TRI-STATE

November 2, 2021

Mr. Zach Trujillo
Environmental Protection Specialist
Colorado Division of Reclamation, Mining & Safety
Department of Natural Resources
1313 Sherman Street, Room 215
Denver, CO 80203

RE: Colowyo Coal Company L.P.
Permit No. C-1981-019
Technical Revision 150 (TR-150)
Salinity Study

Dear Mr. Trujillo,

Tri-State Generation and Transmission Association Inc. (Tri-State), is the parent company to Axial Basin Coal Company, which is the general partner to Colowyo Coal Company L.P. (Colowyo). Therefore, Tri-State on behalf of Colowyo is submitting technical revision 150 (TR-150) to Permit No. C-1981-019.

Per a meeting with the Division on May 28, 2020, Tri-State committed to conducting a salinity study to assessment material damage on pastures below the Colowyo Mine. The commitment to conduct this study was also documented in two letters sent to the Division on June 8, 2020 and September 22, 2020 respectively. TR-150 provides Exhibit 7 Item 16 *Salinity Material Damage Assessment* which address if material damage impacts are occurring down gradient of the Colowyo Mine from irrigation water acquired from Good Spring Creek that is comingled with water discharged from Colowyo.

Included in this technical revision is a change of index sheet to ease incorporation of this technical revision into the permit document, and a public notice for the Division's review. If you should have any additional questions or concerns, please feel free to contact Tony Tennyson at (970) 326-3560 at your convenience.

Sincerely,

DocuSigned by:
Chris Gilbreath
D250C711D0BF450...

Chris Gilbreath
Senior Manager
Remediation and Reclamation

CG:TT:der

Enclosure

cc: Jennifer Maiolo (BLM-LSFO)
Tony Tennyson (via email)
Angela Aalbers (via email)
File: C. F. 1.1.2.138 - G471-11.3(21)d

CHANGE SHEET FOR PERMIT REVISIONS, TECHNICAL REVISION, AND MINOR REVISIONS

Mine Company Name: **Colowyo Coal Company**

Permit Number: **C-1981-019**

Date: **November 1, 2021**

Revision Description: **TR-150 Salinity Study**

Volume Number	Page, Map or other Permit Entry to be REMOVED	Page, Map or other Permit Entry to be ADDED	Description of Change
1	Page 2.04-22 (1 page)	Page 2.04-22 (1 page)	A change was made to clarify some ponds at Colowyo are nondischarging structures.
1	Pages 2.04-37 through 2.04-69 (33 pages)	Pages 2.04-37 through 2.04-70 (34 pages)	Text and a citation to the salinity study has been inserted into Section 2.04.7 which caused a pagination shift.
2A			No Change
2B	Page Exh. 7-14TOC-1 (1 page)	Page Exh. 7-14TOC-1 (1 page)	Volume 2B list of exhibits has been updated.
2C	Page Exh. 7-14TOC-1 (1 page)	Page Exh. 7-14TOC-1 (1 page)	Volume 2B list of exhibits has been updated.
2D	Page Exh. 7-14TOC-1 (1 page)	Page Exh. 7-14TOC-1 (1 page)	Volume 2B list of exhibits has been updated.
2E	Page Exh. 7-14TOC-1 (1 page)	Page Exh. 7-14TOC-1 (1 page)	Volume 2B list of exhibits has been updated.
3			No Change
4			No Change
4			No Change
5A			No Change
5B			No Change
6			No Change
7			No Change
8			No Change
9			No Change
10			No Change
12	South Taylor/Lower Wilson - Rule 2, Page 26 (1 page)	South Taylor/Lower Wilson - Rule 2, Page 26 (1 page)	Water right on Taylor Creek has been added.
13			No Change
14			No Change
15			No Change
16			No Change
17			No Change
18A			No Change

CHANGE SHEET FOR PERMIT REVISIONS, TECHNICAL REVISION, AND MINOR REVISIONS

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18B					No Change
18C					No Change
18D					No Change
19					No Change
20					No Change
21					No Change
22					No Change

available in the Annual Reclamation and Hydrology Reports submitted to the CDRMS for the period 1983 through the present.

Permit Area

Surface water in the mine area is limited to Streeter Gulch, Streeter Pond, East Taylor Gulch, East Taylor Pond, West Pit Pond, Warehouse Pond and sediment sump, Work Area Pond, three evaporative sewage ponds, Section 16 Pond, Prospect Pond, West Taylor Pond, and Section 28 Pond. Three additional detention ponds are located at the Loadout Area. All ponds, with the exception of the warehouse/sewage pond complex, are sedimentation ponds and respond only to runoff related events. The ponds are designed to treat the 10-year, 24-hour precipitation event, or fully contain the 100-year, 24-hour precipitation event. Additionally, water flowing off of the reclaimed lands is retained by contour furrows, revegetated slopes and a number of small depressions/stock ponds. A number of permanent drainage channels and temporary drainage channels will also be incorporated into the final reclaimed landscape to route water efficiently to sediment ponds. Refer to Map 12 and Map 12A and Exhibit 7 for the location and information about these various pond, depressions and ditch structures.

Surface Water Quality

General Area

Surface water quantity in the general area is variable and inconsistent from drainage to drainage. Drainages in the general area have not received the attention that the drainages adjacent to and within the permit area have received because there is no hydrologic connection between these areas. Flow estimates and water balance calculations for these areas have not been examined because they will not be disturbed by the Colowyo Mine.

Permit Area

The drainages that have been the most intensively studied in and adjacent to the mine area include Taylor Creek, Goodspring Creek and Wilson Creek. Continuous flow recorders have been maintained on Taylor Creek and Wilson Creek by the USGS since 1974. A continuous recorder was operated on Goodspring Creek from 1974 to 1978. The flow information resulting from these gages is presented in Table 2.04.7-8.

These data reflect the highly variable nature of surface flows in the drainages. Taylor Creek, the intermittent stream, had mean monthly flows of 0.0 cubic feet per second (cfs) for much of the period of record. Mean flows greater than 0.0 cfs were extremely low and reached a peak of 2.80 cfs in May 1980 reflecting the high snowmelt generated runoff. The maximum and minimum monthly flows also included for Taylor Creek give a further insight into its dependence on snowmelt and rainstorm runoff. This information supports the contention of very limited groundwater seepage to sustain flows near the mining area. The maximum daily flow value of 18.00 cfs in February, 1980 was a result of high snowmelt runoff and rainfall on a melting snowpack. Minimum flows of 0.0 cfs again reflect the highly sporadic nature and intermittency of this stream.

A study was conducted in 2021 to invesigate potential salinity impacts to irrigation waters from mine discharges within Goodspring Creek. Irrigation water is obtained from Goodspring Creek down gradient of Colowyo's lowest discharge point on Goodspring Creek, and is used to irrigate pastures below Colowyo's mining operations. The study presented in Volume 2B Exhibit 7 Item 16 demonstrates that material damage to the pastures is not occurring from use of irrigation water that is comingled with water discharged from Colowyo's sediment ponds and native water flowing in Good Spring Creek.

Effects of Mining on Water Rights

No significant effect will occur to surface or ground water rights in or adjacent to the Colowyo Mine. Water consumed by Colowyo as a part of their water rights will be done in accordance with the Colowyo Water Augmentation Plan approved by the Colorado State Engineer's Office and the Division of Water Court.

Hydrologic Balance

Postmining Drainage

The initial excavation from the mined area was placed in the Streeter Fill, and subsequent excavation is being placed in the area where mining has been completed. Similarly, as mining proceeds into the upper reaches of Streeter Gulch, Gulch A, and Prospects Gulch, overburden material will be backfilled in the mined area adjacent to Gulch A initially, followed by backfilling and reclaiming the areas as mining activities are completed. Later, as the mining proceeds into the area adjacent to a tributary of Taylor Creek, the areas will be progressively mined and backfilled by successively mined overburden and interburden. The final configuration after all mining is completed will be that the entire area will approximate the original topography with some minor variations. These minor variations, which will have no significant affect on the overall hydrology, are the Streeter Gulch mine fill, the West Pit mine fill, a small fill area in Section 16 and the final area in section 16 and adjacent to Taylor Creek, which will be lower than the original ground.

Drainage of the mined and backfilled areas will be accomplished by diverting drainage through berm ditches to the reconstructed channels. See Map 19 for channel locations. Berm ditches will be used on all 3:1 reclaimed slopes, including the areas that are not a part of the Streeter Fill. The ditches will be built by cut and fill construction, and will flow towards the permanent mine drainages. The design for berm ditches will be 12 feet wide, slope towards the fill at a minimum of 10%, have a longitudinal grade of 2%, and be located approximately every 100 feet of elevation. These berm ditches are constructed to control the runoff from the reclaimed areas. The replaced topsoil and regraded spoils (especially on 3:1 slopes) are quite susceptible to erosion until vegetation is reestablished. Therefore, the berm ditches will provide protection against excessive topsoil loss during the initial period of revegetation. It is expected that these berm ditches will slowly silt up over a period of years.

All premining drainages with defined channels, except some minor drainages, will be restored to approximately their historic drainage condition. Two tributaries to Streeter Gulch, Streeter Gulch and the upper reaches of Gulch A will be reconstructed in approximately their historic location.

The upper reaches of Prospects Gulch will be reconstructed in its approximate original location. The reconstructed channel will tie into the existing drainage at the disturbance limit and route water to a sediment pond at the base of Prospects Gulch. The final pit for the East Pit multiple seam operation will be adjacent to an un-named tributary to Goodspring Creek. The upper reaches, above the disturbance limits, of this un-named tributary will be reconstructed slightly south of the original location. This ditch will drain the Final East Pit area to a diversion that routes the drainage to the proposed Prospect Pond.

In the West Pit area the tributary to Taylor Creek will be reconstructed along the length of the disturbance. Also in the West Pit area, three additional ditches will be constructed including the West Pit Fill Ditch, the Gulch B Ditch, and the Final West Pit Ditch. other diversion ditches, built on existing natural ground, to collect and route runoff from disturbed areas include the North Prospects Ditch, the South Collection Ditch, Section 16 West Ditch and Section 16 North Ditch. It should be noted that once the West Pit is developed the Section 16 West Ditch, the Section 16 North Ditch, and the Temporary Section 16 Pond will no longer be needed. See Map 19 for the locations of all drainages.

The stream channels of Wilson, Taylor and Goodspring Creek will be undisturbed. Although there will be some changes in the areas tributary to the intermittent and ephemeral drainages in the vicinity of the mine, there will be no, change in the major drainage areas tributary to Goodspring Creek, Taylor Creek or Wilson Creek. Premining and postmining tributary areas for the various drainage basins are summarized as follows:

	Estimated Tributary Areas Acres		
Basin	Premining	Postmining	Differences
Goodspring Creek	25,600	25,600	0
Tributaries to Goodspring Creek:			
Streeter Gulch	1,424	1,186	-238
Gulch "A"	419	648	+229
Prospect Gulch and Other Drainages	905	881	- 24
Taylor Creek	3,977	3,977	0
Tributaries to Taylor Creek:			
Taylor tributary	1,379	1,403	+ 24

All of the mining area drainages have been designed in accordance with the Colorado Mined Land Reclamation Board's regulations. Particular attention has been given to the design of the permanent channels draining Streeter Fill, the Gulch A mine area and the unnamed tributary to Taylor Creek.

When designing channels constructed in erodible material, several criteria must be met. The channel must have adequate capacity to carry the maximum flow (in this case the runoff from the 100-year, 24-hour precipitation event) and it must have adequate stability to resist the erosive action of flowing water under all flow conditions. There are two main design procedures for insuring the stability of erodible channels. One procedure is based on a limiting velocity concept and the other on a limiting tractive force concept. Table 2.04.7-24 shows allowable velocities and tractive force values for several kinds of channels. This table is taken from Lane (1955) and is based on the work of Forier and Scobey (1926).

When using the limiting velocity concept, one sizes the channel so that it has adequate capacity and so that the average velocity does not exceed the permissible velocity for any given material. It is estimated this maximum allowable non-erosive velocity in the Colowyo mine area is approximately 6 feet per second.

When using the limiting tractive force concept, a channel with adequate capacity will not erode if its average shear stress (given by the equation, shear stress is equal to the unit weight of the fluid times the hydraulic radius of the channel times the slope of the channel in ft/ft) is equal to or less than the permissible tractive force for any given material. It is estimated this maximum allowable tractive force is approximately 0.7 lbs. per square foot at the Colowyo Mine site.

It can be seen that the allowable velocities and tractive forces for erodible channels are quite small, thus requiring very wide shallow channels for the slopes at the Colowyo Mine. This type of channel would appear unnatural and becomes unacceptable as rill erosion and gullying would develop in the channel bottoms during the low flows associated with precipitation events less than the given design storm. On the other hand, if the channel is protected from erosion, the allowable velocities can be increased resulting in a deeper, narrower and more natural looking channel. An effective and permanent form of protection is rock riprap lining of channels in those sections with excessive velocities or tractive forces.

An examination of the premining and postmining stream profiles show that the stream gradients, while at somewhat different elevations, are very similar (see Map 33). The original stream channels in steep slopes had scatterings of rock, boulders and debris. Frequently these channels were into bedrock, providing a stable channel. It should be kept in mind that the original streams had developed over centuries to reach this state of dynamic equilibrium. The mining operation necessarily removes the bedrock in its natural state, and it is replaced in an unconsolidated condition. While it is impossible for the mining and reclamation operation to reconstruct the stabilizing affects of these drainages in bedrock, it is possible and desirable to recreate the stabilizing affects of the rock protection. This method has been elected to armor and stabilize the permanent stream channels constructed or to be constructed at the Colowyo Mine site. A summary of these channels is presented below, and the location of the areas to receive rock riprap protection are shown on Map 12- Hydrology, South.

	Length of Drainage Channels – Feet		
Destination	Unprotected	Rock Protected	Total
Southwest Tributary to Streeter	0	3,200	3,200
South East Tributary to Streeter	2,500	4,000	6,500
Streeter Gulch	5,700	13,000	18,700
Section 11 Ditch	0	1,000	1,000

Prospect	1,400	2,200	3,600
Final East Pit	1,200	4,600	5,800
Section 16 Fill	0	900	900
South Connection	0	1,200	1,200
West Pit	2,700	14,300	17,000
Taylor Tributary	2,500	11,500	14,000
West Pit Fill	1,300	5,000	6,300
Permanent Drainage Channels			
Total	17,300	60,900	78,200

This rock riprap protection in the channels on steep slopes will pass the intermittent low flows normally found in the area and approximate the original cascading flows while protecting the channel during the infrequent high flows the design event is likely to produce. Given time, vegetation will encroach portions of these channels, debris will accumulate and the stream will again reach a state of dynamic equilibrium. Calculation for rock riprap sizing and gradation are found in Exhibit 7.

Selected References

Bishop, M., Kelly, K., Kimball, D. and G. Quinn 1982 Cumulative hydrologic assessment: Effects of coal mining on the Yampa River basin, Moffat and Routt Counties, Colorado. Report to U.S. Department of Interior Office of Surface Mining and Colorado Department of Natural Resources Mined Land Reclamation Division. KT-81-031 (R). January.

EMRIA Report No. 3-1975. Resource and potential reclamation evaluation: Taylor Creek study site Axial Basin coal field.

Giles, T.F. and R.E. Brogden 1978. Selected hydrologic data, Yampa River basin and parts of the White River basin, Northwestern Colorado and Southcentral Wyoming. USGS Open-file Report 78-23.

Leonard Rice Consulting Water Engineers 1979. Ground water quality Colowyo Coal Mine. October 1979.

NAS 1972. National Academy of Sciences Water Quality Criteria, 1972. U.S. Government Printing Office, Washington, D.C.

Parker, R.S. and J.T. Turk 1981. Water quality characteristics of six small, semiarid watersheds in the Green River coal region of Colorado. USGS Water Resources Investigation 81-19.

Skogerboe, R.K., Lavallee, C.S., Miller, M.M. and D.L. Dick. 1979. Environmental effects of western coal surface mining: Part III - The water quality of Trout Creek, Colorado. USEPA, EPA-600/3-79-008. January.

Shiffler, W.D. and R.A. Rhodes 1981. Hydrologic and erosional characteristics of regraded surface coal mined land in Colorado. Department of Earth Resources, Colorado State University, Ft. Collins, CO.

VTN 1975. Environmental impact assessment for the proposed Colowyo Mine, Colowyo Coal Company. December.

USFWS 1977. An indexed, annotated bibliography of the endangered and threatened fishes of the Upper Colorado River system. U.S. Fish and Wildlife Service FWS/OBS-77/61. October.

