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.

Drought

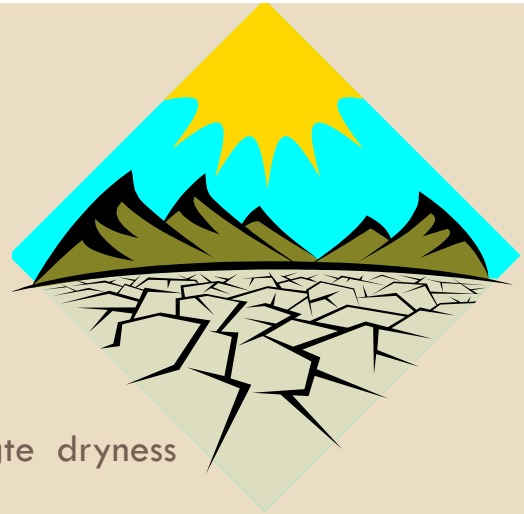
Drought [drout]

noun 1. a period of dry weather, especially a long one that is injurious to crops.

2. an extended shortage: a drought of good writing.

3. Archaic. thirst.

Also, drouth [drouth]



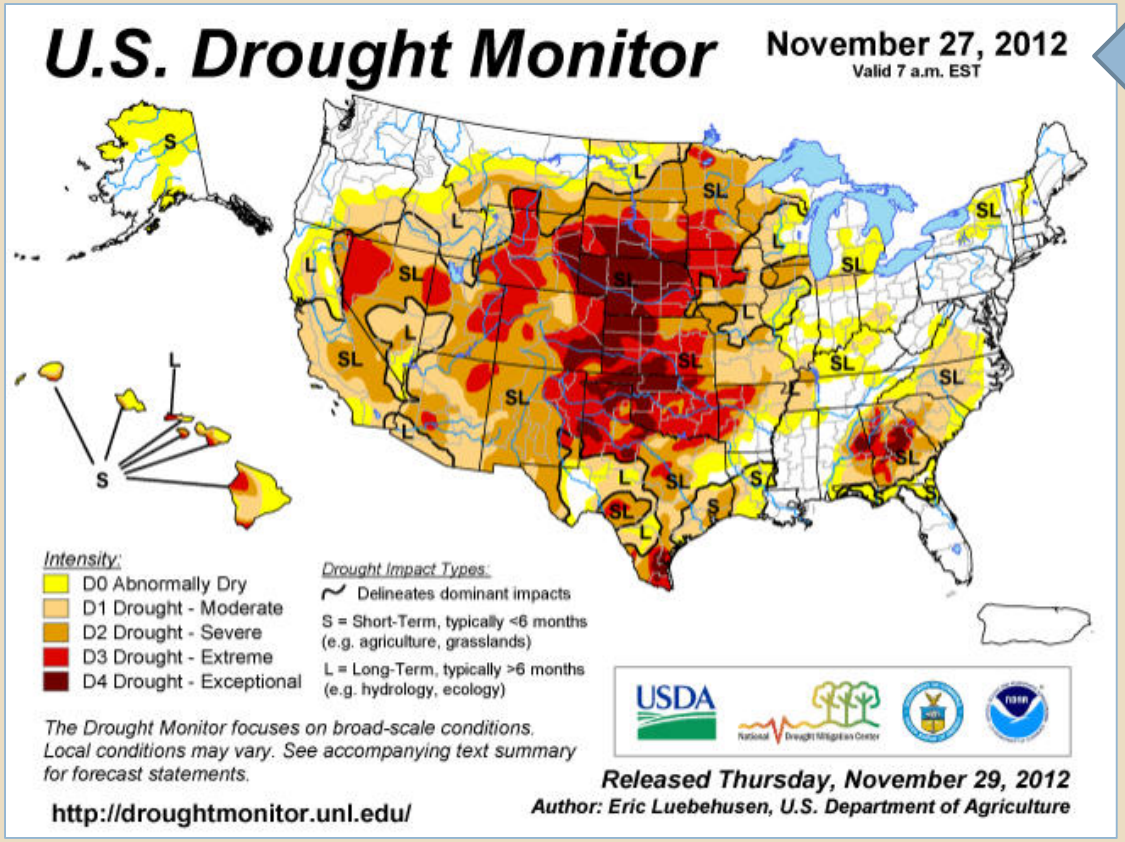
Origin:
before 1000; Middle English; Old English drūgath,

equivalent to drūg- (base of drȳge dry) + -ath -th[1] ; cognate with Dutch droogte dryness

