TRI-STATE

November 30, 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 No. 150 (MR-150)
Adequacy Response

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 this adequacy response for technical revision 150 (TR-150) to Permit No. C-1981-019.

Tri-State received the Division's adequacy letter dated November 23, 2021, and has the following responses to the Division's concerns:

1. *Please justify the use of weighted averages in Table 1 to develop a salinity tolerance for an entire field, rather than looking at tolerance for individual crop species. It is the opinion of the Division that if a farmer is using irrigation water with high TDS concentrations it could likely impact the yield of sensitive crops (or moderately sensitive crops such as alfalfa) regardless of the other types of crops grown in that field.*

   Response: Tri-State has updated Exhibit 7 Item 16 specifically adding a species level material damage assessment for the most sensitive species (alfalfa) for fields 6 and 11. The results of this additional assessment demonstrate that yield reduction for alfalfa as a individual species is below the 3% threshold for crop reduction as outlined in *"A Description of the Material Damage Assessment Process Pertaining to Alluvial Valley Floors, Surface Water, Ground Water and Subsidence at Coal Mines, Banta 1998"*.

Included in this adequacy response is a change of index sheet to ease incorporation of this adequacy response into the permit document. 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: Tony Tennyson (via email)
Angela Aalbers (via email)
File: C. F. 1.1.2.139 - G471-11.3(21)b

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			No Change
2A			No Change
2B	Exhibit 7 Item 16 All Pages (15 pages)	Exhibit 7 Item 16 All Pages (16 pages)	Exhibit 7 Item 16 has been updated.
2C			No Change
2D			No Change
2E			No Change
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			No Change
13			No Change
14			No Change
15			No Change
16			No Change
17			No Change
18A			No Change
18B			No Change
18C			No Change

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

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

Colowyo Mine

SALINITY MATERIAL DAMAGE ASSESSMENT

NOVEMBER 2021

PREPARED BY:

CEDAR CREEK ASSOCIATES, INC.