2.04.8 Climatological Information

The closest active reporting stations to the permit area are at Craig, Colorado, which is about 28 miles northeast of the area and at Meeker, Colorado, which is about 20 miles south of the area. Information from both locations is presented herein to provide the best data as related to the permit area and to indicate the variability in climatological characteristics that may be expected within short distances. Also, the data collected at the Colowyo mine site are presented.

The climate of the area can be described as typical of a high plains, continental, mid-latitude region with warm summers and cold winters characterized by high diurnal and seasonal temperature variations. The low relative humidity usually makes the hot summer days pleasant. The summer nights are generally cool because of strong out-going terrestrial radiation. The combination of dry air and strong solar radiation tempers the cold temperatures of winter days.

The outstanding characteristic of the climate of northwest Colorado is its aridity and is sometimes referred to as semi-arid steppe. The flow of Pacific air dominating the climate descends into the area as a warming and drying mass after depositing its moisture over the western slopes of the Sierra Nevada and Cascade Mountains. A large rain shadow is created over Nevada, Utah, and western -Colorado by the clocking action of these natural barriers to the moist, maritime air.

Intense cold waves are rare because of the barriers created by the mountains of the Continental Divide. Generally, severe storms and low pressure systems bypass the region by deflecting north or south over lower elevations of the Rocky Mountains in Wyoming and New Mexico, respectively. The predominant air mass over the Rocky Mountains during the winter is usually continental polar and sometimes maritime polar and produces cold, dry air during stormfree periods. High pressure systems that result in fine, light, powdery snow tend to become established in winter over the region which lies within the mean winter storm track.

During the summer months, the air masses are generally maritime polar and, much less often, continental tropical. This region is usually south of the main storm track in the summer; however, localized thundershowers do occur primarily during the afternoon, if a moisture supply is available either locally or in the air mass.

Precipitation

Precipitation information for Craig and Meeker is shown in Table 2.04.8-1, Monthly Normals of Temperature and Precipitation (1941-1970), in Table 2.04.8-2 Monthly Precipitation (1971-1979) for Craig, Colorado and Table 2.04.8-3, Monthly Precipitation (1971-1979) for Meeker, Colorado.

Temperature

Temperature data for Craig and Meeker are presented in Table 2.04.8-1, Monthly Normals of Temperature and Precipitation (1941-1970), in Table 2.04.8-4, Monthly Average Temperature (1971-1979) for Craig, Colorado and in Table 2.04.8-5, Monthly Average Temperature (1971-1979) for Meeker, Colorado. Based on data collected by the United States Department of Commerce, the mean annual temperature of Craig is 42.4°F while the mean annual temperature at Meeker is 44.2°F. Mean maximum and minimum monthly temperatures for both Craig and Meeker are shown in Table 2.04.8-6, Temperature Summary - Means.

Wind

The synoptic flow in the area is characterized by prevailing westerly winds, which influence air quality in the region. The direction and speed of the winds are greatly affected by the local topography.

The general area contains two large drainage basins: the Yampa River Basin and the Williams Fork River drainage system. The Yampa Valley forms a broad canyon which channels the airflow into an east-west orientation reflecting upslope and downslope motion. Similar upslope-downslope wind flow exists in the Williams Fork Valley. The flow draining this Valley is directed northwardly along the high ground west of Craig prior to joining the main stream flowing up and down the Yampa Valley at the end of the ridge.

The high frequency of near-calm conditions exists because of the protection afforded by the local terrain in most of the valleys. These conditions generally occur at night and in the early morning. The strongest winds in the area can be expected during the winter and early spring, especially in March, and briefly during summer thunderstorms.

The prevailing winds over most of the permit area will be from the southwest at an average speed of approximately 8 to 9 miles per hour; some 10 to 15 percent of the time the wind will blow out of the northeast. Strong winds will occur due to cold fronts and thunderstorms moving through the area, but fair weather winds will rarely exceed 20 to 25 miles per hour.

Meteorological Work at Colowyo

Site specific meteorology and total suspended particulate analyses for the Colowyo operation are set forth in Exhibit 8, Air Quality Information under the title of "Report of Site Meteorology and Total Suspended Particulate Studies." This one year baseline monitoring program was conducted by Western Scientific Services, Inc. of Fort Collins, Colorado during 1976.

Site-specific precipitation data obtained at the Colowyo operation are presented in Table 2.04.8-7, Monthly Precipitation - Colowyo Permit Area.

Representative wind roses are set forth in Figure 2.04.8-1, Wind Rose – Mine Site and Figure 2.04.8-2, Wind Rose – Gossard Loadout.

2.04.9 Soils Resource Information

Much of the area within the permit boundary to be disturbed by mining is covered by soils that provide an excellent source of plant growth media. They are deep, dark brown loam and clay loam soils with physical and chemical properties that are generally well suited for revegetation. The percentage of organic: matter is suitable; the cation exchange capacity is normal to high; the soil texture and structure is adequate for moisture retention and aeration; the salt content is low; and the sodium absorption ratio is low.

A portion of the area is covered by soils that are comparatively less desirable because they are shallow and stoney, or have subsurface soils that are heavy clays with a hard columnar structure and sticky, plastic properties.

The soils in the permit area are extremely variable, depending upon slope, aspect, parent material, and location on the slope. Soil series mapping and descriptions are presented for use in generalized volume calculations and general reclamation potential evaluations. The soils within each series are so variable that on the ground staking of each soil series would not be useful for topsoil removal, and would most likely result in a poor job of topsoil removal. Actual soil removal is determined at each site by close coordination between reclamation personnel and equipment operators.

The potential of each soil for use in reclamation is essentially the same as its current potential. The shallow rocky or clay soils that currently produce very little vegetation will not be very useful for reclamation purposes, and the deep loamy soils will provide an excellent source of plant growth media. It is quite possible that the overall productivity of the area to be mined could be increased. During the topsoil removal process, the smaller amounts of poorer soils will become mixed with good soils, and currently unproductive areas may become more productive.

Detailed data on chemical and physical characteristics are only presented for the soils in the area to be mined. The disturbances associated with facility construction on lands adjacent to the mining area are very small in size for each soil type, currently no additional facilities are planned at the Colowyo mine.

Twelve (12) soil series as mapped by the Soil Conservation Service (SCS) are found within the permit area. They are as follows.

03B	Havre Fine Sandy Loam
14	Burnette Loam
17	Work Loam
19	Campspass
28	Forelle Loam

32	Yamac Loam
33	Pinelli Loam
101	Torriorthents – Rock Outcrop Complex
104	Borolls – Rock Outcrop Complex
105	Kemmerer – Moyerson – Silty Clay Loams
X-110	Kemmerer – Yamac Complex
RL	Rock Ledge

The soil series are delineated on the Soils - North Map (Map 5) and the Soils - South Map (Map 6).

Soil profile descriptions and Range Site Descriptions from information provided by Soil Conservation Service are found in Exhibit 9, Soils Information.
The descriptions of the soils series are as follows:

<u>03B – Havre Fine Sandy Loam, 0 to 5 Percent Slopes</u>

This is a deep, well drained soil that occurs along drainage ways in and adjacent to the permit area. A very small area (about: 1 acre) of this series was disturbed by the access road, no additional activity is anticipated on areas of this series. Therefore, detailed chemical and physical data has not been collected for this series. It developed in stratified alluvium from sandstone and shale and is on flood plains and terraces. The average annual precipitation ranges from 12 to 16 inches, the average annual soil temperature is 42° to 47°F, and the frost-free season is 75 to 95 days.

Included with this soil in mapping are small areas of Homelake, Glendive, and Havre saline phase soils.

Typically the surface layer is a dark gray fine sandy loam about 3 inches thick. The substratum is calcareous and stratified with colors of gray, light brownish gray, and pale brown. Textures are fine sandy loam, loam, sandy clay loam, silt loam, and silty clay loam. Mottling may occur below 40 inches.

Permeability is moderate. The available water capacity is high. Effective rooting depth of 60 inches or more. Surface runoff is slow, and the erosion hazard is moderate from wind and low from water.

Most of this mapping unit is used for non-irrigated and irrigated hay and pasture. Present and potential productivity of the soil is good.

<u>14E – Burnette Loam, 12 to 25 Percent Slopes</u>

This is a deep, well drained soil that occurs throughout the area to be mined. This soil provides the best and most abundant source of plant growth medium of the soils in the permit area. The depth of useable soil is extremely variable, depending upon slope and location, and in the bottom of the Streeter drainage the A horizon has been found to be as thick as twenty (20) feet. The soil developed in mixed sandstone and shale and is found on upland valley sideslopes and benches.

The average annual precipitation ranges from 16 to 18 inches, the average annual soil temperature is 43°F to 45°F, the mean summer soil temperature is 56 to 56°F., and the frost-free season is 70 to 90 days.

Included within this mapping unit are a few small areas of sandstone or shale outcrops and small areas of Work and Campspass soils.

The duff layer consists of decomposed and undecomposed leaves, twigs, and grass. Typically the surface layer is a dark grayish brown loam about 20 inches thick. The subsoil is a light yellowish brown clay loam about 25 inches thick. The substratum is a light yellowish brown clay loam to a depth of 60 inches.

Permeability is moderate. The available water capacity is high. Effective rooting depth is 60 inches or more. Surface runoff is slow, and the erosion hazard is moderate from wind and high from water.

Most of this mapping unit is native range and used for grazing. Present and potential productivity of this soil is good.

14F – Burnette Loam, 25 to 65 Percent Slopes

This soil has the same characteristic as the previous soil, except it is found on steeper slopes. It developed in mixed sandstone and shale and is on upland valley sideslopes. The average annual precipitation ranges from 16 to 18 inches, the average annual soil temperature is 43°F to 45°F, the mean summer temperature is 56°F to 59°F, and the frost-free season is 75 to 90 days.

Included with this soil in mapping are a few small areas of sandstone and shale outcrops, shallow soils over sandstone, and small areas of work soils.

The duff layer is decomposed and undecomposed leaves, twigs, and grass. Typically the surface layer is a dark grayish brown loam about 20 inches thick. The subsoil is a light yellowish brown clay loam about 25 inches thick. The substratum is a light yellowish brown clay loam to a depth of 60 inches.

Permeability is moderate. The available water capacity is high. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the erosion hazard is moderate from wind and high from water.

Most of this mapping unit is native range and used for grazing. Present and potential productivity of this soil is good.

17D – Work Loam, 3 to 12 Percent Slopes

This is a deep, well drained soil that is found throughout the permit area. The soil is very useful for reclamation purposes, and its usefulness is limited only by its clay content. Mixing of this soil may prove beneficial, as the heavy, textured horizons will be mixed with lighter textured horizons.

The soil developed in interbedded sandstone and shale and is on upland benches and sideslopes. The average annual precipitation ranges from 16 to 18 inches, the average annual soil temperature is 43°F to 46°F, and -the frost-free season is 75 to 95 days.

Included with this soil in mapping are a few small areas of Regent, Burnette, and Campspass soils.

Typically the surface layer is a grayish brown loam about 7 inches thick. The upper subsoil is a brown heavy clay loam about 22 inches thick. The lower subsoil is a yellowish brown clay loam about 30 inches thick. It is calcareous below about 47 inches.

Permeability is moderate. The available water capacity is high. Effective rooting depth is 60 inches or more. Surface runoffs slow, and the erosion hazard is moderate from wind and water.

Most of this mapping unit is native range and used for grazing. Present and potential productivity of this soil is good.

17E – Work Loam, 12 to 25 Percent Slopes

This soil has the same characteristics as the previous soil, except that it is found on steeper slopes. The soil developed in interbedded sandstone and shale and is found on upland benches and sideslopes. The average annual precipitation ranges from 16 to 18 inches, the average annual soil temperature is 43°F to 46°F, and the frost-free season is 75 to 95 days.

Included with this soil in mapping are a few small areas of Burnette and Regent soils.

Typically the surface layer is a grayish brown loam about 7 inches thick. The upper part of the subsoil is a brown heavy clay loam about 22 inches thick. The soil is calcareous below about 47 inches.

Permeability is moderate. The available water capacity is high. Effective rooting depth is 60 inches or more. Surface runoff is medium and the erosion hazard is moderate from wind and high from water.

Most of this mapping unit is native range and used for grazing. Present and potential productivity of this soil is good.

19E Campspass Fine Sandy Loam, 12 to 25 Percent Slopes

This is a deep, well drained soil that occurs throughout the permit area. Only the surface soil of this series is acceptable for reclamation purposes. The usefulness of the subsurface soil is limited by its high clay content. It developed in interbedded sandstone and shale and is on upland valley sideslopes. The average annual precipitation ranges from 15 to 18 inches, the average annual soil temperature is 42°F to 47°F, and the frost-free season is 75 to 95 days.

Typically the surface layer is a grayish brown fine sandy loam about 2 inches thick. The subsurface layer is light brownish gray fine sandy loam about 2 inches thick. The subsoil is light brownish gray heavy clay loam about 27 inches thick. The subsoil is calcareous in the lower 7 inches. The substratum is gray heavy clay loam about 30 inches thick. It is calcareous. The surface layer may be absent.

Permeability is slow. The availability water capacity is high. Effective rooting depth is 60 inches or more. Surface runoff is rapid, and the erosion hazard is high from wind and water.

Most of this mapping unit is native range and used for grazing. Present and potential productivity of this soil is fair.

<u>28D – Forelle Loam, 3 to 12 Percent Slopes</u>

This is a deep, well drained soil that occurs in very limited areas at the north end of the permit area. A small area (less than 5 acres) of this series was disturbed by the access road. No additional activities are planned on areas with this soil series, therefore detailed chemical and physical data has not been collected for this soil type. The soil developed in mixed aeolian materials and is found on gently to moderately sloping terraces. The average annual precipitation ranges from 12 to 15 inches, -the average annual soil temperature is 42°F to 47°F, and the frost-free season is 75 to 95 days.

Included with this soil in mapping are a few small areas of Yamac and Pinelli soils.

Typically the surface layer is a grayish brown loam about 5 inches thick. The subsoil is a light brownish gray clay loam about 16 inches thick. The substratum is a light grayish brown loam to a depth of about 60 inches.

Permeability is slow. The available water capacity is high. Effective rooting depth is 60 inches or more. Surface runoff is medium, and the erosion hazard is moderate from wind and water.

Most of this mapping unit is cultivated and used for non-irrigated small grains. Present and potential productivity of this soil is fair.

<u>32D-Yamac Loam, 5 to 15 Percent Slopes</u>

This is a deep, well drained soil that occurs at the northern edge of the permit area. A portion of the unit train loadout facility was constructed on an area of this soil series. No additional disturbances are anticipated on areas with this soil series, therefore detailed data on chemical and physical characteristics are not presented. The soil developed in weathered sandstone, siltstone and windlain materials, and is found on upland ridges and benches. The average annual precipitation ranges from 12 to 15 inches, the average annual soil temperature is 42° to 47°F, and the frost-free season is 75 to 95 days.
Included with this soil in mapping are a few small areas of Forelle soils.

Typically the surface layer is a pale brown loam about five inches thick. The subsoil is a pale brown loam about 10 inches thick. The substratum is a pale brown to very pale brown loam to a depth of about 60 inches. Permeability is moderate. The available water capacity is high. Effective rooting depth is 60 inches or more. Surface runoff is medium, and the erosion hazard is medium from wind and water.

Most of this mapping unit is native range and used for grazing. Present and potential productivity of this soil is fair.

33D - Pinelli Loam, 3 to 15 Percent Slopes

This is a deep, well drained soil that occurs at the north edge of the permit area. A portion of the railroad loadout loop was constructed on an area of this soil series. No additional disturbances are anticipated in areas of this soil series; therefore, no detailed chemical or physical data has been collected. The soil developed in local reworked alluvium and is found on upland benches and in swells. The average annual precipitation ranges from 12 to 15 inches, the average annual soil temperature is 42°F to 45°F, and the frost-free season is 75 to 95 days.

Included with this soil in mapping are few small areas that are 40 to 60 inches over soft shale and small areas of Forelle and Evanston sails on north slopes or slightly steeper areas.

Typically the surface layer is a brown loam about 6 inches thick. The subsoil is a yellowish brown heavy clay loam about: 17 inches thick and is calcareous in the lower part. The substratum is; a light yellowish brown clay loam and is calcareous.

Permeability is slow. The available water capacity is high. Effective rooting depth is 60 inches or more. Surface: runoff is moderate, and the erosion hazard is moderate from wind and water.

Most of this mapping unit is cultivated and used for non-irrigated small grains. Some of the area is native range and is used for grazing. Present and potential productivity of this soil is fair.

