSC with Rubber rabbitbrush, big sagebrush, and Juniper on the Thermopolis Shale formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-2	Silty Clay	2.5Y 3/2	1 f Granular	10% Chan	None	Eo
Cr	2-15	Clay Loam	2.5Y 3/2	Massive	60% Sandstone	None	Eo

Map Unit 44B-1: (Loamy Lithic Torriorthent), 0 - 15 percent slopes, soils described on the Frontier formation.

Pedon 1: Loamy Lithic Torriorthent. This soil was described on a 10% slope in a MSC on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Sandy Loam	2.5Y 6/4	1 f Granular	<1%	None	Eo
C1	1-12	Sandy Loam	2.5Y 5/4	Massive	10% Gravel	None	Esl

Pedon 44: Loamy Lithic Torriorthent. This soil was described on a 10 % slope with Junipers in a MSC vegetation unit on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-4	Sandy clay loam	2.5Y 5/2	1 f Granular	<1%	none	Estr
Cr	4-16	Sandy clay loam	2.5Y 5/3	Massive	50% soft Sandstone	10% Lime	Estr

Pedon 52: Loamy Lithic Torriorthent. This soil was described on a 2% slope in an area that is dominated with Greasewood and annuals on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-1	Clay Loam	2.5Y 4/2	1 f Granular	5% Shale Chips	None	Eo
C1	1-9	Clay Loam	2.5Y 3/2	Massive	None	None	Eo
C2	9-17	Loam	2.5Y 4/2	Massive	None	None	Eo

Pedon 57: Loamy Lithic Torriorthent. This soil was described on a 5 % slope with Rubber Rabbitbrush in a MSC vegetation unit on the Frontier formation. The soil samples are acidic.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Clay loam	2.5 Y 4/2	1 f Granular	1%	None	Eo
R	3-10	Fracture Shale		Massive			Eo

Pedon 58: Loamy Lithic Torriorthent. This soil was described on a 10% slope in a cheatgrass infested area on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-5	Loamy Sand	2.5Y 4/2	1 f Granular	0%	none	Eo
R	5+	Sandstone Bedrock					

Map Unit 46B-3: (Typic Torriorthent), 0- 15 percent slopes described on the Frontier formation.

Pedon 12: Typic Torriorthent. This soil was described on a 15 % slope in a MSC dominated with big Sagebrush on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A1	0-2	Clay Loam	2.5Y 5/2	1 f Granular	<1%	None	Estr
C1	2-10	Sandy Clay Loam	2.5Y 5/2	Massive	None	20% Lime & Gyp	Esl
C2	10-19	Sandy Clay Loam	2.5Y 5/2	Massive	None	10% Lime & Gyp	Esl
C3	19-36	Clay Loam	2.5Y 4/4	Massive	None	None	Estr
C4	36-50	Clay Loam	2.5Y 4/4	Massive	None		Estr

Pedon 47: Typic Torriorthent. This soil was described on a 5% slope in a MSC dominated with big sagebrush on the Frontier formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-3	Sandy Loam	2.5Y 3/2	1 f Granular	<1%	None	Eo
C1	3-9	Sandy Clay Loam	2.5Y 3/2	Massive	<1%	None	Eo
C2	9-18	Sandy Loam	2.5Y 4/2	Massive	<1%	None	Eo
C3	18-36	Sandy Clay Loam	2.5Y 4/4	Massive	<1%	3% Lime	Estr
C4	36-50	Sandy Clay Loam	2.5Y 4/2	Massive	<1%	None	Esl

Map Unit 48C-2: (Lithic Torripsamments), 16-25 percent slopes, soils described on the Mowry formation.

Pedon 59: Lithic Torripsamments. This soil was described on a 25% slope in a sparse Juniper annual grass area on the Mowry formation.

Horizon	Depth (in)	Texture	Color	Structure	Coarse Fragments (%)	Visible Salts	Reaction to 10% HCl
A	0-6	Sand	2.5Y 5/2	1 f Granular	>1%	None	Eo
R	6-10+	Sandstone					Eo

APPENDIX D-7.2

SOIL LABORATORY RESULTS

D-8. Vegetation

METHODS

Matthew Call and Joe Sylvester of Wyo-Ben, Inc performed vegetation community mapping for this proposal in the summer of 2011. Map unit boundaries were identified and mapped in the field on scaled aerial photographs and then transferred into electronic format (Vegetation Maps 1, 2, & 3). Four vegetation map units and one bare map unit were identified and described in the study area, and species lists for each unit were developed (Table D-8.2).

Numerical cover data were estimated using the line transects sample method applied as outlined in WDEQ/LQD Guideline 2, Vegetation. Each map unit was sampled using an extended reference area concept as described in Guideline 2. Line transect starting locations were randomly selected by overlaying the rectified aerial photographs with a numbered grid system and utilizing a random number generator (www.random.org/nform.html). The aerial was then used in the field to locate actual transect starting points. Transect directions were randomly determined by spinning a ballpoint pen. Each transect was conducted by stretching a 50 meter tape in a straight line, then walking down the left side of the tape and dropping a sharpened rod at one meter intervals (50 observations per transect). Only the first hit of the rod was recorded. However, if the transect path encountered large barren outcrops, the path of a previously measured transect, the disturbance boundary, or another map unit, a new random direction was determined by spinning the pen. Separate cover values were calculated for vegetation, rock, litter, and bare ground for each transect using the following equation:

$$\% \text{ cover} = \frac{\text{total \# of parameters hit per transect}}{\text{50 (total possible hits per transect)}} * 100$$

Sample adequacy (or a maximum number of transects as described in Guideline 2) was achieved in each map unit of the proposed extended reference area as defined by the formula recommended in Guideline 2. Average vegetation cover values were calculated for each map unit. These data summaries and the vegetation field data sheets are presented in Appendix D-8.1 and Appendix D-8.2 respectively.

Shrub density belt transects were also conducted by counting each shrub and subshrub rooted within one (1) meter of the right side of the 50 meter long tape on each transect. The data is summarized in Appendix D-8.3.

Representative vegetation map unit photographs are presented for each proposed pit area (Appendix D-8.4 on disk included in the binder). Photograph locations are illustrated on Vegetation Maps 1, 2, & 3, there are two picture at each location in opposite directions for example Ten Claims Veg Pic 001 NW and Ten Claims Veg Pic 001 SE.

Site Description

The area included with this application consists of five proposed pits located 1.5 miles west of Ten Sleep, Wyoming. The proposed pits are located in the 10 to 14 inch precipitation zone (USDA-SCS, January, 1982). The average annual air temperature is

48° degrees Fahrenheit. The growing season for cool season species is approximately April 15 to June 30.

Three of the proposed pit areas occupy the Frontier Formation geologic formation and are the F2 (Pit Ten 1), F3 (Pit Ten 2), and Beaver (Pit Ten 3). Proposed pits of the Mowry Shale geologic formation include the Mowry A (Pit Ten 4) and Mowry B (Pit Ten 5).

Topography across the study area is characterized by both gentle toeslopes cut by ephemeral drainages, and steep sideslopes. Native soils are mostly residual, thin, fine textured, and salt-affected with some areas of outcropping shale, sandstone, and bentonitic clays. Soils along drainages are deeper, and coarser textured. The proposed disturbance areas will affect vegetation map units variously dominated and/or codominated by Utah Juniper (*Juniperus osteosperma*), Big Sagebrush (*Artemisia tridentata*), Rubber Rabbitbrush (*Chrysothamnus nauseous*), Greasewood (*Sarcobatus vermiculatus*), and annual grasses including Cheatgrass (*Bromus tectorum*) and Annual Wheatgrass (*Agropyron tritceum*). Barren outcrops also occur throughout the proposed disturbance area.

Based on a list of Primary Selenium Indicator Plant Species found in DEQ/LQD Guideline 2, Appendix III, only one selenium indicator species was identified during the vegetation mapping of the Ten Claims New Permit. Woody Aster, (*Xylorhiza galbriuscula*), was identified during mapping in all vegetation mapping units.

The list of Prohibited and Noxious Weeds, located in the DEQ/LQD Guideline2, Appendix I, was reviewed, and it was determined that there were none identified during the field work. Yearly monitoring of the proposed disturbance area for noxious weeds will occur. If any are found, Wyo-Ben will contract Washakie County Weed and Pest (or a licensed herbicide applicator contractor) for treatment of those noxious species after receiving permission from the BLM.

Proposed disturbance acreages for each vegetation map unit are summarized by pit in Table D-8.1.

