SOIL AMENDMENT APPLICATIONS DURING DROUGHT PERIODS ON OIL AND GAS SITES IN WYOMING

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BKS Environmental Associates, Inc.

WHAT DO PLANTS REQUIRE?

- Sunlight
- Nutrients
- Air
  - CO^2 above ground
  - O^2 below ground
- Water

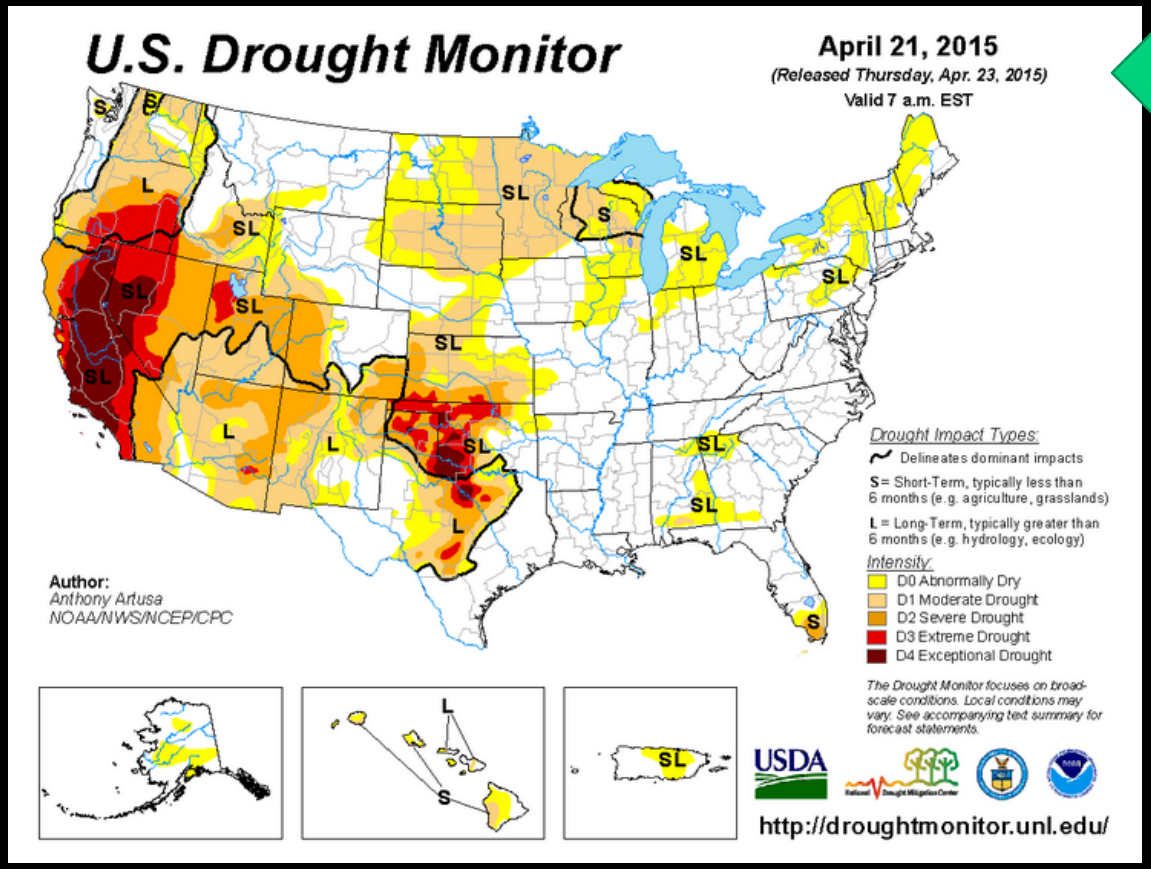
- In an arid/semi-arid landscape,
  water tends to be the limiting factor.