101 – Torriorthents – Rock Outcrop, Complex

This strongly sloping to very steep complex is on terrace and escarpment faces and valley sideslopes throughout the permit area. Soils are extremely variable in this series. Much of the area has parent material to the surface and is not useful for reclamation purposes. Useable solids are found in isolated pockets throughout this series. Because of the variability of the soils in this series, no detailed chemical or physical data has been collected. The average annual precipitation ranges from 13 to 16 inches, the average annual soil temperature is 42°F to 47°F, and the frost=free season is 75 to 95 days. The Torriorthents make up about 50 percent of this complex and occupy small colluvial fans, toeslopes, and areas of weathered shale. The Rock outcrop part makes up about 40 percent of this complex and occupies vertical ledges, ridgetops and steeper sideslopes. Included with this complex in mapping are a few small- areas of exposed shale ledges, with Rock river and Yamac soils in toeslope positions which make -up the other 10 percent.

The Torriorthents part consists of shallow to moderately deep, coarse to medium textured, stoney and cobbly, well drained soils over sandstone and shale at depths of 10 to 40 inches. These soils have light colored surface and substratum layers, with moderate to rapid permeability, low available water capacity, a moderate wind erosion hazard, and a high water erosion hazard.

The Rock outcrop part is predominantly sandstone in long narrow bands with colluvial stones, cobbles and boulders at the base.

Most of this complex is in native range and has limited use for grazing. Present and potential productivity is poor.

104 – Borolls-Rock Outcrop Complex

This moderately steep to very steep complex is on north and west valley sideslopes and ridges. The soil occurs throughout the permit area. In the areas where rock outcrop do not occur, the solids have a good potential for reclamation. The average annual precipitation ranges from 15 to 18 inches, the average annual soil temperature is 42°F to 47°F, and the frost-free season is 75 to 95 days. The Borolls make up about 50 percent of this complex and occupy lesser slopes. The Sandstone Rock outcrop part makes up about 30 percent of this complex and occupies steeper slopes and ridgetops. Included with this complex in mapping are a few small areas of shale outcrops and shallow shale soils which make up the other 20 percent.

The Borolls are shallow to deep, medium to fine textured, well drained soils over interbedded sandstone and shale at a depth of 10 to 60 inches. They may be cobble or stone filled.

Typically the surface layer is dark grayish brown sandy loam or loam from 8 to 20 inches thick. The subsoil, where present, is grayish brown sandy clay loam, or clay from 10 to 20 inches thick. The substratum is light brownish gray sandy loam or sandy clay loam. Soft interbedded sandstone and shale are at depths ranging from 10 to more than 60 inches.

The Boroll portion has moderate to rapid permeability and the available water capacity ranges from low to high. The effective rooting depth is from 10 to 60 inches or more. Surface runoff is medium, and erosion hazard is slight to moderate from wind and high from water. Most of the Boroll portion is native range and used for grazing. Present and potential productivity is poor.

105 – Kemmerer-Moyerson Silty Clay Loams, 20 to 40 Percent Slopes

These moderately steep and steep soils are on foothill ridge crests and sideslopes near the center of the permit area. A very small area (less than 1 acre) of this series was disturbed by the access road. No additional activities are planned in areas covered by this soil, therefore detailed chemical and physical data has not been collected for this series. The average annual precipitation is about 13 to 16 inches, the average annual air temperature is about 45°F. Kemmerer soil makes up about 45 percent of the mapping unit and Moyerson soil about 40 percent. Small areas of a soil similar to Kemmerer soil but is deep, and Pinelli soils make up the other 15 percent.

Kemmerer soil is a moderately deep, well drained soil. It is formed in weathered residuum from Mancos shale.

Typically the surface layer is a light brownish gray silty clay loam about 3 inches thick. The substratum is a light brownish gray silty clay and overlies soft Mancos shale at a depth of 28 inches.

Permeability is slow and available water capacity is low. Surface runoff is rapid, and erosion hazard is moderate.

Moyerson soil is a shallow, well drained soil. It is formed in residuum in Mancos shale.

Typically the surface layer is a light gray silty clay loam about 1 inch thick. The underlying material is a light brownish gray gravelly, silty clay loam and overlies soft Mancos shale at a depth of 17 inches.

105 – Kemmerer-Moyerson Silty Clay Loams

Permeability is slow and available water capacity is low. Surface runoff is rapid and erosion hazard is high. Most of this unit is native range and used for grazing. Present and potential productivity is poor.

X110-Kemmerer-Yamac complex

A small area (about 5 acres) of this soil complex was disturbed during construction of the access road and the Colowyo administration building.

No additional disturbance is anticipated in areas of this soil complex, and no detailed chemical or physical data have been collected.

The Yamac soil is a deep, well drained soil forming in loess and sandstone residiuum at a depth of 20 to 60 inches.

Typically the surface layer is pale brown loam about 5 inches thick. The subsoil is a pale brown loam about 10 inches thick. The substratum is calcareous, very pale brown loam or light clay loam.

The Yamac soil has moderate permeability and the available water capacity is high. The effective rooting depth is 60 inches or more. Surface runoff is moderately low, and erosion hazard is slight from wind and moderate from water.

Most of this complex is native range and used for grazing. Present and potential productivity is poor.

RL-Rock Outcrop

About 70 percent of the surface consists of barren rock exposures. Weakly developed coarse or medium textured soils and talus slopes make up the remaining 30 percent. The major portion of the unit is sandstone. A small area of this series has been disturbed as a source for road surfacing material near the north edge of the lease. No additional disturbance is anticipated, and no detailed chemical or physical data have been collected for this series. Present and potential productivity is poor.

Topsoil Suitability

Table 2.04.9-1, Suitable Topsoil Available for Reclamation, contains a Summary of the approximate depth of topsoil to be removed for each of the soil series. Table 2.04.9-2, Suitability as a Plant Growth Media of Soils by Horizon in the Area to be Mined, provides an approximate suitability by horizon for the major soils to be disturbed by mining.

The chemical and physical data for soils to be disturbed at the Colowyo mine site are shown in Table 2.04.9-3, Chemical and Physical Data for Soils Colowyo Mine. Soil sample locations are shown on the Soils - South Map (Map 6). The information was supplied by the Bureau of Reclamation Lab in Denver, Colorado.

Topsoil Removal

Soils information for the area to be mined has, in the past, been gathered by the Soil Conservation Service and the Bureau of Land Management. Information supplied by these two agencies has provided sufficient information concerning the soil resources available for reclamation at Colowyo. This information has been confirmed by reclamation personnel at the mine who have been closely monitoring topsoil removal operations since the initiation of mining in the fall of 1976.

Therefore, the amount of soil sampling and mapping is considered quite adequate for determining topsoil volume estimates. Any additional mapping and sampling would have no beneficial effect on topsoil volume estimates or reclamation operations at Colowyo.

The sequence of topsoil removal at the Colowyo Mine is shown on the Topsoil Handling Map (Map 28) and explained in detail in section 2.05.3 and 2.05.4.

Overall, topsoil removal will include all of the A horizon and B horizon material available which is not the heavy clay with the hard columnar structure and sticky, plastic properties less suitable for revegetation. Based on the topsoil volume calculations, and 12+ years of topsoil experience, we have confirmed that there is a sufficient quantity of more desirable horizons with loam and clay loam textures making it unnecessary to remove undesirable heavy clay horizons.

In addition, there are areas of rock outcrops or shallow and stoney soils where little or no suitable topsoil is available for removal. The shale or sandstone outcrops within the Work and Burnette mapping units comprise an insignificant area within these two units. Therefore, topsoil volume projections for these areas would not be affected to any significant amount.

During 2005, Colowyo modified the topsoil redistribution depth based on a volumetric analysis. This determination is provided in Rule 2.05 and the revised distribution depth is discussed in Rule 4.06.

2.04.10 Vegetation Information

Six vegetation communities and a small amount of cropland exist within the Colowyo permit boundary. The vegetation communities are sagebrush, mountain shrub, juniper, aspen woodland, riparian and grassland.

The approximate extent of the vegetation communities throughout the permit area is shown on Regional Vegetation Map (Map 3). The vegetation communities on the area to be disturbed by' mining are mapped in more detail on the Vegetation Map (Map 4). The amount of area comprising each type to be mined is found in Table 2.04.10-1, Vegetation Community Distribution on Areas to be Mined.

During the summer of 1980, an intensive vegetation study was completed covering the initial permit area to be disturbed by mining. The area to be mined consists, primarily, of the sagebrush and mountain shrub communities with small inclusions of aspen and grass.

During the summer of 1988 vegetation study was completed for the additional areas to be added to the permit. The additional areas to be mined consisted, primarily, of the sagebrush, mountain shrub and aspen communities.

Vegetative mapping was accomplished utilizing information from previous vegetation surveys in the area, the 1976 VTN Colorado Inc. study, color aerial photography and on the ground observations. Sampling locations were selected by using 300 foot by 300 foot numbered grid system covering the entire area to be sampled. Individual transect sites were sampled at random using the numbers from the grid system for each vegetation type. At each selected point, a 100 foot transect was laid out oriented in a randomly selected compass direction. Five random points along each transect were then selected for the quantitative vegetation sampling.

Herbaceous cover data was collected using a 10 point frame at each of the five points along the transect. The first hit by each pin on the herbaceous vegetation was then recorded by species.

Production samples were taken by clipping a 30cm x 60cm plot at each of the same five points along the transect. The clipped herbaceous vegetation was separated into grasses and forbs. There were no measurable amounts of annuals sampled. The samples were air dried then weighed. 60cm x 60cm plots were used for the 1988 data and samples were oven dried prior to weighing.

Woody plant density data was obtained by recording the numbers of woody plants along a three foot wide belt the entire 100 foot length of each transect.

Species composition and cover for the initial 1980 data is shown in Table 2.04.10-2, 1980 Herbaceous Cover by Species. The 1988 data is summarized in Table 2.04.10-3, 1988 Herbaceous Cover by Species. Summaries of the data can be found on Table 2.04.10-4, Summary of Herbaceous Cover.

Herbaceous productivity for the sagebrush, mountain shrub, and aspen communities is shown on Table 2.04.10-5, Production Data Summary.

Information pertaining to statistical tests to be performed for determination of revegetation success is contained in Section 4.15.
Woody plant density, by species, for the sagebrush, mountain shrub, and aspen communities is shown on Table 2.04.10-6, Woody Plant Density:

Following is a general description of each of the vegetation communities, including various environmental factors contributing to the distribution of the types. The relationships between soil particle size versus soil moisture and their combined effect on vegetation community distribution is illustrated on Figure 2.04.10-1, Environmental Gradient/Plant Tolerance Graph.

Sagebrush Community

The sagebrush community is characterized by almost complete dominance of the overstory by big sagebrush **(Artemisia tridentatel)**, and snowberry **(Symphoricarpos oreophilus)**, at a density of 2,739 and 1,822 plants per acre, respectively. The measurement of snowberry density is a very subjective measurement whereby large clumps of the species make actual measurement of individual plants along the transect very difficult. Therefore, the given density value is, at best, an approximation of actual density but still provides an indication of relative abundance in the overall vegetative community. For additional woody plant density values by species refer to Table 2.04.10-6, Woody Plant Density.

The growth form of the community is characterized by scattered shrubs of low to medium height, rarely exceeding four feet. Numerous areas of: open ground exist with various grasses and forbs comprising the understory. The most abundant grasses are western wheatgrass **(Agropyron smithii)**, Kentucky Bluegrass **(Poa pratensis)**, mountain brome **(Bromus marginatus)**, and green needlegrass **(Stipa viridula)**. The most abundant forbs are lupine **(Lupinus caudatus)**, wild onion **(Allium spp.)**, arrowleaf balsamroot **(Balsamorhiza sagittata)**, and yarrow **(Achillea lanulosa)**. During 1980 and 1989 the total herbaceous cover was determined to be 30.9% and 39.71% respectively. For details on cover of individual species refer to Table 2.04.10-2, 1980 Herbaceous Cover by Species and Table 2.04.10-3, 1988 Herbaceous Cover by Species.

During 1980 and 1988, total herbaceous production for the sagebrush community was determined to be 436.1 and 825 pounds per acre respectively. According to these production figures, the carrying capacity in animal unit months (AUMs) , assuming 1,000 pounds of air dry forage per AUM at 50% utilization, would be from 0.22 to .41 AUMs per acre. Based on the determination by the Bureau of Land Management of an average production of 0.14 AUMs per acre for the sagebrush type in this area, it is evident that the condition of the sagebrush community with the permit area is good. Grazing has not occurred from the initial lease area since 1977. Grazing on the permit area addition should be discontinued in 1991 with the construction of wire livestock fencing.

The sagebrush community is found throughout the permit area on all elevations, slopes and soils. On portions of the permit area where soil moisture retention and soil depth become limiting to the other vegetation communities, the sagebrush community develops. Snowberry will occur in greater numbers within the community where moisture retention is favorable.

For further details on Soil/Moisture relationships in determining vegetation communities refer to Figure 2.04.10-1, Environmental Gradient/Plant Tolerance Graph.

Mountain Shrub Community

The mountain shrub community is characterized by varying densities of serviceberry **(Amelanchier alnifolia)**, GambelI's oak **(Quercus gambelii)**, and chokecherry **(Prunus virginiana)**. During 1980 and 1988, overall woody plant density for the mountain shrub community was determined to be approximately 6,970 and 6,370 plants per acre respectively. The woody plant density for additional species is contained on Table 2.04.10-6, Woody Plant Density.

The density measurements for snowberry, involve many of the same problems in the mountain shrub community as encountered in the sagebrush community. Large clumps of snowberry were encountered making measurements of individual plants very difficult.

The growth form of this community is characterized by an overstory of shrubs ranging in height from two to twelve feet. Typically, serviceberry and Gambell's oak are the predominate overstory throughout the community. Serviceberry can be found in open to dense stands while Gambel's oak tend to be found-in dense stands. On north facing slopes and in drainages where soils are deeper with higher soil moisture conditions, moderately dense to dense stands of chokecherry are found. Throughout the mountain shrub community, snowberry is the most common associated shrub found in open to dense stands.

Numerous forbs and grasses occur in varied densities throughout this diverse community. The most abundant grasses are Kentucky bluegrass **(Poa pratensis)**, western wheatgrass and needle and thread grass **(Stipa comata)**. The most abundant forbs are lupine, yarrow, bedstraw **(Gallium spp.)**, and American vetch **(Vicia americana)**. For 1980 and 1988 the total herbaceous cover for the community was determined to be 41.9% and 56.67% respectively: For specific cover values for individual species refer to Table 2.04.10-2, 1980 Herbaceous Cover by Species and Table 2.04.10-3, 1988 Herbaceous Cover by Species

For 1980 and 1988, the total herbaceous production for the mountain shrub community was determined to be 569.0 and 933 pounds per acre respectively. According- to these production figures, the carrying capacity in AUM's, assuming 1,000 pounds of air dry forage per AUM at 50% utilization, would be .28 and .47 AUM's per acre.

Based on the determination by the Bureau of Land Management of an average production of .18 AUM's per acre for the mountain shrub type in this area it is evident that the condition of the mountain shrub community within the permit area is good.

Grazing has not occurred from the initial lease area since 1977 so it is anticipated that the condition of the mountain shrub community will remain stable or improve. Grazing on the permit area addition should be discontinued in 1991.

The mountain shrub community is typically found in the areas of higher soil moisture and deep, medium to fine textured soils on all slopes and aspects within the permit area. Generally, the areas with decreased soil moisture and shallower soils will tend towards elements of the sagebrush community in a diverse transition area.

For further details on soil/moisture relationships refer to Figure 2.04.10-1, Environmental Gradient/Plant Tolerance Graph.

Juniper Community

Within the permit area the juniper community is limited to the area around Mount Streeter and the bluffs along the lower portion of Taylor Creek and Goodspring Creek. The community is dominated by an open overstory of Utah juniper (Juniperus utahensis), rarely over 15 feet tall, with big sagebrush as a major associate.

The open understory contains a sparse population of grasses and forbs with the major species being Indian ricegrass (Oryzopsis hymenoides), bluebunch wheatgrass (Agropyron spicatum), prickly pear cactus (Opuntia polycantha), and lupine.

According to the 1975 USDI, BLM, EMRIA Taylor Creek Study, the herbaceous cover for the juniper community was determined to be 1.6 percent.

Overall, the productivity of the juniper community is low due to the combined effects of shallow to rocky soils, southerly aspect and steep, highly erodible slopes. Productivity, as determined by the BLM is .036 AUM's per acre for the juniper type in this area.

Only a limited amount of this vegetation community was disturbed mainly for material to be crushed for pit haul road use during the initial permit term.

Aspen Woodland Community

The aspen community is very limited within the permit area comprising less than to of the area to be mined. Groves of aspen occur within the upper reaches of Streeter and Taylor Creek watersheds in locations where snow melt continues to provide moisture later in the spring.