Table D-8.1. Vegetation Map Units; Affected Acreages

MAP UNIT	Ten 1 (F2)	Ten 2 (F3)	Ten 3 (Beaver)	Ten 4 (Mowry A)	Ten 5 (Mowry B)	COP/TOP HW & SOIL PILES	Total By Map unit
Juniper	3.2	7.7	13.4	15.0	12.3	3.1	**54.7**
Mixed Shrub Complex (MSC)	25.3	7.3	27.6	14.9	11.9	13.4	**100.4**
Barren Outcrop	0.7	0.4	1.2	22.5	0.1	2.4	**27.3**
Steep Complex	25.8	1.5	1.9	2.5	1.1	2.4	**35.2**
Greasewood/Annual Grasses	0.8	3.7	5.8	1.2	0.5	2.7	**14.7**
Totals	**55.8**	**20.6**	**49.9**	**56.1**	**25.9**	**24.0**	**232.3**

MAP UNIT DESCRIPTIONS

Juniper (Map Unit 1)

This map unit generally occurs on shallow, varied soils in the Mowry geologic formation associated with this proposal. This unit is associated with bentonitic shale outcrops and, in some areas, littered with small to medium sized stones. Terrain is variable, ranging from 0 to 60 percent on varied aspects. The primary vegetation for this map unit is Utah Juniper trees with varied understories. In areas with better soil qualities the primary understory shrub is Wyoming big sagebrush and in areas of lesser soil quality the primary understory shrub is sparse dwarfed Wyoming big sagebrush. At the top of the map unit there is a band of Rubber rabbit brush as the dominate shrub. The grasses include Bluebunch Wheatgrass and Cheatgrass. Several photographs included in Appendix D-8.4 illustrate different aspects of this vegetation map unit.

Mixed Shrub Complex (MSC) (Map Unit 2)

This map unit occurs across all geologic formations associated with this proposal, and contains a variety of soils, topographic aspects and slopes ranging from 0 – 50 degrees. Vegetation dominance within this map unit ranges dramatically reflecting the diversity. In general, this map unit is dominated by Wyoming big sagebrush with about 20% Utah Juniper. All of which occur either alone or in various combinations of abundance and dominance throughout the map unit. Other locally occurring shrubs/subshrubs within this map unit include Gardner saltbush, Rubber rabbitbrush, and Prickly gillia.

Occasional areas of perennial grass include Blue Gramma, Needle and Thread, Sandberg bluegrass, Red threeawn, Indian Rice Grass and cheatgrass. Cheatgrass

drastically increases in areas where shrub density is very low. Other common understory species include prickly pear cactus, Sego lily, and Prairie pepperweed.

Numerous photographs of these groups illustrate various visual aspects of each within both the proposed disturbed areas and the reference areas in Appendix D-8.4.

MSC Mowry

The MSC Mowry map unit is very similar to the MSC Complex described above with the exception that there is a lot more Rubber rabbitbrush present on the higher elevations of the Mowry formation.

MSC Frontier

On the Frontier beds in steep uplift areas, the shrub dominance decreases and the grass abundance increases on the north facing slopes and Juniper abundance increase on south facing slopes.

Barren Outcrop (Map Unit 3)

This map unit consists of areas mostly devoid of vegetation establishment with small intermittent inclusions of wild buckwheat. Occasional crosscutting drainages bisect the bare outcrop supporting small areas of increased vegetation in the drainages. Soils tend to be mostly salt and sodic affected clay. Slopes are variable, ranging between 0 and 40 percent with varied aspects.

Steep Complex (Map Unit 4)

This map unit generally occurs on shallow, varied soils on the Frontier and Mowry geologic formation associated with this proposal. This unit is associated with steep bentonitic shale outcrops. Terrain is steep with slopes ranging from 30 - 60 degrees with varied aspects. This complex is a barren area with sparse vegetation influence from the surrounding features including Mixed Shrub Complex with Wyoming big sagebrush and Rubber rabbitbrush. Several photographs included in Appendix D-8.4 illustrate different aspects of this vegetation map unit.

Greasewood/ Annual Grasses (Map Unit 5)

This map unit occurs across all geologic formations associated with this proposal, and contains a variety of soils, topographic aspects and slopes (0 – 50 degrees).
It occurs mainly in the flood plains of the base drainages that bisect the project with primary vegetation of Greasewood, annual grass, and forbs such as Cheatgrass and Prairie pepperweed. There is occurrence of this unit on the toe of the Thermopolis Shale and Frontier formation. Where perennial grasses occur it is mostly Western Wheatgrass and Sand Dropseed. Clasping pepperweed is a common forb for this unit as well as annual wheatgrass.

Threatened or Endangered Plant Species

In reviewing the U.S. Fish and Wildlife Service (FWS) website at www.fws.gov for threatened and endangered plants, it indicates the possible occurrence of Ute ladies'-tresses (*Spiranthes diluvialis*) in Washakie County, a threatened Orhchidaceae species in

the Big Horn Basin. This herbaceous plant occurs in moist meadows associated with wetlands, springs, lakes, or perennial streams.

This species was not encountered during vegetation sampling or species inventory fieldwork. In order to identify potential encounters of this species, Wyo-Ben's field staff has been instructed on the identification and characteristics of the plant. Furthermore, Wyo-Ben does not anticipate mining through these environments and thus will most likely not encounter this species. Wyo-Ben personnel will contact the FWS and take measures to protect this species should it be encountered during mining activities.

The other species on the FWS website are not located in the Big Horn Basin, the locality of these species have been located in the southern part of Wyoming. Those species include threatened species Butterfly plant, Colorado (*Gaura neomexicana var. coloradensis*), Yellowhead, desert (*Yermo xanthocephalus*), and endangered Penstemon, blowout (*Penstemon haydenii*).

Table D-8.2 VEGETATION SPECIES LIST (Ten Claims New Permit).
(Four letter code follows species name in bold)

Scientific name		Common Name	Four Letter Code				
Genus	Species			Juniper	MSC	Save/Annual	Steep Complex
		ANNUAL FORBS					
Alyssum	*alyssoides*	Pale madwort	**Alal**				X
Arabis	*holboellii*	Holboell Rockcress	**Arho**	X	X		X
Atriplex	*argentea*	Silverscale Saltbush	**Atar**			X	
Atriplex	*dioica*	Dioica	**Atdi**				X
Chenopodium	*album*	Goosefoot	**Chal**	X			
Descurainia	*richardsonii*	Richardson Tanseymustard	**Deri**	X	X	X	
Euphorbia	*serpyllifolia*	Thymeleaf Spurge	**Euse**			X	
Gilia	*leptomeria*	Sand Gilia	**Gile**	X			
Halogeton	*glomeratus*	Halogeton	**Hagl**	X	X	X	
Lappula	*redowskii*	Western Stickweed	**Lare**	X	X		
Lepidium	*Densiflorum*	Prairie Pepperweed	**Lede**	X	X	X	
Lepidium	*Perfoliatum*	Clasping Pepperweed	**Lepe**		X	X	X
Machaeranthera	*canescens*	Hoary Tansyaster	**Maca**		X	X	X
Mentzelia	*albicaulis*	Whitestem Blazing Star	**Meal**	X			
Monolepis	*nutelliana*	Poverty Weed	**Monu**			X	
Plantago	*patagonica*	Wooly Plantain	**Plpa**			X	
Salsola	*kali*	Russian Thistle	**Saka**			X	
Sisymbrium	*altissimum*	Tumble mustard	**Sial**		X	X	
		PERENNIAL FORBS					
Allium	*textile*	Textile Onion	**Alte**		X		
Astragalus	*chamaeleuce*	Cicada milkvetch	**Asch**	X	X		
Calochortus	*nuttallii*	Sego Lily	**Canu**		X		
Cryptantha	*celosioides*	Miner's Candle	**Crce**	X			
Erigeron	*canus*	Hoary fleabane	**Erca**	X			
Eriogonum	*brevicaule*	Short Stem Wild Buckwheat	**Erbr**	X			X
Lomatium	*orientale*	Northern Idaho Biscuitroot	**Loor**	X	X		
Melilotus	*officinalis*	Yellow Sweetclover	**Meof**				X
Penstemon	*nititus*	Waxleaf Penstemon	**Peni**	X			X
Penstemon		Unknown Penstemon					X
Phlox	*hoodii*	Spiny Phlox	**Phho**	X	X		X
Platyschkuhria	*integrifolia*	Platyschkuhria	**Plin**	X			X
Sphaerophysa	*salsula*	Swainsonpea	**Spsa**	X			X
Vicia	*americana*	American Vetch	**Viam**	X	X	X	
Xylorhiza	*glabriuscula*	Woody Aster	**Xygl**	X	X	X	X
		ANNUAL GRASSES					
Bromus	*tectorum*	Cheat Grass	**Brte**	X	X	X	X
Bromus	*japonicus*	Japanesse Brome	**Brja**				X

