Attachment 2.05.4(2)(d)-1

Walsh Report on Subsoil Suitability

February 2008 (Revised July 2008)

Walsh
Environmental Scientists and Engineers, LLC

August 12, 2008

Mr. Ross Gubka
Western Fuels Colorado LLC
Box 628
Nucla Colorado 81424

Subject: REVISED Subsoil Suitability Study
New Horizon Mine
Walsh Project No. 7873-010

Dear Mr. Gubka:

Walsh Environmental Scientists & Engineers, LLC (Walsh) has performed a limited soil investigation and inspections of operations at the New Horizon Mine in Nucla, Colorado. Work was conducted under contract to Western Fuels – Colorado LLC (WFC). This letter describes investigation techniques, results, and their implication to mine operations and is a revision of the original soil investigation dated March 20, 2008. Revisions are based on comments received from the Division of Reclamation, Mining, and Safety (DRMS) in a letter dated May 28 2008.

Background
The New Horizon Mine mines coal under a DRMS permit. The permit defines soil handling procedures that have been followed by WFC. Prior to February 2008, the permit did not recognize any soil within the permit boundary as being "prime farmland" as defined in the DRMS regulations and by the National Resource Conservation Service (NRCS). Soil handling was consistent with the permit and the NRCS ruling prior to permit issuance that there were no prime farmland soils within the permit area. In February 2008, the NRCS determined that some of the soil within the permit boundary qualified as prime farmland. Some of that prime farmland had been mined and reclaimed, some had been mined but had not yet been fully reclaimed, and some of the material has not yet been mined. WFC has chosen to take steps to ensure that the unreclaimed mined area that has been reclassified as prime farmland is replaced with soil and subsoil that is suitable to restore prime farmland characteristics.

Mining Operations
Coal is mined by stripping topsoil in one or two lifts, mechanically stripping subsoil and weathered Dakota Formation bedrock overburden, blasting remaining bedrock overburden, and mining coal. The mining pit is backfilled first with the interburden and blasted overburden followed by placement of the weathered bedrock overburden, and finally the soil lift(s).

The working face of the mine reveals 10 to 30 feet of weathered sandstone and shale bedrock that has decomposed and is mostly friable (see photos). This material is called "Bench 1" or "overburden unit 1" material in the permit and by WFC. It grades imperceptibly into the overlying soil, and contains root structures to a depth of greater than 10 feet depth. A single discontinuous layer of broken angular rock about six to twelve inches thick is present within much of the observed cut face. This is the only competent rock in the bench 1 cut face. The bench 1 material overlies competent overburden, which overlies the coal seams that are mined (see Photo 1). Bench 1 material is mechanically removed as a separate unit and is the last overburden unit to be placed over the reclaimed mine. As such there are generally several or more feet of the bench 1 material underlying replaced topsoil in the reclaimed areas.

Part of the area of the mine south of BB Road and west of 2700 Road (reclassified as prime farmland) and part of the area north of BB Road (non-prime farmland) have been mined and have had overburden placed, but have not had topsoil replaced (Figure 1). The suitability of the Bench 1 subsoil for use as the lower layer of prime farmland soil is the focus of this study.

Preliminary Investigation

On January 31, 2008, WFC personnel obtained six soil samples from the upper two feet of overburden (samples 101 through 106, Figure 1). The soil was analyzed for texture, conductivity, pH, nitrogen, organic matter, some anions and cations, calcium carbonate, moisture, and sodium adsorption ratio. A summary of results relevant to prime farmland soil is presented in Table 1 and the lab data sheet is attached to this letter. These samples were all within suitability criteria established in the permit and by the NRCS for prime farmland subsoil for target analytes with the exception of one sample which exceeded the electrical conductivity (soluble salts) suitability standard of 4.0 with a reading of 4.1 micromhos/cm.

Second Investigation

After a meeting with the DRMS, NRCS, WFC, and other personnel, WFC agreed to further analyze the condition of the subsoil by examining the soil in pits placed on a 2.5-acre grid (330 feet per side). These grid points were sequentially numbered across the portion of the mine that had been mined and partially reclaimed. Of the 34 grid points, twenty were within areas that had been brought to grade with overburden and were accessible (e.g. not covered with topsoil piles). These locations had soil pits excavated, with 13 south of BB Road (in prime farmland) and seven north of BB Road (in non-prime farmland) (sample points numbered 1 through 34, Figure 1). All pits were excavated in areas that had been brought to grade with overburden, but had not been prepared for topsoil placement or had topsoil placed. WFC dug pits using a backhoe to a depth of three to four feet. Walsh personnel visited the site on March 5, 2008 and described soil color, texture, percent coarse fraction (gravel, cobbles, stones, and boulders), and hardness. Information was recorded into a field notebook and transferred to Table 2. No boulders (>25 inches) were observed in any soil pit.

Soil samples were obtained from the upper two feet of the exposed soil. Samples from the prime farmland area and select samples from the non-prime farmland area were sent to Servi-Tech Laboratories of Hastings, Nebraska for pH, texture, calcium carbonate, and exchangeable sodium percentage (ESP) and other analyses. Laboratory results are summarized in Table 2. Selected lab analyses were based on discussions with David Dearstyne of the NRCS Montrose office. Mr. Dearstyne stated in an email dated February 20, 2008 that soil deeper than 24 inches in prime farmland should be tested for these parameters and compared to standards (shown on Table 2). If the soil is within these criteria it would provide suitable subsoil (copy of email correspondence is attached).

USDA criteria for prime farmland state that the total topsoil plus subsoil depth must equal or exceed 40 inches. These criteria were used to modify the soil suitability criteria table (Table 2.04.9-2) in the DRMS permit.

All soil samples during the March 5 sampling event were within suitable ranges for selected analytes and field parameters. The upper two feet of subsoil was investigated, but there was no change observed to the total soil pit depth in any soil pit, suggesting that the soil suitability criteria would be met in the three to four feet of observed subsoil at all or most sampling locations.

Re-sampling for pH and Electrical Conductivity

Comments from the DRMS in a letter dated May 28, 2008 revealed that the March 5 subsoil analyses utilized 1:1 extract for the soil pH and electrical conductivity (EC), rather than the permit-required paste method for these analytes. Walsh discussed the situation with DRMS and NRCS personnel and determined that there is a proportional relationship between 1:1 extract and paste extract EC results. A published formula was applied to the 1:1 EC results, and revealed that up to four sample points may exceed the paste EC criteria of 4.0 (samples 21, 26, 32, and 33). Based on this, the eight sample points that had 1:1 EC higher than 1.2 were resampled and analyzed for paste EC (Table 2). WFC personnel resampled soil at the original sampling points using a 2" hand auger for a total depth of 24". A fraction of the extracted sample was placed in a zip-loc bag and shipped to Servi-Tech Labs of Hastings, Nebraska. The sampling points were located with a survey-grade GPS to match the March 5, 2008 sampling points. The sampled areas had not yet had topsoil placed at the time of sampling.

Of the eight samples obtained, two exceeded the topsoil permit criteria of 4. These were sample 21 with a paste EC of 4.34 and sample 32 with a paste EC of 7.33. The sample 32 location is near a top-soil pile, which may have affected this location. The samplers noted that as many as five attempts were made at sample 32 to get a complete hole due to refusal of the hand auger. This suggests that sample 32 may not be representative of the subsoil in the area.

