Integrated Land Reclamation in Coal Basin, Colorado

Brian McMullen, White River National Forest Soil Scientist

Presentation Themes

- Public/private partnership to reclaim abandoned coal mine land using innovative techniques and materials
- Involvement of local grazing, watershed, and community groups to enhance public lands and watershed conditions
- Stimulation of local restoration economies
- Technology/knowledge sharing + transfer
- SCIENCE !!!

THIS PRESENTATION IS BROUGHT TO YOU BY THE LETTER "C"

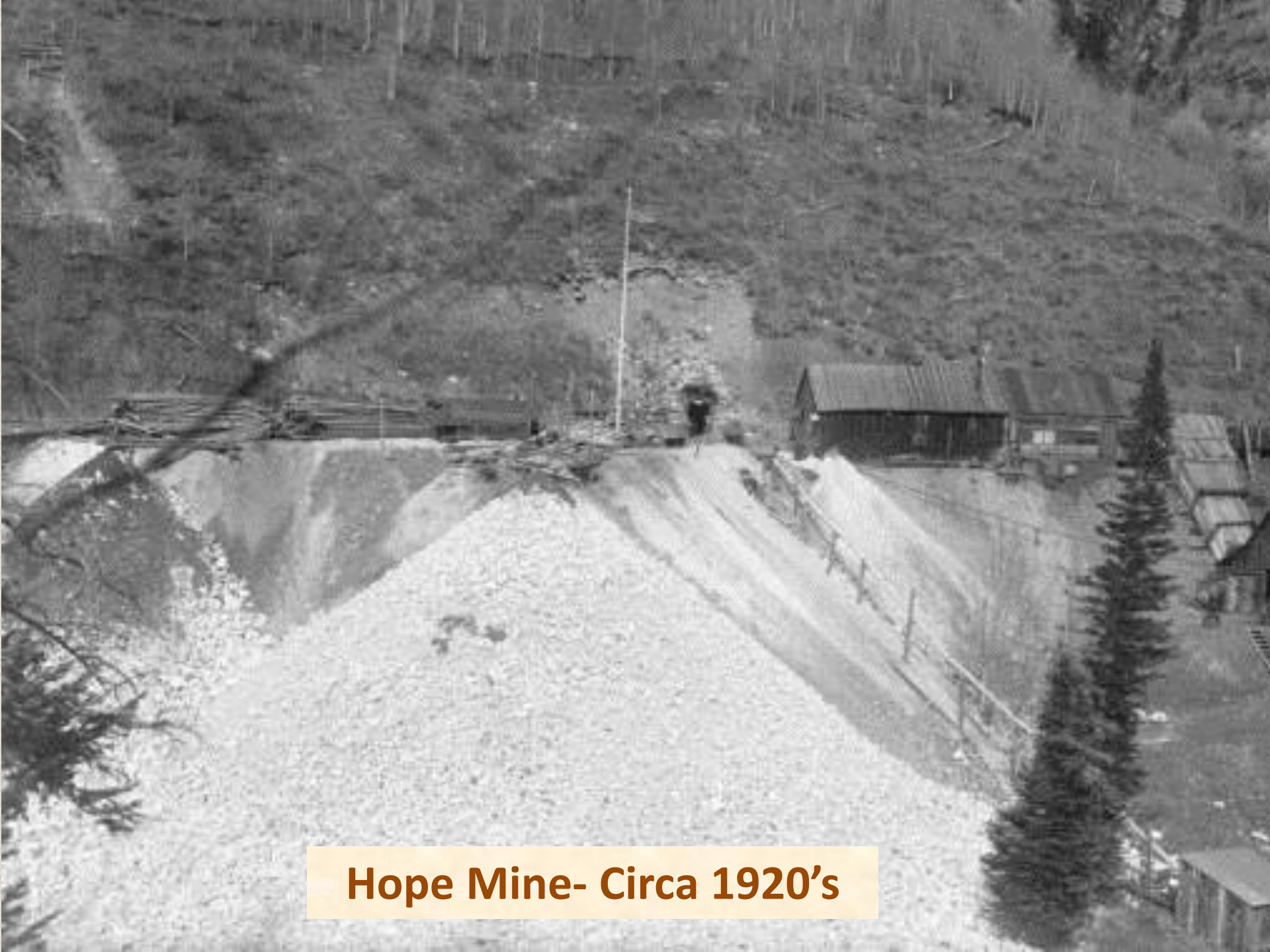
1												13	14	15	16	17	2
H Hydrogen 1.01																	He Helium 4.00
3 Li Lithium 6.94	4 Be Beryllium 9.01											5 B Boron 10.81	6 C Carbon 12.01	7 N Nitrogen 14.01	8 O Oxygen 16.00	9 F Fluorine 19.00	10 Ne Neon 20.18
11 Na Sodium 22.99	12 Mg Magnesium 24.31	3	4	5	6	7	8	9	10	11	12	13 Al Aluminum 26.98	14 Si Silicon 28.09	15 P Phosphorus 30.97	16 S Sulfur 32.07	17 Cl Chlorine 35.45	18 Ar Argon 39.95
19 K Potassium 39.10	20 Ca Calcium 40.08	21 Sc Scandium 44.96	22 Ti Titanium 47.88	23 V Vanadium 50.94	24 Cr Chromium 52.00	25 Mn Manganese 54.94	26 Fe Iron 55.85	27 Co Cobalt 58.93	28 Ni Nickel 58.69	29 Cu Copper 63.55	30 Zn Zinc 65.39	31 Ga Gallium 69.72	32 Ge Germanium 72.61	33 As Arsenic 74.92	34 Se Selenium 78.96	35 Br Bromine 79.90	36 Kr Krypton 83.80
37 Rb Rubidium 85.47	38 Sr Strontium 87.62	39 Y Yttrium 88.91	40 Zr Zirconium 91.22	41 Nb Niobium 92.91	42 Mo Molybdenum 95.94	43 Tc Technetium (98)	44 Ru Ruthenium 101.07	45 Rh Rhodium 102.91	46 Pd Palladium 106.42	47 Ag Silver 107.87	48 Cd Cadmium 112.41	49 In Indium 114.82	50 Sn Tin 118.71	51 Sb Antimony 121.76	52 Te Tellurium 127.60	53 I Iodine 126.90	54 Xe Xenon 131.29
55 Cs Cesium 132.91	56 Ba Barium 137.33	71 Lu Lutetium 174.97	72 Hf Hafnium 178.49	73 Ta Tantalum 180.95	74 W Tungsten 183.84	75 Re Rhenium 186.21	76 Os Osmium 190.23	77 Ir Iridium 192.22	78 Pt Platinum 195.08	79 Au Gold 196.97	80 Hg Mercury 200.59	81 Tl Thallium 204.38	82 Pb Lead 207.20	83 Bi Bismuth 208.98	84 Po Polonium (209)	85 At Astatine (210)	86 Rn Radon (222)
87 Fr Francium (223)	88 Ra Radium (226)	103 Lr Lawrencium (262)	104 Rf Rutherfordium (261)	105 Db Dubnium (262)	106 Sg Seaborgium (263)	107 Bh Bohrium (262)	108 Hs Hassium (265)	109 Mt Meitnerium (266)	110 Ds Darmstadtium (281)	111 Rg Roentgenium (280)	112 Cp Copernicum (285)						