Eremopyrum	*triticeum*	Annual Wheatgrass	**Ertr**			X	X
		PERENNIAL GRASSES					
Agropyron	*smithii*	Western Wheatgrass	**Agsm**		X	X	X
Agropyron	*spicatum*	Bluebunch Wheatgrass	**Agsp**	X	X	X	X
Agropyron	*species*	Species Wheatgrass	**Ag spp**		X		
Aristida	*longiseta*	Red Threeawn	**Arlo**	X	X		X
Bouteloua	*gracilis*	Blue Gramma Grass	**Bogr**	X	X	X	X
Oryzopsis	*hymenoides*	Indian Rice Grass	**Orhy**	X	X	X	
Poa	*sandbergii*	Sandberg Bluegrass	**Posa**	X	X	X	X
Sitanion	*hystrix*	Bottlebrush Squirreltail	**Sihy**	X	X	X	X
Sporobolus	*airoides*	Alkali Sacaton	**Spai**		X	X	
Sporobolus	*cryptandrus*	Sand Dropseed	**Spcr**			X	X
Stipa	*comata*	Needle and Thread Grass	**Stco**		X	X	
		SUBSHRUBS					
Artemisia	*spinescens*	Bud Sage	**Arsp**		X	X	
Atriplex	*gardneri*	Gardner's Saltbush	**Atga**		X	X	
Gutierrezia	*sarothrae*	Broom Snakeweed	**Gusa**	X			X
		SHRUBS					
Artemisia	*tridentata*	Wyoming Big Sage	**Artr**	X	X	X	X
Atriplex	*confertifolia*	Shadscale	**Atco**		X	X	X
Atriplex	*gardneri*	Gardner's Saltbush	**Atga**		X	X	
Chrysothamnus	*nauseosus*	Rubber Rabbitbrush	**Chna**	X	X	X	X
Chrysothamnus	*viscidiflorus*	Green Rabbitbrush	**Chvi**		X		
Leptodactylon	*Pungens*	Prickly-gilia	**Lepu**	X	X		
Rhus	*trilobata*	Skunkbush	**Rhtr**	X			
Sarcobatus	*vermiculatus*	Greasewood	**Save**		X	X	X
Yucca	*glauca*	Soapweed Yucca	**Yugl**				X
		SUCCULENTS					
Opuntia	*polycantha*	Prickly Pear	**Oppo**	X	X	X	X
		TREES					
Juniperus	*osteosperma*	Utah Juniper		X			X

Key to vegetation map unit codes

1) Juniper
2) Mixed Shrub Complex
3) Bare
4) Steep Complex
5) Save/Annual

Appendix D-8.1

VEGETATION SUMMARY TABLES

Ten Claims New Permit Area

Line Transect Data

Juniper Extended Reference Unit

STUDY AREA	% Veg Cover*	% Litter Cover	% Rock Cover	% Bare Ground	%Total Cover	Number of Samples (N)	Sample Adequacy (N Min) Veg Cover	Standard Deviation Veg Cover
DISTURBED	34.3	11.5	21.7	32.5	67.5	20	18.33	8.11

Mixed Shrub Complex (MSC) Extended Reference Unit

STUDY AREA	% Veg Cover*	% Litter Cover	% Rock Cover	% Bare Ground	%Total Cover	Number of Samples (N)	Sample Adequacy (N Min) Veg Cover	Standard Deviation Veg Cover
DISTURBED	47.5	17.9	3.8	30.8	69.2	20	10.82	8.636

Greasewood and Annuals Extended Reference Unit

STUDY AREA	% Veg Cover*	% Litter Cover	% Rock Cover	% Bare Ground	%Total Cover	Number of Samples (N)	Sample Adequacy (N Min) Veg Cover	Standard Deviation Veg Cover
DISTURBED	87.9	6.6	0.0	5.5	94.5	20	1.78	6.47

Steep Complex Extended Reference Unit

STUDY AREA	% Veg Cover*	% Litter Cover	% Rock Cover	% Bare Ground	%Total Cover	Number of Samples (N)	Sample Adequacy (N Min) Veg Cover	Standard Deviation Veg Cover
DISTURBED	13.3	5.3	37.8	43.6	56.4	11	12.31	2.57

* All percentages are mean values

Appendix D-8.2

VEGETATION FIELD DATA SHEETS

Ten Claims New Permit Area

Appendix D-8.3

SHRUB BELT TRANSECT DATA

SUMMARY TABLES

Ten Claims New Permit Area

Belt Transect Data

Species	Shrub Density for Juniper Unit (# individuals/M^2)	Shrub Density for Greasewood & Annuals Unit (# individuals/M^2)
Artr	0.376	0.099
Arsp	0.000	0.024
Juniper	0.084	0.000
Atga	0.055	0.000
Chna	0.051	0.001
Rhtr	0.004	0.000
Save	0.000	0.262
Lepu	0.047	0.000
Species	**Shrub Density for MSC (# individuals/M^2)**	**Shrub Density for Steep Complex Unit (# individuals/M^2)**
Atga	0.056	0.000
Artr	1.456	0.008
Arsp	0.012	0.000
Atco	0.007	0.025
Chvi	0.001	0.000
Chna	0.022	0.066
Save	0.008	0.012
Lepu	0.029	0.000

Appendix D-8.4

VEGETATION ASPECT PHOTOGRAPHS

PLEASE REFER TO ENCLOSED DISK OF PHOTOGRAPHS

D-9. Wildlife

The area associated with this proposal was evaluated for potential significant or critical/important wildlife habitat during site visits by Matt Call and Joseph Sylvester in 2012. This habitat information was sent to the United States Federal Fish and Wildlife Service (USFWS) and the Wyoming Game and Fish Department (WGFD) for review.

During wildlife surveys and other site visits to the Ten Claims New Permit area by Wyo-Ben personnel, pronghorn have been sighted on several occasions, Chuckar, Waterfowl, Ravens, Horny Toads, Horned Lark, and Pinion Jays but not mule deer. Wyo-Ben commits to stay current with reclamation of mine sites in order to reduce potential hardships to cattle, antelope and mule deer, and to reestablish habitat as climatic and soil conditions allow. We would anticipate other wildlife to include Lark Sparrow, Loggerhead Shrike, Rock Wren, Sage Sparrow, Says Phoebe, Western Meadowlark, Coyote, and Prairie Dogs.

Wyoming Game and Fish Department (WGFD)

The WGFD indicated possible concern for the overlap of Wyo-Ben's proposed mining on the F2 bed with the Sage Grouse Core Area and addressed several Aquatic Considerations for Wyo-Ben to consider (see Exhibit D-9.1).

The WGFD has concern for offsite sedimentation to waterways near the project area, specifically Nowood River. Wyo-Ben will agree to install check dams, where necessary in newly constructed drainages, and establish native vegetation communities in those reclaimed drainages to control sediment runoff in the waterways. All equipment will be serviced at least 300 feet from any riparian areas and streams (Little Cottonwood Creek). Wyo-Ben does not mine in an aquatic environment, so the concern of spreading aquatic invasive species (AIS) from one body of water to another is a not an appropriate mitigation. Wyo-Ben agrees to collect water from waterways that are free of AIS.

In regards to the Sage Grouse Core Area, Wyo-Ben has reviewed the DDCT boundary with Wyo-Ben's boundary and has verified that there is an overlap of the F2 bed with the Sage Grouse Core Area. Wyo-Ben personnel then visited that site to verify the habitat from the County Road (Old Ten Sleep Highway) north to the F2 Frontier bed. The habitat did not meet suitable habitat in our opinion, however we continued to do a pedestrian survey in the overlap area to verify sage grouse usage of the area by identifying sage grouse droppings. In our search we did not find any sage grouse droppings. On Monday August 5, 2013 Joe Sylvester (Wyo-Ben) met with Bart Kroger, Wildlife Biologist, of the Wyoming Game and Fish Department (WGFD) to review the habitat. In the wrap-up discussion, Bart stated that he was going to contact Mary Flanderka with the WFGD Habitat Protection Team to see if they would be able to exclude this area from the DDCT or if they could allow the mining without any Sage Grouse stipulations due to the lack of suitable habitat. After Bart Kroger (WGFD) visited with Mary Flanderka (WPT), Wyo-Ben was given the following options in a phone call conservation with Mary Flanderka:

1. Complete the DDCT process or
2. Do a Vegetation map for the area in question and submit to the DDCT team for review

Wyo-Ben will choose to do the latter and complete a detailed map of the proposed overlap area and the area that our haul road will use in the Sage Grouse Core Area. This has been completed and the Habitat Protection Team (HPT) has rejected the vegetation report since there was a map unit with greater than 5% sagebrush cover. Therefore, a DDCT report was completed by Wyo-Ben, finalized by Ted Igleheart (BLM Wildlife Specialist), and has been submitted to the DDCT team for review. Results from the DDCT are located at 73.1.

Specific Voluntary Sage Grouse Mitigations

Wyo-Ben will continue to mitigate potential impacts to the Sage Grouse birds in this proposed mining area by the following voluntary mining restrictions:

1) During the mating season, from March 15 through May 30, no mining or hauling activity will occur within ½ mile of a lek during the consecutive hours between 6:00 pm and 8:00 am to reduce impacts to mating birds due to audio and visual distractions.
2) No initial surface disturbing activities will occur between May 15 (nesting season) and July 15 (brooding season) in areas that are within a ¼ mile of active leks.
3) Areas planned for disturbance that are further than ¼ mile from active leks will be checked for possible nesting or brooding sage grouse between April 15 and July 15 before any activities begin. If nesting or brooding sage grouse hens or chicks are found, mining will be halted until the birds can survive independent of the immediate nest habitat.
4) Wyo-Ben will include staying current with reclamation, including the separation and saving or direct spreading of top and subsoil in order to increase the chances of quick revegetation success.
5) Wyo-Ben will use a seed mix that will establish a diverse population of vegetation. Wyoming big sagebrush seed will be targeted to areas most likely to support initial sagebrush establishment at a rate of two to four pounds per acre.