Discussion

The original soil survey (Intermountain Resource Inventories, Inc., 1998) performed laboratory analyses on three soil profiles within the prime farmland unit south of BB Road. Of these three, four individual soil horizons from the approximately 24-48 inch subsoil interval were analyzed. Paste EC ranged from 0.7 to 3.8, with an average of 1.9. Percent $CaCO_3$ ranged from 3 to 36%, with an average of 17%. No cobbles, stones, or boulders were observed in the horizons, and lab analysis of gravel ranged from 9.1 to 31.5%, with an average gravel content of 20.7%. This indicates that the replacement subsoil has higher average paste EC (3.1%), lower $CaCO_3$ (2%-4%), and lower coarse fraction (11.7%) than the original tested subsoil. Sample averages are shown on tables 1 and 2.

Walsh discussed the impact of EC on crops with Mr. Dave Dearstyne of the NRCS, who indicated that crops are more sensitive to elevated EC in topsoil than in subsoil. Elevated EC in subsoil can impact established crops but not establishing crops, and established crops are generally more tolerant of elevated EC than establishing crops. Mr. Dearstyne stated that subsoil with a paste EC up to 6 would not be detrimental to grasses or alfalfa. As such, establishing a paste EC criterion of 6 for subsoil in prime farmland for the permit may be appropriate.

The bench 1 material that has been used as top dressing prior to soil placement has characteristics of suitable subsoil for use during reclamation, with the exception of elevated EC at one or two locations. There is sufficient bench 1 material available to provide 24 inches or more top dressing across the prime farmland areas that have been mined as of February 14, 2008. There may be sufficient bench 1 material to also place at least 12 inches on the non-prime farmland areas for use as suitable subsoil.

Please contact me at (970) 241-4636 if you have any questions on this matter. Thank you for selecting Walsh for your project.

Sincerely,
Walsh Environmental Scientists & Engineers, LLC

Edward M. Baltzer, CPG, CHMM
District Manager

Attachments:

- Figure 1
- Photos
- Tables
- Laboratory analytical data
- NRCS email

Photo 1: View of mine face showing Bench 1 material (upper face) and lower overburden material.

Photo 2: Bench 1 cut face cross-section; face is about 20 feet high.

Table 1 - Subsoil Sample Results, January 31, 2008

Sample	pH (unitless)	EC mmhos/cm	Saturation (percent)	SAR (unitless)	CaCO3 (percent)	SE (ppm)	Texture (lab)
CRITERIA*	**6.1-8.4**	**0-4.0**	**25-80**	**0-4.0**	**0-15.0**	**0-2.0**	**
44946 (101)	8.0	2.9	55.0	1.7	2.1	<1.0	SCL
44947 (102)	7.8	3.3	53.0	0.9	2.0	<1.0	SCL
44948 (103)	7.9	2.4	56.0	0.7	1.3	<1.0	SCL
44949 (104)	7.7	3.5	45.0	0.9	2.9	<1.0	SCL
44950 (105)	7.6	**4.1**	63.0	0.9	1.4	<1.0	SCL
44951 (106)	8.0	2.3	42.0	1.0	2.2	<1.0	SCL
Average	7.8	3.1	52.3	1.0	2.0	<1.0	SCL

Notes: Bold indicates exceedance of suitability criteria
* Based on Table 2.04.9-2 Criteria for Evaluating Soil Suitability
** All soil types are acceptable except for s, 1s, sc, sic, & c
NA indicates that sample was not analyzed for specific parameter
Sample numbers in parentheses are numbers shown on Figure 1

Table 2 - Subsoil Sample Results, March 5 and June 25, 2008

Sample	pH	Colors	1:1 EC	Paste EC	texture field*	texture lab*	ESP	% $CaCO_3$	%Gravel (2mm-3")	%Cobbles (3"-10")	%Stones (10"-25")	%Rock Frag's	Consistence
1	7.9	10YR 2/1; 10YR 6/3; 10YR 6/4	1.36	2.72	SCL	SCL	2	6.1	5	10	0	15	S/VH
2	8	10YR 5/2	1		SCL	SCL	2	1.7	3	5	0	8	S/H
3	7.6	NA	1.07		CL	SCL	1	1.3	20	2	1	23	
6	8.2	2.5YR 4/4; 7.5YR 4/1;7.5YR 7/3	0.52		NA	SCL	1	12.8	2	2	0	4	EH
8	7.9	7.5YR 4/4; 10YR 2/1	1.08		CL	SCL	1	2.5	10	5	1	16	L
12	8.1	10YR 3/1; 10YR 6/6	0.72		SL	SL	1	10.1	5	2	0	7	S/R
13	7.8	varied	0.94		L	SCL	1	3.8	5	10	2	17	HA
14	8.2	10YR 5/6	0.55		NA	SL	1	1.8	10	15	5	30	L
20	7.9	7.5YR 4/4; 7.5YR 3/1	1.36	3.43	SCL	SCL	1	11.9	5	4	0	9	SH/EH
21	8	3.5YR 4/3; 10YR 5/2	2.19	**4.34**	CL	SCL	1	2.5	2	2	0	4	SH
22	7.9	5YR 5/4; 10YR 5/6; 10YR 3/1	1.24	3.99	SL	SL	1	5.7	5	5	1	11	VH
23	7.9	NA	1.22	3.86	NA	SCL	1	2	5	5	2	12	SH
24	7.9	NA	0.85		NA	SL	1	4.5	5	5	1	11	HA
25	8.3	10YR 4/4; 10YR 8/1	0.33		SiL	SCL	2	1	5	15	2	22	HA
26	7.8	NA	1.64	3.66	NA	SCL	1	3.3				0	
27	8.2	104R 4/2	0.42		SCL	SCL	1	1.8	3	3	1	7	S/VH
30	7.9	10YR 4/3; 10YR 4/4; 5YR 5/3	1.03		CL	SCL	1	5.3	2	1	0	3	MH
32	8	10YR 2/1; 10YR 7/6; 10YR 3/1	1.54	**7.33**	CL	SCL	3	2.5	10	5	1	16	HA
33	7.9	NA	1.71	3.97	NA	SCL	1	4.8	5	5	1	11	MH
34	8	5YR 5/8	1.14		CL	SCL	1	4.2	5	2	0	7	SH
Average	7.97		1.1				1.25	4.48	5.89	5.42	0.95	11.65	
Suitability	4.5-8.4	none		< 4	* s, ls, sc, sic, c		<15%	<40%	total < 50%; <25% ave				

Notes:
Soils compared to the USDA Soil Classification System; refer to this system for definition of terms and abbreviations
Suitability based on Table 2.04.9-2 *Criteria for Evaluating Soil Suitability*
* All soil types are acceptable except for s, ls, sc, sic, & c
NA indicates that sample was not analyzed for specific parameter
Not all analytical data are shown; see attached lab data sheets for additional analytes
No boulders were observed in any soil pit; as such they are not shown in this table.
Coarse fragment values are based on visual estimate of cobble and stone volume and on sieve volume estimate of gravel.