The aspen community is characterized by tall, dense groves of aspen (Populus tremuloides), as the primary upper level overstory with elements of the mountain shrub community, particularly serviceberry and chokecherry, as a secondary overstory.

The deep loamy soils combined with the favorable soil moisture condition continuing on into summer contribute to a rich, diverse and productive understory. Grasses and forbs are very prevalent with the dominates being Kentucky bluegrass, mountain brome, yarrow, prairie coneflowers, and American vetch.

According to 1988 sampling herbaceous cover was determine to be 73.00%. For additional details refer to Table 2.04.10-3, 1988 Herbaceous cover by species. Production sampling indicated 772 lbs/acre of herbaceous production. According to these production figures, the carrying capacity in AUM's, assuming 1000 pounds of air dry forage per AUM at 50% utilization, would be .39 AUM's per acre.

Productivity, as determined by the BIM, is .25 AUM's per acre for the aspen type in this area indicating that the condition of the mountain shrub community within the permit area is good.

As previously stated, the deep, loamy soils and high soil moisture conditions together with the generally northern aspect combine to provide the required conditions for the aspen community.

Where soil moisture becomes less plant available earlier into the summer, elements of the mountain shrub community begin to dominate. Generally, this occurs due to a change in aspect of the topography or shallower soil depth.

For further details on soil/moisture relationships in determining the aspen vegetation community refer to Figure 2.04.10-1, Environmental Gradient/Plant Tolerance Graph.

Riparian Community

Within the permit area the riparian community is very limited. The community is confined to areas along Good Spring Creek and Taylor Creek.

The community is characterized by a very limited overstory of a few isolated cottonwoods (Populus angustifolia), and boxelder trees (Aver negundo). Understory vegetation includes Wood's rose (Rosa woodsii), willows (Salix spp.), rushes (Juncus spp.), sedges (Carex spp.), and cattails (Typha spp.).

The riparian community is found along the drainage bottoms where soil moisture is abundant throughout the growing season. Soil texture ranges from fine clay to coarse, sandy loam soils. Elements of the sagebrush and mountain shrub communities are soon encountered adjacent to the riparian community where plant available moisture begins to decrease. For further details on Soil/Moisture relationships in determining the riparian vegetation community refer to Figure 2.04.10-1, Environmental Gradient/Plant Tolerance Graph.

Grassland Community

Within the permit area, the grassland community covers a very limited area. Small, isolated patches of almost exclusively western wheatgrass growing on heavy clay soils are scattered in the middle elevations of the southern part of the permit area. The community is of such limited extend (+/- 30 acres) that only mention of occurrence is contained here.

Cropland

Within the north end of the permit area a few areas of cropland are encountered at the southern edge of Axial Basin. The previous landowners removed the sagebrush and cultivated the land for winter wheat production.

The soils are primarily a clay loam texture on a flat to rolling topography. The area surrounding the croplands incorporates elements of the sagebrush community encountered throughout the rest of the permit area.

Rare and Endangered Plant Species

To date, vegetation surveys in the area conducted by numerous governmental agencies, private consultants, and Colowyo have failed to discover, or have indicated a potential occurrence of, any rare and endangered plant species within the permit area. Therefore, it is anticipated that there will be no potential for impacts.

During the 1997 Permit Renewal process the Division requested an up-to-date consideration of the latest (August 21, 1996) USFWS list of federal threatened and endangered (T&E) plant species. In particular the Piceance twinpod, *(Physaria obcordata)*. Graham beardtongue, *(Pensteon grahamii)*, White River beardtongue *(Penstemon scariosus* var. *albifluzis)*; Dudley Bluffs bladderpod *(esauerella concresta)* were recently listed as either listed as threatened or considered for listing. Subsequent discussions with local BLM officials confirmed that these species are endemic to areas along the White River and Piceance Basin and would not occur in the Colowyo area. For a copy of the BLM correspondence please see Exhibit 10 Vegetation Information.

2.04.11 Fish & Wildlife Resources Information

Rangeland makes up a major portion of the permit area and adjacent areas. The mountain shrub ecosystem supports substantial populations of big game, small game and a diverse complex of other mammals, birds, reptiles and amphibians.

Investigation of wildlife resources and their habitats were initiated in 1974 on the Colowyo Federal Coal Lease #D-034365 and surrounding areas under a contract with VTN, Colorado, Inc. Information from this early work, along with additional resources information and habitat requirements obtained from the Colorado Parks and Wildlife (CPW) and the U.S. Fish and Wildlife Service (USFWS), were presented in the Northwest Colorado Coal Environmental Statement. Additional site specific data collected by VTN through 1977, along with surveys and observations made by Colowyo personnel through 1980, have been included within this application.

In November 1985, Camp, Dresser and McKee, Inc. (CDM) completed the report "Wildlife Baseline Report for the Danforth l and 3 Federal Coal Leases" prepared for Consolidation Coal Company. The report in its entirety can be found in Exhibit 11, Wildlife Information.

The report provides an inventory of site specific and regional wildlife resources of the Danforth 1 and 3 Federal Coal Leases and vicinity and was complete April 1984 through June 1985. Existing background information was complemented by a year-long program of site-specific field studies.

Although the focus of the study is of a much broader regional scale than necessary for areas to be mined by Colowyo, it offers very valuable information to update the original baseline information in the initial Colowyo permit. In most cases the report serves to reconfirm many of the predictions initially made by Colowyo regarding the impacts of mining to local wildlife populations.

Colowyo has made every effort to coordinate all studies, management techniques, and habitat improvement programs with the State and Federal agencies having responsibility for managing wildlife habitat. Several meetings were held with USFWS and CPW personnel during 1979 and 1980 to discuss any additional resource information that is available and also to assess the management techniques employed by Colowyo.
CPW personnel were contacted November, 1990 regarding any significant updates on their Wildlife Value Maps. Map 14, Wildlife Agent Information was updated and reflects these changes.

The following wildlife resource information has been developed from five years of observations, site specific analysis, existing literature, contracts with wildlife biologists at other mines in northwest Colowyo, and numerous contacts with State and Federal Wildlife officials. Most of the following information remains virtually unchanged as submitted initially in the First Colowyo Permit Application. Notations are made where necessary to refer the reader to substantially updated information in the CDM November, 1985 report.

Wildlife Habitat Use Study

Colowyo initiated a revegetation and wildlife habitat use study in 1974 to determine the feasibility and techniques of revegetating with native shrub revegetation adapted to the mine site. The study consisted of two separate but closely coordinated areas. The main objective of the revegetation test plot study was to determine the most cost effective and successful methods of establishing mature shrubs. The revegetation test plot study is set forth in Exhibit 10, Vegetation Information. The wildlife habitat use study was designed to determine the condition, trends, and seasonal use characteristics within the anticipated areas of disturbance.

Large Mammals

The wildlife habitat use study was primarily oriented towards evaluating the use of the mine site and surrounding area by big game, i.e., deer and elk. The study which was conducted by VTN, consisted of aerial and ground observations, browse utilization studies, and pellet group transects. Specifically the studies were directed towards providing the following information:

(1) Seasonal habitat use patterns by deer, elk, and cattle and competition for browse between these species.

(2) Condition of range and browse and trends in the habitat carrying capacity (i.e., increasing or decreasing).

(3) Interspecific differences in utilization of browse species and intraspecific differences in utilization under different conditions at various sites.

(4) Impacts of mining and habitat management measures to maintain total browse availability.

The techniques used to provide this information included intensive and extensive browse utilization transects and pellet group plot counts.

Methodology

Eight intensive browse transects were established in fall 1974, and two extensive browse transects were established in spring 1975. Three additional extensive transects were run in 1976. Both intensive and extensive browse transects were used also as pellet group transects in addition to the pellet group plot transects established in the habitat improvement areas in summer 1975 and 1976. Transect locations are shown on the Big Game Use Information Map (Map 13). (See CDM report for additional information)

Each intensive transect was comprised of ten stations along a 1000 ft. transect line. Each station consisted of a plant of the species which the transect was sampling. A major stem of that plant with 10 to 20 young shoots was designated for measurement and identified by a metal tag. All shoots above the metal tag were measured in centimeters and converted to inches. Measurements were made in the fall (October) after the growing season had ended, but before the deer and elk moved into the range, and again in the spring (late April - early May) after the deer and elk moved off the range but prior to the start of the growing season.

Sampling consisted of measuring and recording the length of all the current year's growth above the metal tag on the designated stem in the fall. The same shoot (stem) was measured again in the spring. By comparing the fall and subsequent spring measurement the amount of growth consumed during the winter was determined, expressed as percent utilization. comparison of fall measurements and winter utilization values over a period of years indicate the average amount of annual growth and use, respectively, and the trends (increase or decrease) in both parameters.

Data from the intensive browse transects are shown in Table 2.04.11-1, Intensive Browse Transects.

Extensive browse transects were placed in known high-use areas on the site to supplement the intensive transect data on deer and elk winter use. By sampling the known high-use areas over a number of years, the browse utilization in these key wintering areas could be more accurately estimated. Each extensive transect consisted of 50 stations. Since these were randomly selected each spring, the same plants were usually not evaluated from year to year.

Data from the extensive browse transects are set forth in Table 2.04.11-2, Extensive Browse Transects.

The investigator would walk ten paces, select the plant nearest his left or right foot and determine: first the condition of the plant (vigorous down to decadent) and second the amount of the current available growth (estimated) has been utilized to the nearest 10%. After 50 shrubs have been evaluated, the average percent utilization of each recorded species is calculated.

The pellet group studies were conducted to determine the average daily use of browse species by season (expressed as days use per acre) and the percentage breakdown of utilization by deer, elk and cattle. Pellet group counts were conducted at each station on the intensive transects on lines paralleling the extensive transects, and in addition at two separate locations in the habitat improvement areas. There were ten pellet group plots or stations in each intensive transect. The pellet group plot transects consisted of 25 stations approximately 100 feet apart. Each pellet group plot was a circular area with an 11-foot 9-inch radius.

The pellet group sampling consisted of counting and recording the number of pellet groups of deer, elk, or cattle within the plot each spring and fall. After they were counted, the pellet groups were swept off the plot to provide a clear base for the subsequent count.

Information on pellet counts for deer, elk, and cattle in set forth in Table 2.04.11-3, Pellet Group Plot Transects For Deer, Elk and Cattle; Table 2.04.11-4, Pellet Group Plot Transects For Deer, Elk and Cattle - Habitat Improvement Areas; and Table 2.04.11-5, Pellet Group Plots - Intensive Transects.

Observations through six winters have indicated there are more deer on the site when snows are minimal and, therefore, movement has not been limited. As the snows become increasingly deeper and conditions more severe, the deer either move to the sagebrush-covered south and southeast-facing exposures above Highway 13 adjacent to the mine site and Streeter Mountain, or they move out of the study area.

The elk normally remain in areas from upper Taylor Creek to several areas in the permit area moving further downslope into Axial Basin only when snows become deep and foraging becomes difficult. However, a few scattered elk are normally observed within the study permit area regardless of snow depth.

Data collected to date indicate that both deer and elk herds using the site and surrounding areas are in good condition, with a young age structure and good reproduction. This is especially evident in the fall, when high numbers of young bucks and bulls have been observed.

Initial observations indicated the presence of suitable, traditional elk habitat located adjacent to the southwest of the Colowyo minesite in an area dominated by aspen and serviceberry as shown on the Big Game Use Information Map (Map 13). Information presented in the CDM report, as well as CPW information indicates this limited area located in the upper reaches of Taylor Creek is on the fringe of a much larger elk calving, nursery and summer range. The area is located in the west fork of Goodspring Creek, east fork of Wilson Creek and the Hole-in-the-Wall Gulch. Based on the data presented in the CDM report for the 1983 and 1984 calving/rearing seasons, this adjacent area likely provides habitat requirements for less than 0.1 percent of the White River herd.

In personal conversations with CPW personnel, there is some indication that due to the expanding range of elk into nontraditional summer ranges, a trend is developing for elk to calve wherever they happen to be located at the time. Another surprising trend is occurring on elk winter ranges. Elk appear to be selecting reclaimed mine lands, reseeded Conservation Reserve Program (CRP) croplands etc. as an important, if not essential, component of the winter range needed for the expanding elk population in northwest Colorado.

It is important that the reader be aware that many traditional concepts regarding elk are becoming outdated as elk populations change their habits in response to increased hunting pressures, increased elk populations and improvements on winter ranges.

Because deer, unlike elk, do not concentrate in certain areas to bear their young, no key deer fawning areas are known to exist; however, the large number of does with fawns commonly observed throughout the early summer in or near dense stands of oak and service berry indicates there is high usage by the does of these areas. In addition, most doe and fawn observations are made near water ponds located on the site, along Taylor Creek and near the springs in upper Streeter Draw, because the does do not like to move considerable distances to water when the fawns are very young. From this observation, it appears that those areas of good cover within one-fourth to one-half mile of water are key areas for fawning.

Data collected from 1974 to 1977 indicated that browse use by deer, elk and cattle, both past and present, was excessive. This was evidenced by the "hedged" and "decadent" condition of the majority of the browse found in the study area. All browse species (e.g., oak, serviceberry, sage, rabbitbrush, snowberry, and bitterbrush) showed signs of over-utilization.

The net result of the past browse use was a reduction in annual growth with less available palatable forage. In addition, species such as oak and serviceberry have grown taller, with palatable growth limited to those portions of the shrubs that are out of reach to all but the largest elk. In some instances, even the larger elk are unable to reach the growth.

As the oak and serviceberry have grown taller, they have created large windbreaks. In the winter these dense areas of cover hold the snow, which becomes deep enough to limit all access by deer and elk. The serviceberry-snowberry transects showed low use for both 1974-1975 and 1975-1976. The snowberry bushes which were completely covered by deep snows showed no use. The use of the serviceberry has been limited to bushes near the edges of the stands where less snow buildup occurs.

During the winter of 1975-1976, deer use of some areas changed from the winter of 1974-1975. The big sage transect showed a higher use in 1975-1976. The snow cover was much lower in 1975-1976 and 1976-1977 than in 1974-1975, and a result the deer were better able to utilize the big sage.

Data from the extensive transects which were biased towards key areas of use, show that the areas to the south and east of the mine are key forage areas for the deer in the winter. These are primarily large expanses of south and east-facing sagebrush-covered slopes where there is less snow cover throughout the winter.

Traditionally, the most extensive use on the site has been during the summer and fall months by cattle, deer, and elk. Over-grazing at times by cattle in conjunction with high numbers of deer and elk have resulted in reduced carrying capacity and a general decline in the condition of the range over several years.

The reduced carrying capacity resulting from the overuse of the range created an increase of pressure on the more healthy plants. Certain more desirable species, such as bitterbrush, were overutilized throughout the year and offered little or no forage during the critical winter months. In most instances, 8 to 10 inches of snow totally covered the plants.

Colowyo initiated range management and habitat improvement programs, and other mitigation measures in 1976 to offset the expected impacts of mining. A detailed discussion of the wildlife mitigation plans is set forth in Section 2.05.6.

Aerial Counts (See CDM report for update information)

Initial aerial transects were flown monthly throughout the winters of 1974-1975 and 1975-1976, and one flight in 1977 to count elk and deer as well as coyotes, bobcats, raptors, etc. The counts were made to establish population trends, activity patterns, and estimate numbers of animals wintering on the site. As shown on the Big Game Use Information Map (Map 13), the study site was gridded into five areas to allow for more detailed observations. The areas were flown on an east-west pattern. Flight lines were normally about one-half mile apart, which allowed observations to be made a quarter of a mile on either side of the aircraft. All observations were recorded on standard forms and included numbers of animals location, habitat type, and when possible sex and age.

During the two winters of observations (1974-1975 and 1975-1976), deer and elk numbers fluctuated from 43 to 101 and from 20 to 119, respectively. Conclusions that can be drawn from the data are as follows: (1) the number of animals observed is greatly affected by counting conditions; (2) the severity of winter affect the total number of animals observed within the area; (3) certain areas are utilized more than others; and (4) deep snows have a greater impact on deer numbers and areas of use than on elk.

As discussed earlier in this section, use of the winter range by deer and elk is directly related to weather conditions and snow depth.

Information from the aerial surveys are shown in Table 2.04.11-6, Aerial Game Counts.

Calving and Fawning Areas

Counts were made each spring in late May and early June (peak of calving and fawning activities) of 1974 and 1975 and again in 1980. The study site was traversed by vehicle and on foot to identify the more desirable areas as shown by the number of females with young. The counts were made early in the morning or late evening. Binoculars or a spotting scope are used to observe the animals at considerable distance. This technique helps to minimize undesirable or unnecessary flushing of the animals. By not driving the animals into the heavy cover, more accurate counts can be made.