There is approximately 4.4 acres that will be disturbed within the Washakie Sage Grouse Core Area as shown on the revised wildlife map and within the WGFD letter dated May 21, 2014. Wyo-Ben will comply with the timing stipulations of the Governor's Sage Grouse Executive Order 2011-5 (SGEO) as detailed above. The proposed disturbance is greater than 0.6 miles from the nearest occupied lek.

The Wyoming Sage Grouse Implementation Team (SGIT) is currently reviewing sage grouse core area boundaries based on its 5 year boundary review. This boundary is being considered for removal from the Washakie Sage Grouse Core Area.

United States Federal Fish and Wildlife Service (USFWS)

The USFWS provided protective measures for threatened and endangered species, migratory birds (MBHFI) in accordance with the Migratory Bird Treaty Act (MBTA), the Bald and Golden Eagle Protection (BGEPA), Wetland/Riparian Areas, Black-footed ferrets, Ute Ladies'-tresses, Greater Sage Grouse, Mountain Plover, White-tailed Prairie Dog (see Exhibit D-9.2).

The USFWS initially provided general protective measures for the protection of Raptors and Eagles including seasonal buffers and spatial buffers. In our field visits and review of habitat we identified high cliff areas outside of the half mile boundary but never found any in flight or whitewash in the area. In 2015 Alex Jensen, Geologist WFO, discovered an active eagle nest between US HWY 16 and our proposed disturbance. The nest is located approximately 0.75 miles from our proposed disturbance boundary. Therefore, Wyo-Ben will maintain at least a 0.5 mile buffer from the eagle nest and will monitor the nest for activity between January 15 and July 31.

The USFWS also provided general protective measures for the Black-footed Ferret. There have been no sightings of black footed ferrets during wildlife surveys or other site visits. However, white-tailed prairie dog towns exist in the immediate area. Therefore, Wyo-Ben will continue to monitor the area for black footed ferrets. If they are discovered within the proposed disturbance area, Wyo-Ben will cease operation and consult with the USFWS for site specific mitigation options. Wyo-Ben does not anticipate any disturbance to prairie dog towns.

In regards to the Ute Ladies'-tresses, numerous searches have been conducted for this species. No specimens were found during searches in this area, or at any of our pits in the Big Horn Basin. In order to make Wyo-Ben field personnel aware of the species, pictures and a description of this plant have been distributed to them for recognition and protection purposes. According to the U.S. Fish and Wildlife Service website (http://www.fws.gov/mountain-prairie/species/plants/uteladiestress/) the "populations of the Ute ladies'-tresses orchids are known to occur in three general areas of the interior western United States – near the base of the eastern slope of the Rocky Mountains in southwestern Wyoming and adjacent Nebraska and north-central and central Colorado…." The proposed Ten Claims New Permit area is not located in any of the areas where the Ute ladies'-tresses are known to exist, and the soil/environment conditions are not conducive to establishment in this area. However, Wyo-Ben will continue to monitor the area for this endangered species and if it is discovered will contact the USFWS for site specific mitigation options.

Further in their response letter, the USFWS requested that Wyo-Ben correspond with WGFD to identify any important sage-grouse habitats in the project area. The WGFD indicated possible concern for the overlap of Wyo-Ben's proposed mining on the F2 bed with the Sage Grouse Core Area. Please refer to the WGFD section for comments on the Sage Grouse.

Within the proposed disturbance area and the half mile buffer there is very little if any suitable mountain plover habitat according to our visit with Ted Igleheart, BLM Wildlife Biologist on February 1, 2012. The closet sighting of Mountain Plover is over 5 miles north from the proposed area. Wyo-Ben, Inc. will mitigate potential impacts to this species by conducting ground searches between April 15 and July 15 within suitable habitat subject to surface disturbing activities. If nesting activity is observed, we will notify the USFWS for mitigation suggestions, and avoid activity in the immediate nesting

area (100 meter buffer) until the young can safely leave the nest.

The USFWS encourages the conservation of prairie dog colonies, so that other animals can prey on them for a food source such as the Black-footed Ferret and several raptors including the golden eagle and ferruginous hawk. Prairie dog colonies also provide shelter for other species such as the mountain plover, and the burrowing owl. Wyo-Ben does not anticipate any disturbance to prairie dog towns and will try to avoid any direct impact to any prairie dog colonies.

USFWS did not express concern for Migratory Birds of High Federal Interest (MBHFI) in the project area; however, Wyo-Ben, Inc. personnel will conduct bird-call surveys within the proposed affected area during the spring breeding period to help determine presence or absence of MBHFI species. Surveys will be conducted according to methodology provided by the FWS. If nesting activity by these species, or any species listed as a "species of special concern" in the Wyoming Natural Diversity Database (Fertig and Beauvais, 1999) is noted, the USFWS LQD will be notified for mitigation recommendations.

Review of the National Wetlands Inventory Map (Ten Sleep Wyoming and Wild Horse Hill Wyoming) by Wyo-Ben personnel indicated the following wetland habitats are within one half mile of our proposed disturbance areas (See Map D-10.2). All of the wetlands that are inventoried below are outside of our proposed disturbance area. Wyo-Ben does not anticipate affecting any wetlands in the proposed New Permit.

NATIONAL WETLANDS INVENTORY MAPS: ALKALI CREEK AND SPENCE USGS QUADS.
Palustrine aquatic bed semi permanently flooded diked/impounded (PABFh)
Palustrine emergent seasonally flooded excavated (PEMCx)
Palustrine emergent seasonally flooded (PEMC)
Palustrine unconsolidated shore temporarily flooded diked/impounded (PUSAh)
Palustrine emergent temporarily flooded diked/impounded (PEMAh)
Riverine intermittent streambed temporarily flooded (R4SBA)
Palustrine Unconsolidated Bottom Semi-permanently Flooded Excavated (PUBFx)

Based on our baseline and continuing wildlife surveys there are no additional mitigations needed at this time. However, if previously unidentified significant habitat or significant wildlife usage are observed during the course of conducting this proposed activity, Wyo-Ben, Inc. will notify the lead agency WYDEQ-LQD and implement appropriate mitigation after consultation.

D-10. Wetlands

The Ten Claims area was surveyed for wetlands using criteria in the 1987 Corps of Engineers (COE) Field Guide for Wetland Delineation Manual prepared by the Wetland Training Institute, and other waters of the U.S.

Wetland surveys involve the analysis of three factors: Vegetation, Hydrology, and Soils. In the vegetation sections, percent cover by dominant plant species is provided as an ocular estimate. When total vegetative cover is greater than 100%, both over and understory species are considered. If criteria were met in all categories, wetland status was assigned.

Probable wetlands were identified during site visits to the Ten Claims area and the National Wetlands Inventory Maps of Ten Sleep Wyoming and Wild Horse Hill Wyoming but will not be disturbed (See Map D-10.2). Wyo-Ben has sent a letter to Matt Billodeau,

Project Manager of the Office of the U.S. Army Corp of Engineers (USACE) in Cheyenne, Wyoming regarding Waters of the U.S. criteria. (See Exhibit D-10.1). On September 4, 2013 Matt Call and Joe Sylvester of Wyo-Ben met with Kevin Little of the USACE and toured the Ten Claims proposed plan of operation. His letter of determination will be forthcoming in the next week or two and a copy will be forwarded once it is received.

Spill Management Plan

Wyo-Ben Inc. will immediately notify both the Wyoming Water Quality Division of the Department of Environmental Quality and the Worland Field Office of the BLM for any accidental spills of petroleum products involving more than twenty-five gallons. Soils contaminated by smaller spills will be removed to the Wyo-Ben Stucco Mill Site for natural weathering treatment.

No solid wastes, either hazardous or non-hazardous, will be disposed of at these sites. All bulk fuel storage tanks will either be bermed for spill containment or placed in an excavated containment pit.

Wyo-Ben, Inc.'s Noxious Weed Management Plan for Federal Lands

Wyo-Ben Inc. will implement the following management plan to address noxious weed control on all of its activities conducted on Federal lands:

- The list of Prohibited and Noxious Weeds, located in the DEQ/LQD Guideline2, Appendix I will be used to identify noxious weeds and other weeds that may reduce wildlife habitat. This list of noxious weeds will be monitored and addressed for treatment once they are identified.
- All Wyo-Ben, Inc. activity areas and access routes will be inventoried for infestations of noxious weeds of particular concern. Wyo-Ben Inc. personnel will conduct on-going monitoring of noxious weed presence at all of our activity sites and their accesses routes and take action, in cooperation with the Washakie County Weed and Pest, to remove noxious weeds when located.
- All off-road access will be limited to only necessary routes to minimize impacted areas and reduce spread of weeds.
- Access will be controlled through infested areas until weed removal is accomplished.
- Wyo-Ben, Inc. will train mining personnel (including contractor representatives) to identify noxious weeds of particular concern to assist in the monitoring process. Weed identification materials will be made readily available to assist in field identification.
- Vegetation will be reestablished on all soil disturbed by construction, reconstruction or maintenance activities at the first available window of opportunity. This may mean waiting until the fall planting season to help ensure the success of vegetation establishment.
- All seed will be laboratory tested for the presence of noxious weed seed. Native seed offered by local collectors will only be utilized after Wyo-Ben, Inc. personnel have consulted with the collectors to ensure they possess the skills necessary to recognize noxious weeds of concern and sign a statement certifying that they have not collected seed in areas with noxious weed infestations.