SOIL ANALYSIS REPORT

WESTERN FUELS-COLORADO
NEW HORIZON MINE
PO BOX 628
NUCLA, CO 81424

Servi-Tech Laboratories
www.servitechlabs.com

1602 Park West Dr.
PO Box 169
Hastings, NE 68902
800.557.7509
402.463.3522
Fax 402.463.8132

LAB NO:	44946 ·
INVOICE NO:	672153
DATE RECEIVED:	02/01/2
DATE REPORTED:	02/08/2

.YSIS RESULTS FOR: WESTERN FUELS-COLORADO

FIELD IDENTIFICATION:

SED:

mple ID	Sample Depth	1:1 Water-Soil Soil pH	Buffer pH	1:1 Water-Soil Sol. Salts mmho/cm	Excess Lime	Mod. WB % Organic Matter	Cd Reduction Nitrate-Nitrogen ppm	Cd Reduction Nitrate-Nitrogen lb. N/A	Mehlich 3 Phosphorus ppm P	Potassium ppm K	Sulfur ppm	Sulfur lb. S/A	Ammonium Acetate Calcium ppm Ca	Ammonium Acetate Magnesium ppm Mg	Ammonium Acetate Sodium ppm Na	Zinc ppm Zn	Iron ppm Fe	Manganese ppm Mn	Cc pp
;-01	0 - 0	8.0		1.08	Hi	0.2	2	0	5	141	469	<1	3962	984	138				
;-02	0 - 0	7.8		1.74	Hi	0.4	3	0	4	134	1240	<1	4738	711	83				
;-03	0 - 0	7.9		0.77	Lo	0.3	3	0	4	127	352	<1	3508	741	60				
;-04	0 - 0	7.7		1.29	Hi	0.3	<1	<0	6	75	1440	<1	5162	542	69				
-05	0 - 0	7.6		1.94	Lo	0.4	3	0	6	142	2660	<1	4518	1254	101				
-06	0 - 0	8.0		0.73	Hi	0.3	2	0	5	88	214	<1	3721	469	69				

SED:

ple)	Sample Depth	Soil Textural Classification	Hydrometer Sand %	Hydrometer Silt %	Hydrometer Clay %	0.4 N Acetic Acid CaCO3 %	Sat. Paste Saturation % Moist.	Sat. Paste Soil pH	Sat. Paste Electrical Conductivity mmho/cm	Sat. Paste Calcium mg/L Ca	Sat. Paste Magnesium mg/L Mg	Sat. Paste Sodium mg/L Na	Sat. Paste Sodium Adsorption Ratio				
-01	0 - 0	Sandy Clay Loam	58	14	28	2.1	55	7.8	2.86	410	210	167	1.67				
-02	0 - 0	Sandy Clay Loam	60	16	24	2.0	53	7.87	3.29	590	250	108	0.94				
-03	0 - 0	Sandy Clay Loam	58	16	26	1.3 `	56	7.73	2.36	370	170	62	0.67				
04	0 - 0	Sandy Clay Loam	68	12	20	2.9	45	7.55	3.60	560	340	108	0.89				
05	0 - 0	Sandy Clay Loam	51.9	16.1	32	1.4	63	7.57	4.09	530	490	118	0.89				
06	0 - 0	Sandy Clay Loam	64	16	20	2.2	42	7.84	2.29	360	150	88	0.98				

RECOMMENDATIONS:

POUNDS ACTUAL NUTRIENT PER ACRE

le	Crop To Be Grown	Yield Goal	Lime, ECC Tons/A to raise pH to: 6.0	6.5	7.0	N	P_2O_5	K_2O	Zn	S	Mn	Cu	MgO	B	Ca	Cl
01																
)2																
)3																
)4																
)5																
)6																

Cation Ex Capac

CEC	%H	%K	%
29	0	1	
30	0	1	
24	0	1	
31	0	1	
34	0	1	
23	0	1	

presentative of the samples submitted

Samples are retained 30 days after report of analysis

Explanations of soil analysis terms are available upor

Reviewed and Approved By: Hans Burken Agronomist

Hans Burken

Page ·
02/08/2008

SOIL ANALYSIS REPORT

CLIENT: 21490	WESTERN FUELS-COLORADO LLC. NEW HORIZON MINE 27646 W 5TH AVE PO BOX 628 NUCLA, CO 81424-0628

Servi-Tech Laboratories
www.servitechlabs.com

1602 Park West Dr.
PO Box 169
Hastings, NE 68902
800.557.7509
402.463.3522
Fax 402.463.8132

LAB NO:	48981 - 48990
INVOICE NO:	672472
DATE RECEIVED:	03/12/2008
DATE REPORTED:	03/19/2008

SOIL ANALYSIS RESULTS FOR: WESTERN FUELS-COLORADO   FIELD IDENTIFICATION: MORGANS PRIME FARMLAND

METHOD USED:

Lab Number	Sample ID	Sample Depth	Soil pH (1:1 Water-Soil)	Buffer pH	Sol. Salts mmho/cm (1:1 Water-Soil)	Excess Lime	% Organic Matter			Phosphorus ppm P	Potassium ppm K (Ammonium Acetate)	Sulfur ppm	Sulfur lb. S/A	Calcium ppm Ca	Magnesium ppm Mg	Sodium ppm Na	Zinc ppm Zn	Iron ppm Fe	Manganese ppm Mn	Copper ppm Cu	Boron ppm B
48981	SS-01	0 - 24	7.9		1.36	Hi					140	1030	7420	5028	565	114					
48982	SS-02	0 - 24	8.0		1.00	Lo					102	970	6980	3716	725	94					
48983	SS-03	0 - 24	7.6		1.07	Lo					119	1920	13800	4000	1186	80					
48984	SS-06	0 - 24	8.2		0.52	Hi					128	260	1870	4701	466	57					
48985	SS-08	0 - 24	7.9		1.08	Lo					114	940	6770	4128	776	72					
48986	SS-12	0 - 24	8.1		0.72	Hi					73	790	5690	4574	380	36					
48987	SS-13	0 - 24	7.8		0.94	Hi					105	1460	10500	5077	626	57					
48988	SS-14	0 - 24	8.2		0.55	Lo					51	225	1620	2488	254	48					
48989	SS-20	0 - 24	7.9		1.36	Hi					140	1020	7340	5399	819	70					
48990	SS-21	0 - 24	8.0		2.19	Lo					126	4370	31500	8220	850	107					

METHOD USED:

Lab Number	Sample ID	Sample Depth	Soil Textural Classification	Sand % (Hydrometer)	Silt %	Clay %	CaCO3 % (0.4 N Acetic Acid)	Saturation % Moist. (Sat. Paste)	Calcium mg/L Ca	Magnesium mg/L Mg	Sodium mg/L Na	Sodium Adsorption Ratio
48981	SS-01	0 - 24	Sandy Clay Loam	60	20	20	6.1	41	510	230	167	1.54
48982	SS-02	0 - 24	Sandy Clay Loam	60.1	14.9	25	1.7	42	470	320	136	1.19
48983	SS-03	0 - 24	Sandy Clay Loam	54	18	28	1.3	46	480	500	106	0.81
48984	SS-06	0 - 24	Sandy Clay Loam	60	16	24	12.8	38	300	108	62	0.78
48985	SS-08	0 - 24	Sandy Clay Loam	60	16	24	2.5	40	480	320	94	0.82
48986	SS-12	0 - 24	Sandy Loam	70	16	14	10.1	34	500	180	54	0.53
48987	SS-13	0 - 24	Sandy Clay Loam	57.9	18.1	24	3.8	41	440	270	74	0.68
48988	SS-14	0 - 24	Sandy Loam	76	10	14	1.8	34	233	101	57	0.78
48989	SS-20	0 - 24	Sandy Clay Loam	54.1	16	29.9	11.9	49	470	250	80	0.74
48990	SS-21	0 - 24	Sandy Clay Loam	58	18	24	2.5	47	470	380	142	1.18