57 La Lanthanum 138.91	58 Ce Cerium 140.12	59 Pr Praseodymium 140.91	60 Nd Neodymium 144.24	61 Pm Promethium (145)	62 Sm Samarium 150.36	63 Eu Europium 151.97	64 Gd Gadolinium 157.25	65 Tb Terbium 158.93	66 Dy Dysprosium 162.50	67 Ho Holmium 164.93	68 Er Erbium 167.26	69 Tm Thulium 168.93	70 Yb Ytterbium 173.04
89 Ac Actinium (227)	90 Th Thorium 232.04	91 Pa Proactinium 231.04	92 U Uranium 238.03	93 Np Neptunium (237)	94 Pu Plutonium (244)	95 Am Americium (243)	96 Cm Curium (247)	97 Bk Berkelium (247)	98 Cf Californium (251)	99 Es Einsteinium (252)	100 Fm Fermium (257)	101 Md Mendelevium (258)	102 No Nobelium (259)

Template for Coal Basin Reclamation- Uplands Area Re-vegetation

Hope Mine Reclamation in 2010 near Aspen

- Non-profit funded demonstration of compost and biochar application to abandoned mine land reclamation
- ***Biochar***- end product of combustion of biomass (beetle-killed pine trees in this case) under high temperature/low oxygen conditions; material is similar to activated charcoal found in water filters, water treatment plants



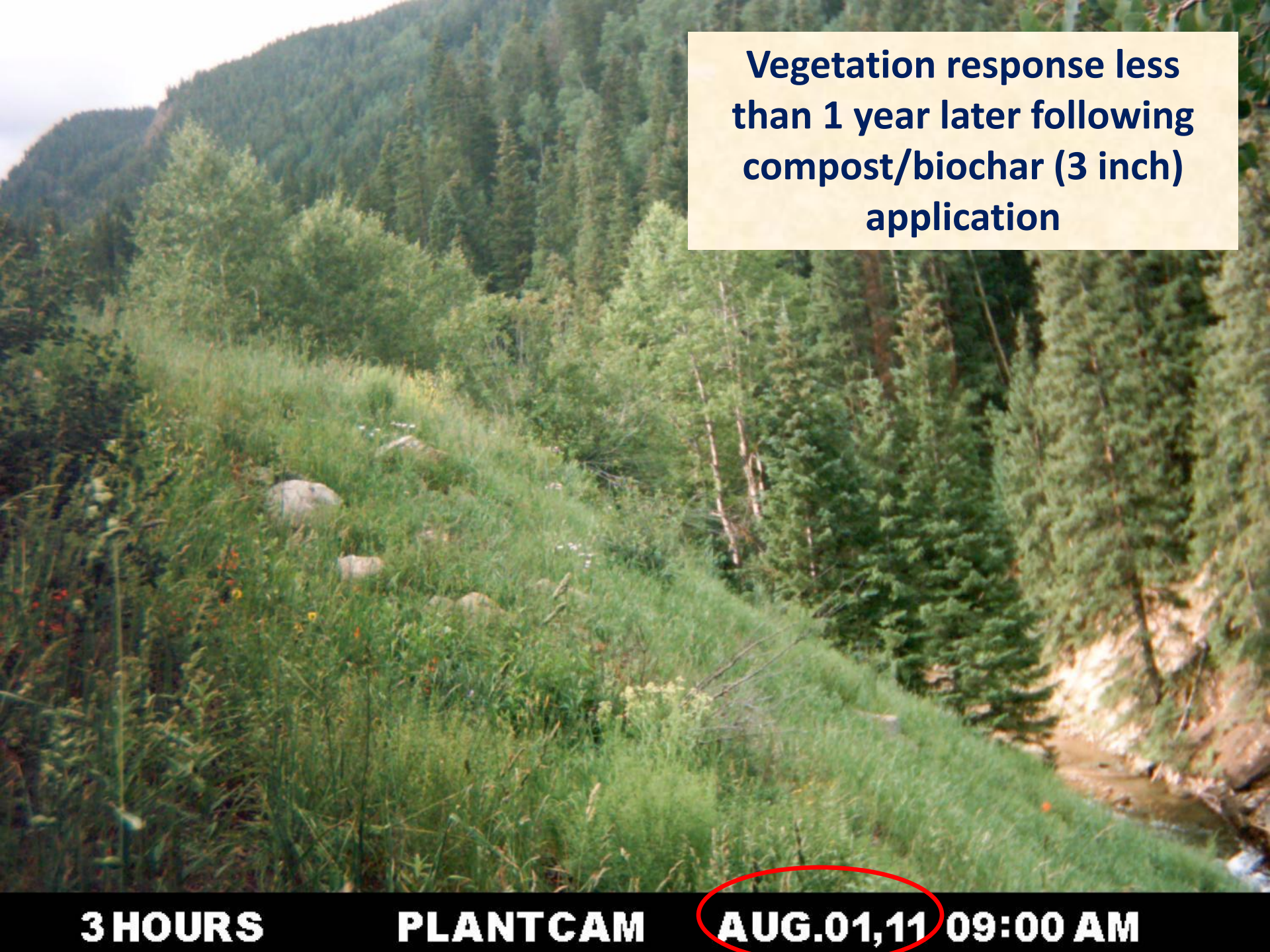
Hope Mine- Circa 1920’s

Steep-sloped compost/biochar application-10.10.10

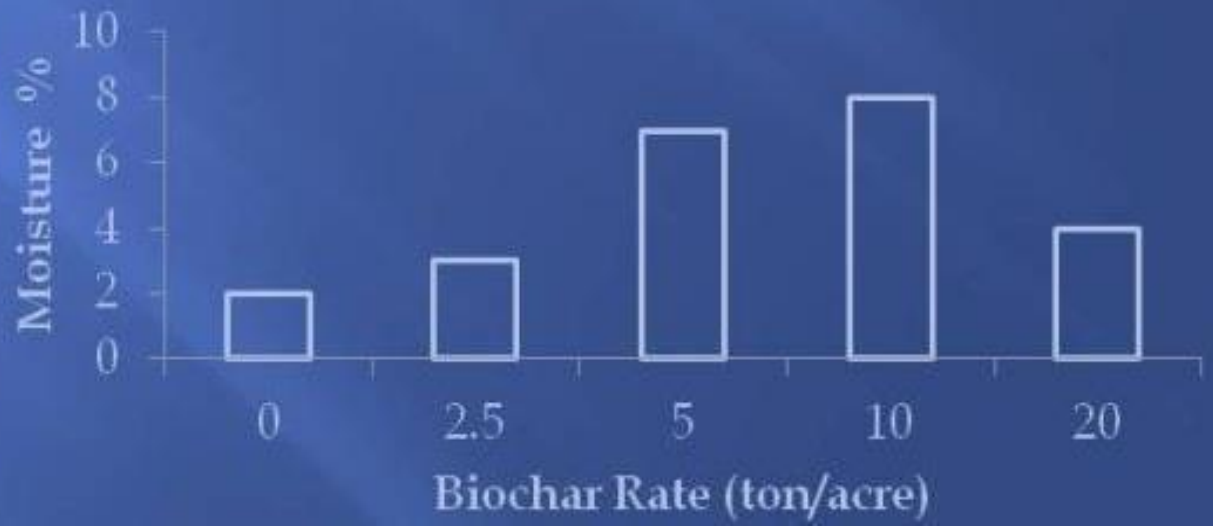
Hydromulched-seeded Slope


3 HOURS
PLANTCAM
JUN.30,11 08:47 AM


3 HOURS
PLANTCAM
JUL.05,11 08:50 AM


Vegetation response less than 1 year later following compost/biochar (3 inch) application
3 HOURS
PLANTCAM
AUG.01,11
09:00 AM