SOIL HEALTH

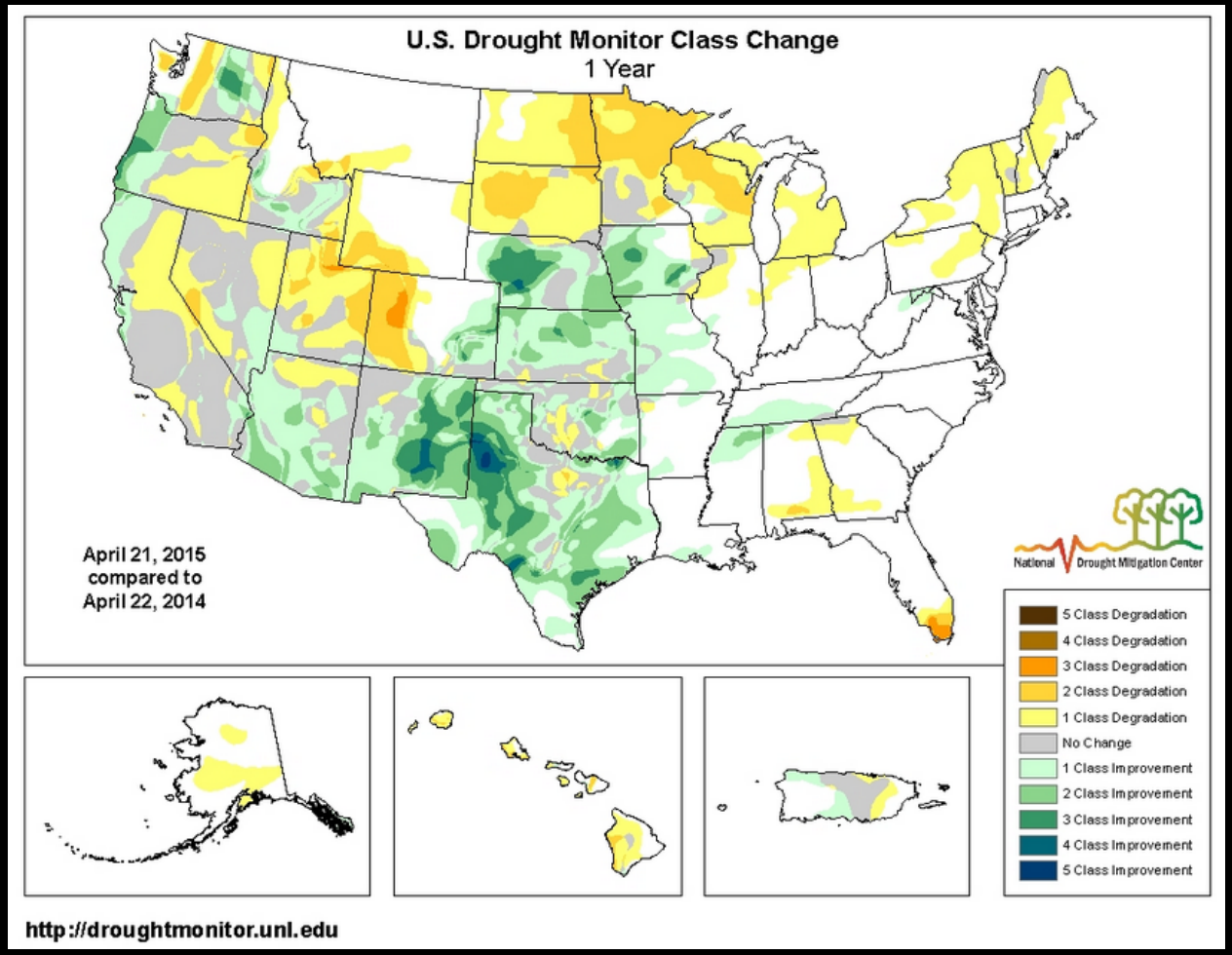
- One of these will be the limiting factor:
  - Nutrient Cycle
  - Energy Flow
  - Succession
  - Water Cycle
- In an arid/ semi-arid landscape,
  water tends to be that limiting factor,
  yet is needed to activate many soil amendments.