Analyses are representative of the samples submitted   Samples are retained 30 days after report of analysis   Explanations of soil analysis terms are available upon request

Reviewed and Approved By: Hans Burken, Agronomist Hans Burken

SOIL ANALYSIS REPORT

CLIENT: 21490

WESTERN FUELS-COLORADO LLC.
NEW HORIZON MINE
27646 W 5TH AVE
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LAB NO:	48981 - 48990
INVOICE NO:	672472
DATE RECEIVED:	03/12/2008
DATE REPORTED:	03/19/2008

SOIL ANALYSIS RESULTS FOR: WESTERN FUELS-COLORADO **FIELD IDENTIFICATION:** MORGANS PRIME FARMLAND

FERTILIZER RECOMMENDATIONS:

Lab Number	Sample ID	Crop To Be Grown	Yield Goal	Lime, ECC Tons/A to raise pH to:			POUNDS ACTUAL NUTRIENT PER ACRE											Cation Exchange Capacity					
				6.0	6.5	7.0	N	P_2O_5	K_2O	Zn	S	Mn	Cu	MgO	B	Ca	Cl	CEC	%H	%K	%Ca	%Mg	%Na
48981	SS-01																	31		1	82	15	2
48982	SS-02																	25		1	73	24	2
48983	SS-03																	31		1	65	32	1
48984	SS-06																	28		1	84	14	1
48985	SS-08																	28		1	74	23	1
48986	SS-12																	26		1	87	12	1
48987	SS-13																	31		1	82	17	1
48988	SS-14																	15		1	84	14	1
48989	SS-20																	34		1	78	20	1
48990	SS-21																	49		1	84	14	1

SPECIAL COMMENTS AND SUGGESTIONS:

Lab Number(s):48981, 48989, 48990

WARNING: Soluble salts level indicates potential salinity problems. Please call if you wish us to run a soil salinity test or for additional information.

Lab Number(s):48981, 48982, 48983, 48984, 48985, 48986, 48987, 48988, 48989, 48990

CEC calculated by cation summation may overestimate true CEC and underestimate exchangeable sodium percentage (ESP) in soils containing excess lime.

Lab Number(s):48981, 48982, 48983, 48984, 48985, 48986, 48987, 48988, 48989, 48990

Servi-Tech Laboratory fertilizer recommendations were not requested.

Analyses are representative of the samples submitted. Samples are retained 30 days after report of analysis. Explanations of soil analysis terms are available upon request.

Reviewed and Approved By: Hans Burken, Agronomist

SOIL ANALYSIS REPORT

CLIENT: 21490	WESTERN FUELS-COLORADO LLC. NEW HORIZON MINE 27646 W 5TH AVE PO BOX 628 NUCLA, CO 81424-0628

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LAB NO:	48991 - 49000
INVOICE NO:	672472
DATE RECEIVED:	03/12/2008
DATE REPORTED:	03/19/2008

SOIL ANALYSIS RESULTS FOR: WESTERN FUELS-COLORADO — FIELD IDENTIFICATION: MORGANS PRIME FARMLAND

METHOD USED:

			1:1 Water-Soil		1:1 Water-Soil						Ammonium Acetate										
Lab Number	Sample ID	Sample Depth	Soil pH	Buffer pH	Sol. Salts mmho/cm	Excess Lime	% Organic Matter			Phosphorus ppm P	Potassium ppm K	Sulfur ppm	Sulfur lb. S/A	Calcium ppm Ca	Magnesium ppm Mg	Sodium ppm Na	Zinc ppm Zn	Iron ppm Fe	Manganese ppm Mn	Copper ppm Cu	Boron ppm B
48991	SS-22	0 - 24	7.9		1.24	Hi					81	1110	7990	4795	402	62					
48992	SS-23	0 - 24	7.9		1.22	Lo					92	2000	14400	4945	550	78					
48993	SS-24	0 - 24	7.9		0.85	Hi					81	1080	7780	4930	332	49					
48994	SS-25	0 - 24	8.3		0.33	Lo					137	84	605	2997	758	89					
48995	SS-26	0 - 24	7.8		1.64	Lo					170	2290	16500	6360	1313	83					
48996	SS-27	0 - 24	8.2		0.42	Lo					126	97	698	3206	568	61					
48997	SS-30	0 - 24	7.9		1.03	Hi					141	650	4680	5038	567	69					
48998	SS-32	0 - 24	8.0		1.54	Lo					130	1850	13300	4430	823	204					
48999	SS-33	0 - 24	7.9		1.71	Hi					95	2520	18100	6680	806	99					
49000	SS-34	0 - 24	8.0		1.14	HI					104	1470	10600	5465	623	60					

METHOD USED:

				Hydrometer			0.4 N Acetic Acid		Sat. Paste			
Lab Number	Sample ID	Sample Depth	Soil Textural Classification	Sand %	Silt %	Clay %	$CaCO_3$ %	Saturation % Moist	Calcium mg/L Ca	Magnesium mg/L Mg	Sodium mg/L Na	Sodium Adsorption Ratio
48991	SS-22	0 - 24	Sandy Loam	70.1	13.9	16	5.7	34	450	190	86	0.86
48992	SS-23	0 - 24	Sandy Clay Loam	64.9	15.1	20	2.0	35	460	280	111	1.01
48993	SS-24	0 - 24	Sandy Loam	68	16	16	4.5	31	500	160	67	0.67
48994	SS-25	0 - 24	Sandy Clay Loam	54.1	15.9	30	1.0	51	90	40	59	1.30
48995	SS-26	0 - 24	Sandy Clay Loam	51.9	20.1	28	3.3	48	400	350	82	0.72
48996	SS-27	0 - 24	Sandy Clay Loam	56	16	28	1.8	52	110	40	43	0.89
48997	SS-30	0 - 24	Sandy Clay Loam	56	19	25	5.3	40	500	170	85	0.84
48998	SS-32	0 - 24	Sandy Clay Loam	59.9	18.1	22	2.5	42	450	340	330	2.86
48999	SS-33	0 - 24	Sandy Clay Loam	62	13	25	4.8	38	450	350	139	1.19
49000	SS-34	0 - 24	Sandy Clay Loam	62	16	22	4.2	35	450	250	72	0.67

Analyses are representative of the samples submitted. Samples are retained 30 days after report of analysis. Explanations of soil analysis terms are available upon request

Reviewed and Approved By: Hans Burken, Agronomist

Hans Burken

03/19/2008 5:12 pm

SOIL ANALYSIS REPORT

CLIENT: 21490	WESTERN FUELS-COLORADO LLC. NEW HORIZON MINE 27646 W 5TH AVE PO BOX 628 NUCLA, CO 81424-0628	**LAB NO:** **INVOICE NO:** **DATE RECEIVED:** **DATE REPORTED:**	48991 - 49000 672472 03/12/2008 03/19/2008

Servi-Tech Laboratories
www.servitechlabs.com
1602 Park West Dr.
PO Box 169
Hastings, NE 68902
800.557.7509
402.463.3522
Fax 402.463.8132

SOIL ANALYSIS RESULTS FOR: WESTERN FUELS-COLORADO **FIELD IDENTIFICATION:** MORGANS PRIME FARMLAND

FERTILIZER RECOMMENDATIONS:

Lab Number	Sample ID	Crop To Be Grown	Yield Goal	Lime, ECC Tons/A to raise pH to: 6.0	6.5	7.0	POUNDS ACTUAL NUTRIENT PER ACRE: N	P_2O_5	K_2O	Zn	S	Mn	Cu	MgO	B	Ca	Cl	Cation Exchange Capacity: CEC	%H	%K	%Ca	%Mg	%Na
48991	SS-22																	28		1	86	12	1
48992	SS-23																	30		1	83	15	1
48993	SS-24																	28		1	89	10	1
48994	SS-25																	22		2	68	29	2
48995	SS-26																	44		1	73	25	1
48996	SS-27																	21		2	75	22	1
48997	SS-30																	31		1	82	15	1
48998	SS-32																	30		1	73	23	3
48999	SS-33																	41		1	82	16	1
49000	SS-34																	33		1	83	16	1

SPECIAL COMMENTS AND SUGGESTIONS:

Lab Number(s):48991, 48992, 48993, 48994, 48995, 48996, 48997, 48998, 48999, 49000

CEC calculated by cation summation may overestimate true CEC and underestimate exchangeable sodium percentage (ESP) in soils containing excess lime.