- All hay or straw used for check-dam construction or mulching will be certified weed-free.
- All herbicides used on the Bureau of Land Management (BLM)-administered public land will be approved by the BLM prior to its application.

MINE PLAN

The mining activity proposed with this submission consists of five proposed pit sequences on various bentonite beds (Ten 1 (F2 Bed), Ten 2 (F3 Bed), Ten 3 (Beaver Bed), Ten 4 (Mowry A Bed), and Ten 5 (Mowry B Bed) to begin January of 2015 or as soon as the permit is approved (see Material Flow Map MP-1). Table MP-1 includes a listing of projected legal descriptions and disturbance acreages for each proposed pit sequence.

TABLE MP-1. PROJECTED DISTURBANCE LOCATIONS AND ACREAGES

PROPOSED PITS	TWP. RGE. SECTION	PROPOSED DISTURBANCE ACREAGE
TEN 1 (F2 BED)	T47N R89W S20, 21, 22, 23, 25, 26	55.4
TEN 2 (F3 BED)	T47N R89W S20, 21, 22, 23, 25, 26	20.2
TEN 3 (BEAVER)	T47N R89W S20, 21, 22, 23, 25, 26	49.5
TEN 4 (MOWRY A BED)	T47N R89W S20, 21, 22, 23, 25, 26	55.7
TEN 5 (MOWRY B BED)	T47N R89W S20, 21, 22, 23, 25, 26	25.5
HAUL ROADS OUTSIDE OF DISTURBANCE	T47N R89W S20, 23, 24, 25, 26, 27, 28	20.8

T.O.P. AND C.O.P. HIGHWALL REDUCTION	**T47N R89W S20, 21, 22, 23, 25**	**22.2**
POTENTIAL DISTURBANCE AREAS	**T47N R89W S20, 21, 22, 23, 25, 26,**	**274.6**

TOTAL PROPOSED POTENTIAL DISTURBANCE 523.9

These will all be open pit bentonite mines excavated using standard castback mining techniques and procedures. Castback mining is a technique that is beneficial both environmentally and economically on many levels. Figure MP-2 shows a model of the castback system as described:

1. In this process, overburden from the first open pit (phase 1) of a pit sequence is usually piled and contoured adjacent to the first open hole (sometimes referred to as a contoured out-of-pit overburden pile (C.O.P.)). Top and subsoil are also stockpiled separately in the same general area. At the earliest opportunity, the original overburden pile from Phase 1 is then contoured to match existing topography and the subsoil and topsoil is spread from existing soil piles in preparation for seeding. If soil stockpiles will be in place longer than one year, they will be seeded with a BLM approved perennial grass species.
2. Once the bentonite is removed from phase 1, the topsoil and subsoil is then placed on the existing piles from Phase 1 and the remaining overburden from the next open pit of the sequence (Phase 2) is cast into the open hole of phase 1.
3. Once the bentonite is removed from Phase 2, the topsoil from Phase 3 is removed and placed on the existing pile from Phase 1 and 2. The subsoil is then castback into Phase 1 and the remaining overburden is cast back into Phase 2.
4. After the removal of bentonite from Phase 3, topsoil from Phase 4 is then cast onto contoured and previously subsoiled Phase 1; the subsoil is then cast onto Phase 2; and the remaining overburden from phase 4 is cast into Phase 3.
5. This process repeats itself until the end of the pit sequence. At this time, since there is not overburden available from another phase of mining, material to fill the last hole is acquired by reducing the highwall's steep grade, also known as a highwall reduction, Figure MP-3. The castback/ highwall reduction process provides ecological and economic pragmatism by promoting live topsoil distribution, as well as eliminating the need for long-distance transport of the original overburden from phase 1. In many cases this distance can exceed a mile. The cost, energy, and equipment necessary for that effort are well above accepted norms.

Environmentally, castback mining with a highwall reduction is beneficial on many levels. First, a pit sequence can take between five to ten years to complete. In this time, micro fauna residing in a deep stockpile effectively die before soils are spread. Also, degradation can occur due to soil compaction. Both conditions degrade a soil's ability to support desirable vegetation on reclaimed pits. Wyo-Ben prefers concurrent reclamation with the spreading of "live" soils to reestablish vegetation, resist erosion, and develop stable and productive habitats following disturbance. Furthermore, complete blocks of reclamation behind the final phases would be impossible because of the need for access corridors to accommodate the hauling of material. Finally, using the castback mining procedure greatly reduces the amount of disturbance when compared to older mining techniques where overburden was piled on the highwall and outcrop sides of the pit until commencement of backfilling.

Mine Plan Maps 1, 2, & 3 show nine highwall reduction sites, the first series of four steep highwall reductions is as the mining approaches Little Cottonwood Creek, an National Wetland drainage. The mining will stop east of the drainage and the final phase will utilize a steep slope highwall reduction as illustrated in Figure MP-3 to fill the final phase east of the drainage. The second series of highwall reductions will occur on the western edge of the proposed mining. Steep slope highwall reduction will be used for these beds due to the steep dipping beds.

Those delineated areas are considered to be the limit of necessary disturbance required to accomplish reclamation of the last phase in a pit sequence. In most cases, less area than that shown on the mine plan map is needed to accomplish final fill and contour of the last phase. Figures MP3 illustrate a typical Sequence 1 through 6 showing schematically the sequence of the steep slope highwall reduction process and Figures MP3a for gentle slope highwall reductions.

A highwall reduction is accomplished by removing top and subsoil adjacent to the last phase, and dozing the underling material adjacent to the highwall into the open hole of the last phase. Once contouring of the last phase is complete, the area is then soiled using both material from the highwall reduction area, and a partial amount of saved soil from two or three previous phases.

The area of disturbance in the highwall reduction is determined by three factors. One is the depth of the highwall of the last phase. The second factor is the size of the phase; and the last factor is swelling of overburden as it breaks up during mechanized removal from the previous phase. In general, a deep highwall will require more disturbances in the highwall reduction area. Similarly, larger pits will require a larger reduction disturbance. Finally, if the overburden in the next-to-last phase has a high swell factor, there will be more material to go into the last phase of mining. This opportunity, when present, minimizes the area of disturbance required for the highwall reduction. Wyo-Ben intentionally reduces the size of its phases of mining as we progress through the pit sequence. When the last phase is reached, it is usually smaller than the first phases of mining, thus reducing the area needed for the highwall reduction. In areas that pie pans exist, part of the outcrop baserock will be cleaned and overburden will contoured to match the surrounding topography and arch of the pie pan. Soil handling in castback mining is also more economically and environmentally sound than in older mine techniques. As mentioned above, stockpiling soil for long periods of time can be detrimental to the resource. Castback mining reduces or eliminates stockpiling time.

Soon after the first phase of overburden is contoured in-place, it can be soiled with stockpiled top and subsoils obtained from the first few phases of mining. Further, as shown in figure MP-2, upon backfilling and contouring of the first and subsequent phases of mining, soils can be spread live as it is being removed from subsequent phases. This has two tremendous advantages. First, it reduces the degradation of soil microbes, and increases vegetation establishment due to seed propagules contained in the soil. Second, it reduces the cost of soil redistribution by decreasing the amount of material handling. As well as salvaging top and subsoil, Wyo-Ben also salvages material below subsoil that is chemically and physically beneficial or neutral to vegetation establishment. This practice allows us to put a buffer between the more detrimental overburden material and the top and subsoil, thus increasing the chance of establishing a diversity of desirable vegetation. Wyo-Ben will commit to the placement of top and sub soil piles on flatter areas where it is reasonable. In other situations, Wyo-Ben will insure that the piles will be protected from erosional situations.

Proposed pit layouts, all potential disturbance areas, temporary stockpile areas (T.O.P.), and contoured overburden piles (C.O.P.) are illustrated on Mine Plan Maps 1, 2, and 3. Pit delineation boundaries show the limit of our resource that is economically viable to extract, based on market demands. Often, due to various economic or physical conditions, we do not disturb to the limits shown in the proposal. This routinely results in less acreage disturbance than originally proposed. Wyo-Ben will commit to the placement of top and sub soil piles on flatter areas where it is reasonable. In other situations, Wyo-Ben will insure that the piles will be protected from erosional situations. Also, the width of disturbance is based on the geologic dip of the bentonite bed of interest. Steeply dipping beds usually result in a narrower pit than flatter-lying beds. When practical, Wyo-Ben leaves mosaics of undisturbed lands within the proposed pit sequence or between adjacent pit sequences which enhance reclamation aesthetics, and serve as a seed source for reclaimed lands. Pit area locations, boundaries and stockpile sites will be staked prior to disturbance; and contractors will be monitored on a regular basis in order to maintain control of Wyo-Ben's high standards of mining and reclamation. The C.O.P. and T.O.P. areas that are identified on the Mine Plan Maps 1, 2, & 3 can consist of the following items: topsoil stockpiles, subsoil stockpiles, temporary bentonite stockpiles, camp sites for the mine equipment, and the initial phases of overburden stockpile. The C.O.P. usually is the volume of the first phase of the pit series. This volume will vary based on the slope of the bentonite bed and the amount of the outcrop for that pit. This are is usually used as an equipment camp site and bentonite stockpile area. The C.O.P. areas will stay out of the drainages for this proposal. After all mining is complete, overburden is contoured to reflect surrounding topography subsoil and topsoil is applied and seeded according to the reclamation plan.