NATIONAL DROUGHT

- Short Term vs. Long Term

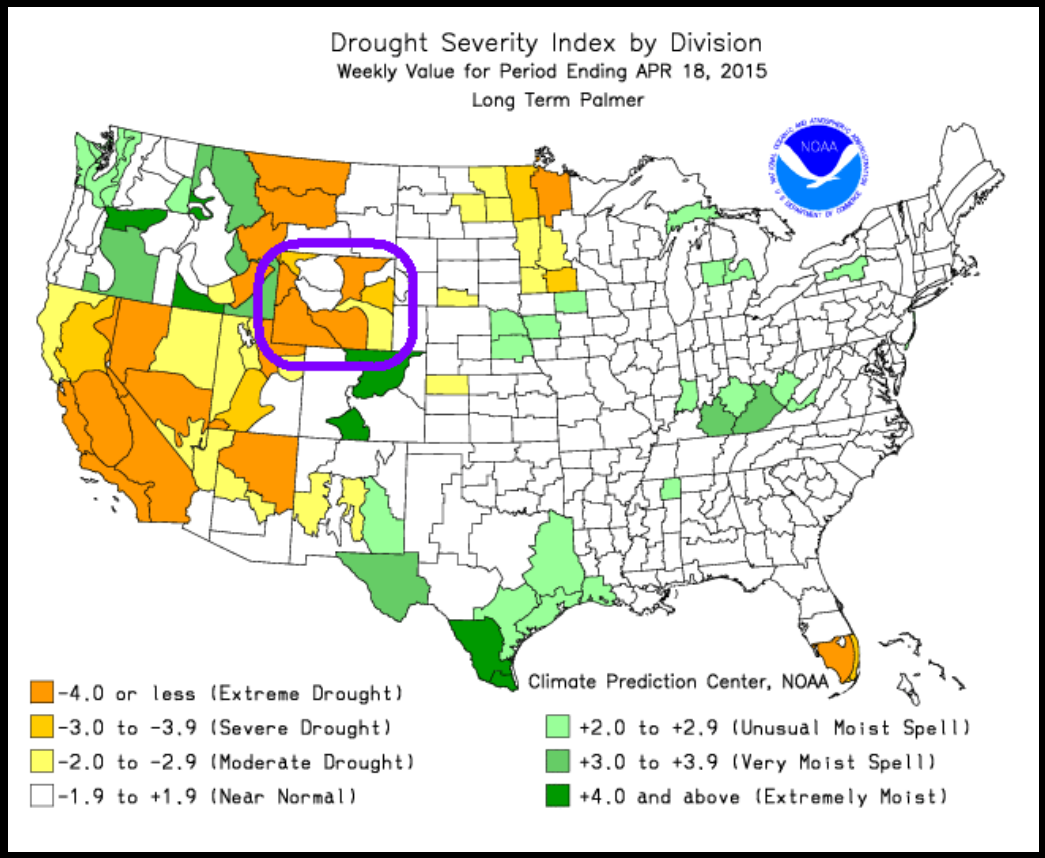


NATIONAL DROUGHT



NATIONAL DROUGHT

- Palmer Index, April 18, 2015

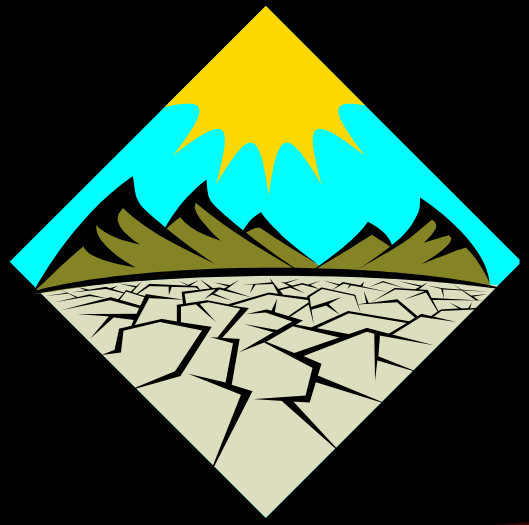


http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/regional_monitoring/palmer.gif