Lab Number(s):48991, 48992, 48993, 48994, 48995, 48996, 48997, 48998, 48999, 49000

Servi-Tech Laboratory fertilizer recommendations were not requested.

Lab Number(s):48995, 48998, 48999

WARNING: Soluble salts level indicates potential salinity problems. Please call if you wish us to run a soil salinity test or for additional information.

Analyses are representative of the samples submitted Samples are retained 30 days after report of analysis Explanations of soil analysis terms are available upon request

Reviewed and Approved By: Hans Burken Agronomist

Hans Burken

SOIL ANALYSIS REPORT

WESTERN FUELS-COLORADO LLC.
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LAB NO:	57505 -
INVOICE NO:	673389
DATE RECEIVED:	06/25/2(
DATE REPORTED:	06/27/2(

ʼSIS RESULTS FOR: WESTERN FUELS-COLORADO

FIELD IDENTIFICATION:

·ED: ·le	Sample Depth	Sat. Paste Soil pH	Sat. Paste Electrical Conductivity mmho/cm
1	0 - 0	7.68	2.72
·20	0 - 0	7.83	3.43
·21	0 - 0	7.88	4.34
·2	0 - 0	7.68	3.99
·3	0 - 0	7.61	3.86
·6	0 - 0	7.8	3.66
2	0 - 0	7.43	7.33
36)	0 - 0	7.8	3.97

RECOMMENDATIONS:

POUNDS ACTUAL NUTRIENT PER ACRE

·e	Crop To Be Grown	Yield Goal	Lime, ECC Tons/A to raise pH to: 6.0	6.5	7.0	N	P_2O_5	K_2O	Zn	S	Mn	Cu	MgO	B	Ca	Cl
·																
0																
1																
2																
3																
5																
2																
36)																

Cation Ex Capa(

CEC	%H	%K	%

ʼMMENTS AND SUGGESTIONS:

s): 57505, 57506, 57507, 57508, 57509, 57510, 57511, 57512

Laboratory fertilizer recommendations were not requested.

ʼresentative of the samples submitted

Samples are retained 30 days after report of analysis

Explanations of soil analysis terms are available upor

Reviewed and Approved By: Hans Burken, Agronomist

Hans Burken

Page ·
06/27/2008

Edward Baltzer

From: Dearstyne, David - Montrose, CO [David.Dearstyne@co.usda.gov]

Sent: Wednesday, February 20, 2008 10:47 AM

To: Edward Baltzer

Cc: Boyd, Jim - Norwood, CO; fcompton@walshenv.com; rgubka@wfcnucla.org

Subject: RE: New Horizon Mine

Hi Edward,

I could suggest sampling for the following items, pH, EC, texture estimate (using the ribbon or similar method), soil color, effervescence (presence or absence of carbonates), estimate of % RF's (rock fragments) - sizes and amount by volume. I would split any layers within this subsoil that are contrasting (came form different replacements) in any of these characteristics. If your sample indicates significant effervescence using HCL (1N), or visual observations of significant calcium carbonate (masses, threads, coats on frags) you may opt to collect a sample and run a calcimeter to determine the CaCO3 equivalent. This is a simple test that usually takes about 3 to 5 minutes to run and requires just a couple of test items and chemicals (10% HCL). It is usually run inside. This is a more comprehensive list. If you just wanted to describe essentials only, they would be in my estimation texture, pH, EC if pH is above 8.4, and amount and sizes of RF's.

Using this information, you can then compare to the requirements for Prime Farmland and to the soil descriptions of the original soils found on the site (In this case the Barx or Devinny soils). You also have the data collected by Intermountain Resources to help you as a baseline for comparison. I would suggest keeping in mind some of the conversations we had during our meeting on the 15th, when comparing the replaced subsoil with the PF requirements. For most agricultural uses, the topsoil is much more significant than the subsoil (though in our conversations you can't assume that anything replaced will suffice for subsoil requirements). Hope this helps. If you have difficulties developing a list of parameters for subsoil replacement characteristics using this information, please feel free to contact me and we can discuss this further.

Dave

From: Edward Baltzer [mailto:ebaltzer@walshenv.com]
Sent: Monday, February 18, 2008 9:50 AM
To: Dearstyne, David - Montrose, CO
Cc: fcompton@walshenv.com; rgubka@wfcnucla.org
Subject: New Horizon Mine

Dear David:

We are proposing to sample the top two feet of subsoil that has been placed over the 98E (Prime Farmland) mined portion of the New Horizon Mine. It will have approximately two feet of reclaimed topsoil placed over it.

Please provide an analyte list that you think is appropriate to determine if the placed suboil is appropriate for the lower horizons of soil. THank you for your time.

Sincerely,

Edward M. Baltzer
Walsh Environmental Scientists & Engineers, LLC
535 Grand Avenue
Grand Junction, Colorado 81501-2790
(970) 241-4636
ebaltzer@walshenv.com

3/17/2008

Resampling of Suitable Subsoil on Prime Farmland Soil Areas and Corresponding Results

As is seen from the lab results of 6/27/08, eight samples were re-run based on saturation paste extract for conductivity in the placed subsoil in prime farmland soils prior to February 2008. Seven of these samples were acceptable, as seen in the included lab sheet, page Attachment 2.05.4(2)(d)-1-14 . One sample, #32, still showed a high level of 7.33 mmhos/cm. Surrounding samples were then taken according to the procedures outlined in the approved permit at the time. The surrounding remediation test samples (4) around site #32 passed. See lab results on page Attachment 2.05.4(20(d)-1-17&18. Since the surrounding test sites passes, no further testing or action was needed for that site.

Sample site #32 will be resampled under the new second phase sampling procedures outlined in Permit Revision 06, and will be remediated if necessary.

There was some question about sample site #21 being elevated, so four more remediation test samples were taken and those passed as well. See lab results on page Attachment 2.05.4(2)(d)-1-17&18. The results on the following pages all show acceptable results in the surrounding area.