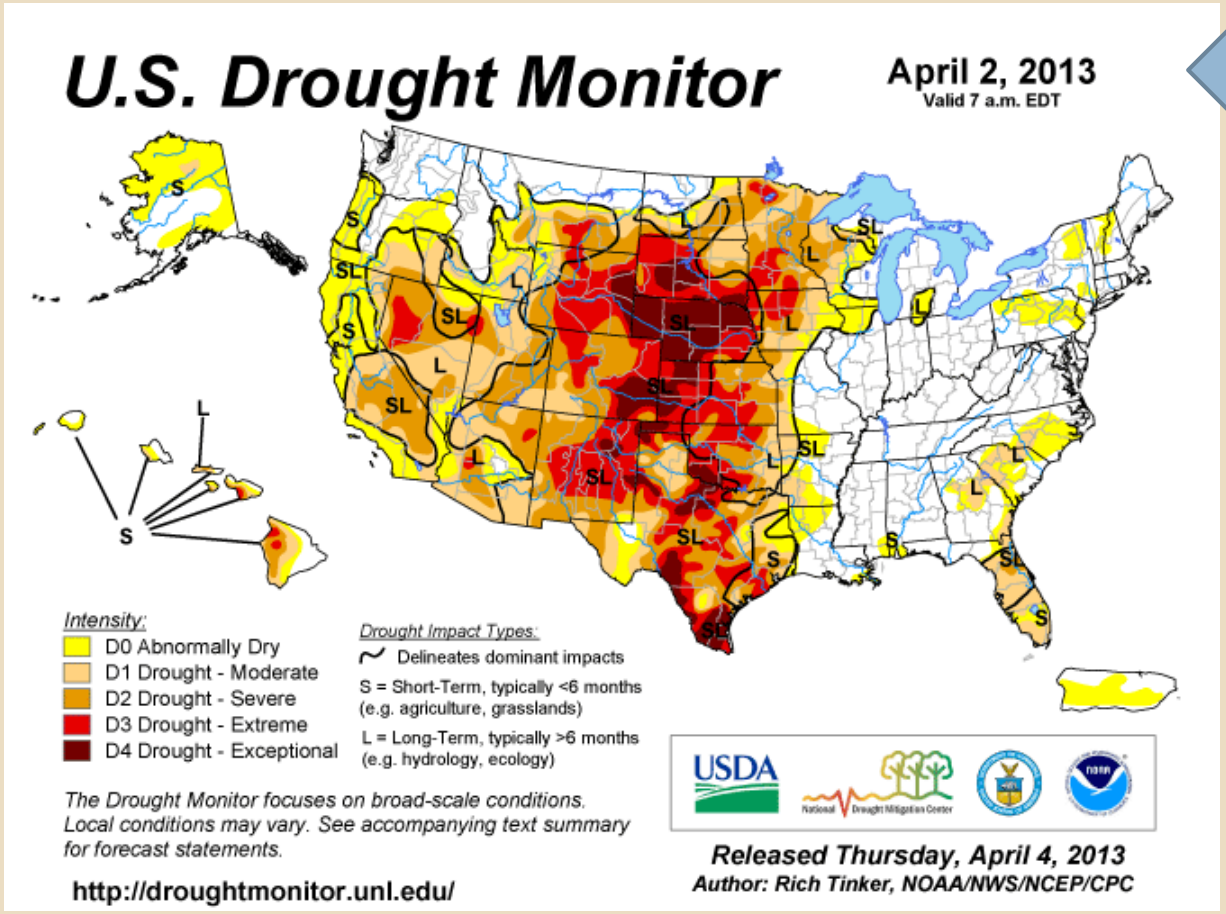
Synonyms
2. scarcity, lack, want, dearth, paucity, famine.