Table MP-2 lists specific volumes, disturbance acreages and projected mining dates for each proposed pit. Wyo-Ben anticipates annual mining of between 12 to 18 acres in the Ten Claims New Permit Area based on market demand.

Wyo-Ben has agreed to some specific voluntary mitigation to address situations for the Ten Claims submittal such as wildlife as referenced in section D-9 and soil handling techniques in section D-7. Please refer to each section for the specific mitigation.

TABLE MP-2. PROJECTED DISTURBANCE ACREAGE AND MINING DATES

PROPOSED PITS BEDS # OF PHASES	PROJECTED OPENING DATE	PROJECTED ENDING DATE	APPROXIMATE DISTURBANCE PER YEAR	AVERAGE OVERBURDEN PER PHASE*	PROPOSED DISTURBANCE ACREAGE
			ACRES	CUBIC YARDS	ACRES
TEN 1 (F2BED)	January, 2015	December, 2025	5.1	40,920	55.8
TEN 2 (F3 BED)	January, 2015	December, 2026	1.7	13,848	20.6
TEN 3 (BEAVER BED)	January, 2015	December, 2026	4.2	33,544	49.9
TEN 4 (MOWRY A BED)	January, 2015	August, 2028	4.1	33,113	56.1
TEN 5 (MOWRY B BED)	January, 2015	August, 2032	1.5	11,826	25.9
T.O.P. AND C.O.P	January, 2015				24.0
HAUL ROAD OUTSIDE OF DISTURBANCE	January 2015				20.8
POTENTIAL DISTURBANCE AREAS	January, 2015				270.8

***ASSUMING A 30 FOOT HIGHWALL**

Figure MP-1, Ten Claims New Permit Material Flow Map illustrates general material movements, volumes, and final pit cut backfill strategies. Backfill of all other phases will be achieved during the castback sequences as illustrated in Figure MP-2. Topsoil (T.S.), subsoil (S.S.), contoured overburden stockpiles (C.O.P.) temporary overburden piles (T.O.P.), and Highwall Reductions locations are also illustrated on the Mine Plan Maps 1, 2, & 3.

Existing Washakie County Road (aka Old Ten Sleep Road) and Castle Garden Road will provide access to the proposed pits. Additional roads will be constructed as illustrated on the Mine Plan Maps. These haul roads will cover 19.0

acres that are outside of the proposed disturbance. Haul roads within the proposed disturbance will normally be within the proposed bentonite bed to minimize overall disturbance. One culvert is planned for proposed Haul Road 63.1 as detailed in the Hydrology section D-6. Haul roads will be constructed with a crown and drainage ditch, with strategically placed water exit ditches to prevent pooling on roads.

Interim Management Plan

Wyo-Ben does not have a schedule of anticipated temporary closure, however in the event that we have to temporarily closes a pit, interim management procedures will be implemented as follows: A Berm will be placed in all areas around the pit phase where a highwall occurs. A berm will also be installed at the ramps of the pit to prevent entrance. Temporary water diversions will be made around the pit to prevent water from entering the particular pit phase. Bentonite stockpiles and stockpiles with potential deleterious material (overburden piles, etc.) will be bermed to prevent off-site sedimentation. Ephemeral drainages that have the potential to receive deleterious material will have check damns installed. If soil piles are expected to be in place for an extended period due to the temporary closure of the pit, they will be seeded to prevent erosion and loss of soil. All equipment and supplies will be kept within the disturbance area. Any fuel storage tanks will either have a perimeter berm or placed within an excavated containment pit to control any potential spills. Annual and semi-annual inspections will be completed by Wyo-Ben employees, a representative from the DEQ, and a representative from the BLM. Finally, the pit area will be monitored on a regular basis to determine if problems are occurring that need to be addressed.

Monitoring Plan

Wyo-Ben utilizes contractors to conduct the mining and reclamation operations of our business. Our mining supervisor, Greg Sweetser, works with our contractor's field supervisors to ensure that mining is being conducted in a lawful and environmentally responsible manner. He also supervises and directs the reclamation of pits. Monitoring of field operations and contact with our contractor's field supervisors occurs on an almost daily basis. This ensures that mining and reclamation is being conducted according to Wyo-Ben's high standards of mine regulation compliance, reclamation and safety. Wyo-Ben will monitor its reclaimed lands as explained below in post closure management.

Migratory birds and BLM sensitive species nest searches will be conducted prior to any initial surface disturbing activities during the dates April 15 to July 15.

TEN CLAIMS RECLAMATION PLAN

The reclamation/revegetation process will be designed to reclaim a mosaic vegetation scheme consisting of site specific dominance of various life forms (shrubs, grasses, and forbs) with a diverse species composition. Additional reclamation goals include basic landscape design principles, which include repeating landscape character elements, minimizing surface disturbance, proper siting and location, site stabilization with erosion control and maintaining visual aesthetics. The primary land use and reclamation goals are directed towards wildlife habitat, livestock grazing, and low visual impact to the western portion of the proposed mining.

Wyo-Ben will utilize the standard castback mining techniques for mining and reclamation. Backfill will be achieved during the castback mining process using variously sized Caterpillar tractor-scrapers depending on availability. Wyo-Ben, Inc.'s mining contractors typically use Caterpillar 627 and 631 tractor-scrapers, supplemented with Caterpillar tractor-dozers ranging from D-8 to D-10 in size, track excavators and rock trucks. The equipment used will depend on availability of equipment, topography of a particular area, size and width of proposed pit and other environmental considerations. The dozers are typically used for backfilling and contouring. Most drainage construction will be done with an excavator in order to minimize the disturbance.

Final reclamation contours will be consistent with those necessary to reestablish the projected postmining land use goals of domestic livestock grazing, wildlife habitat, and low visual impact to the western portion of the proposed mining. Final slopes and surface contours will approximate native gradients and will blend with adjacent topography. Through drainage will be reestablished in all backfilled phases. Ephemeral channels to be impacted by this proposed mining activity will be temporarily directed around open pits during active mining stages. Channel design for both temporary and permanent diversions will match premine channel gradients and cross-sectional shapes. Temporary diversions will comply with Noncoal rules, section 2(e)(ii)(F) to allow passage of peak runoff from a 2 year, 6 hour precipitation event in a nonerosive manner. Permanent diversions (including reconstructed channels and adjacent topography) will comply with Noncoal rules, section 2 (e) (iv), to be erosionally stable during the passage of the peak runoff from a 100 year, 6 hour precipitation event.

Reclamation backfill will follow the castback mining sequence illustrated in Figure MP-2 in the Mine Plan Section. Following backfilling and contouring, all compacted surfaces will be ripped to improve water infiltration and retention. Subsoil and topsoil will be replaced from stockpiles or hauled directly during the castback mining sequence. Average topsoil and subsoil redistribution depths are reported in Table D-7.5. Where necessary on initial pit cuts, out-of–pit overburden stockpiles will be contoured in-place and used for temporary bentonite and soil stockpile locations (C.O.P. locations on the Mine Plan Map). Final reclamation of these areas will include deep-ripping, spreading topsoil/subsoil and seeding.

Reclamation of the steep-sloped bentonite beds like the A and B beds of the Mowry Formation may include leaving the upper portion of the post mine base rock exposed, in VRM Class III & IV areas, with backfilling and contouring of overburden occurring below that point, in small areas. Contouring will simulate the "pie-pan" nature of premine topography, with the lateral outside edges of those features forming reclaimed drainages that will tie into native drainages.

Wyo-Ben, Inc. will comply with the requirements listed in Noncoal rules, Chapter 13, Section 3 (a) (vi) regarding the timeliness of reclamation.