SOIL ANA YSIS REPORT

CLIENT:	
21490	WESTERN FUELS-COLORADO LLC. NEW HORIZON MINE 27646 W 5TH AVE PO BOX 628 NUCLA, CO 81424-0628

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LAB NO:	59586 - 59593
INVOICE NO:	673621
DATE RECEIVED:	08/18/2008
DATE REPORTED:	08/26/2008

SOIL ANALYSIS RESULTS FOR: WESTERN FUELS-COLORADO **FIELD IDENTIFICATION:**

METHOD USED:											Ammonium Acetate										
Lab Number	Sample ID	Sample Depth	Soil pH	Buffer pH	Sol. Salts mmho/cm	Excess Lime	% Organic Matter			Phosphorus ppm P	Potassium ppm K	Sulfur ppm	Sulfur lb. S/A	Calcium ppm Ca	Magnesium ppm Mg	Sodium ppm Na	Zinc ppm Zn	Iron ppm Fe	Manganese ppm Mn	Copper ppm Cu	Boron ppm B
59586	SS-21WEST	0 - 24									71	1911	13800	5870	380	62					
59587	SS-21EAST	0 - 24									87	1493	10800	4419	551	101					
59588	SS-21NORTH	0 - 24									103	4251	30600	48240	750	93					
59589	SS-21SOUTH	0 - 24									65	1516	10900	4056	495	96					
59590	SS-32NORTH	0 - 24									75	1036	7460	5770	428	51					
59591	SS-32WEST	0 - 24									86	1473	10600	4747	652	161					
59592	SS-32EAST	0 - 24									64	973	7010	4169	429	85					
59593	SS-31	0 - 24									67	2365	17000	6181	455	151					

METHOD USED:				Hydrometer			0.4 N Acetic Acid	Sat. Paste											
Lab Number	Sample ID	Sample Depth	Soil Textural Classification	Sand %	Silt %	Clay %	CaCO3 %	Saturation % Moist.	Soil pH	Electrical Conductivity mmho/cm	Calcium mg/L Ca	Magnesium mg/L Mg	Sodium mg/L Na	Sodium Adsorption Ratio					
59586	SS-21WEST	0 - 24	Sandy Loam	69	12	19	2.1	39	7.68	3.23	910	390	75	0.52					
59587	SS-21EAST	0 - 24	Sandy Clay Loam	63	16	21	1.6	38	7.5	3.58	590	290	101	0.85					
59588	SS-21NORTH	0 - 24	Sandy Clay Loam	63	12	25	2.7	41	7.78	4.00	590	440	92	0.70					
59589	SS-21SOUTH	0 - 24	Sandy Clay Loam	65	14	21	1.7	38	7.68	3.49	580	300	104	0.87					
59590	SS-32NORTH	0 - 24	Sandy Clay Loam	64	15	21	4.4	38	7.8	3.04	640	216	47	0.41					
59591	SS-32WEST	0 - 24	Sandy Clay Loam	64	15	21	1.8	43	7.76	3.92	570	370	160	1.28					
59592	SS-32EAST	0 - 24	Sandy Loam	69	12	19	2.4	42	7.8	3.27	590	260	85	0.73					
59593	SS-31	0 - 24	Sandy Loam	69	12	19	2.3	39	7.81	3.68	560	290	172	1.47					

Analyses are representative of the samples submitted   Samples are retained 30 days after report of analysis   Explanations of soil analysis terms are available upon request

Reviewed and Approved By: Hans Burken, Agronomist

Hans Burken

SOIL ANA 'SIS REPORT

CLIENT: 21490

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LAB NO: 59586 - 59593
INVOICE NO: 673621
DATE RECEIVED: 08/18/2008
DATE REPORTED: 08/26/2008

SOIL ANALYSIS RESULTS FOR: WESTERN FUELS-COLORADO **FIELD IDENTIFICATION:**

FERTILIZER RECOMMENDATIONS: POUNDS ACTUAL NUTRIENT PER ACRE

Lab Number	Sample ID	Crop To Be Grown	Yield Goal	Lime, ECC Tons/A to raise pH to: 6.0	6.5	7.0	N	P_2O_5	K_2O	Zn	S	Mn	Cu	MgO	B	Ca	Cl	Cation Exchange Capacity: CEC	%H	%K	%Ca	%Mg	%Na
59586	SS-21WEST																	33		1	89	10	1
59587	SS-21EAST																	27		1	81	17	2
59588	SS-21NORTH																	248		0	97	3	0
59589	SS-21SOUTH																	25		1	81	17	2
59590	SS-32NORTH																	33		1	88	11	1
59591	SS-32WEST																	30		1	79	18	2
59592	SS-32EAST																	25		1	84	14	1
59593	SS-31																	36		0	87	11	2

SPECIAL COMMENTS AND SUGGESTIONS:

Lab Number(s):59586, 59587, 59588, 59589, 59590, 59591, 59592, 59593
Servi-Tech Laboratory fertilizer recommendations were not requested.

Analyses are representative of the samples submitted   Samples are retained 30 days after report of analysis   Explanations of soil analysis terms are available upon request

Reviewed and Approved By: Hans Burken, Agronomist   Hans Burken

Attachment 2.05.4(2)(d)-2

Salt Tolerance of Plants

Electric Conductivity (EC)

Electric Conductivity (EC) of plants.

An internet search on plant tolerance of Electric Conductivity (EC) was performed and the Alberta Canada Agriculture and Rural Development paper on Salt Tolerance of Plants study appeared. **(http://www1.agric.gov.ab.ca/$department/deptdocs.nsf/all/agdex3303)**. Within this document the author stated on page 1, Table 2 that Alfalfa, Birdsfoot Trefoil, and Bromegrass forage had a salt tolerance $EC_{ds/m}$ value of 8. Tall Wheatgrass, Russian Wildrye and Slender Wheatgrass had a salt tolerance $EC_{ds/m}$ of 16 and Crested Wheatgrass and Intermediate Wheatgrass had a Moderate ($Ec_{ds/m}$=4).

`

A second internet search from Colorado State University revealed the conversion between $EC_{cds/m}$ and $EC_{SP\ (mmho/cm)}$. The conversion is a 1:1. See below:

(http://www.ext.colostate.edu/PUBS/crops/00506.html)

Salt Tolerance of Plants

Plant species vary in how well they tolerate salt-affected soils. Some plants will tolerate high levels of salinity while others can tolerate little or no salinity. The relative growth of plants in the presence of salinity is termed their salt tolerance.

Salt tolerances are usually given in terms of the stage of plant growth over a range of electrical conductivity (EC) levels. Electrical conductivity is the ability of a solution to transmit an electrical current. To determine soil salinity EC, an electrical current is imposed in a glass cell using two electrodes in a soil extract solution taken from the soil being measured (soil salinity). The units are usually given in deciSiemens per metre (dS/m).

Table 1 categorizes salinity into general ranges from non- saline to very strongly saline. These values are used for plant selection for saline soils. Salinity levels vary widely across a saline seep. Salinity also varies from spring to fall. Salinity usually appears on the soil surface just after spring thaw.

A high salt level interferes with the germination of new seeds. Salinity acts like drought on plants, preventing roots from performing their osmotic activity where water and nutrients move from an area of low concentration into an area of high concentration. Therefore, because of the salt levels in the soil, water and nutrients cannot move into the plant roots.

As soil salinity levels increase, the stress on germinating seedlings also increases. Perennial plants seem to handle salinity better than annual plants. In some cases, salinity also has a toxic effect on plants because of the high concentration of certain salts in the soil. Salinity prevents the plants from taking up the proper balance of nutrients they require for healthy growth.

Extensive research on salt tolerance for prairie conditions was done in 1988 (Table 2). It should be noted that crop tolerances developed for chloride-dominated soils, such as those in California, may not be applicable to crops grown on the sulphate-dominated soils typically found in western Canada.