National Drought

- Short Term vs. Long Term

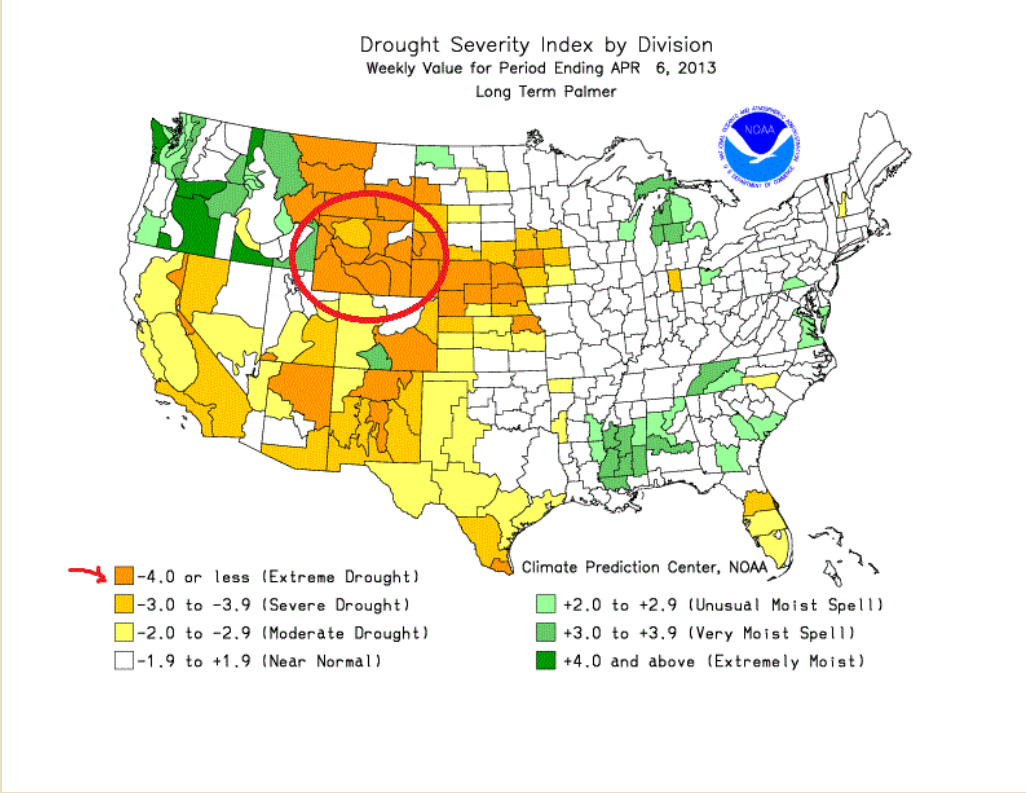


National Drought



National Drought

- Palmer Index, early April, 2013

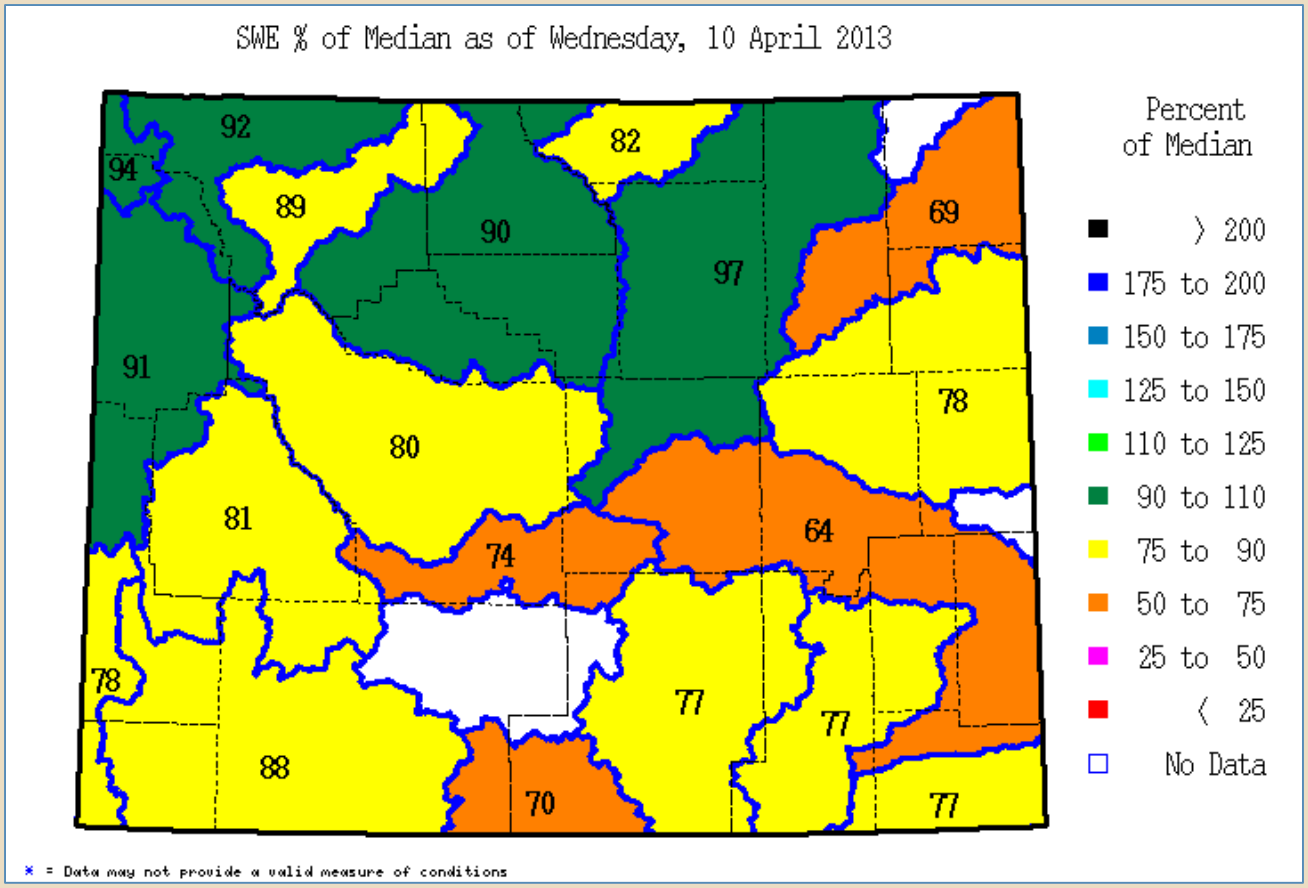


Although the Palmer is the main drought index used by the U.S. government, it is slow to detect fast-emerging droughts, and does not reflect snowpack, an important component of water supply in the western United States.

Drought

- In Wyoming, 3 main factors:
  - **Rangeland precipitation**
  - **Water supply**
  - **Mountain snowpack**