By establishing a baseline for numbers of calves and fawns born each spring, average reproductive rates, and identification of desirable calving and fawning locations, potential or actual impacts can be evaluated. Appropriate mitigation measures (as discussed in Section 2.05.6) have been implemented.

The deer and elk observations are summarized in Table 2.04.11-7, Sex and Age Ratios.

1980 Observations

Observations were conducted along a 15.6 mile road transect during the summer of 1980. The transect was divided into eight segments to more accurately, determine distribution of animals. The counts were made in early morning and late evening during June through August. All species observed along the transect were noted, together with location and vegetation type. Information on sex, age, condition, etc. were also recorded. The information will be used to compare calving and fawning activity, brood site, etc. in the spring with population numbers, sex and age ratios, etc. through the end of the summer to determine the condition of the potential breeding populations and what impacts, if any, have occurred. Winter aerial counts will also be used to supplement the summer observations. The results of the observations and location of the transect are summarized in Table 2.04.11-8, Wildlife Transect Observations and on the Wildlife Observations Map (Map 15).

Rodent Studies

The purpose of the rodent studies was to determine densities of rodents within the various habitat types on the site. From the data collected, the diversity, density, and the potential influence by rodents on the revegetation program were evaluated.

Small mammals (rodents) were sampled using two methods.' First, two grids each 120 by 135 (72 traps) were set on two different locations on the site. Grid No. l was located in sagebrush-grass habitat type. The conditions at this site were conclusive to a large rodent population. Grid No. 2 was located. near -the revegetation study plot, the sagebrush-grass-serviceberry type of less quality. The grids were trapped for five consecutive night using oatmeal as bait in the traps. Rodents trapped were eartagged using Monell No. 1 tags for positive identification and released. Records of the species, age conditions, sex, trap location and capture - recapture were kept. From these data, species diversity and densities were calculated. This information is set forth in Exhibit 11, Wildlife Information.

To supplement data collected from the grids, a 24 station trap transect was located adjacent to each of five browse transects. These transects were trapped for three consecutive nights, each spring and in the fall through the spring of 1976. The transects were designed only to give supplemental data on species diversity and relative abundance within the various habitat types. No absolute numbers or abundance were generated; only an indication of abundance was derived. In addition, 24-station trap transects were located in habitat improvement areas two and three. As with the other transects, these were trapped for three consecutive nights in the spring of 1976. These transects were conducted to collect data on small mammal response to the removal of cover in the habitat improvement areas.

The rodent trapping grids were sampled during the fall of 1975 and spring of 1976. For the fall of 1975, grid 1 (in sage-grass habitat type) averaged 36.7 rodents/acre, 99% of which were deer mice. Grid 2 (in sage grass -serviceberry habitat type) was in poor condition (shrubs were sprayed in the past to improve grazing) and produced an average of 25 rodents per acre on grid 2, 96+% of the rodents captured were deer mice. During the spring of 1976, grid l produced an average of 25.4 rodents/acre, and grid 2 produced an average of 20 rodents/acre. Trapping success for grids l and 2 were 30% and 23%, respectively.

Total numbers of rodents captured and density per acre were higher in the fall than in the spring. This is a function of post-reproduction versus pre-reproduction numbers.

Data from the trapping transects located adjacent to the browse transects was collected only to determine rodent species diversity within the habitat types. Table 2.04.11-9, Rodent Species/Habitat Type, shows the habitat types and the species captured.

The U.S. Fish and Wildlife Service also conducted a nine day small mammal sampling program in 1975. Five traps were used on a 5-acre grid in a mark-recapture effort for six days. After the 6th day, a transect line (20 stations, 3 traps per station) was used to sample the area for three days and nights. Results of the small mammal sampling are shown in Table 2.04.11-10, USFWS - Small Mammal Transects. Additional information concerning the USFWS sampling program is found in Exhibit 11, Wildlife Information.

Data collected for 1975 and 1976 show that, (1) rodent densities on the site were high compared to those of other areas of the west; (2) total numbers of rodents were affected by condition of the habitat; (3) habitat type also affected the diversity and numbers of rodents; and d(4) rodents were not drastically affected by cover removal of the habitat improvement areas.

Lagomorphs

When the pre-mining wildlife studies began in 1974, Lagomorph numbers were extremely low. The CPW estimated jackrabbit densities at 4.0 animals/square mile and cottontail densities at about 10.0 animals/square mile in 1974. Observations from 1974-1979 showed a stead increase in numbers with a peak probably occurring in 1979. Cyclic population fluctuations of these two species is a common occurrence which makes it difficult to accurately estimate numbers.

Relative abundance, presence, and probably habitat of Lagomorphs are set forth in Table 2.04.11-11, Wildlife Species that Occur or are Likely to Occur in the Colowyo Permit Area.

Avifauna

Species of birds that occur or are likely to occur in the permit area and the habitat where the species is likely to occur are listed in Table 2.04.11-11, Wildlife Species That Occur Or Are Likely To Occur In The Colowyo Permit Area. All species that were observed during field surveys are noted on the list.

Raptors

Surveys were conducted by VTN personnel during baseline data collection in 1974-1977, and again by Colowyo personnel during the spring and summer of 1980. The most common raptors observed on the permit area from 1974 to the present include Red-tail Hawks, Marsh Hawks, American Kestrels, Great Horned Owls, Golden Eagles, Prairie Falcons, and Turkey Vultures, all of which represent year-round residents with the exception of the turkey vulture. Other raptors that have been observed include the Swainson's Hawk, Cooper's Hawk, Rough Legged Hawk, and Perigrine Falcon.

Raptor nests located during field surveys are recorded on the Wildlife Observations Map (Map 15). Red-trailed hawks are known to have nested on the northern side of the Streeter Draw lease in 1975 and 1978. A pair of Red-tailed Hawks nested on a power pole in Taylor Creek in 1980. One Fledgling was observed. A pair of Cooper's Hawks has been observed at a possible nesting site during 1979 and 1980. The location of two Golden Eagle nesting complexes were obtained from the CPW. The nests are located on sandstone cliffs adjacent to State Highway #13 as shown on the Wildlife Observations Map (Map 15).

The area to be mined does not provide suitable nesting habitat for most of the species mentioned. Most of the preferable nesting habitat such as sandstone cliffs, rock outcropping, and trees are found to the north in Axial Basin, to the west along Taylor and Wilson Creeks, and to the east along Good Spring Creek. To date no raptor nests have been found in the area to be mined, although these areas and the reseeded areas provide excellent hunting areas for raptors.

Raptor species that occur or are likely to occur in the permit area are listed in Table 2.04.11-11, Wildlife Species that Occur Or Are Likely To Occur In The Colowyo Permit Area.

Upland Game Birds

Observations of sage grouse have been common in the vicinity of the mine for the last several years; the area is used heavily for nesting and brood rearing from the nesting season through the fall months. No strutting grounds have been found on or near the area to be mined, but information contained in a July 23, 1980 letter rand map from the CPW noted that the general area immediately north of the Colowyo permit area and west of Milk Creek is a very important sage grouse area as shown on the Wildlife Agency Information Map (Map 14). The area supports a strutting nesting complex, and there is a large sage grouse brood concentration area north of the complex. During the summer of 1975, brood size averaged 4.3 birds on the mine site. Observations during the summer of 1980 averaged 3.7 birds.

Observations have been made of sage grouse use on the mine plan area through seven winters beginning with the winter of 1974-1975. It has been commonly observed in mountain shrub communities in Northwest Colorado and in other areas that sage grouse move out of these areas in winter due to high snow depths. Observations at Colowyo support these generally accepted sage grouse use patterns. The winters of 1976-1977 and 1980-1981 were extremely dry and mild with very limited snow cover. Sage grouse were observed on the mine plan area during the entire winter. The other five winters beginning in 1974 were all normal or above normal winters with snow depths ranging from 75-100 inches. No sage grouse use was observed during the winter months of these years. Snow buildup from drifting snow around oak, serviceberry, chokecherry, and larger sage effectively limits use by most species. Use of the mine plan area as a winter range by deer, elk, or sage grouse is directly in response to the type of winter we have on the site.

A discussion of potential impacts on sage grouse is provided under Section 2.05.6(2).

Sharp-tailed grouse have rarely been observed south of the permit area, but have not been known to nest in the area.

Blue grouse also utilize the area for nesting, but the population is much smaller than the sage grouse population. Brood size averaged 4.8 birds in 1975. Observations during the summer of 1980 showed an average brood size of 3.6 birds.

Morning doves are occasionally observed during the summer months in the mine vicinity; however, the infrequent observations indicate a fairly low population.

Waterfowl

A few species of ducks such as the Mallard and Green-winged teal are occasionally observed on the stock ponds which are scattered around the mine site; however, due to lack of adequate nesting cover it is unlikely that any nesting occurs. Several species of ducks, geese, and shorebirds have been- observed on the Wilson Reservoir which is located at the extreme northern end of the permit area adjacent to State Highway #13. Most of the waterfowl observations have been made at the Wilson Reservoir and are listed in Table 2.04.11-11, Wildlife Species That Occur Or Are Likely To Occur In The Colowyo Permit Area.

Non-Game Birds

A large variety of birds have been observed on the mine site. Most species are migrants that either nest on or near the site during the summer months, or are observed as they pass through the area. The relative abundance of species that could possibly occur on the site and those that have definitely been observed are listed in Table 2.04.11-11, Wildlife Species That Occur Or Are Likely To Occur In The Colowyo Permit Area.

The U.S. Fish and Wildlife Service conducted a seven day breeding bird sampling program on a 40-acre plot on the Colowyo mine site in 1975. The number of birds, by species, that were spot mapped in the various sampling periods is set forth in Table 2.04.11-12, USFWS - Bird Transects. Table 2.04.11-13, USFWS - Breeding Bird Transects, shows the best approximation of number of breeding birds for the Colowyo site and three other areas sampled in northwest Colorado for the seven sampling periods. Additional information and plot location are included in Exhibit 11, Wildlife Information, and the Wildlife Observations Map (Map 15).

Reptiles and Amphibians

The permit and adjacent areas contain rock outcropping, rock ledges, etc. which provide preferred habitat for many of the species listed in Table 2.04.11-11, Wildlife Species That Occur Or Are Likely To Occur On The Colowyo Permit Area. Although no specific population or habitat information has been collected, several species including the northern sagebrush lizard and Great Basin Gopher Snake, and the Prairie Rattlesnake are commonly observed.

Aquatic Biology

Colowyo's permit area contains portions of Good Spring Creek along the eastern edge of the permit boundary. The CPW has classified Good Spring Creek as a non-fishery stream, although it has been assumed that species such as Black Bullheads, Creek Chubs, Fannelmouth and White Suckers, Flathead Minnows, and Red Shiners are likely to be present. The Wilson reservoir is located in the extreme northeast corner of the permit area adjacent to State Highway #13. The reservoir has been stocked regularly in the past with rainbow trout by the CPW and probably contains about 75% of that species. Other species in the reservoir are Black Bullheads, Sunfish, Yellow Perch, Channel Catfish, Crappie, and Largemouth Bass. Good Spring Creek and the Wilson Reservoir will not be disturbed by the mining operation; therefore, no analysis on the potential fisheries population or benthic fauna has been done.

Threatened and Endangered Species

State or federally listed threatened or endangered animal species are known to rarely utilize the habitats present on the permit area; it is unlikely that any impact will occur with respect to those threatened and endangered species which are known to occur on the region.

VTN biologists observed a single Perigrine Falcon hunting on the mine site during summer field work in 1974 and 1975. There have been no observations since 1975, and it is most likely that the observations occurred during migration.

Bald Eagles are frequently observed along the White and Yampa Rivers during the winter months and may rarely be found on the mine site. During the winter of 2005 a pair of Bald Eagles where observed hunting within the permit boundary and were reported in writing to the Colorado Division of Reclamation, Mining and Safety. Please refer to Volume 4, Exhibit 11, Letter dated March 8, 2005 for documentation.

Golden Eagles are known to occasionally hunt on the mine site but are not listed as threatened or endangered. However, they are included under the Bald Eagle Protection Act which basically gives the Golden Eagle the same protection as the Bald Eagle. Golden Eagle nests in the area have been identified by the CPW and are shown on the Wildlife Agency Information Map, (Map 14). Correspondence from the CPW concerning the Golden Eagles is set forth in Exhibit 11, July 23, 1980 letter from Bill Clark of CPW to Colowyo concerning wildlife on the Colowyo mine and adjacent areas.

The permit does not provide suitable nesting habitat for raptor species, except for the cliffs along Good Spring Creek and the south side of Streeter Draw. Raptors are known to occasionally hunt on the site or migrate through the area. The primary impact for raptor species will be loss of hunting habitat until mined areas have been reseeded, but experience has indicated that the Post underground and current surface mining operations have had little negative effect on cliff nesting success especially for the Golden Eagle.

During the 1996 Permit renewal process the Division requested an up-to-date consideration of the latest (August 21, 1996) USFWS list of federal threatened and endangered wildlife species. In particular, the Southwestern willow flycatcher, the Mexican spotted owl, the Mountain plover and the Boreal toad appeared as recently listed T&E species. Subsequent discussions with local BLM officials confirmed that these species would not occur on the Colowyo area. A copy of the BLM correspondence can be found in Exhibit 10 - Vegetation Information.

Impact of Mining Operations on Wildlife Resources Within the Permit Area

Initial wildlife studies beginning in 1974, indicated that prior to mining the following conclusions could be made: (1) some browse species continually receive more use than others; (2) use of browse is both a function of desirability and availability; (3) the general condition of the browse remains poor overall but is steadily being improved by range management practices; (4) carrying capacity is also below the potential for the site, but is steadily increasing as habitat improvement areas accumulate; (5) poor range management practices have occurred in the past; and (6) the study area is utilized on a year-around basis, depending on snow depth with highest use during spring and fall.

Before the startup of mining operations at Colowyo, the potential wildlife impacts predicted in environmental work included the displacement of wildlife from large areas around mine sites; disruption of migration routes; disruption of calving and fawning area with untold negative impacts on populations, habitats lost for long periods of time, etc.

Observations at Colowyo, and at several other mines in northwest Colorado over the last five years, have shown that many of these potential impacts have not materialized. It has become very evident that wildlife are a lot more adaptable than previously predicted in baseline studies. Numerous healthy populations of wildlife, i.e., deer, elk, sage grouse, and raptors, are commonly observed on the mine site and on areas immediately adjacent to the mine. Other than loss of habitat, which had been mitigated for by offsite habitat improvement (Sec. 2.05.6), and successful reclamation efforts, the effect on local deer and elk herds has proven minimal. There has been no evidence that any of the wildlife populations have been adversely affected by the mining activity. None of the species has shown signs of altering seasonal use patterns or in any way avoiding the mining operations. Observations during the last five years at Colowyo confirmed by similar observations at several other mines in northwest Colorado tend to contradict earlier expected impacts on wildlife. This is especially true during the fall months when hunting puts pressures on the local elk and deer herds. The Colowyo permit area has proven to be more of a wildlife preserve. Where elk and deer number in the hundreds adjacent to the mining operations as they feed and rest undisturbed.

Elk and deer are routinely observed foraging on the now extensive reclaimed areas as well. It is well accepted in northwest Colorado that extensive acres of reclaimed grasslands on reclaimed mined lands and CRP cropland serve as "magnets" for elk and deer populations. During the spring greenup of grasses and forbs these reclaimed areas are also providing valuable spring rangeland for the local wintering deer and elk herds. It is not uncommon to see hundreds of elk and deer grazing on the Colowyo reclamation areas early in the spring while snow is still covering adjacent native rangelands.

In summary, the preponderance of evidence provides little doubt that activities associated with the Colowyo mine have in fact proven beneficial to local wildlife populations rather than a detriment.

2.04.12 Prime Farmland Investigation

In order to determine the presence of potential prime farmlands within the permit area, a reconnaissance inspection was conducted to determine if any prime farmland was present in those areas to be disturbed by surface operations or facilities. Results of the investigation indicate that all of the area to be disturbed by surface operations or facilities can be excluded as prime farmland, since the land has not historically been used as cropland. This conclusion is based upon consultation with the local Soil Conservation Service (SCS). Based also on soil-survey information supplied by the Soil Conservation Service, no soil series encountered on the area have been designated as soil mapping units applicable as prime farmland. This conclusion is confirmed by correspondence from Mr. William Lee Hill, the USDA Soil Conservationist for Moffat County, to Colowyo, enclosed as Exhibit 9, Soils information as a December 18, 1980 letter from Mr. William Lee Hill of SCS to Colowyo. The letter states that “No lands in Moffat County have been designated as prime farmland.”