Table 1. Salinity rating and electrical conductivity value

Soil Depth	Non-Saline	Weakly Saline	Moderately Saline	Strongly Saline	Very Strongly Saline
0-60 cm (0-2 ft)	<2 ds/m*	2-4 ds/m	4-8 ds/m	8-16 ds/m	>16 ds/m
60-120 cm(2-4 ft)	<4 ds/m	4-8 ds/m	8-16 ds/m	16-24 ds/m	>24 ds/m

* ds/m = decisiemens per metre.

The dominant salts in prairie saline seeps are calcium (Ca), magnesium (Mg), sodium (Na) cations and sulfate (SO4) anions. If Na levels are high or not balanced with the Ca and Mg, soil tilth can also be effected. The positively charged Na cations attach to the negatively charged clay particles in the soil, causing the soil to be sticky when wet, and hard and impermeable when dry.

Table 2 gives salinity tolerance ratings for a range of plant species and a range of salinity levels. New research underway may modify the rating of some plant types. As a general rule, plants that have low drought tolerance will have low salinity tolerance.

Table 2. Salt tolerance of various types of plants

Salt Tolerance EC (ds/m)	Field Crops	Forages	Vegetables	Trees, Shrubs
Very High 20		beardless wildrye fulks altai grass levonns alkaligrass alkali sucatan		
High 16	kochia sugar beets	altai wildrye tall wheatgrass Russian wildrye slender wheat grass		Siberian salt tree sea buckthorn silver buffaloberry
8	6-row barley safflower sunflower 2-row barley fall rye winter wheat spring wheat	birdsfoot trefoil sweetclover alfalfa bromegrass	garden beets asparagus spinach	hawthorn Russian olive American elm Siberian elm villosa lilac laurel leaf willow
Moderate	oats yellow mustard	crested wheatgrass intermediate wheatgrass	tomatoes broccoli	spreading juniper poplar
	meadow fescue flax	reed canary grass	cabbage	ponderosa pine apple

A third internet search revealed a document from Colorado University that lists some trees, shrubs, flowers, grasses and other ground cover vegetation that have different salt tolerance (EC). Alfalfa, and some species of grasses WFC plants are in in this list. (www.coopext.coloradostate.edu/tra/plants/stable.html)(See the Reports below.

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Comments are
appreciated.

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Attachment 2.05.4(2)(d)-2-5

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SALT TOLERANCE OF VARIOUS TEMPERATE ZONE ORNAMENTAL PLANTS

Prepared by:

Curtis E. Swift, Ph.D., Area Extension Agent (Horticulture)
Colorado State University Extension
Tri River Area

An Introduction

Soluble salts can cause harm to plants if they are in high enough concentration in water or soil. This effect is mainly indirect by pulling moisture out of roots and reducing the uptake of water and nutrients to affected plants. Some salts can be toxic to root tissue. Tip and edge burn of leaves, slow growth, nutrient deficiencies, wilting and eventual death of the plant can occur if the salt level is excessive for the plant and the problem is not corrected. To avoid plant loss in salty sites, a **soil test** should be done to determine the soil salt level and plants selected based on their salt tolerance.

Soil testing laboratories will report the salinity (conductivity) of soil in decisiemens per meter (dS/m) (equivalent to the old measure of millimhos per centimeter). The salinity of irrigation water is typically reported in micromhos per centimeter (umhos/cm) or microsiemens per meter (uS/m) .

Conductivity is defined as the ability of a solution to conduct an electrical current, or the reciprocal of the solution's ability to resist the current. This current is conducted by electrically charged particles called ions, which are present in almost all solutions. Different solutions have different kinds and amounts of ions: distilled water has very few ions, and therefore a low conductivity, while sea water has a large number of ions, and a high conductivity. The greater the conductivity of the solution the higher the reading.

Publications Available Elsewhere

The following references on salts are available from the Colorado State University Publications on Line Site:

1. **Salt-affected soils** - an explanation of saline, sodic and saline-sodic soils and their treatment
2. **Management of salt- and sodium-affected soils** - covers problem diagnosis, reclamation treatments and prevention and control
3. **Crop tolerance to soil salinity** - provides some data on the salt tolerance of field, forage, vegetable and fruit crops
4. **Irrigation water quality criteria** - explains the four basic criteria for evaluating water quality for irrigation purposes - salinity and sodium hazard, toxic elements and bicarbonate concentration
5. **Growing turf on salt-affected (alkali) sites** - provides information on the salt tolerance of various cool-season grasses used for turf and provides information on which turf grasses to choose based on the salt level in the soil. How to reduce the salt level in the soil is also discussed.

To access these publications contact the Colorado State University Extension Web site. To read some of these publications you will need to download Acrobat Reader. A link to Acrobat Reader is provided from CSU's site. If you live in Colorado these publications are available from any CSU Extension office.

The Plant List

The following information was gleaned from various publications and personal experiences of nurseryman in Western Colorado's Tri River Area and is suggested as a guide when recommending trees, shrubs, vines and herbaceous plants for salty sites. Information regarding other temperate zone plants and their salt tolerance would be appreciated. Please send comments and additional references to cswift@coop.ext.colostate.edu .

Trees and their salt tolerances
Deciduous Trees

High Tolerance - up to 8 mmhos(mS)
Acer plantanoides - Norway Maple
Aesculus hippocastanum Common Horsechestnut
Ailanthus altissima - Tree of Heaven
Amelanchier canadensis - Shadblow
Crataegus crus-galli - Cockspur Hawthorn
Elaeagnus angustifolia - Russian Olive - possibly up to 10 mmhos
Gleditsia triacanthos - Honeylocust
Quercus alba - White Oak
Quercus robur - English Oak
Quercus rubra - Red oak
Robinia pseudoacacia - Black Locust
Ptelea trifoliata - Wafer Ash

Moderately High Tolerance - up to 6 mmhos
Acer negundo - Box-elder
Acer ginnala - Amur maple
Betula lenta - Sweet Birch
Betula populifolia - Grey Birch
Betula alleghaniensis - Yellow Birch
Betula papyrifera - Paper Birch
Fraxinus americana - White Ash
Populus alba - White Poplar
Populus deltoides - Eastern Cottonwood
Populus grandidentata - Large-toothed Aspen
Populus nigra - Lombardy Poplar

Populus tremuloides - Trembling (Quaking) Aspen
Prunus padus - European Bird Cherry
Prunus serotina - Black Cherry
Prunus virginiana - Choke Cherry
Salix alba `Tristis' - Golden Weeping Willow
Salix alba `Vitellina' - Golden Willow
Salix nigra - Black Willow
Sophora japonica - Japanese Pagoda Tree
Ulmus pumila - Siberian Elm

Moderate Tolerance - up to 4 mmhos
Catalpa speciosa - Northern Catalpa
Celtis occidentalis - Hackberry
Celtis reticulata - Netleaf hackberry
Cercis occidentalis - Western Redbud
Fraxinus anomala - Singleleaf Ash
Fraxinus excelsior - European Ash
Fraxinus pennsylvanica - Green Ash
Ginkgo biloba - Maindenhair Tree
Koelreuteria paniculata - Goldenrain Tree
Maclura pomifera - Osage-Orange
Pyrus species - Pear
Ulmus americana - American Elm

Slight Tolerance - up to 2 mmhos
Quercus palustris - Pin Oak
Malus species and cultivars - Apple and Crabapple

Sensitive or Intolerant
Acer rubrum - Red Maple
Acer saccharinum - Silver Maple
Acer saccharum - Sugar Maple
Cercis canadensis - Eastern Redbud
Juglans nigra - Black Walnut
Plantanus acerifolia - London Plane
Sorbus aucuparia - European Mountain-Ash
Tilia americana - American linden
Tilia cordata - Littleleaf Linden