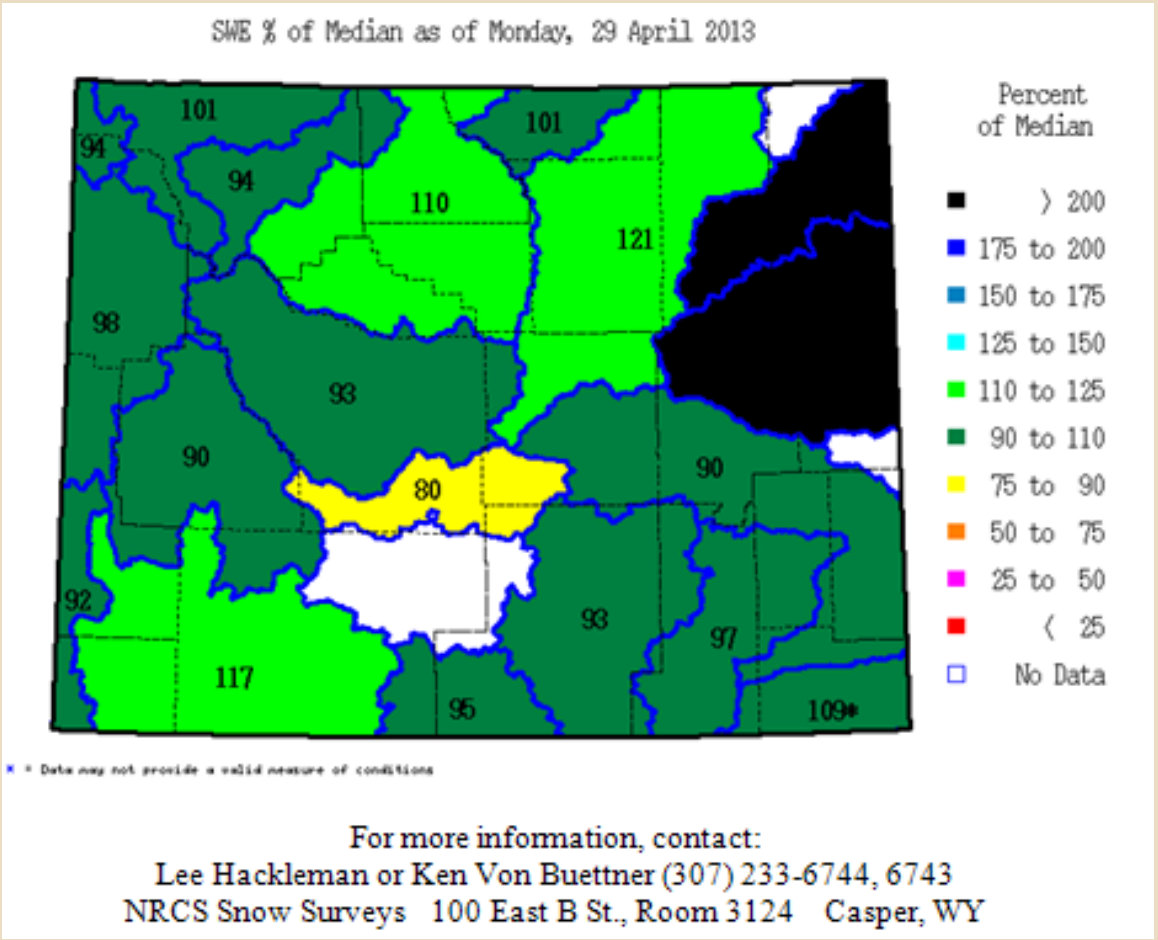
Wyoming Snowpack



Map of Percent of Average Snow Water Equivalent