Based upon the soil survey conducted by the U.S. Soil Conservation Service and subsequent interpretation of that survey by the SCS, Colowyo is hereby requesting a negative determination for prime farmland.

2.04.13 Annual Reclamation and Hydrology Report

By March 15 of each year, Colowyo will file an annual reclamation and hydrology report covering the previous calendar year (January 1 through December 31) for all areas under bond. The report will include text, discussion and maps to address the following:

- The name and address of the permittee and permit number;
- Location and number of acres disturbed during the previous year;
- Location and number of acres backfilled and graded during the previous year;
- Location and number of acres topsoiled during previous year;
- The species, location and number of acres of vegetation planted during previous year, including any augmented seeding or cultural practices. Discrete areas planted with

specific seed mixes will be indicated, and seed tags, invoices or other comparable documentation will be included;
- Location, number of acres and date of planting for all previously revegetated areas;
- Overbruden Sampling Results;
- Interim Revegetation Monitoring;
- Topsoil Volume Inventory and Overall Balance;
- Post-Mine Drainge Construction Certifications;
- Weed Management;
- Water Quantity Data for the Report Year;
- Water Quality Data for the Report Year;
- A Written Interpretation of the Water Monitoring

Exhibit 7
Hydrology Information

Volume 2B

1) Ground Water Quality Colowyo Coal Mine, Leonard Rice Consulting Water Engineers, Inc., 1979

6) Hydrologic and Erosional Characteristics of Regraded Surface Coal Mined Land in Colorado, Striffler and Rhodes, 1981

7) Modification of both Surface Water Monitoring and Alluvial Groundwater Monitoring Locations, 1991

8) Geotechnical Assessment East Taylor Pond, CTL/Thompson, Inc. 1995

9) Haulroad Culvert Redesign, 1997

10) Stoker Crusher Ditch, 1997

12) Section 16 Taylor Ditch, 1997

14) Lower Administration Building Small Area Exemption

15) Haul Road A Upper and Lower Ditches

16) Salinity Material Damage Assessment, Cedar Creek Associates, Inc.

Volume 2C

14) Emergency Spillway, Temporary and Permanent Channel Designs, Existing Structures Summary Text
Appendix Exh. 7-14A Emergency Spillway Outslope Channel Designs
Appendix Exh. 7-14B Side Channel Designs (Temporary)
Appendix Exh. 7-14E Streeter Gulch and Buckskin Draw Ditches (Permanent)
Appendix Exh. 7-14F Coal Road Ditch
Appendix Exh. 7-14P Small Area Exemption
Appendix Exh. 7-14R East Pit Reclamation Area, Prospect Ditch, North Trib East Pit Ditch, Final East Pit Ditch

15) Stability Evaluation, Existing Sedimentation Pond Embankments, CTL/Thompson Inc. 1998

16) Adjudicated and permitted surface and groundwater locations within 1 mile of the Permit boundary

18) Gulch A Small Area Exemption

Exhibit 7 Item 16

Salinity Material Damage Assessment

Cedar Creek Associates, Inc.

October 2021

Colowyo Mine

SALINITY MATERIAL DAMAGE ASSESSMENT

OCTOBER 2021

PREPARED BY:

CEDAR CREEK
ASSOCIATES, INC.

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Telephone: (303) 818-1978

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Colowyo Mine

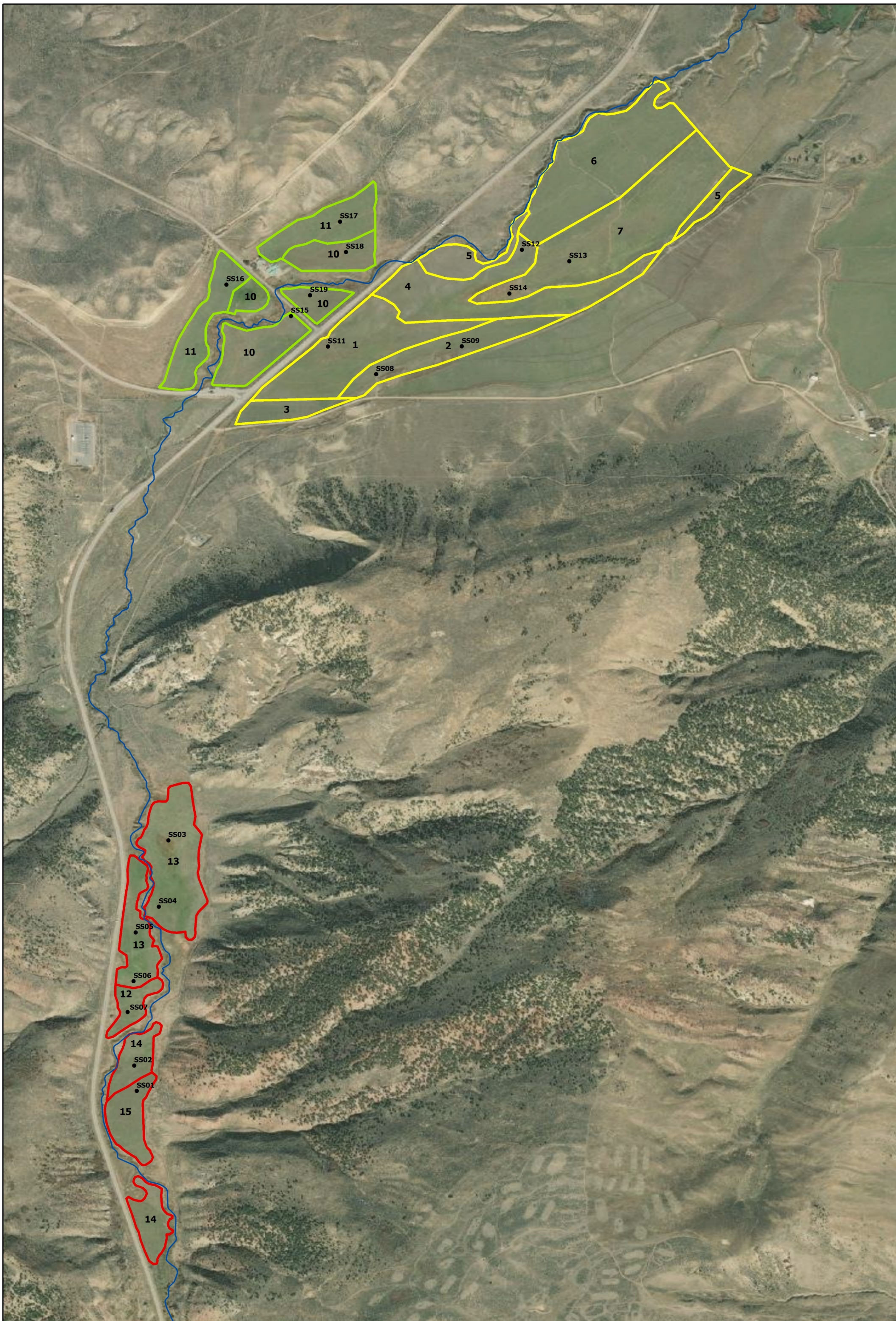
SALINITY IMPACT ASSESSMENT

1.0 INTRODUCTION

This Salinity Impact Assessment has been prepared by Cedar Creek Associates, Inc. (Cedar Creek) for the Colowyo Mine. This assessment was conducted in accordance with the requirements of the Regulations of the Colorado Mined Land Reclamation Board for Coal Mining. Rule 2.05.6(3)(b)(iii) requires that the permit applicant estimate the likely hydrologic impacts through an analysis known as the Probable Hydrologic Consequences (PHC)(Rule 2.05.6(3)(b)(iii). Colorado Division of Reclamation, Mining, and Safety is required by Rule 2.07.6(2)(c) to use this and other hydrologic information to determine whether the operation is preventing material damage outside the permit area. This assessment included data collection pertaining to water quality, soils evaluation, and vegetation composition of the irrigated fields.

The Colowyo Mine is located approximately 28 miles south of Craig, Colorado. Colowyo uses surface mining methods to remove multiple coal seams in the upper coal group of the upper Williams Fork formation. The Trout Creek Sandstone lies some 800 feet below the lowest coal seam that is mined, and the only regional aquifer in the vicinity of Colowyo is below the Trout Creek Sandstone. No regional ground water system exists above the flood plain of Goodspring Creek other than very isolated, perched aquifers. The Colowyo Mine is bisected by a number of tributaries of Milk Creek prior to entering the Yampa River. The Yampa/Milk Creek confluence marks the furthest downstream extent of potential cumulative surface water impacts to the Yampa River due to all mining in the region.

This study evaluates potential salinity impacts to irrigation waters from discharges within Goodspring Creek only. Taylor Creek was not evaluated as part of this study as the only water right available on Taylor Creek are used for industrial activities. Further, the water right on Taylor Creek does not have infrastructure to convey irrigation water, nor are there any fields down gradient of this water right that can be or have been historically irrigated from this one water right. Irrigation water from Goodspring Creek is used down gradient of Colowyo's lowest discharge point to Goodspring Creek. Based on information provided by Colowyo, there are approximately 259 acres of irrigated fields where irrigation water from Goodspring Creek is used. Figure 1 displays the fields irrigated by Goodspring Creek.



CEDAR CREEK ASSOCIATES, INC.

Coordinate System:
UTM NAD83 z13N

Sources:
Cedar Creek

N
W E
S

0 1,000 2,000 Feet

Legend

- Soil Sample Sites
- Goodspring Creek

Field Name

- Cox
- Elkhorn & Streeter
- Proctor

Colowyo Mine

Figure 1

Salinity Assessment

2.0 FIELD COMPOSITION AND SALINITY TOLERANCES

In June of 2021, Cedar Creek traveled to the irrigated fields to evaluate the plant composition of the irrigated fields. As defined on Table 1, Cedar Creek subdivided the irrigated fields into 11 subparts based on dominant composition. The dominant species observed were smooth brome (*Bromus inermis*), alfalfa (*Medicago sativa*), and tall fescue (*Festuca arundinacea*) along with other less dominant pasture grasses and forbs. None of the fields are managed monocultures (e.g. alfalfa fields). Rather, the fields are typically comprised of both alfalfa and pasture grasses in varying dominances.

The ability of the solution to carry a current is called electrical conductivity (EC). EC is measured in deci-Siemens per meter (dS/m). The salinity tolerance (the EC where crops yield begin to diminish) of dominant species on each field were determined using Colorado State University Extension fact sheets 0.503 - Managing Saline Soils and 7.227 - Growing Turf on Salt-Affected Sites. Pettygrove and Asano (1985) indicate that yield reductions for moderately sensitive crops could be expected to result from irrigation water having conductivities between 0.75 and 2.0 dS/m, while the threshold for moderately tolerant species would range between 2.1 and 4.0 dS/m. For tolerant crops, the threshold range would be 4.0 to 6.5 dS/m. The authors indicate that, for salt sensitive species, irrigation water threshold level would be reached at EC levels below 0.75 dS/m. Table 1 displays the dominant species, relative composition, species salinity tolerance using EC (dS/m), divisions for classifying crop tolerance to salinity (Pettygrove and Asano 1985), and the field subpart salinity tolerance using electrical conductivity (dS/m).

Table 1 Colowyo - Salinity Study - 2021								
Field Composition and Salinity Tolerances								
Field	**Field Subpart**	**Acreage**	**Dominant Species**	**Common Name**	**Relative Composition**	**Species Salinity Threshold - Electrical Conductivity (dS/m)**	**Salt Tolerance Adapted from Maas (1986) and Pettygrove and Asano (1985).**	**Field Salinity Threshold - Electrical Conductivity (dS/m)**
Cox	10	25.3	*Bromus inermis*	Smooth Brome	80%	3.5	Moderately Sensitive	**3.75**
			Thinopyrum intermedium	Intermediate Wheatgrass	10%	7.5	Tolerant	
			Medicago sativa	Alfalfa	5%	2.0	Moderately Sensitive	
			Other Grasses and Forbs		5%	2.0	Moderately Sensitive	
	11	22.1	*Medicago sativa*	Alfalfa	80%	2.0	Moderately Sensitive	**2.43**
			Bromus inermis	Smooth Brome	10%	3.5	Moderately Tolerant	
			Thinopyrum intermedium	Intermediate Wheatgrass	5%	7.5	Tolerant	
			Other Grasses and Forbs		5%	2.0	Moderately Sensitive	
Cox Summary		**47.4**			**100%**		**Moderately Sensitive**	**3.13**
Elkhorn & Streeter	12	4.1	*Medicago sativa*	Alfalfa	50%	2.0	Moderately Sensitive	**3.25**
			Pascopyrum smithii	Western Wheatgrass	20%	7.5	Tolerant	
			Poa bulbosa	Bulbous Bluegrass	10%	3.5	Moderately Tolerant	
			Other Grasses and Forbs		20%	2.0	Moderately Sensitive	
	13	30.2	*Festuca arundinacea*	Tall Fescue	35%	3.9	Moderately Tolerant	**3.01**
			Juncus balticus	Baltic Rush	25%	3.5	Moderately Tolerant	
			Carex nebrascensis	Nebraska Sedge	10%	3.5	Moderately Tolerant	
			Poa compressa	Canada Bluegrass	10%	3.5	Moderately Tolerant	
			Other Grasses and Forbs		20%	2.0	Moderately Sensitive	
	14	11.6	*Poa secunda*	Sandberg's Bluegrass	35%	3.5	Moderately Tolerant	**4.28**
			Carex sp.	Sedge	25%	3.5	Moderately Tolerant	
			Pascopyrum smithii	Western Wheatgrass	25%	7.5	Tolerant	
			Other Grasses and Forbs		15%	2.0	Moderately Sensitive	
	15	7.6	*Medicago sativa*	Alfalfa	45%	2.0	Moderately Sensitive	**3.93**
			Pascopyrum smithii	Western Wheatgrass	35%	7.5	Tolerant	
			Other Grasses and Forbs		20%	2.0	Moderately Sensitive	
Elkhorn & Streeter Summary		**53.5**			**100%**		**Moderately Sensitive**	**3.43**
Proctor	1	25.3	*Festuca arundinacea*	Tall Fescue	45%	3.9	Moderately Tolerant	**5.33**
			Thinopyrum intermedium	Intermediate Wheatgrass	45%	7.5	Tolerant	
			Other Grasses and Forbs		10%	2.0	Moderately Sensitive	
	2	13.8	*Bromus inermis*	Smooth Brome	40%	3.5	Moderately Tolerant	**2.60**
			Medicago sativa	Alfalfa	30%	2.0	Moderately Sensitive	
			Other Grasses and Forbs		30%	2.0	Moderately Sensitive	
	3	5.3	*Bromus inermis*	Smooth Brome	40%	3.5	Moderately Tolerant	**2.98**
			Medicago sativa	Alfalfa	30%	2.0	Moderately Sensitive	
			Poa bulbosa	Bulbous Bluegrass	25%	3.5	Moderately Tolerant	
			Other Grasses and Forbs		5%	2.0	Moderately Sensitive	
	4	27.3	*Festuca arundinacea*	Tall Fescue	45%	3.9	Moderately Tolerant	**5.21**
			Thinopyrum intermedium	Intermediate Wheatgrass	40%	7.5	Tolerant	
			Poa compressa	Canada Bluegrass	10%	3.5	Moderately Tolerant	
			Other Grasses and Forbs		5%	2.0	Moderately Sensitive	
	5	9.6	*Bromus inermis*	Smooth Brome	35%	3.5	Moderately Tolerant	**3.90**
			Thinopyrum intermedium	Intermediate Wheatgrass	20%	7.5	Tolerant	
			Festuca arundinacea	Tall Fescue	20%	3.9	Moderately Tolerant	
			Medicago sativa	Alfalfa	15%	2.0	Moderately Sensitive	
			Other Grasses and Forbs		10%	2.0	Moderately Sensitive	
	6	35.9	*Medicago sativa*	Alfalfa	90%	2.0	Moderately Sensitive	**2.55**
			Thinopyrum intermedium	Intermediate Wheatgrass	10%	7.5	Tolerant	
	7	40.9	*Carex sp.*	Sedge	40%	3.5	Moderately Tolerant	**3.20**
			Phleum pratense	Timothy	20%	3.5	Moderately Tolerant	
			Bromus inermis	Smooth Brome	20%	3.5	Moderately Tolerant	
			Other Grasses and Forbs		20%	2.0	Moderately Sensitive	
Proctor Summary		**158.1**			**100%**		**Moderately Tolerant**	**3.72**

3.0 SOILS EVALUATION

Salinity is measured by passing an electrical current through a soil solution extracted from a saturated soil sample. Figure 1 displays the soil samples collected from 0-6 inch depth to evaluate the existing salt content and other agronomic indicators. The 18 soil samples indicated EC ranging from 0.3 to 3.7 dS/m. The two highest EC's (3.7 and 3.6) were collected from the Proctor fields, which also receives comingled irrigation water from Milk Creek (Milk Creek was not evaluated under this study). However, EC values when averaged out for an entire field are well below the threshold (2.0 dS/m) for soils to be considered saline. Overall, salt deposition from irrigation water from Good Spring Creek is not occurring over the fields encompassing this study area.