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Colowyo Mine

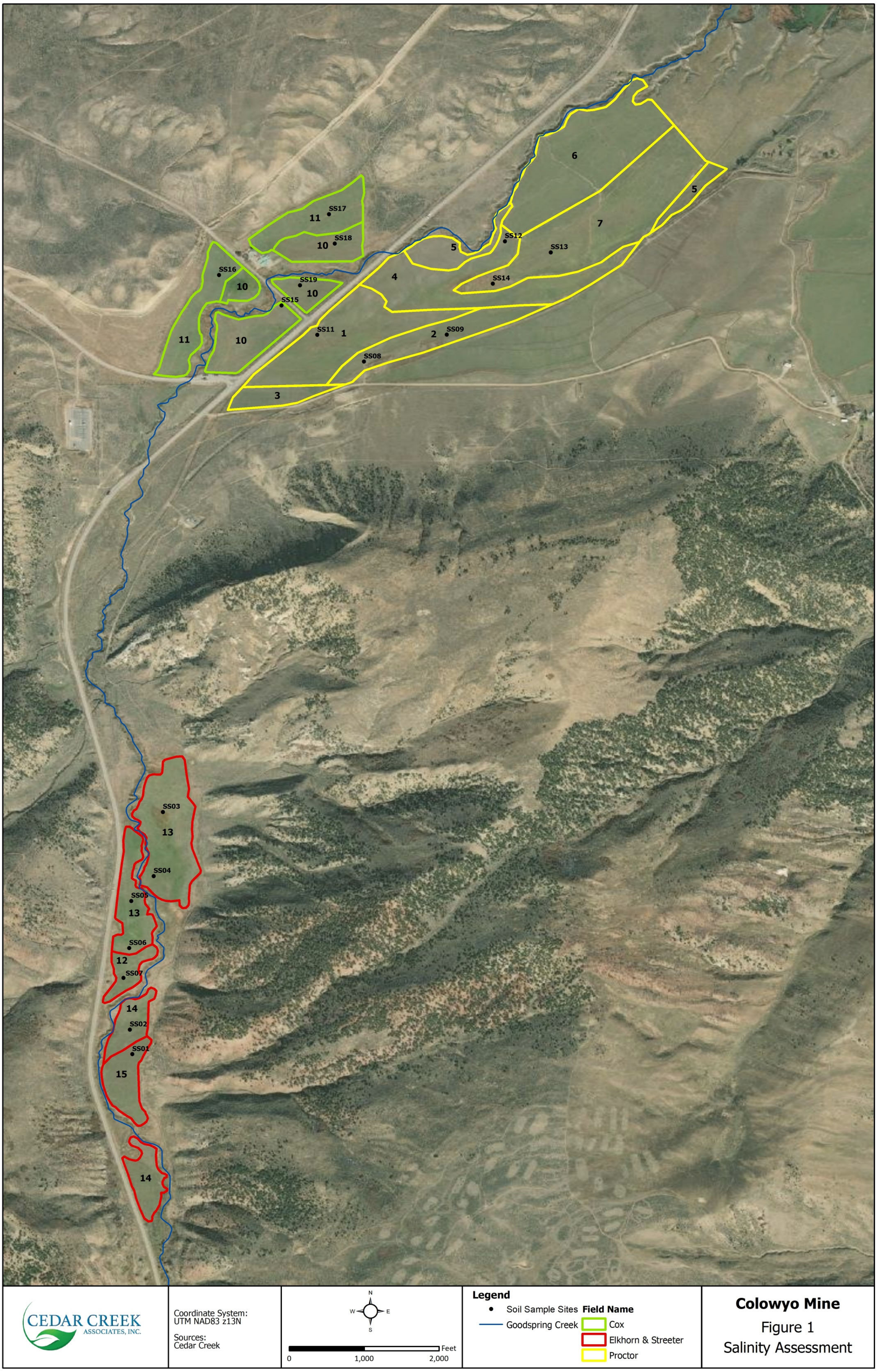
SALINITY IMPACT ASSESSMENT

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.



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**	

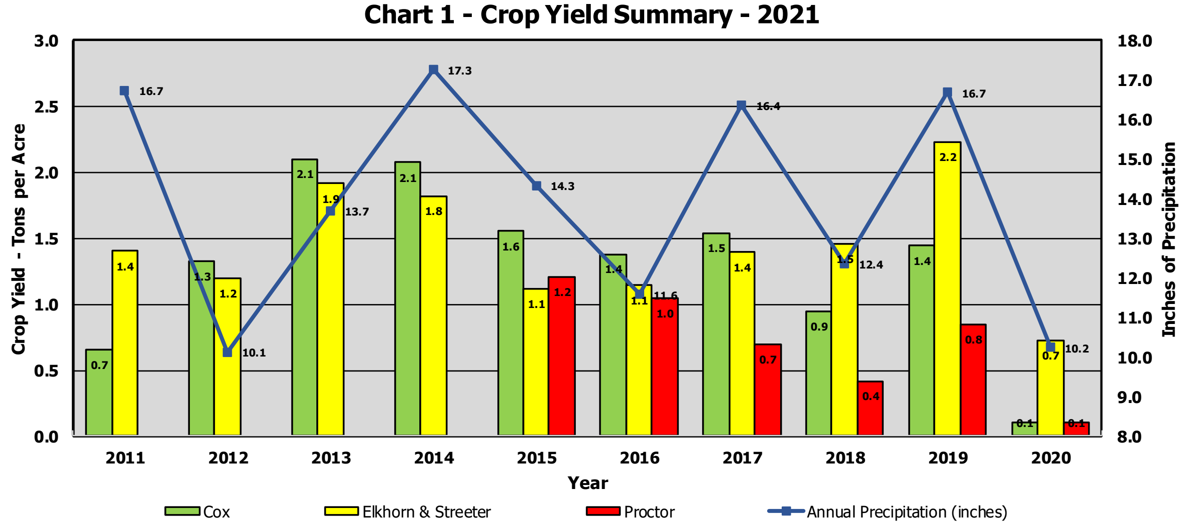
4.0 CROP YIELD

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

Chart 1 - Crop Yield Summary - 2021



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 Species Level Material Damage Assessment

On the two fields where a material damage assessment was warranted, a conservative species level damage assessment was implemented. This entails conducting a material damage assessment on the most salt sensitive species (alfalfa) as if it were the only species in the field (Table 8). The resulting calculation is the same for both fields. In this species level assessment, the field salinity threshold is lowered to the most sensitive species (alfalfa - 2.00 dS/m). Based on the field salinity threshold, the effective field irrigation water quality threshold is 1.34 dS/m. Finally, the percent yield decrease per unit increase is specific to alfalfa. Therefore, the species level material damage assessment on the alfalfa in fields 11 and 6 resulted in a yield reduction of 2.72% based on the life of mine average irrigation water from Goodspring Creek (1.72 dS/m). This value is below the 3% threshold for significance demonstrating that no material damage has occurred.

Table 8 Colowyo - Salinity Study - 2021

Species Level Material Damage Assessment

Field Number	Field Salinity Threshold - Electrical Conductivity (dS/m)	Field Irrigation Water Quality Threshold - Conductance (dS/m)	Irrigation Water Quality - Lower Goodspring Creek - Lab Collected Life of Mine Average (dS/m)	Percent Yield Decrease Per Unit Increase in Conductivity of Irrigation Water (%)	Yield Reduction (%)
11	2.00	1.34	1.72	7.14	2.72
6	2.00	1.34	1.72	7.14	2.72

6.5 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

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