by Wyoming Basin

April 10, 2013

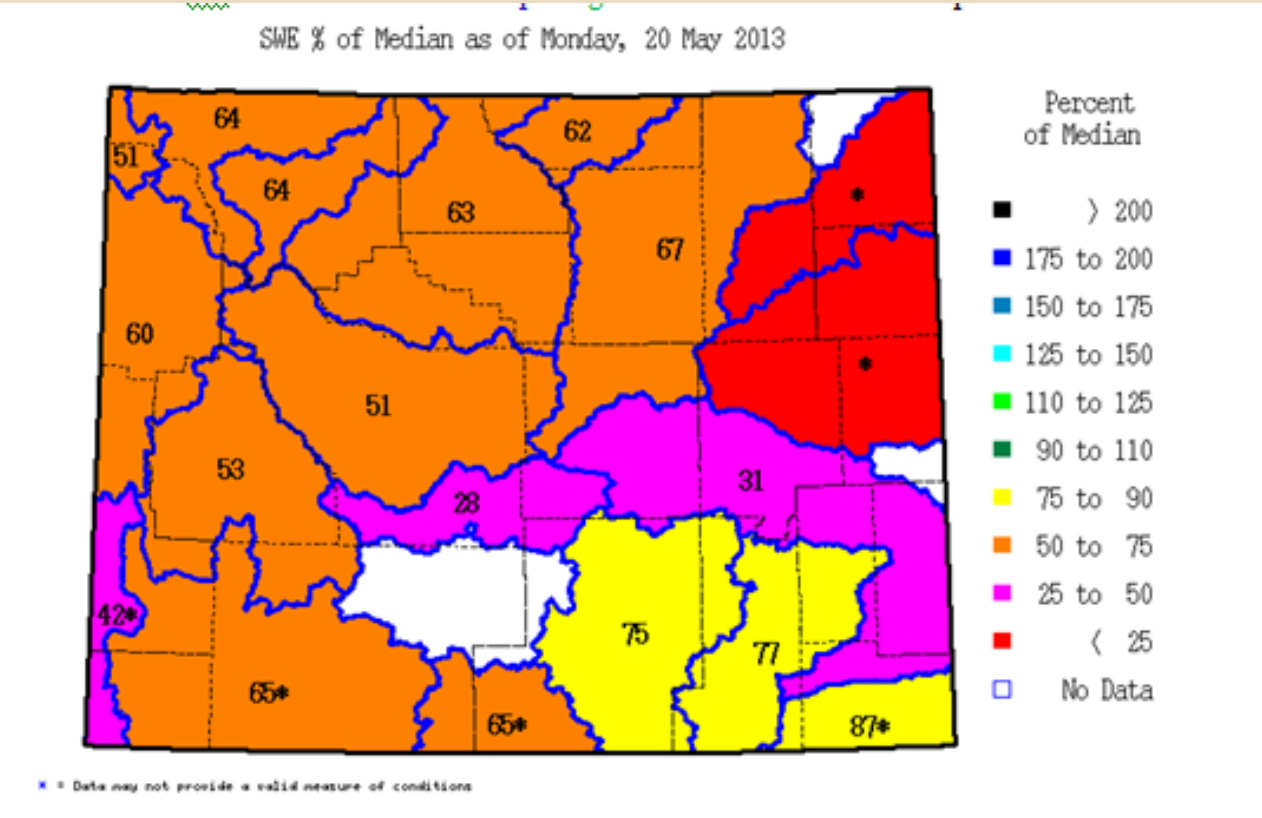
Less than 3 weeks later:



Map of Percent of Average Snow Water Equivalent by Wyoming Basin

April 29, 2013

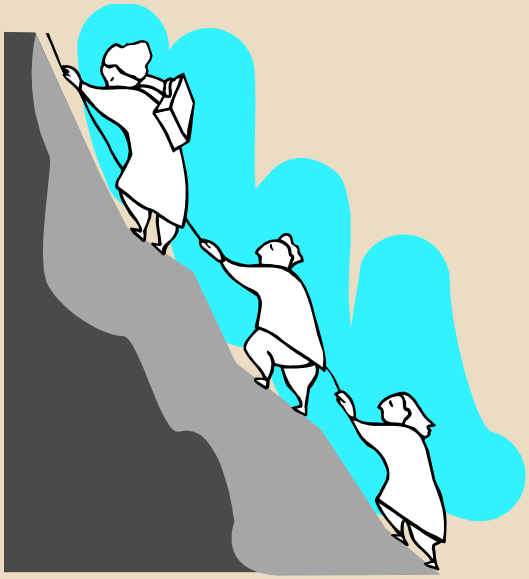
One month later:



Spring snowpack once again at below average levels. (Note significant change in NE WY.)

May 20, 2013

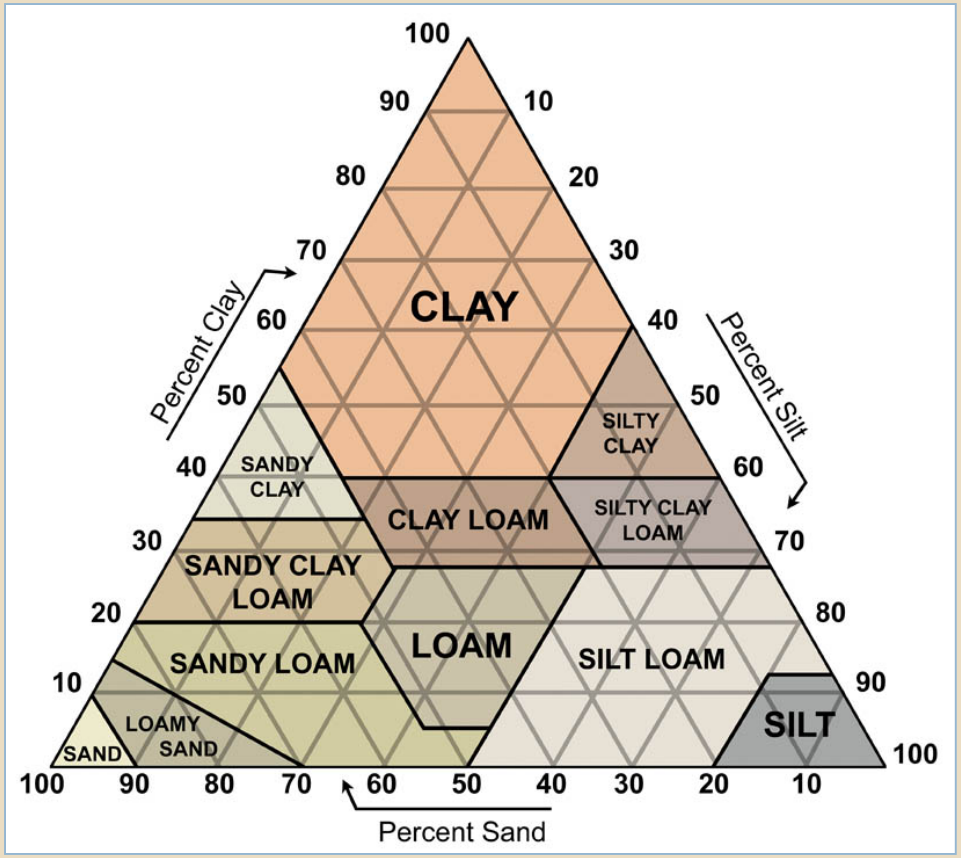
Challenges to Reclamation



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

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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