Table 2 Colowyo - Salinity Study - 2021
Soil Laboratory Results

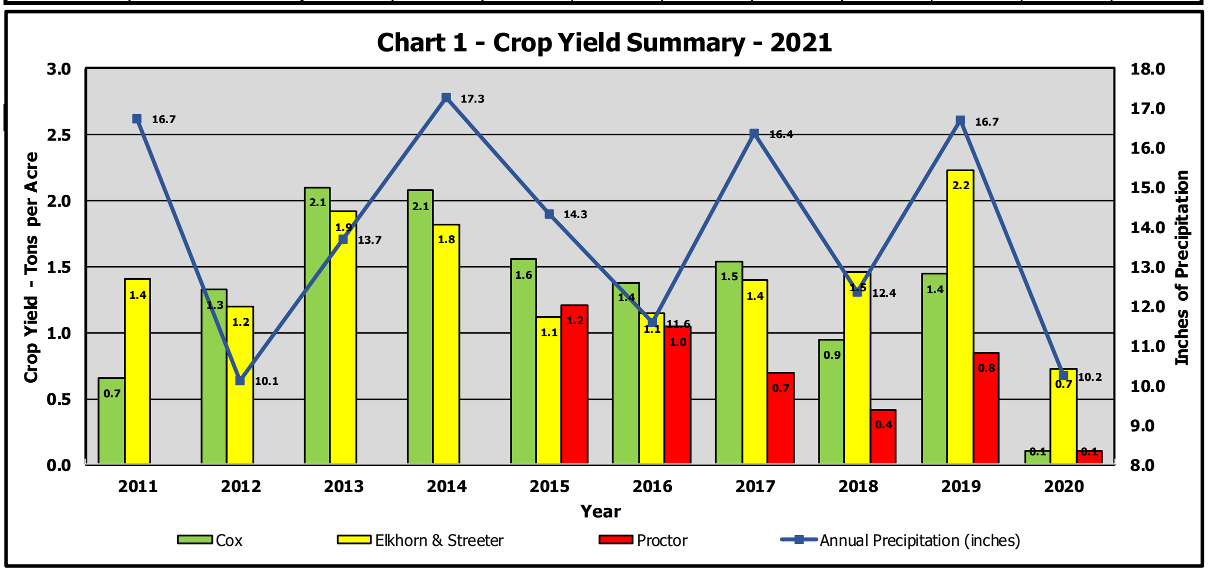
Field	Sample ID #	EC dS/m	Ca	Mg	Na	K	SAR	Sand	Silt	Clay	Texture
			---meq/L---					---%---			
Cox	SS15	0.5	3.7	4.0	1.3	0.9	0.7	32	42	26	Loam
	SS16	0.7	5.2	6.8	1.4	0.9	0.6	58	22	20	Sandy Loam
	SS17	0.8	5.2	7.1	0.5	1.6	0.2	48	27	25	Sandy Clay Loam
	SS18	0.6	1.7	5.5	4.8	0.5	2.6	24	35	41	Clay
	SS19	2.0	5.2	23.3	12.2	1.9	3.2	22	35	43	Clay
Cox Average		**0.9**	**4.2**	**9.3**	**4.0**	**1.2**	**1.5**	**37**	**32**	**31**	
Elkhorn & Streeter	SS1	0.7	3.4	4.6	1.9	0.5	1.0	48	32	20	Loam
	SS2	1.3	7.2	10.4	4.6	0.6	1.5	58	27	15	Sandy Loam
	SS3	0.6	4.1	5.3	0.5	0.9	0.2	48	35	17	Loam
	SS4	3.4	20	34.3	12.9	3.2	2.5	58	25	17	Sandy Loam
	SS5	1.9	10.4	18.9	7.9	0.6	2.1	50	29	21	Loam
	SS6	1.0	6.3	8.5	4.1	0.9	1.5	58	28	14	Sandy Loam
	SS7	1.2	7.1	8.7	3.8	1.3	1.4	58	25	17	Sandy Loam
Elkhorn & Proctor Average		**1.6**	**9.2**	**14.4**	**5.6**	**1.3**	**1.5**	**55**	**28**	**17**	
Proctor	SS8	0.3	2.5	1.7	0.1	1.6	0.1	74	18	8	Sandy Loam
	SS9	0.8	5.5	6.3	0.7	2.0	0.3	56	25	19	Sandy Loam
	SS11	3.6	15.5	39.6	15.2	-	2.89	26	48	26	Loam
	SS12	0.4	2.2	2.2	0.6	0.7	0.4	42	35	23	Loam
	SS13	3.7	19.9	42.9	12.4	0.2	2.2	48	19	33	Sandy Clay Loam
	SS14	0.42	3.5	1.4	0.3	-	0.2	23	45	32	Clay Loam
Proctor Average		**1.5**	**8.2**	**15.7**	**4.9**	**1.1**	**1.0**	**45**	**32**	**24**	

4.0 CROP YIELD

Total crop yields were available from 2011 to 2020 for the Cox and Elkhorn & Streeter fields and from 2015 to 2020 for the Proctor fields. Table 3 and Chart 1 display the acreage, total yield, and tons per acre for the Cox, Elkhorn & Streeter, and Proctor Fields. Since irrigation water used on these field are junior water rights, when dry years occur, these field often receive diminished irrigation water, which leads to diminished yields, or no irrigation water at all. In the Cox fields, the tons per acre yield ranged from 0.1 in 2020 (an exceedingly dry year and subject to the Streeter Fire) to 2.1 in 2013 and 2014. In the Elkhorn & Streeter fields, the tons per acre yield ranged from 0.7 in 2020 (an exceedingly dry year) to 2.2 in 2019. In the Proctor fields, the tons per acre yield ranged from 0.1 in 2020 (an exceedingly dry year and subject to the Streeter Fire) to 1.2 in 2015. Overall, there does not appear to be systematically diminishing crop yields, rather crop yields in any given year are more likely result of the availability and delivery of irrigation water.

Table 3 Colowyo - Salinity Study - 2021
Crop Yield Summary

Field		2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Cox	Acreage	47.4	47.4	47.4	47.4	47.4	47.4	47.4	47.4	47.4	47.4
	Total Yield (Tons)	31.1	62.8	99.6	98.3	73.6	65.4	73.0	44.9	68.4	5.0
	Tons / Acre	0.7	1.3	2.1	2.1	1.6	1.4	1.5	0.9	1.4	0.1
Elkhorn & Streeter	Acreage	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5
	Total Yield (Tons)	75.0	64.0	102.4	97.4	59.8	61.1	74.5	78.0	119.3	38.8
	Tons / Acre	1.4	1.2	1.9	1.8	1.1	1.1	1.4	1.5	2.2	0.7
Proctor	Acreage	-	-	-	-	158.1	158.1	158.1	158.1	158.1	158.1
	Total Yield (Tons)	NA	NA	NA	NA	191.0	165.2	110.0	66.3	133.9	16.6
	Tons / Acre	-	-	-	-	1.2	1.0	0.7	0.4	0.8	0.1



5.0 DATA DISCUSSION

Salt-affected soils develop from a wide range of factors including: soil type, field slope and drainage, irrigation system type and management, fertilizer and manuring practices, and other soil and water management practices. In Colorado, perhaps the most critical factor in predicting, managing, and reducing salt-affected soils is the quality of irrigation water being used. The primary effect of high EC water on crop productivity is the inability of the plant to compete with ions in the soil solution for water (physiological drought). The higher the EC, the less water is available to plants.

Excessive soil salinity reduces the yield of many crops. This ranges from a slight crop loss to complete crop failure, depending on the type of crop and the severity of the salinity problem. Plants are usually most sensitive to salt during the emergence and early seedling stages. Tolerance usually increases as the crop develops. The salt tolerance values apply only from the late seedling stage through maturity, during the period of most rapid plant growth. Saline soils cannot be reclaimed by chemical amendments, conditioners or fertilizers. A field can only be reclaimed by removing salts from the plant root zone. In some cases, selecting salt-tolerant crops may be needed in addition to managing soils.

Based on this assessment, salinity tolerances in the irrigated field subparts ranges from 2.43 (in alfalfa dominated fields) to 5.33 (in pasture grass dominated fields) ds/m. These field tolerances are based on the salt tolerant species planted in the fields. The 18 soil samples indicated EC ranging from 0.3 to 3.7 dS/m. Overall, the soil salinity presented on Table 2 is below the allowable salt tolerances (prior to crop reductions) presented on Table 1. Therefore, this indicates that crop yield reductions have not occurred. Collected crop yields, presented in Section 4.0 are a responsive to unpredictable volumes of irrigation water delivered to these fields, since they are junior water rights.

Under irrigated conditions in arid and semi-arid climates, the build-up of salinity in soils is inevitable. The severity and rapidity of build-up depends on a number of interacting factors such as the amount of dissolved salt in the irrigation water and the local climate. However, with proper management of soil moisture, irrigation system uniformity and efficiency, local drainage, and the right choice of crops, soil salinity can be managed to prolong field productivity.

6.0 DETERMINATION OF MATERIAL DAMAGE

6.1 Regulatory Basis

The 1988 Mined Land Reclamation Division report "A Description of the Material Damage Assessment Process Pertaining to Alluvial Valley Floors, Surface Water, Ground Water and Subsidence at Coal Mines" (MLRB 1988) describes the regulatory basis for material damage assessments:

> The Colorado Surface Coal Mining Reclamation Act contains the following prohibition with respect to alluvial valley floors:
>
> No permit or permit revision shall be approved unless it is demonstrated that the surface coal mining operations would not materially damage the quantity or quality of surface water or ground water systems that supply an alluvial valley floor (34-33-114(2)(e)).
>
> The "Regulations of the Mined Land Reclamation Board For Coal Mining" define material damage with respect to alluvial valley floors as:
>
> Changes in the quality or quantity of the water supply to any portion of an alluvial valley floor where such changes are caused by surface coal mining and reclamation operations and result in changes that significantly and adversely affect the composition, diversity or productivity of vegetation dependent on subirrigation, or which result in changes that would limit the adequacy of the water for flood irrigation of the irrigable land acreage existing prior to mining. (Rule 1.04(72)).

6.2 Irrigation Water Salinity

Numerous studies have been conducted which relate plant growth and physiological functions to soil salinity. Most of the studies indicate that in the absence of soil moisture deficiency, crop yield is directly related to the average soil salinity in the portion of the root zone where maximum water uptake occurs during the growing season. These thresholds are based on agricultural species relative salt tolerance based on salinity level at initial yield decline and yield decrease per unit increase in salinity beyond the threshold level. The relationship between irrigation water salinity and soil solution salinity is greatly affected by irrigation frequency and by the percent of applied water which percolates below the rooting zone. The Mined Land Reclamation Board report (1988) uses an adjustment factor of 1.5 to account for applied irrigation water due to the concentrating effect of evapotranspiration when calculating field irrigation water conductance thresholds.

Table 4 presents the field salinity thresholds along with the field irrigation water conductance thresholds. Irrigation water quality (conductance) was provided by Colowyo, collected from the LGSC surface water monitoring location, which is located below Colowyo's lowest discharge point (Streeter Pond) on Goodspring Creek, but above where the irrigation water is diverted to be utilized on these fields. The lab analyzed data spans from 4/7/1982 to 5/24/2021 and averages 1.72 dS/m (Table 5). If the LGSC conductance (1.72 dS/m) exceeds the field irrigation water quality thresholds, then a material damage assessment is warranted.

Table 4 Colowyo - Salinity Study - 2021				
Material Damage Assessment				
Field Number	**Field Salinity Threshold - Electrical Conductivity (dS/m)**	**Field Irrigation Water Quality Threshold - Conductance (dS/m)**	**Irrigation Water Quality - LGSC - Lab Collected Life of Mine Average (dS/m)**	**Material Damage Caclulation Warranted**
Cox Fields				
10	3.75	2.51	1.72	No
11	2.43	1.63	1.72	Yes
Summary	**3.13**	**2.10**	**1.72**	**No**
Elkhorn & Streeter Fields				
12	3.25	2.18	1.72	No
13	3.01	2.02	1.72	No
14	4.25	2.85	1.72	No
15	3.93	2.63	1.72	No
Summary	**3.43**	**2.30**	**1.72**	**No**
Proctor Fields				
1	5.33	3.57	1.72	No
2	2.60	1.74	1.72	No
3	2.98	2.00	1.72	No
4	5.21	3.49	1.72	No
5	3.90	2.61	1.72	No
6	2.55	1.71	1.72	Yes
7	3.20	2.14	1.72	No
Summary	**3.72**	**2.49**	**1.72**	**No**

Table 5 Colowyo - Salinity Study - 2021

Lower Goodspring Creek Specific Conductance (Lab Collected)