Technology Transfer/Lessons Learned – "Recipe" and Techniques Applied to other USFS Projects



2012 Dutch Creek Road Rehabilitation Project

ROARING FORK CONSERVANCY

FOREST SERVICE US DEPARTMENT OF AGRICULTURE

COLORADO WATER CONSERVATION BOARD STATE OF COLORADO 1876 1937

PITKIN COUNTY

Healthy Rivers and Streams Board

Coal Basin, CO

Technology Transfer/Lessons Learned – Compost Logistics

South Canyon Landfill- Garfield County/Heartland Environmental/City of Glenwood Springs

The Recipe

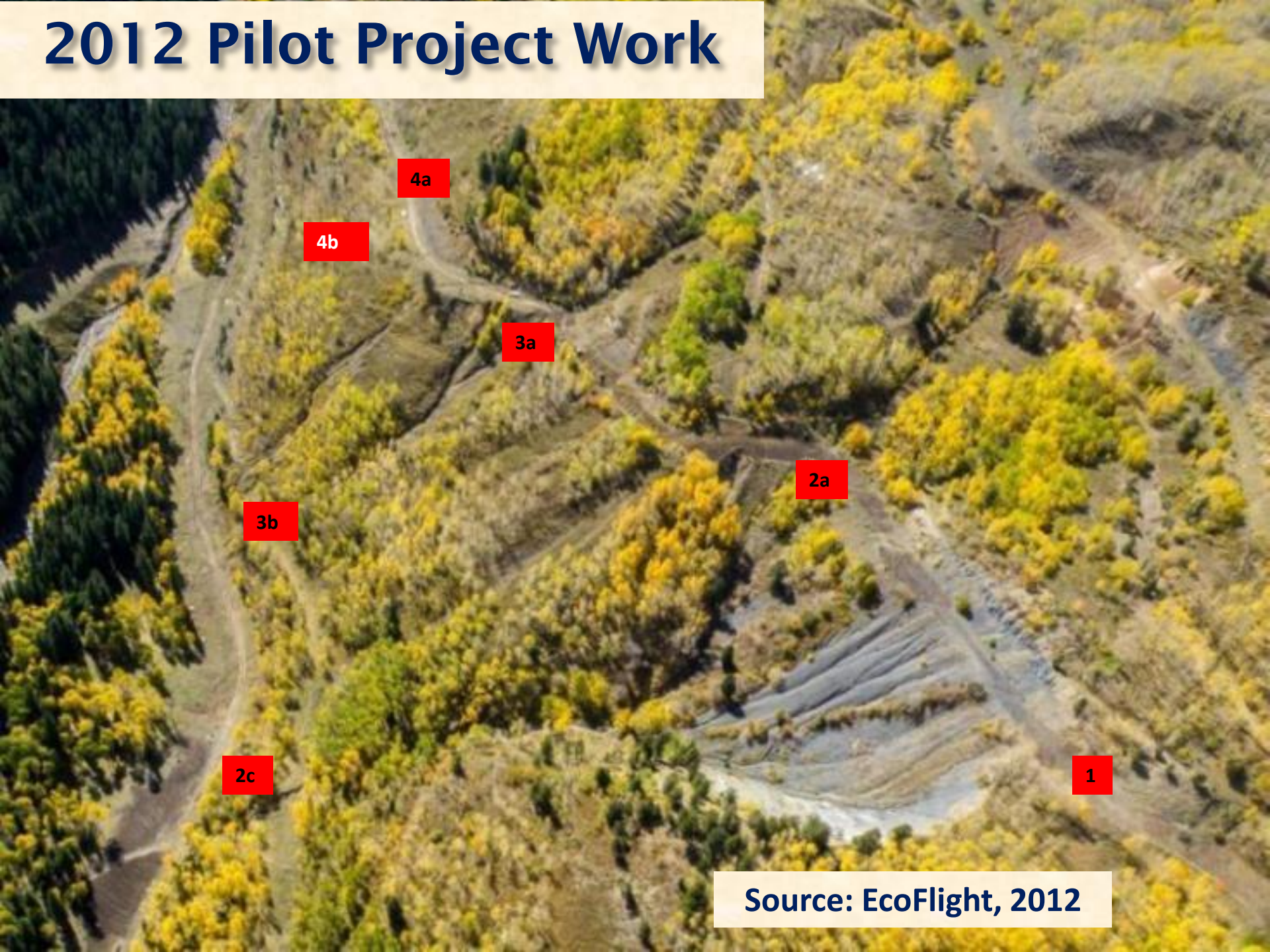
- Recommended application rate for compost on “tough” sites= 400 yd^3/acre = 3” application thickness

- Biochar Solutions Inc. found biochar most effective at 2.5 – 5.0% by volume at Hope Mine test plots

- To get 400 yd^3/acre soil amendment at 5% biochar to 95% compost, need 20 yd^3/biochar : 380 yd^3/compost

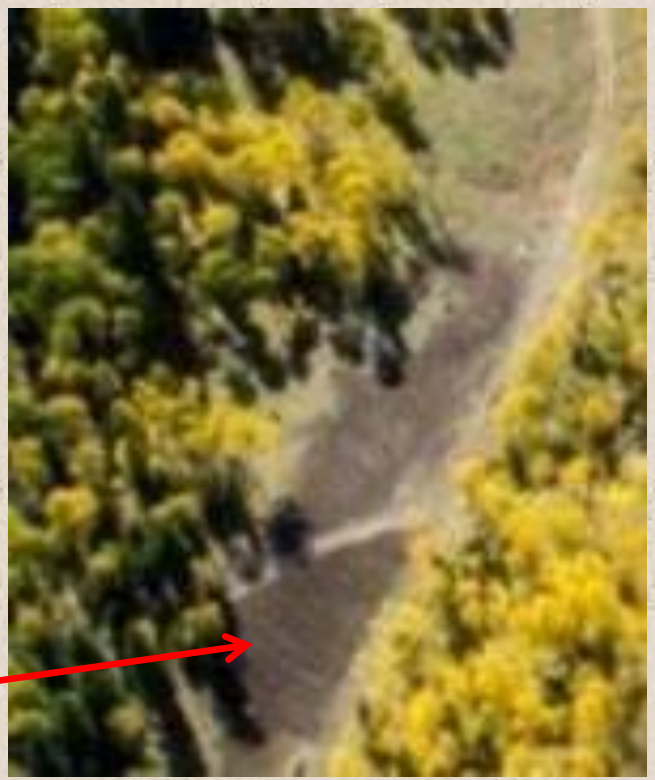
- Compost $20/ton; 1 yard ≈ 1500 pounds ≈ $15/$yd^3$
- Biochar (BSI Inc.)- $250/$yd^3$; 1 yard ≈ 300 pounds