For the area that is specifically located within the VRM Class II area, Wyo-Ben proposes the following additional reclamation and visual viewshed solutions:

Landform – Wyo-Ben will minimize the amount of disturbance in this area by:

- Highwall Buffer – typically Wyo-Ben will place a dozer blade width above the highwall (8' - 12') to place a highwall berm, when there is potential for activity above the highwall, and a void space between the native vegetation and the disturbance. For the VRM Class II area, Wyo-Ben will limit the size of the highwall buffer from (8' – 12') to (3' – 5'), since we have determined that there is limited potential for activity above the highwall area and in order to limit the amount of the disturbance and make the disturbance less visible. If at any later time, it is determined that there is a potential hazard, then this buffer will be increased to a safe distance as determined by our Mining Supervisor.
- Associated Disturbance –Normally an area preceding the open pit will be approx. 150' to 200' depending on the equipment being operated and the required turning radius and a safe slope of the ramps of 3:1. For the VRM Class II area Wyo-Ben will limit this amount of disturbance to 100' to 150' depending on the required amount of room to maneuver the equipment. This will help to limit the size of the disturbance and make it less visible.
- Wyo-Ben will commit to keeping the haul roads contained within the bentonite bed disturbance and off of the ridgelines, where possible. This will reduce the amount of disturbance and make it less visible and lower the impact of sensitivity.
- Wyo-Ben normally constructs a haul road up to a 60 foot disturbance footprint. For this area we will reduce the haul road to a 35 foot footprint for the VRM Class II area to minimize the disturbance and make it less visible.
- Wyo-Ben will commit to locating bentonite stockpiles into the adjacent lower VRM Class IV area. This will help to reduce the visibility of the stockpiles, place the stockpiles in a less sensitive area and help to reduce the color contrast of the bentonite stockpiles in the VRM Class II.
- Wyo-Ben will commit to locating top soil and sub soil stockpiles behind existing geological structural features or shape the stockpiles to repeat the landscapes basic elements. This will help to reduce the visual impact or relocate them into a less sensitive VRM classification.
- Wyo-Ben will commit to maintain all equipment "camp" areas outside of the VRM Class II area in order to reduce the visual impact and to place them in a less sensitive VRM Classification.
- Wyo-Ben will maintain partial contouring with the castback mining technique to mimic the original premine contour to reduce the visual impact. Wyo-Ben has been mining in this type of steeply dipping bed environment for the past 20+ years. We are proud of our past reclamation abilities of reclaiming the lands back to similar original topography of feathering the topsoil into the disturbance line. In the past, Wyo-Ben has been recognized for going above and beyond in the reclamation filed and has received several awards from the Governor of the State of Wyoming, Wyoming Game and Fish Department - Heritage Award and most recently received the National BLM Hardrock Mineral Environmental Award in 2010. A separate Appendix for Reclamation plan has been included with this submittal. This Appendix illustrates previous and current mining within the Big Horn Basin. It includes pictures and descriptions to the - cast back mining

technique from premine, the associated disturbance, open pit, back filled areas, contoured landscape, to reclamation with vegetation. Please refer to Appendix for Reclamation Plan on page 82.2.

- Premine landform pictures have been taken in the VRM Class II area for reference when reestablishing the landform after mining along with the GPS coordinates. These will assist Wyo-Ben and our contractor in reestablishing the land form after mining. Please refer to the VRM Class II – Premine Pictures located on page 82.3.

Vegetation

- Wyo-Ben has completed vegetation transects for the Ten Claims and has designed the seed mix to reflect similar vegetation that is found within the Ten Claims disturbance boundary. This seed mix is a diversified seed mix including native grasses, forbs, and shrubs and is listed in the Revegetation Techniques and Seed Mixtures on Page 85. As per the BLM IM-2006-073 all seed mixtures will be certified to be free of noxious weed seed.
- Normally, Wyo-Ben prefers to seed all topsoiled lands in the fall however for the VRM Class II area, Wyo-Ben will commit to concurrent reclamation with seeding to be completed in the fall and spring season as the mine sequence advances to minimize the amount of disturbed lands and to get the vegetation started as quickly as possible.
- Wyo-Ben will seed soil stockpiles with a 3 grass seed mixture as determined by per the vegetation transects. As a substitute to one of the grass seeds, Wyo-Ben will consider using a nitrogen fixing plant such as a Vetch (American), Scarlet Globemallow, Purple Prairie clover, and/or a low lying penstemon as per BLM Management suggestion, subject to price and availability.
- Wyo-Ben uses a broadcast pitter for the seeding of our disturbance. The pits that are created by the pitter are beneficial by helping to harvest moisture with the pitted area and breakup the landscape with more native random vegetation pattern and avoiding uniform harrow lines in the final reclamation. With the pitting, the vegetation resembles more of the natural random setting.
- Wyo-Ben may use a hydro seeder to help re-establish and stabilize the vegetation in a timely manner. The hydro seeder may be used in areas of concern of highly erosive soils and areas that we are unable to get the pitter on.
- Minimize the removal of native vegetation by reducing the physical footprint of our mining activity as indicate above in the landform section.
- Limit access to and from the site with a single haul road access. Wyo-Ben will commit to keeping the haul roads contained within the bentonite bed disturbance and off of the ridgelines, where possible. Wyo-Ben normally constructs a haul road with a 60 foot disturbance footprint and will reduce the haul road to a 35 foot footprint for the VRM Class II area. This will minimize the impact to the native vegetation, reduce the foot print of our mining operations and place the roads in a less visible area.
- Wyo-ben will recommend that our contractor utilize carpooling for the mining crew in order to reduce the amount of traffic in this area.

- Limit the amount of equipment working in the Class II area to a single crew of (Rock Truck, Scraper, Dozer, and Excavator) as not to distract the eye of the casual observer and make the activity less visible.
- Reclamation will be feathered back into the original native soils to minimize the contrast of the disturbance and to establish a diffuse edge.
- Wyo-Ben typically monitors the vegetation on all our mine sites in the spring of each year. Wyo-Ben will monitor the area within the VRM Class II, every spring and fall to visually see the vegetation growth, growth of invasive species, and any erosion issues. Typically, Wyo-Ben monitors the sites for 2 or 3 years before making the determination that an area will need additional supplements or reseeding of the area. Wyo-Ben will commit to soil testing in areas that are struggling after 2 growing season to determine what supplement(s) may need to be added to a particular area. Monitoring results are reported in the Annual Report under the Pit Summary.
- If noxious weeds are discovered we will treat them as identified in the "Wyo-Ben. Inc.'s Noxious Weed Management Plan for Federal Lands" on page 76.
- Bentonite mining is a short term linear transitory effect to the lands following the geological outcrops of the various bentonite beds. Our mine plan for the VRM Class II area will progress from Little Cottonwood Creek and work westerly to US HWY 16. The disturbance will be in various phases as a result of the cast back mining technique. The long term goals for any mining activity are achieving bond release as quickly as possible. The State of Wyoming requires that the earliest that an area can be bond released is 5 years. It is Wyo-Ben's goal to try to achieve bond release at the 5 year threshold but is also realistic that some landscapes take a little more time to achieve the Wyoming Department of Environmental Quality and Bureau of Land Management Reclamation Standards.

Structures

- Wyo-Ben will not have any structures within the VRM Class II area.
- All Camp Equipment sites, porta potties, and bentonite stockpile areas will be located in adjacent higher VRM sites of III & IV.
- Wyo-Ben will commit to locating top soil and sub soil stockpiles behind existing geological structural features or shape the stockpiles to repeat the landscapes basic elements. This will help to reduce the visual impact or relocate them into a less sensitive VRM classification.
- Haul roads and all disturbances will be minimized and located to have the least visual impact within the VRM Class II Area.

Wyo-Ben, Inc. will consider alternative innovative techniques for reclamation in order to achieve bond release. Some of these innovative techniques may include pitting, broadcasting, drilling, or hydro-seeding, the crimping of straw, candy-striping of soil where there is little to spread, seed coating, additives to the soil (including but not limited to mycorrhizae, boron, gypsum, limestone, fertilizers, mulch, grass clippings, wood chippings, weed free manure, bio-solids, polymers, sugar), sagebrush seedlings, fencing, spraying of invasive species before and/or after mining, alternative irrigation techniques,

alternative seed mixtures which may include approved non-native species, or other methods that will require BLM and DEQ approval prior to the application.

Space Left Blank Intentionally

Drill-Hole Plugging

All drill holes are filled with overburden that is augured out of the hole during the drilling process immediately after the intended drill sample has been obtained.

Feasibility of Pit Backfill

As previously mentioned, Wyo-Ben utilizes a castback mining procedure when stripping pits. This method of mining is both economical and environmentally compatible. The fact that overburden is handled only once in the process of material movement during the stripping and reclamation process is an economical method of mining. Also, using the castback method allows reclamation to stay concurrent with mining as backfilling and contouring of a previous phase is occurring at the same time the current phase of a pit is being stripped. Finally, moving material between phases of a pit is safer than pushing it laterally into the open hole over the highwall.

Isolation and Control of Acid-Forming, Toxic, or Deleterious Material

Wyo-Ben, Inc. characterizes the overburden from the surface down to the bentonite in each formation it plans to mine (reported in D-5). In this process, a material sample is obtained every five feet down to the bentonite and sent to Intermountain labs in Sheridan, Wyoming for testing of chemical and physical parameters. If it is shown that a particular pit has the potential for acidic, deleterious or toxic material near the surface, Wyo-Ben will attempt to cover it with at least two feet of a more neutral overburden material from adjacent pits in a lateral castback procedure, or bury that layer deeper in the profile during backfill. If deleterious material (bentonite, overburden) is intentionally placed on the surface, it will be bermed to prevent off-site sedimentation of the material.

In the situation of unintentional placement of deleterious materials on native lands, i.e. a large bentonite spill, Wyo-Ben or it's contractor will remove the deleterious material from the lands as soon as possible and reseed the disturbed area with an appropriate seed mixture.

Post Closure Management

Wyo-Ben monitors all of its reclaimed lands post closure for off-site sedimentation, erosion and seeding failures. Off-site sedimentation is controlled by installation of straw bail or fabric check dams into affected drainages. If unacceptable erosion is detected, it is repaired at the first available opportunity. Repair in the past has mostly been accomplished by reconstructing the drainage and lining it with erosion control fabric, rock, or installation of rock gabions. Finally, seeding is monitored on a regular basis. If after two to four growing seasons vegetation establishment is not adequate, Wyo-Ben will determine the reason for failure and mitigate the problem including reseeding of the site.