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

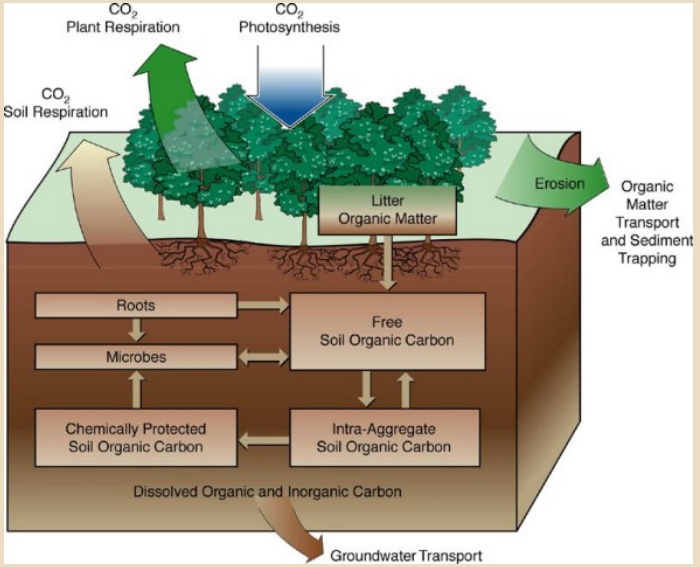
Enhance moisture infiltration and retention

- 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

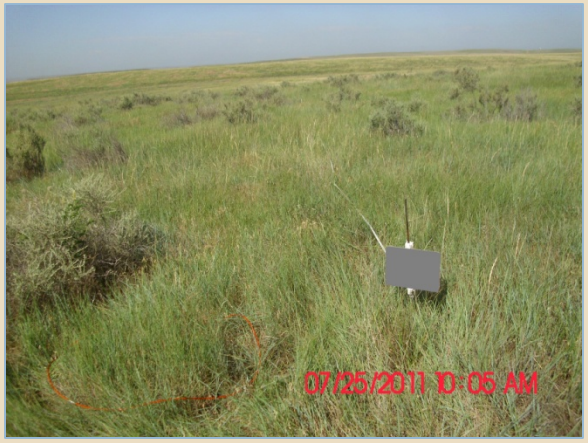
Summary

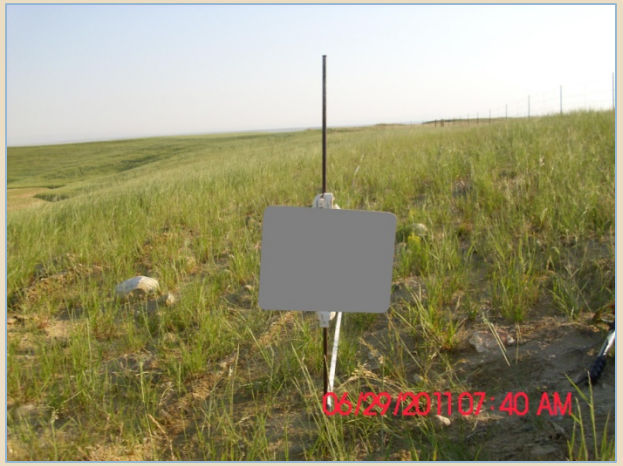
Minimizing the effects of drought

- 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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