2012 Pilot Project Work

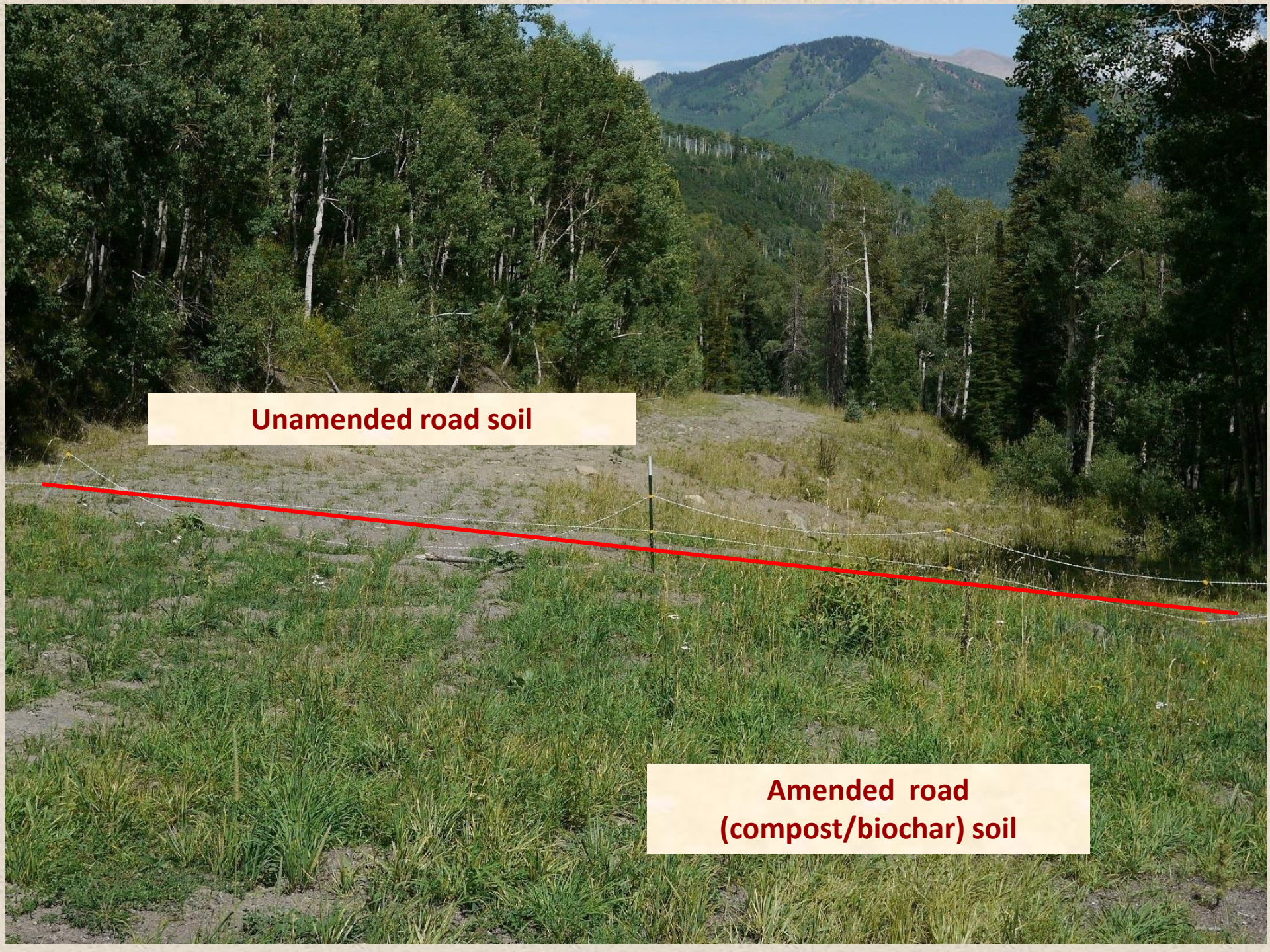


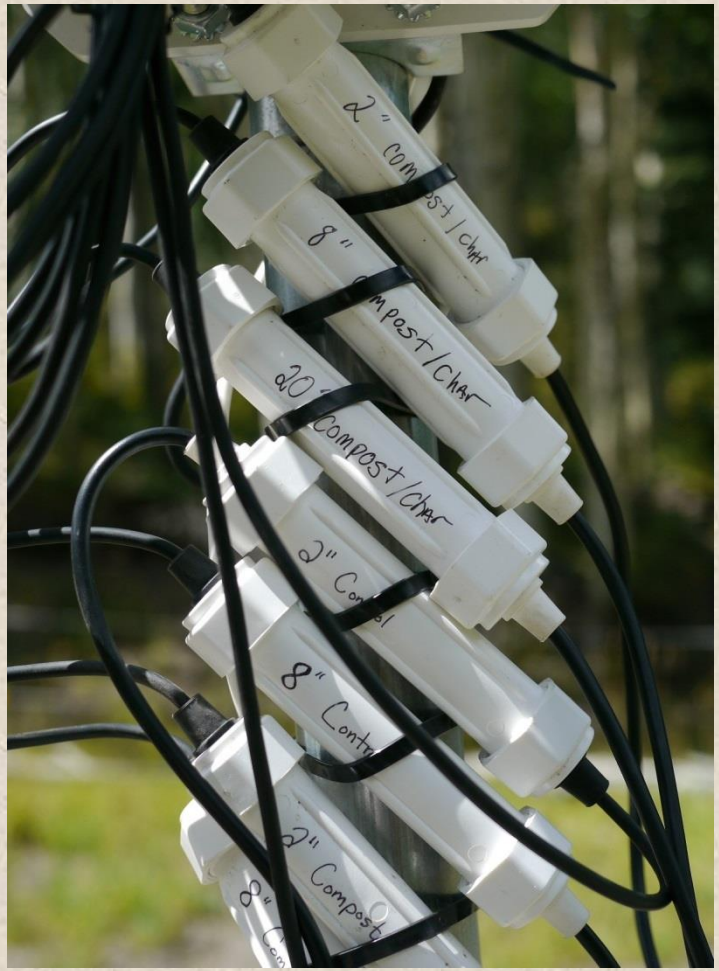
Source: EcoFlight, 2012

Reconstruction of Alluvial Fan
(before and after)
Dutch Creek Road



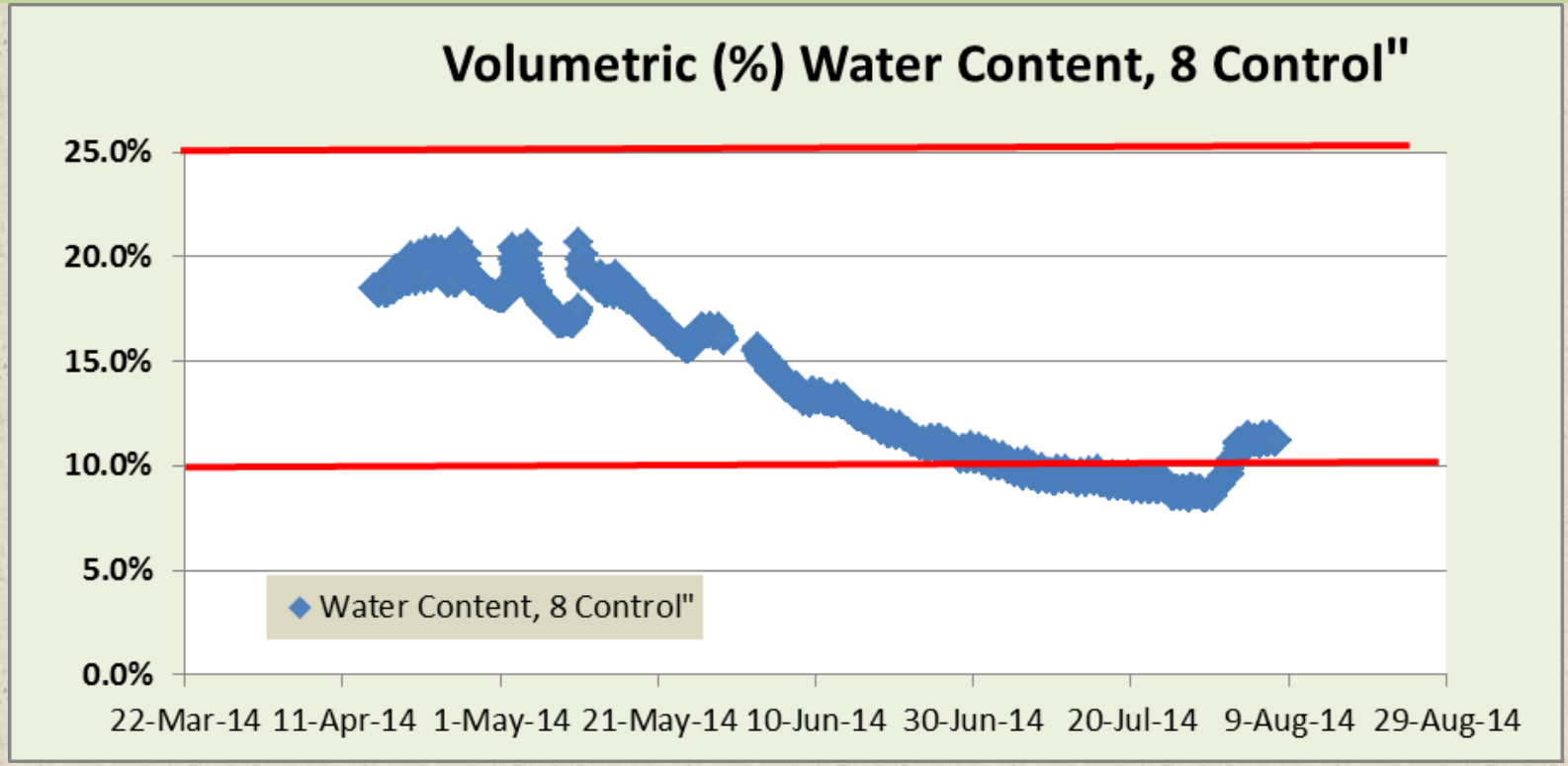
16 May 2013- Germination on amended soil


Unamended road soil
Amended road (compost/biochar) soil



Data logger, soil moisture probes, and weather station- Dutch Creek Pilot Project