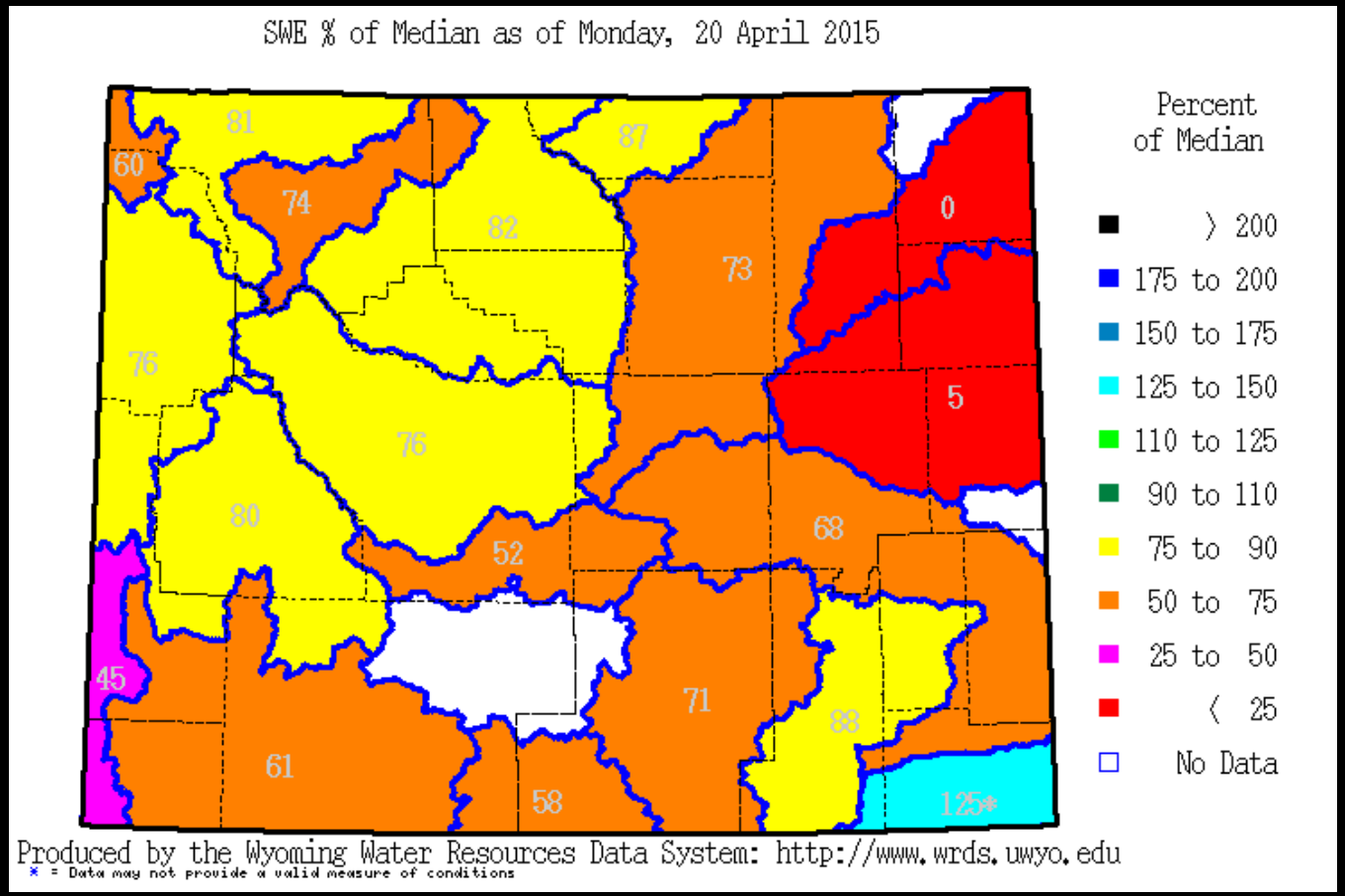
Although the Palmer is the main drought index used by the U.S. government, it is slow to detect fast-emerging droughts, and does not reflect snowpack, an important component of water supply in the western United States.