Obs. #	Sample Date	umhos/cm	Obs. #	Sample Date	umhos/cm	Obs. #	Sample Date	umhos/cm	Obs. #	Sample Date	umhos/cm
1	4/7/1982	1410	91	3/27/1990	1450	181	11/18/1997	1660	271	6/25/2005	1500
2	6/14/1982	1100	92	4/30/1990	1920	182	12/8/1997	1650	272	7/19/2005	1600
3	7/6/1982	1220	93	5/30/1990	1870	183	1/6/1998	1880	273	8/22/2005	1820
4	7/12/1982	1250	94	6/29/1990	1970	184	2/19/1998	1790	274	9/14/2005	1970
5	3/29/1983	1370	95	7/19/1990	1960	185	3/6/1998	1800	275	9/16/2005	1850
6	5/5/1983	1030	96	8/9/1990	2040	186	4/9/1998	1450	276	10/17/2005	1700
7	6/15/1983	1170	97	9/5/1990	1950	187	4/27/1998	1170	277	11/21/2005	1820
8	7/6/1983	1070	98	9/21/1990	2180	188	6/11/1998	1370	278	12/13/2005	1980
9	7/14/1983	1320	99	11/9/1990	2120	189	7/6/1998	1520	279	1/18/2006	1740
10	7/25/1983	1270	100	2/25/1991	1810	190	8/3/1998	1550	280	2/21/2006	1860
11	8/1/1983	1290	101	3/28/1991	2140	191	9/10/1998	1710	281	3/15/2006	1810
12	8/9/1983	1350	102	4/16/1991	1750	192	10/8/1998	1740	282	4/12/2006	1580
13	8/19/1983	1350	103	5/17/1991	1760	193	11/5/1998	1840	283	5/18/2006	1600
14	8/26/1983	1380	104	6/26/1991	1980	194	12/14/1998	1920	284	6/6/2006	1860
15	9/2/1983	1310	105	7/23/1991	1540	195	1/7/1999	1810	285	7/25/2006	1920
16	9/9/1983	1430	106	8/19/1991	1750	196	2/22/1999	1890	286	8/23/2006	2040
17	9/16/1983	1200	107	9/30/1991	2320	197	3/3/1999	1720	287	9/20/2006	1840
18	9/23/1983	1200	108	10/16/1991	1710	198	4/6/1999	1720	288	10/16/2006	1900
19	9/27/1983	1300	109	11/15/1991	2570	199	5/17/1999	1250	289	11/15/2006	1880
20	10/4/1983	1300	110	12/18/1991	2510	200	6/10/1999	1420	290	12/13/2006	1830
21	10/12/1983	1200	111	1/22/1992	2220	201	7/6/1999	1620	291	2/7/2007	1530
22	10/20/1983	1300	112	2/10/1992	1930	202	8/19/1999	1640	292	3/13/2007	1600
23	10/27/1983	1320	113	3/26/1992	1640	203	9/3/1999	1720	293	4/9/2007	1400
24	11/18/1983	1030	114	4/28/1992	1560	204	10/13/1999	1920	294	5/15/2007	1500
25	12/12/1983	1500	115	5/14/1992	1730	205	11/11/1999	1880	295	6/11/2007	1850
26	3/13/1984	1210	116	6/23/1992	161	206	12/6/1999	1850	296	7/17/2007	1860
27	4/30/1984	1010	117	7/6/1992	1830	207	1/7/2000	1820	297	8/14/2007	1860
28	5/31/1984	1090	118	8/17/1992	1880	208	2/7/2000	1780	298	9/20/2007	1840
29	7/25/1984	1360	119	9/30/1992	1700	209	3/7/2000	1730	299	10/16/2007	1790
30	8/13/1984	1740	120	10/15/1992	1700	210	4/17/2000	1550	300	11/8/2007	1930
31	9/6/1984	1670	121	11/23/1992	1820	211	6/5/2000	1570	301	12/18/2007	1880
32	10/2/1984	1790	122	12/17/1992	1940	212	7/3/2000	1700	302	1/15/2008	1940
33	11/1/1984	1600	123	1/19/1993	2820	213	7/31/2000	1730	303	2/13/2008	1830
34	11/6/1984	1600	124	2/27/1993	1990	214	8/21/2000	1890	304	3/11/2008	1470
35	11/16/1984	1920	125	3/13/1993	1690	215	9/7/2000	1880	305	4/15/2008	1420
36	12/12/1984	1990	126	4/21/1993	1710	216	10/2/2000	1790	306	5/12/2008	1180
37	2/22/1985	1870	127	5/27/1993	861	217	11/8/2000	1920	307	6/18/2008	1420
38	4/30/1985	1110	128	6/1/1993	923	218	12/4/2000	1860	308	8/13/2008	1650
39	5/31/1985	1580	129	7/30/1993	1740	219	1/2/2001	1750	309	11/10/2008	1790
40	6/28/1985	2050	130	8/23/1993	1710	220	2/5/2001	1620	310	3/17/2009	1610
41	7/29/1985	2000	131	9/14/1993	1070	221	3/5/2001	1630	311	6/3/2009	1590
42	8/21/1985	2170	132	10/19/1993	1724	222	4/16/2001	1640	312	8/19/2009	1780
43	9/18/1985	1980	133	11/30/1993	1770	223	5/7/2001	1450	313	11/2/2009	1750
44	10/16/1985	1910	134	12/1/1993	1780	224	6/15/2001	1370	314	2/23/2010	1710
45	10/30/1985	1860	135	1/18/1994	1761	225	7/5/2001	1750	315	5/5/2010	1100
46	11/26/1985	1720	136	2/27/1994	1090	226	8/6/2001	1740	316	8/3/2010	1680
47	12/26/1985	1860	137	3/21/1994	1650	227	9/20/2001	1950	317	11/4/2010	1730
48	1/28/1986	1940	138	4/19/1994	1697	228	10/1/2001	2000	318	3/21/2011	1580
49	2/24/1986	1700	139	5/31/1994	1750	229	10/17/2001	1140	319	5/3/2011	1130
50	3/27/1986	1630	140	6/1/1994	1744	230	11/5/2001	1600	320	8/17/2011	1680
51	4/29/1986	1220	141	7/22/1994	1920	231	12/5/2001	1950	321	11/10/2011	1970
52	5/30/1986	1440	142	8/23/1994	1860	232	1/2/2002	1950	322	3/13/2012	1230
53	6/17/1986	1650	143	9/30/1994	2060	233	2/11/2002	1860	323	5/14/2012	1780
54	7/24/1986	1690	144	10/21/1994	2010	234	3/14/2002	1580	324	8/2/2012	2190
55	8/4/1986	1670	145	11/18/1994	1750	235	4/5/2002	1740	325	10/31/2012	2240
56	9/25/1986	1720	146	12/13/1994	2080	236	5/8/2002	1970	326	3/12/2013	2080
57	10/13/1986	1850	147	1/18/1995	1870	237	6/28/2002	2020	327	5/21/2013	1780
58	11/25/1986	1810	148	2/28/1995	1820	238	7/8/2002	2060	328	7/30/2013	2150
59	12/31/1986	1920	149	3/15/1995	1820	239	8/2/2002	2190	329	11/18/2013	2350
60	2/12/1987	1710	150	4/26/1995	1840	240	10/3/2002	2450	330	3/19/2014	1770
61	3/24/1987	1830	151	5/23/1995	1040	241	10/24/2002	2320	331	5/20/2014	1380
62	5/1/1987	1080	152	6/19/1995	1190	242	12/13/2002	2140	332	8/28/2014	2100
63	6/2/1987	1600	153	7/26/1995	1540	243	1/23/2003	2070	333	11/6/2014	2230
64	7/20/1987	1840	154	8/24/1995	1640	244	2/12/2003	2050	334	1/14/2015	2070
65	8/18/1987	1710	155	9/13/1995	1640	245	3/10/2003	1730	335	4/8/2015	1830
66	9/14/1987	1840	156	10/25/1995	1890	246	4/1/2003	1840	336	8/4/2015	1830
67	10/21/1987	1830	157	11/29/1995	1820	247	5/28/2003	1750	337	10/21/2015	2100
68	11/25/1987	1950	158	12/5/1995	1710	248	6/2/2003	1700	338	2/25/2016	1760
69	12/21/1987	1770	159	1/3/1996	1890	249	7/1/2003	1930	339	4/27/2016	1200
70	2/1/1988	1590	160	2/20/1996	1310	250	8/7/2003	2270	340	9/13/2016	1850
71	3/1/1988	1600	161	3/18/1996	1550	251	9/2/2003	2310	341	11/22/2016	1810
72	3/31/1988	1410	162	4/1/1996	1800	252	10/7/2003	1700	342	3/16/2017	1340
73	4/20/1988	1410	163	5/6/1996	1416	253	11/11/2003	2080	343	5/23/2017	1520
74	5/31/1988	1240	164	6/3/1996	1567	254	12/1/2003	1690	344	9/19/2017	2020
75	6/27/1988	1520	165	7/1/1996	1625	255	1/21/2004	2060	345	11/30/2017	1980
76	7/29/1988	1660	166	8/8/1996	1709	256	2/16/2004	1810	346	3/14/2018	1600
77	8/16/1988	1720	167	9/26/1996	1886	257	3/11/2004	1870	347	5/1/2018	1820
78	9/19/1988	1810	168	10/3/1996	2036	258	4/5/2004	1800	348	8/21/2018	3300
79	10/12/1988	1750	169	11/19/1996	1623	259	5/4/2004	1740	349	11/28/2018	2040
80	11/30/1988	1750	170	12/18/1996	1937	260	6/17/2004	1780	350	3/5/2019	2070
81	12/6/1988	1860	171	1/19/1997	1699	261	7/19/2004	1840	351	5/15/2019	1260
82	2/22/1989	1800	172	2/26/1997	1681	262	8/10/2004	1880	352	9/19/2019	2110
83	3/30/1989	1120	173	3/19/1997	1446	263	10/5/2004	1830	353	11/12/2019	2120
84	5/1/1989	1640	174	4/21/1997	1170	264	11/1/2004	1800	354	3/9/2020	1800
85	5/26/1989	2000	175	5/20/1997	1020	265	12/14/2004	2010	355	6/4/2020	1840
86	7/27/1989	1920	176	6/26/1997	1440	266	1/6/2005	2070	356	9/14/2020	2490
87	10/4/1989	2040	177	7/9/1997	1490	267	2/10/2005	2070	357	12/10/2020	2400
88	12/4/1989	2200	178	8/14/1997	1570	268	3/9/2005	1820	358	3/23/2021	1900
89	12/28/1989	2150	179	9/11/1997	1620	269	4/20/2005	1540	359	5/24/2021	2110
90	2/28/1990	1820	180	10/30/1997	1490	270	5/23/2005	851	**Average Conductance**		**1721**

6.3 Material Damage Assessment

There are two fields where a material damage assessment was warranted as shown on Table 4. On Cox field 11, the irrigation water from LGSC water exhibits 1.72 dS/m which exceeds the field salinity threshold, calculated to be 1.63 dS/m. On Proctor field 6, the irrigation water from LGSC water exhibits 1.72 dS/m which exceeds the field salinity threshold, calculated to be 1.71 dS/m. Both of these fields are dominated by the moderately sensitive alfalfa.

The formula "Y = 100 - Bw (ECw - Aw)" developed by Maas and Hoffman (1977) modified for irrigation water would be used to predict crop yield loss, where:

Y = Relative Yield

Aw = Salinity Threshold (irrigation water)

ECw = Predicted Conductivity (irrigation water)

Bw = Percent Yield Decrease Per Unit Increase in Conductivity of Irrigation Water

The equation is based on the assumption that a 3% loss would be significant to a small operation while the largest operations could absorb production losses of up to 10% (MLRB 1988).

As shown on Table 7, field specific percent yield decrease per unit increase in conductivity of irrigation water was calculated for Cox field 11 (6.80%) and Proctor field 6 (7.10%). Based on these calculated values, the field salinity thresholds, and the field irrigation water conductance thresholds, the material damage formula yield a crop yield reduction of 0.62% on Cox field 11 and 0.08% on Proctor field 6. Both values are vastly below the 3% threshold for significance demonstrating that no material damage has occurred.

Table 7 Colowyo - Salinity Study - 2021

Percent Yield Decrease Per Unit Increase in Conductivity of Irrigation Water

Field	Field Subpart	Dominant Species	Common Name	Relative Composition	Percent Yield Decrease Per Unit Increase in Conductivity of Irrigation Water	
					By Species	By Field (weighted average)
Cox	11	*Medicago sativa*	Alfalfa	80%	7.14	**6.80**
		Bromus inermis	Smooth Brome	10%	4.00	
		Thinopyrum intermedium	Intermediate Wheatgrass	5%	6.67	
		Other Grasses and Forbs		5%	7.14	
Proctor	6	*Medicago sativa*	Alfalfa	90%	7.14	**7.10**
		Thinopyrum intermedium	Intermediate Wheatgrass	10%	6.67	

6.4 Material Damage Conclusion

This assessment was implemented to evaluate whether irrigation water contains salinity values which are causing materials damage to Cox, Elkhorn & Streeter, and Proctor fields on Goodspring Creek. In addition, implementation of the study included collection of data and additional analysis to support the material damage findings. A composition evaluation was implemented and revealed that irrigated fields are not managed monocultures, rather field are composed of a combination of alfalfa and pasture grasses, along with other grasses and forbs. Therefore, this site-specific data was used in the material damage calculation. A soil study was also implemented to investigate whether salt accumulation has been occurring in the irrigated fields. Laboratory results do not demonstrate elevated salinity across the irrigated fields. Finally, crop yields from 2001 to 2020 were investigated to determine whether a diminishing trend could be identified. However, the crop yields are more closely related to quantity of water received, which was variable from year to year because irrigation water applied to the target fields are junior water rights. Based on all the supporting studies and the calculated material damage assessment presented in Section 6.3 found that the crop yield reductions were not significant, in accordance with the Mined Land Reclamation Board report from 1988.

7.0 REFERENCES

Colorado State University Extension. 2013. Irrigation Water Quality Criteria. Fact Sheet No. 0.506.

Colorado State University Extension. 2013. Managing Saline Soils. Fact Sheet No. 0.503.

Colorado State University Extension. 2014. Growing Turf on Salt-Affected Sites. Fact Sheet No. 7.227.

Maas E. V. 1986. Salt Tolerance of Plants. Applied Agricultural Research. Springer Verlag New York Inc. Volume 1, No. 1, PP. 12-26.

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Mined Land Reclamation Board. 1988. A Description of the Material Damage Assessment Process Pertaining to Alluvial Valley Floors, Surface Water, Ground Water and Subsidence at Coal Mines.

Pettygrove, G, S. and Takasha Asano. 1985. Irrigation With Reclaimed Municipal Wastewater - A Guidance Manual, Lewis Publishers, Inc. 403 pages.

Exhibit 7
Hydrology Information

Exhibit 7
Hydrology Information

Exhibit 7
Hydrology Information

Volume 2B

1) Ground Water Quality Colowyo Coal Mine, Leonard Rice Consulting Water Engineers, Inc., 1979

6) Hydrologic and Erosional Characteristics of Regraded Surface Coal Mined Land in Colorado, Striffler and Rhodes, 1981

7) Modification of both Surface Water Monitoring and Alluvial Groundwater Monitoring Locations, 1991

8) Geotechnical Assessment East Taylor Pond, CTL/Thompson, Inc. 1995

9) Haulroad Culvert Redesign, 1997

10) Stoker Crusher Ditch, 1997

12) Section 16 Taylor Ditch, 1997

14) Lower Administration Building Small Area Exemption

15) Haul Road A Upper and Lower Ditches

16) Salinity Material Damage Assessment, Cedar Creek Associates, Inc.

Volume 2C

14) Emergency Spillway, Temporary and Permanent Channel Designs, Existing Structures Summary Text
    Appendix Exh. 7-14A Emergency Spillway Outslope Channel Designs
    Appendix Exh. 7-14B Side Channel Designs (Temporary)
    Appendix Exh. 7-14E Streeter Gulch and Buckskin Draw Ditches (Permanent)
    Appendix Exh. 7-14F Coal Road Ditch
    Appendix Exh. 7-14P Small Area Exemption
    Appendix Exh. 7-14R East Pit Reclamation Area, Prospect Ditch, North Trib East Pit Ditch, Final East Pit Ditch

15) Stability Evaluation, Existing Sedimentation Pond Embankments, CTL/Thompson Inc. 1998

16) Adjudicated and permitted surface and groundwater locations within 1 mile of the Permit boundary

18) Gulch A Small Area Exemption

TDS concentrations measured at USGS gaging stations in the in Good Spring, Taylor, Wilson, and Jubb Creeks near Axial, Colorado in 1999 and 2000 ranged from 167 mg/L in Taylor Creek to 1,660 mg/L in Jubb Creek (Table 2.04.7-32). Mean TDS concentrations range from 590 mg/L in upper Wilson Creek to 1089 mg/L in lower Good Springs Creek. The USGS has discontinued monitoring at most of these stations.

Sufficient water rights to Good Spring Creek are held by Colowyo to allow them to avoid using the volume of water that is diminished during and after mining. Colowyo is a large surface water right owner in the Upper Yampa area (Water District 44) of Colorado Water Division 6. Included in these rights are several diversions on Good Spring Creek controlled by Colowyo. The appropriation date on these diversions owned by Colowyo are in the 1890's, making them the most senior rights on Good Spring Creek. Therefore, any reduction in base flow can be met by Colowyo not exercising their water rights on Good Spring Creek in the amount of the reduction of the base flow, if it is found to be necessary. Please see table below defining current water rights owned by Colowyo on Good Springs Creek.

Water Right Name	Twshp	Range	Sect	Q160	Q40	Appropriation Date	Rate Amount (CFS)	Volume Amount (ACFT)
ARTHUR COLLOM DITCH	4N	93W	23	SE	NE	1885-05-10	0.1000	
ELK HORN DITCH	3N	93W	2	SE	NW	1883-03-20	1.2300	
GOOD SPRING DITCH NO 1	3N	93W	2	SE	SW	1885-05-20	0.5000	
GOOD SPRINGS DITCH NO 2	3N	93W	2	SE	SW	1885-05-20	1.0000	
JOSEPH COLLOM DESERT LAND DITCH	3N	93W	11	NE	NW	1883-03-20	0.5000	
SPRING CREEK DITCH 2	4N	93W	26	NE	NW	1887-06-30	0.5800	
SPRING CREEK DITCH 2	4N	93W	26	NE	NW	1887-06-30	0.2900	
TAYLOR DITCH	3N	93W	2	NE	NW	1879-05-01	1.6600	
WILSON RESERVOIR	4N	93W	13	SE	SE	1975-09-16		349.6000
COLOWYO TAYLOR PUMP NO. 1	4N	93W	27	NW	SW	1980-12-31	1.11	

Surface Water Use – Surface water is used extensively in the broader stream valleys of the area. Surface water consumption is predominantly associated with irrigation of agricultural lands. Surface water withdrawals in the Lower Yampa River basin totaled 75.2 million gallons per day (mgd) in 1995 (USGS 1995). About 99 percent of the surface water withdrawals (75.1 mgd) were used for irrigation. The irrigated acreage totaled 13,240 acres. Mining and livestock use account for the remaining surface water withdrawals.

All of the major streams are over-appropriated, and therefore, many of the surface water rights are inactive (CDM, 1985b). Large storage reservoirs are often constructed to capture spring runoff and facilitate irrigation of fields in the summer months when natural flows are diminished.

Surface water adjudication rights within the South Taylor Permit Revision Area are summarized in Table 2.04.7-36, based on a CDWR water rights database (CDWR 2005). Most of the adjudications support multiple uses. The adjudication does not necessarily reflect the amount of water available in any given year for the intended uses, only a representation of legal claims to the water in a particular stream course.

Detailed Surface Water Resource Information

Surface Water Characteristics – The South Taylor/Lower Wilson permit revision area includes the drainages of Good Spring, Wilson, Taylor, and Jubb Creeks. Colowyo's existing mining operations exist primarily in the Good Spring Creek drainage. Although Taylor Creek is a tributary to Wilson Creek, the point of confluence is several miles downstream from the South Taylor/Lower Wilson permit revision