Technology Transfer/Lessons Learned – Soil Moisture



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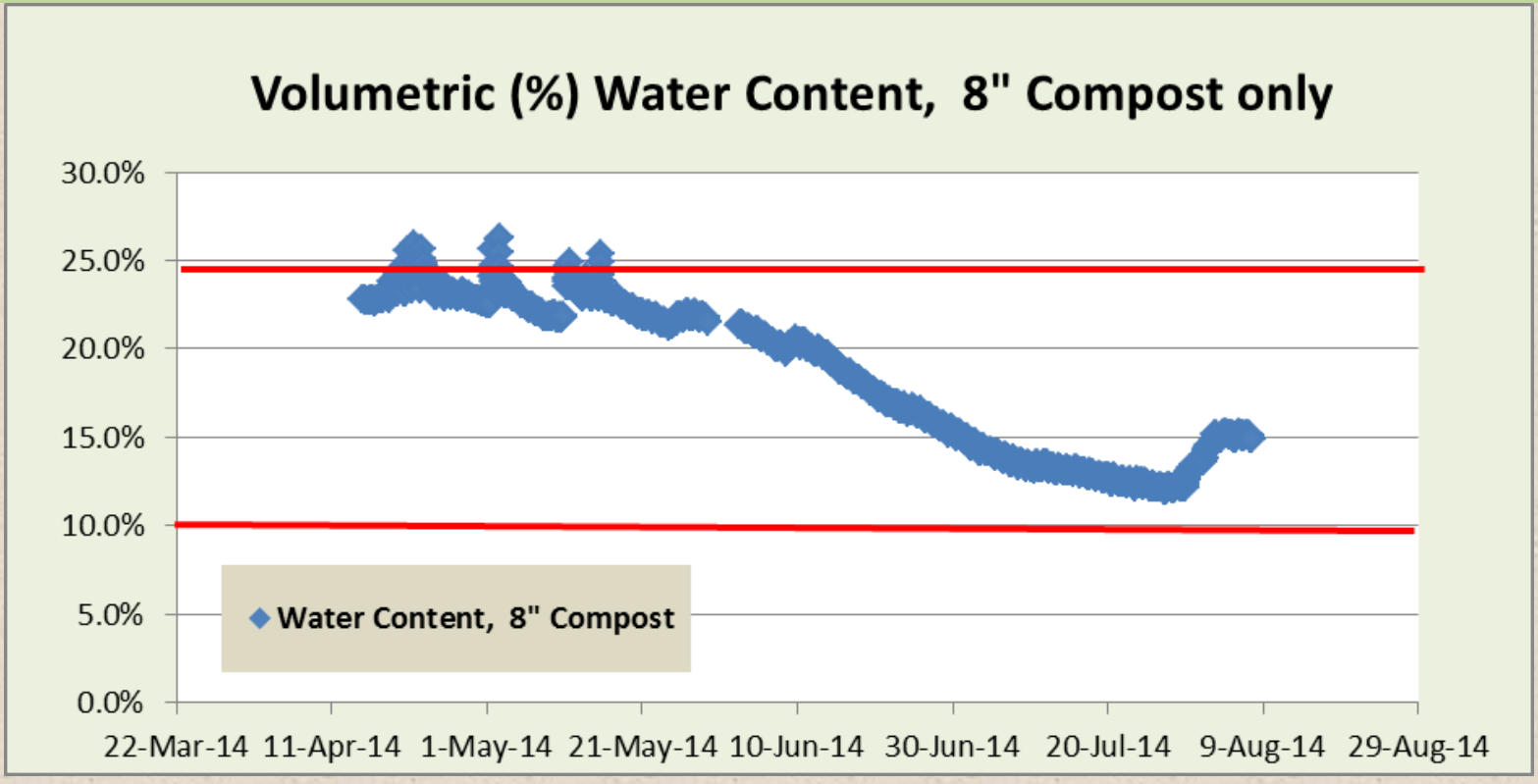
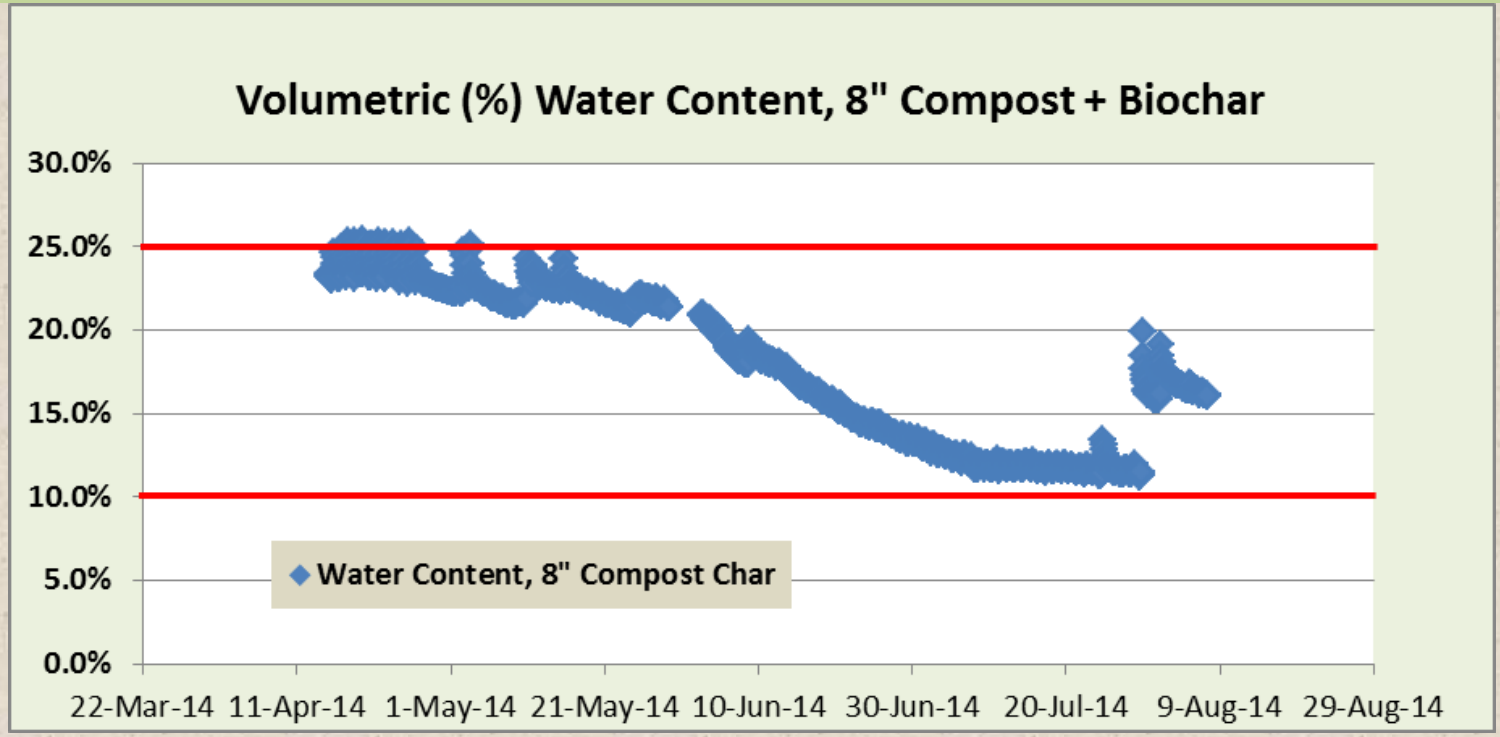
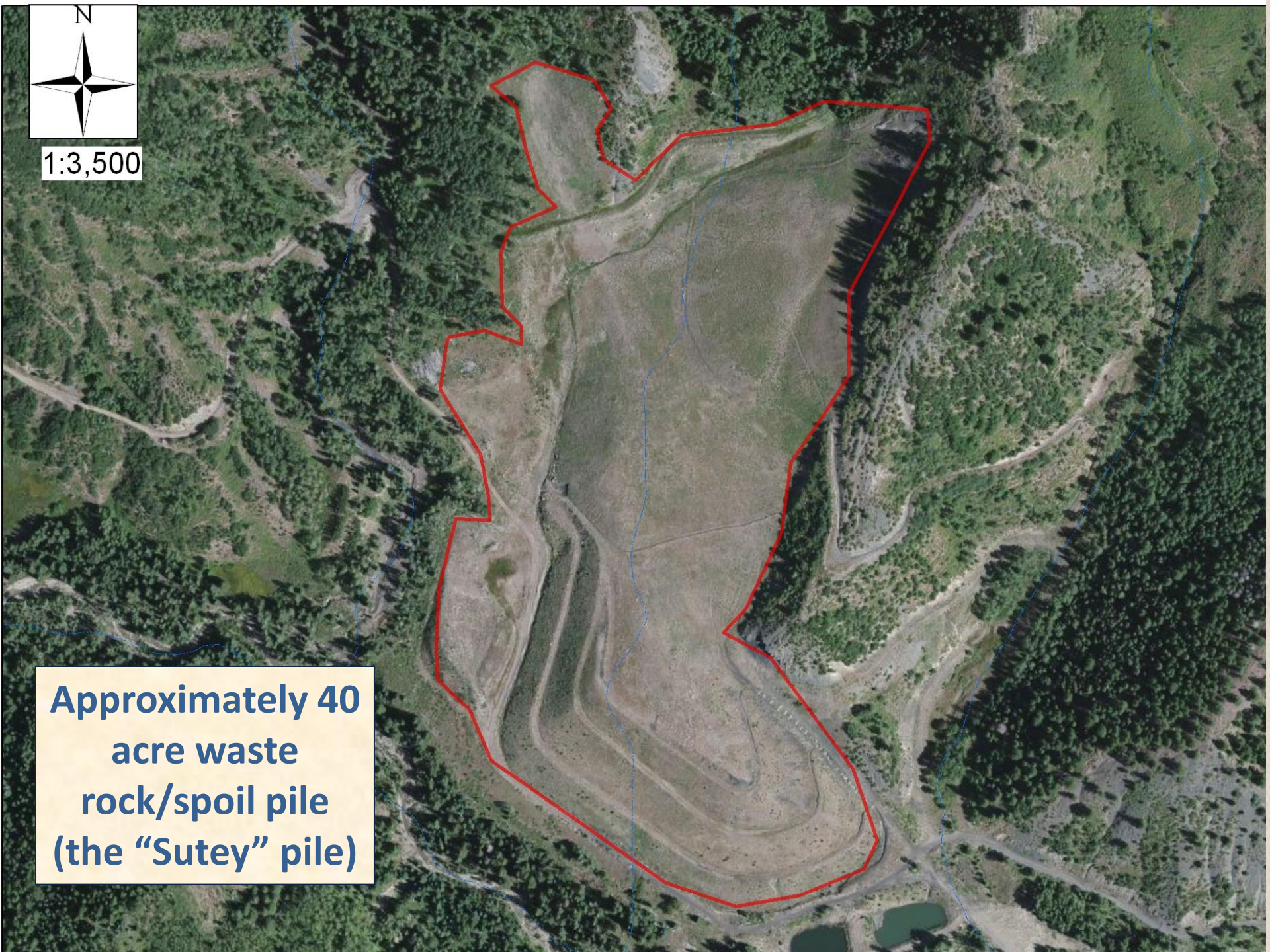


Technology Transfer/Lessons Learned – Soil Moisture




N
1:3,500
Approximately 40 acre waste rock/spoil pile (the “Sutey” pile)

CROSSOVER APPEAL AND COOPERATION WITH RANGE/BOTANY

Technology Transfer/Lessons Learned – Holistic Grazing/New Incorporation Methods

Cows incorporate compost/biochar, seed, and straw through hoof action while eating hay