DROUGHT IN WYOMING

- Rangeland precipitation
- Water supply
- Mountain snowpack



WYOMING SNOWPACK



Map of Percent of Average Snow Water Equivalent by Wyoming Basin

April 20, 2015

COMPARED TO ONE YEAR AGO:

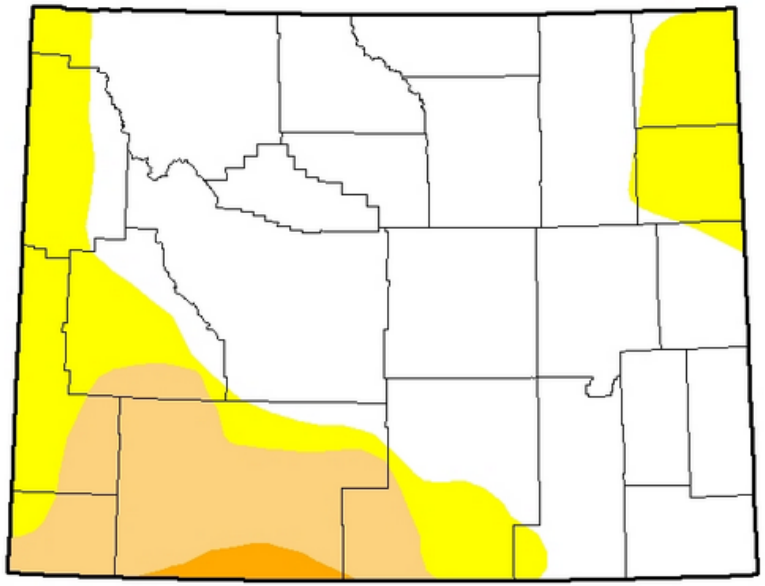
DRAINAGE BASIN	4/20/2015	4/20/2014
SNAKE RIVER	76	143
MADISON	60	119
YELLOWSTONE	81	154
WIND RIVER	76	125
BIGHORN BASIN	82	157
SHOSHONE RIVER	74	150
POWDER	73	166
TONGUE	87	152
BELLE FOURCHE	0	340
CHEYENNE	5	152
UPPER N. PLATTE	71	126
SWEETWATER	52	105
LOWER N. PLATTE	68	129
LARAMIE	88	147
S. PLATTE	125	179
LITTLE SNAKE RIVER	58	123
UPPER GREEN	80	160
LOWER GREEN	61	126
UPPER BEAR	45	109
Weighted State Average	66	150

Table shows the snow water equivalent as a percent of median.

All drainage basins have less snow water equivalent than they did one year ago on April 20th

On average, there is **52%** less snow water in 2015 as compared to 2014.

U.S. Drought Monitor
Wyoming



April 21, 2015
(Released Thursday, Apr. 23, 2015)
Valid 7 a.m. EST

Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	66.62	33.38	14.31	1.19	0.00	0.00
Last Week 4/14/2015	63.09	36.91	14.39	1.19	0.00	0.00
3 Months Ago 1/20/2015	97.56	2.44	0.00	0.00	0.00	0.00
Start of Calendar Year 12/30/2014	97.56	2.44	0.00	0.00	0.00	0.00
Start of Water Year 9/30/2014	97.56	2.44	0.00	0.00	0.00	0.00
One Year Ago 4/22/2014	97.19	2.81	0.00	0.00	0.00	0.00

Intensity:

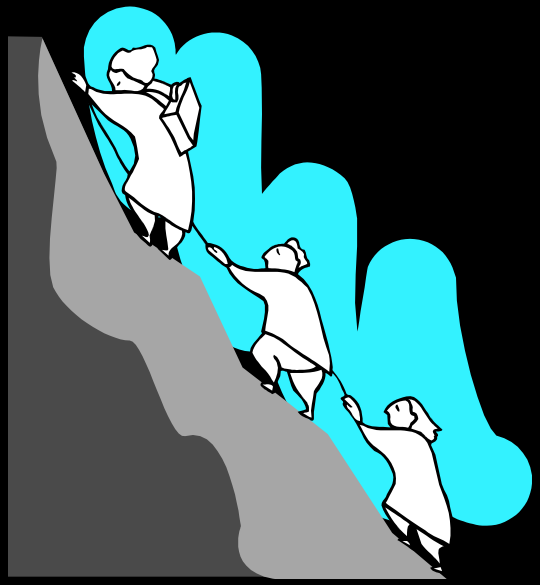
- D0 Abnormally Dry
- D1 Moderate Drought
- D2 Severe Drought
- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.