Revegetation Techniques and Seed Mixtures

Revegetation considerations include use of the area for domestic livestock grazing and wildlife habitat. Revegetation procedures will begin following contouring and topsoiling of the disturbed areas as previously described.

Seedbed preparations may include deep-ripping after soil replacement to break up the surface and loosen the soil. Additional surface manipulations such as deep parallel

furrows or pitting may be used to enhance moisture harvesting capacities of the areas receiving seed. Seed mixtures will be broadcast seeded when using the pitter or 4-wheeler and no till drill seeded with the Truax depending on the terrain and soil conditions. In general, seeding shall be conducted in the fall and early winter (prior to freeze-up) to take full advantage of fall, winter and spring moisture. From time to time, we may exercise our discretion to attempt spring seeding on areas where live topsoil has been directly placed during winter months to reduce destruction of native species volunteering during the first growing season and prior to what would be the fall seeding period. Although no negative grazing impacts are anticipated on newly seeded areas, attempts will be made to coordinate timing of use with the grazing permittee if problems develop.

Reclamation of haul roads will be accomplished by contouring to restore drainage patterns, remove culverts, and blend with surrounding topography. These areas will then be deep-ripped, subsoiled/topsoiled and seeded.

Composition of the proposed seed mixtures are detailed below after reviewing the species list and visiting with a local seed supplier. Use of all species depends on seed availability in the year of seeding. Due to the mostly poor quality soils of the proposed disturbance area, Wyo-Ben will use a less diversified seed mix for the Steep Complex, and Greasewood/Annual map units as shown below:

Seed Species	Rate-lb. PLS/acre
Gardner saltbush (*A. gardneri*)	4.0
Fourwing saltbush (*A. canescens*)	2.0
Rubber rabbitbrush (*Chrysothamnus nauseosus*)	1.0
Bluebunch wheatgrass (*Agropyron spicatum*)	2.0
Indian ricegrass (*Oryzopsis hymenoides*)	1.5
Red threeawn (*Aristida longiseta*)	1.0
Sandberg bluegrass (*Poa sandbergii*)	1.0
Western wheatgrass (*Agropyron smithii*)	1.0
American vetch (Vicia Americana)	1.0
Rocky mountain bee plant (Cleome serrulata)	1.0
Tanseyleaf tansyaster (Machaeranthera tanacetifolia)	1.0
	16.5 lb/acre

This mixture will be supplemented with Big sagebrush (*Artemisia tridentata*) at a rate of 1 to 2 pounds per acre in targeted areas of greater moisture potential (i.e. drainages and depressions), in the Mixed Shrub Complex (MSC) and Juniper map unit, and higher quality soils, basin wildrye (*Elymus cinereus*) broadcast onto uplands and reconstructed drainages and other low-lying areas at a rate of 0.5 to 2 pounds per acre. Monitoring of past reclamation successes and failures may influence seed mixture composition and surface preparation techniques.

Quality Assurance

Wyo-Ben utilizes two drill trucks to characterize the volume and quality of bentonite in the various beds during the development of pits. This allows us to tighten planned disturbance boundaries of our pits, which in many cases, reduces the amount of

disturbance that would otherwise occur. Soils of proposed mine areas are characterized to an order 2 level. This allows us to determine the quality and volume of soils that can be saved to produce quality reclamation. As stated previously, Wyo-Ben commits to save all available top and subsoil for reclamation during the initial stripping part of the mining process, and will either stockpile or spread it live. The stripping of pit phases is accomplished using a castback mining procedure. This practice allows reclamation to be concurrent with mining. Typically, previously mined phases of a pit are reclaimed through backfilling and contouring almost adjacent to the open phase of a pit, with soiled and seeded phases not far from this. Before a pit is backfilled, bentonite cleanings and any other deleterious materials are pushed against the bottom of the highwall to ensure they will be buried deep. In the reclamation of bentonite stockpile areas, the pad (portion of bentonite near the bottom of a stockpile that is not used) is buried, followed by the ripping and soiling of the area. All compacted areas, such as roads and other stockpile areas are also ripped prior to soiling to reduce compaction. The movement of overburden during the mining process is done in a tiered castback process, which places material from the current phase of mining into a previous open pit in approximately the same order as it was removed. This process is employed unless overburden testing reveals the need to place at least two feet of neutral overburden material over a toxic layer near the surface (i.e., very high SAR or acid potential).

BOND CALCULATIONS

Reclamation bonding assessments have been calculated for the projected first year's mining activity anticipated with this application (Table RP-1). Wyo-Ben, Inc. updates and adjusts its overall Reclamation Bonding liability each May 1 with the Annual Report.

The calculations presented in Table RP-1 make the following assumptions:

PITS

Overburden: If necessary, backfill can be achieved using material from associated contoured out- of-pit overburden stockpiles (C.O.P.) and/or highwall reductions. The calculation below is for one phase only plus 4,000 cubic yards as a cushion.

Topsoil: If necessary, topsoil/subsoil redistribution can be achieved using material from associated topsoil/subsoil stockpiles. Topsoil and subsoil is calculated for the initial 3 phases only and then the castback mining will be in full effect.

Seeding: Seeding costs are calculated using $300/acre times the total proposed disturbance area.

TABLE RP-1. BONDING SUMMARIES

PIT NUMBER/ SEQUENCE	TOPSOIL & SUBSOIL REPLACEMENT (YD^3)	OVERBURDEN REPLACEMENT (YD^3)	GRADING COST PER ACRE	SEEDING COST PER ACRE	TOTAL BOND REQUIREMENT
Current Rates	$0.72	$0.72	$60.00	$300.00	
Ten 1 F2 Bed	20,550 $14,796.00	38,070 $27,410.40	5.1 $306.00	5.1 $1,530.00	$44,042
Ten 2 F3 Bed	7,650 $5,508.00	15,298 $11,014.56	1.7 $102.00	1.7 $510.00	$17,135
Ten 3 Beaver Bed	18,450 $13,284.00	31,394 $22,603.68	4.2 $252.00	4.2 $1,260.00	$37,400
Ten 4 Mowry A Bed	4,800 $3,456.00	35,513 $25,569.36	4.1 $246.00	4.1 $1,230.00	$30,501
Ten 5 Mowry B Bed	16,200 $11,664.00	10,426 $7,506.72	1.5 $90.00	1.5 $450.00	$19,711

Total Calculated First Year Reclamation Bonding Requirement	**$148,789**
Contingency Fee @ 25%	**$37,197**
Total Pit Bonding Requirement	**$185,986**

Proposed Haul Roads 63.4 (partial) & 63.5 & 5 C.O.P. areas

These reclamation bonding costs were developed using the following assumptions:

Ripping the roadbed and recontouring using a motor-grader
2 hours per acre @ $60 per hour

Drainage establishment using a front-end loader or track-hoe:
1 hour per acre @ $75 per hour

Topsoil redistribution using a self-loading scraper:
1.5 hours per acre @ $110 per hour

Seeding @ $300 per disturbance acre

Total Estimated Reclamation Costs per Acre:	**$660**
Total Proposed Haul Road Disturbance Acreage:	**5**
Total Proposed C.O.P. Acreage:	**5.9**
Total Reclamation Bonding requirement for Haul Roads, C.O.P., & T.O.P.	**$7,194**
Contingency Fee @ 25%	**$1,799**
Total Haul Road Bonding Requirement	**$8,993**

GRAND TOTAL RECLAMATION BONDING REQUIREMENTS:

Total Pit Bonding Requirement	**$185,986**
Total Haul Road Bonding Requirement	**$8,993**
Grand Total	**$194,979**
Anticipated First Year Bonded Acres on Federal Lands:	**26.7 Acres**
Anticipated First Year Bonded Acres on State and Private Lands:	**0.8 Acres**

Allotment Fences – Wyo-Ben voluntarily agrees to maintain temporary fences as we are mining through a particular area and to coordinate with the Ranchers the timing of their leases. Once an area is fully mined out, stockpiles have been removed, soil has been replaced and seeded, and then Wyo-Ben will voluntarily replace the fence with a permanent fence.

Bond Release

The State or Wyoming has adopted successful standards for all operators in measuring revegetation success. This is identified in Chapter 3, Section 2(d)(vi) as:

Revegetation shall be deemed to be complete when:

1) The vegetation species of the reclaimed land are self-renewing under natural conditions prevailing on the site;
2) The total vegetation cover of perennial species (excluding noxious weed species) and any species in the approved seed mix is at least equal to the total vegetation cover of perennial species (excluding noxious weed species) on the area before mining;
3) The species diversity and composition are suitable for the postmining land use;
4) The requirements of (1), (2), and (3) are achieved during one growing season, no earlier than the fifth full growing season on the reclaimed lands.

Wyo-Ben proposes for the Ten Claims submittal that the final bond release vegetation sampling to occur in each of the premine vegetation map units, as detailed in the premine vegetation mapping, section D-8, and to follow the Wyoming DEQ Guideline 2 suggestions detailed in Section 3. In areas that bond release is being requested that have multiple premine vegetation mapping units, we would propose using a weighted average based on the acreage of disturbance.