Soil surface following short duration/high intensity grazing in 2013


Roughened surface with micro-sites for seed establishment and moisture storage

Early (2014) vegetation response with soil amendment

Early (2014) vegetation response without soil amendment

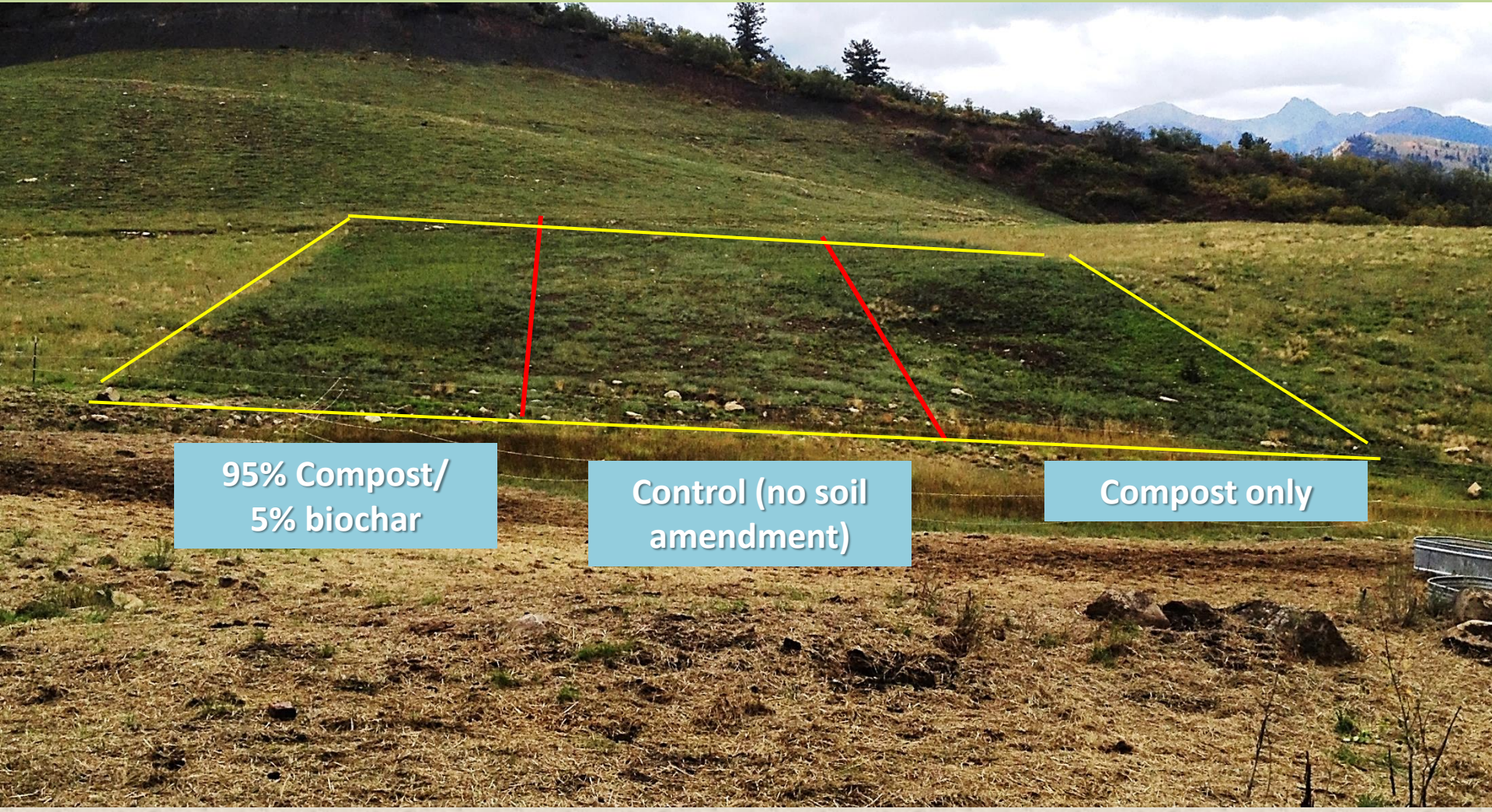
Early (2014) vegetation response with soil amendment

Early (2014) vegetation response without soil amendment

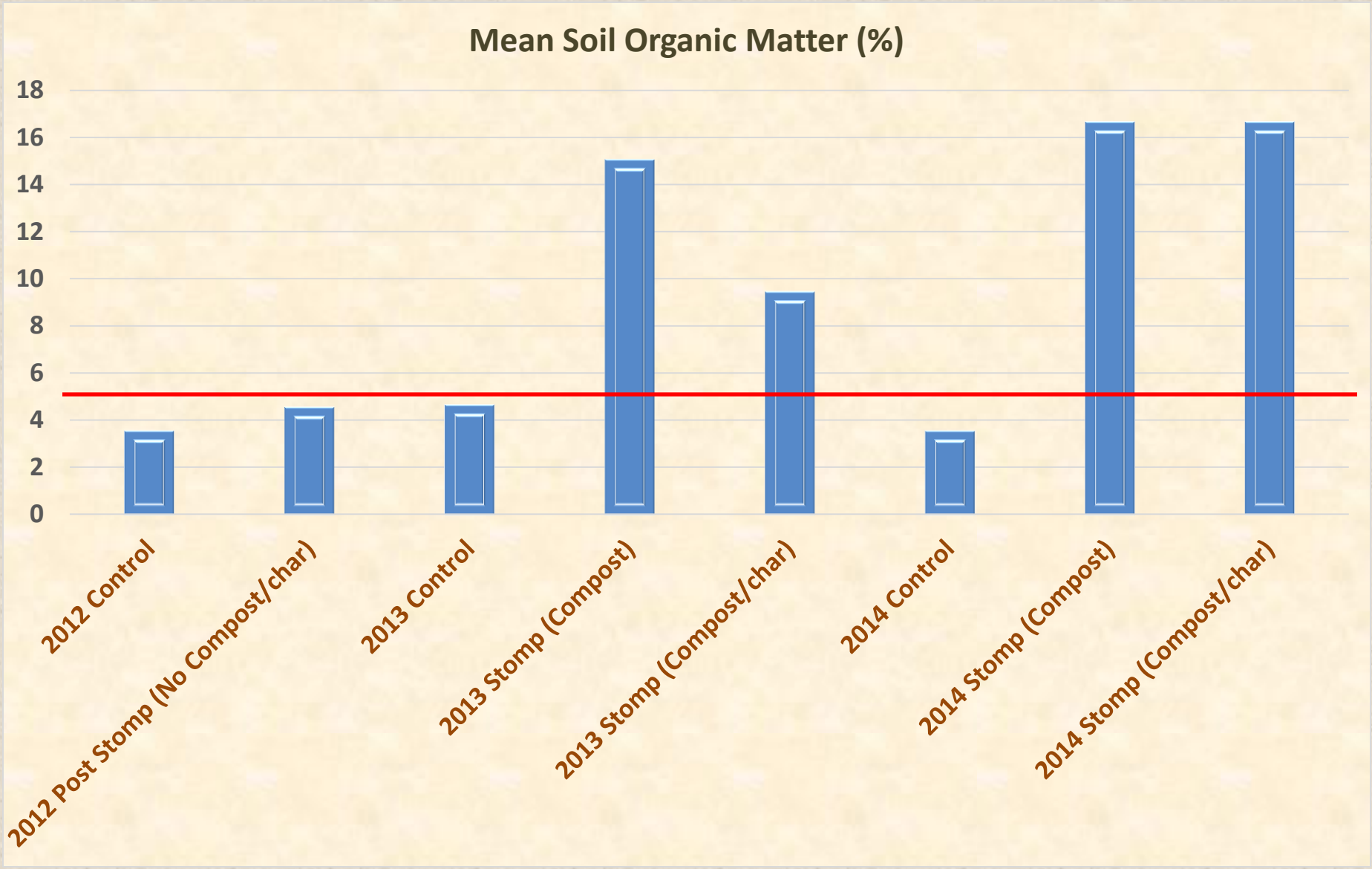
Hoof prints micro-site vegetation establishment- early stages of Year 1 native grass growth