Author:
Anthony Artusa
NOAA/NWS/NCEP/CPC

http://droughtmonitor.unl.edu/

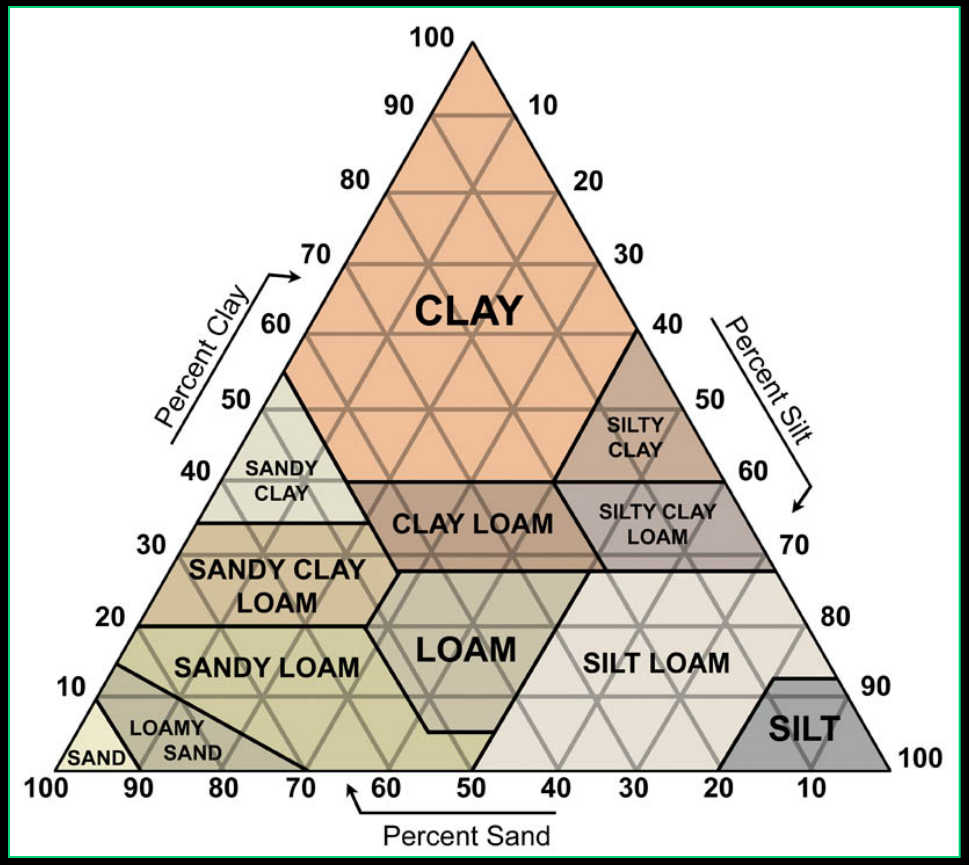
CHALLENGES TO RECLAMATION



WHAT ARE YOUR GOALS?

SOIL CHALLENGES

- Physical - Texture
  - Excess Sand
  - Excess Clay
  - Excess Silt



MITIGATION OF PHYSICAL FACTORS

- Water catchment
- Erosion prevention

CHEMICAL CHALLENGES AND MITIGATION

- Salinity and Sodicity
- Possible mitigation
  - Gypsum and/or flushing

MITIGATION DURING DROUGHT

FOR SOIL HEALTH… DROUGHT OR NOT

- On drastically disturbed lands
  - The focus should be diversity.

- Get soil microorganisms resuscitated ASAP.
- Get some cover on there.
  - --John Stika, USDA NRCS, ND

- Focus early management on soil organic matter
  - Soil resilience, lower potential for issues
- The best weed killer is to not grow them!
  - Weed free seed and diversity

ORGANIC MATTER

- Provides a number of benefits
  - Increases infiltration and water holding capacity
  - Increases percolation and drainage
  - Ameliorates effects of salinity
  - Provides cover from elements
  - Greater microbial diversity

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GENERAL MITIGATION MEASURES

- Provide natural water gathering systems
  - Pitting
  - Surface roughness
  - Directing water
- Increase infiltration and water holding capacity
- Reduce negative impacts of salinity

GENERAL MITIGATION (CONTINUED…)

- Increase organic matter
  - Nurse/cover crops, carbon, microbial amendments
- Wind-rows
- Other erosion control structures
- Proper topsoil salvage and storage!