Coniferous Trees

High Tolerance - up to 8 mmhos
Juniperus chinensis - Pfitzer juniper
Picea glauca ` densata' - Black Hills Spruce
Pinus mugo - Mugho Pine
Pinus nigra - Austrian Pine

Moderately High Tolerance - up to 6 mmhos
Pinus ponderosa - Ponderosa Pine
Pinus thunbergiana - Japanese Black Pine
Thuja occidentalis - American Arborvitae

Slight Tolerance - up to 2 mmhos
Picea albies - Norway Spruce
Pinus strobus - Eastern White Pine
Pinus sylvestris - Scot's Pine
Pseudotsuga menziesii - Douglas Fir
Taxus cuspidata - Japanese Yew

Sensitive or Intolerant
Abies balsamea - Balsam Fir
Pinus resinosa - Red or Norway Pine
Tsuga canadensis - Canadian Hemlock

Shrubs and their salt tolerances

Very High Tolerance - Up to 10 mmhos
Atriplex canescens - Fourwing Saltbush
Atriplex convertifolia - Shadscale Saltbush
Atriplex corrugata - Mat Saltbush
Atriplex nuttalli - Nuttall Saltbush
Atriplex nuttalli cuneata - Castle Valey Clover
Atriplex nuttalli gardneri - Gardner Saltbush
Baccharis emoryi - Emory Baccharis
Baccharis glutinosa - Seep-Willow
Ceratoides lanata - Common Winterfat
Chrysothamnus greenei - Greene Rabbitbrush
Chrysothamnus linifolius - Flaxleaf Rabbitbrush
Ephedra species - Mormon Teas
Ephedra torreyana - Torrey Ephedra
Kochia americana - Greenmolly Summercypruss
Sarcobatus vermiculatus - Black Greasewood
Tamarix pentandra - Five-Stamen Tamarix, Tamarisk

High Salt Tolerance - up to 8 mmhos
Caragana arborescens - Siberian Peashrub
Chrysothamnus albidus - Alkali Rabbitbrush
Cytisus scoparius - Scotch Broom
Elaeagnus commutata - Silverberry
Elaeagnus multiflora - Cherry Elaeagnus
Euonymous japonica - Spindle Tree
Halimodendron halodendron - Salt-tree
Hippophae rhamnoides - Sea Buckthorn
Juniperus chinensis - Pfitzer Juniper
Lonicera tatarica - Tararian honeysuckel
Rhamnus cathartica - Common Buckthorn
Rhus trilobata - Squawbush
Rhus typhina - Staghorn Sumac
Rhamnus frangula - Glossy Buckthorn
Shepherdia canadensia - Buffaloberry
Spiraea vanhouttei - Van Houtte Spirea
Symphoricarpuos albus - Snowberry
Syringa amurensis japonica - Japanese Tree Lilac
Syringa vulgaris - Common Lilac
Potentilla fruiticosa `Jackmanii' - Jackman's potentilla
Tamarix gallica - Manna Plant - Tamarisk

Moderately High Tolerance - up to 6 mmhos
Artemisia frigida - Fringed Sagewort
Artemisia spinescens - Bud Sagebrush
Artemisia tridentata - Basin Big Sagebrush
Buxus microphylla - Japanese Boxwood
Chrysothamnus nauseosus - Rubber Rabbitbrush
Chrysothamnus visci diflorus - Douglas Rabbitbrush
Ephedra nevadensis - Nevada Mormontea
Forsythia x intermedia - Showy Border Forsythia
Juniperus communis - Common Juniper
Philadelphus coronarius - Sweet Mockorange
Purshia glandulsa - Desert Bitterbrush
Pyracantha fortuneana - Pyracantha
Rhus glabra - Smooth Sumac
Rhus trilobata - Skunkbush Sumac - Three-leaf Sumac
Shepherdia rotundifolia - Roundleaf Buffaloberry
Spirea `Froebel's' - Froebel's spirea

Slight to Moderate - up to 4 mmhos
Artemisia cana - Silver Sagebrush
Berberis fremontii - Fremont Barberry
Robinia neo-mexicana - New Mexican Locust
Rosa woodsii - Wood's Rose
Salix exigua - Coyote Willow

Slight Tolerance - up to 2 mmhos
Chaenomeles speciosa - Flowering Quince
Ligustrum vulgare - Common Privet
Rosa rugosa - Rugosa Rose - may be slightly tolerant
Viburnum opulus - High Bush Cranberry

Sensitive or Intolerant
Cornus racemosa - Grey Dogwood
Cornus stolonifera - Red-osier dogwood
Rosa - Rose

Vines and their salt tolerances

High Tolerance - up to 8 mmhos
Lonicera tataricum `Zabelii' - Zabel's Honeysuckle
Parthenocissus quinquefolia - Virginia Creeper - Woodbine

Slight Tolerance - up to 4 mmhos
Lonicera japonica - Japanese Hall's Honeysuckle

Flowers and their salt tolerances

High to Moderate - 6 to 8 mmhos
Aquilegia micrantha - Cliff Columbine
Machaeranthera xylorrhiza - Common Woody Aster
Psilostrophe bakerii - Paperflower
Stanley pinnata - Prince's Plume - a good indication that the soil is high in selenium

Moderate Salt Tolerance - 4 to 6 mmhos
Fallugia paradoxa - Common Apache
Oenothera caespitosa - Tufted Evening Primrose
Sphaeralcea coccinea - Scarlet Globemallow
Yucca elata Soaptree - Yucca
Yucca glauca - Small Soapweed

Slightly Tolerant - 2 to 4 mmhos
Argemone species - Prickly Poppies
Calochorutus species - Mariposa Lilly
Chyrsopsis villosa - Hairy Goldenaster
Gallardia pennatifida - Cutleaf Blanketflower
Mentzelia species - Blazing Stars
Physaria australus - Twinpod

Grasses and other Ground Covers and their salt tolerances

High tolerance - 14 to 18 mmhos
Agropyron elongatum - Tall Wheatgrass
Agropyron smithii - Western Wheatgrass
Distichlis - Saltgrass
Elymus triticoides - Beardless wildrye
Lotus corniculatus = Birdsfoot trefoil - a legume
Puccinellia - alkaligrass
Sporobolus airoides - Alkali sacaton

Moderately High - 12 to 8 mmhos
Bromus marginatus - Mountain brome
Lolium perenne - Perennial ryegrass
Melilotus alba - White sweet clover
Melilotus officinalis - Yellow sweet clover
Trifolium fragiferum - Strawberry clover

Moderate - 8 to 4 mmhos
Agropyron cristatum - Crested Wheatgrass
Agropyron riparium - Streambank Wheatgrass
Agropyron trachycaulum - Slender Wheatgrass
Arrhenatherum elatium - Tall meadow oatgrass
Bromus inermis - Smooth brome
Buchloe dactyloides - Buffalograss
Dactylis glomerata - Orchardgrass
Elymus giganteus - Mammoth wildrye
Elymus junceus - Russian wildrye
Festuca arundinacea - Tall Fescue
Medicago sativa - Alfalfa
Phalaris arundinacea - Reed Canarygrass

Low salt Tolerance
Alopecurus pratensis - Meadow foxtail
Festuca rubra - Red fescue
Festuca elatior - Meadow fescue
Poa pratensis - Kentucky Bluegrass
Trifolium pratense - Red clover

Trifolium repens - White clover

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