Special thanks to Wayne Ives and Ben Carlsen (USFS Range staff) – brain child's of Coal Basin "Cow Stomp" and instrumental in the implementation of these projects. Extra special thanks to Dorothea Farris, fundraiser and cheerleader extraordinaire

2013 Cowstomp (background) 2014 (foreground) – photo taken 23 Sept 2014




POTR undistubed
2014 Stomp char
2014 Stomp control
2014 Stomp compost


Mean Soil Organic Matter (%)
18
16
14
12
10
8
6
4
2
0
2012 Control
2012 Post Stomp (No Compost/char)
2013 Control
2013 Stomp (Compost)
2013 Stomp (Compost/char)
2014 Control
2014 Stomp (Compost)
2014 Stomp (Compost/char)

CFI Training/Field Biology Class – Colorado Mountain College

Sustainability Implications of Soil Amendments In Coal Mine Restoration

Jon Plybon

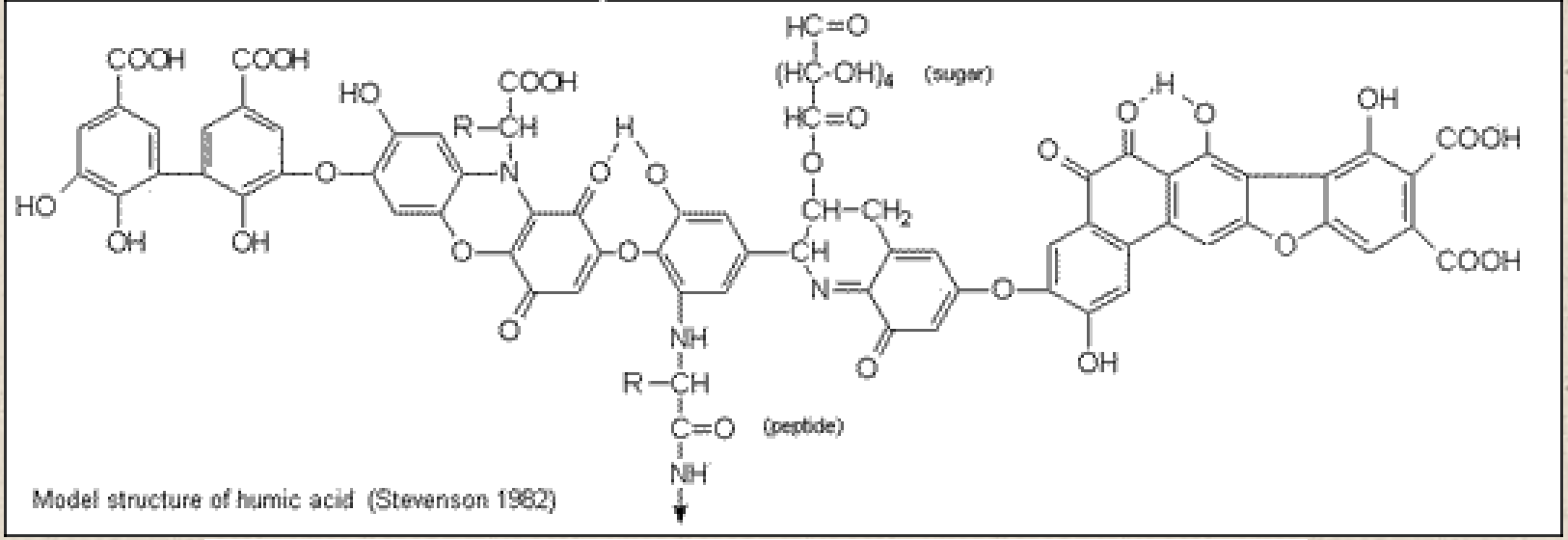
Colorado Mountain College
Bachelor of Arts | Sustainability Studies

Sutey Pile "Bio-Islands" - USFS and Colorado Correctional Industries, Colorado Mountain College

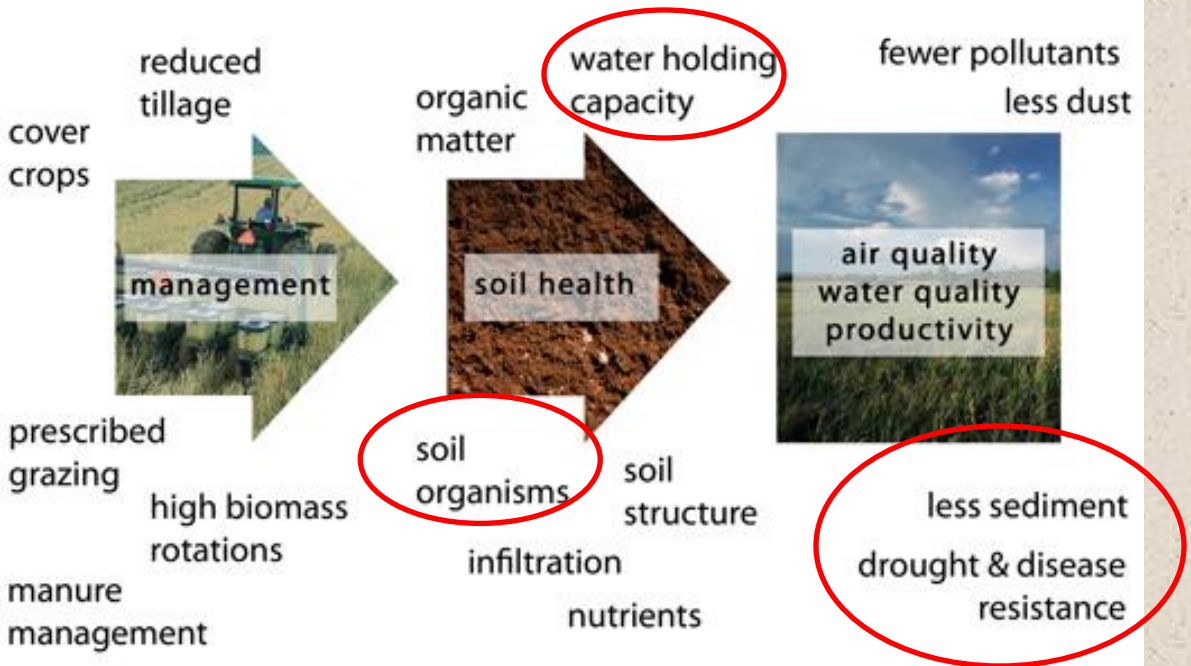

Mtn
Dew

Technology Transfer/Lessons Learned – CMC Env. Science Project

Senior capstone project (Jon Plybon) monitoring efficacy of plants, soil



Managing soil organic matter is the key to air and water quality.



Compost Tea Application – Bioorganix/ David Bernhardt

Technology Transfer/Lessons Learned – Ski Area Rehabilitation

***Keystone Ski Resort*- Graded Ski Trail treated with 50/50 topsoil + compost blend**

- **Other ski area projects include *Breckenridge, Snowmass*, and *Aspen Mountain* – all since 2012 (post-Coal Basin/Hope Mine)**

Technology Transfer/Lessons Learned – Homestake Reservoir

Questions?

Contact –

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970-309-5164