POTENTIAL TOOLS OR PRODUCTS

ENHANCE MOISTURE INFILTRATION AND RETENTION

- Hay or Straw Mulch
  - Provides erosion protection
  - Reduces surface soil temperatures during the day and provides buffer at night
- Biosol
  - Slow release organic fertilizer
  - Dry broadcast or applied with hydro-seeding equipment
- Organifix
  - High in organic carbon
  - Contains humates
- Biotic Earth
  - High in organic carbon
- Sustane
  - Slow release organic fertilizer
  - Different formulations commercially available
  - Dry broadcast or applied with hydro-seeding equipment

EXAMPLE, SUSTANE:

- a natural, biological recycling process made from renewable, agricultural resources that in the end optimizes new plant growth with the least possible inputs, the most savings in labor, time and money and the most favorable impact on the environment.

- OR
- adds organic carbon to the soil.
    - --Kyle Lilly, Regulatory Affairs & Technical Services Specialist, Sustane

ENHANCE MOISTURE INFILTRATION AND RETENTION

- AM 120
  - Enhance mycorrhizal fungi growth in the soil
- Incorporation of straw or hay mulch with tackifier
- Wood chips
  - Research on bentonite areas of NE Wyoming recommended 30 ton/acre of sawmill by-products
  - Little Snake River Conservation District project in Carbon County used aspen chips in conjunction with gypsum and sulfur amendments.
  - Source and transportation cost considerations

MINIMIZE CHEMICAL EFFECTS

- Gypsum Plus and Sulfur Plus by Encap
  - Polymerized products to amend SAR and lower pH, respectively
  - Rates are about ¼ the rate of typical agricultural applications due to high surface area interaction with soil particles.
  - Currently undergoing empirical trials by Encap

REDUCE EROSION

- PAM12 Plus
  - Temporary soil stabilizer
  - Short and long-term release polyacrylamide impregnated into a paper pellet
  - Applied dry using broadcast spreaders or wet-applied with hydro-seeding equipment
  - Applied as stand-alone or in combination with other mulch products

OTHERS

- Irrigation
  - Consider if available
  - Minimize amount to kick-start germination
  - Do not want as long-term solution
  - Be careful in sodic areas
- Adapted Species
  - Usually cheapest solution
  - May have to consider two-phase seeding to get site established and diversity at a later date

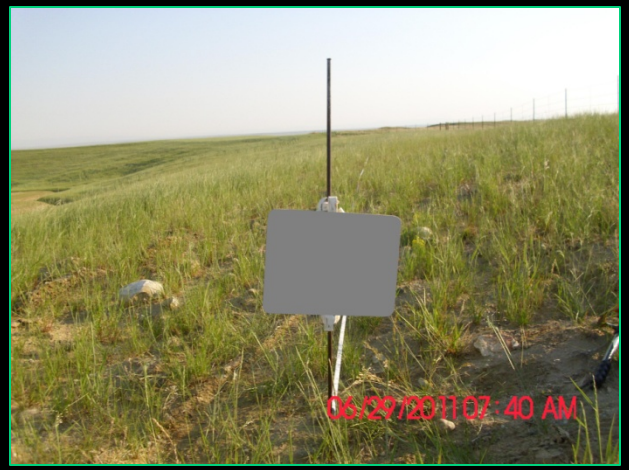
SUMMARY

MINIMIZING THE EFFECTS OF DROUGHT

- Drought intensifies reclamation challenges
- Plan ahead for an average year
  - Do not wait for a wet year before proceeding
- Always minimize effects of drought which cannot hurt in the “wet years”
- Seed in the winter months, if ground conditions are favorable, especially shrubs and forbs
- Diligently salvage all suitable material

REMEMBER

- Think long-term.
  - Management driven by land use goals
  - Manage for and maintain long-term soil health.
- Forward thinking will be economical.
  - Extra steps early for less mitigation in the future



QUESTIONS

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