Before we start…..

- Pipeline Reclamation Workshop March 5th in Sidney, MT
  - Contact Beth Redlin: beth.redlin@ARS.USDA.GOV (phone 406-433-9427)
- WRRC 2nd Land Reclamation Symposium June 1-8 in Laramie, WY
  - Contact Kristin Herman: kherman@uwyo.edu (phone 307-766-3576).

IT STARTS WITH THE SOIL

Reclamation – Bringing Ideas Together
Dickinson, ND
February 26, 2013

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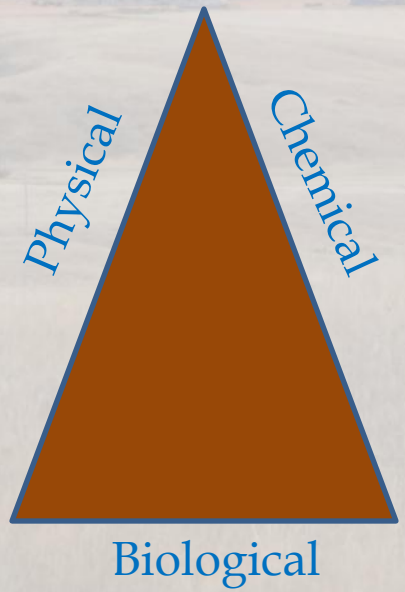
Soils
Starting with the Basics

- Complex, dynamic, living system
- Changes to one property category will impact the other two

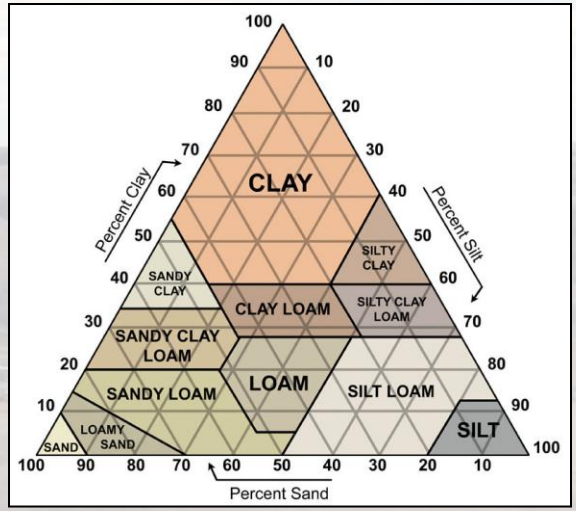


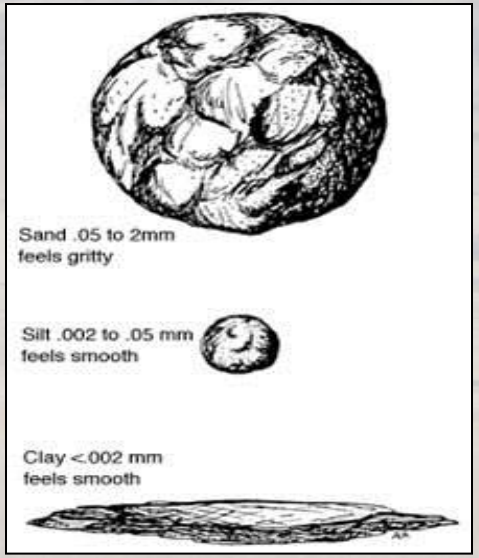
Chemical Properties

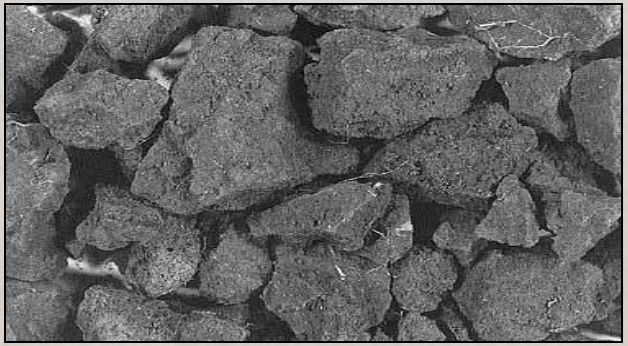
- pH
- $CaCO_3$
- Metal toxicity based on climate and geology
  - Selenium for example
- Salinity and/or sodicity
  - Seep areas
- Fertility
- Organic matter (physical property also)

Physical Properties

- Texture
- Bulk density
- Compaction
- Structure
- Organic Matter
- O_2 concentration
  (waterlogged soils)







Organic Matter

Why is it important to salvage and segregate that top layer?

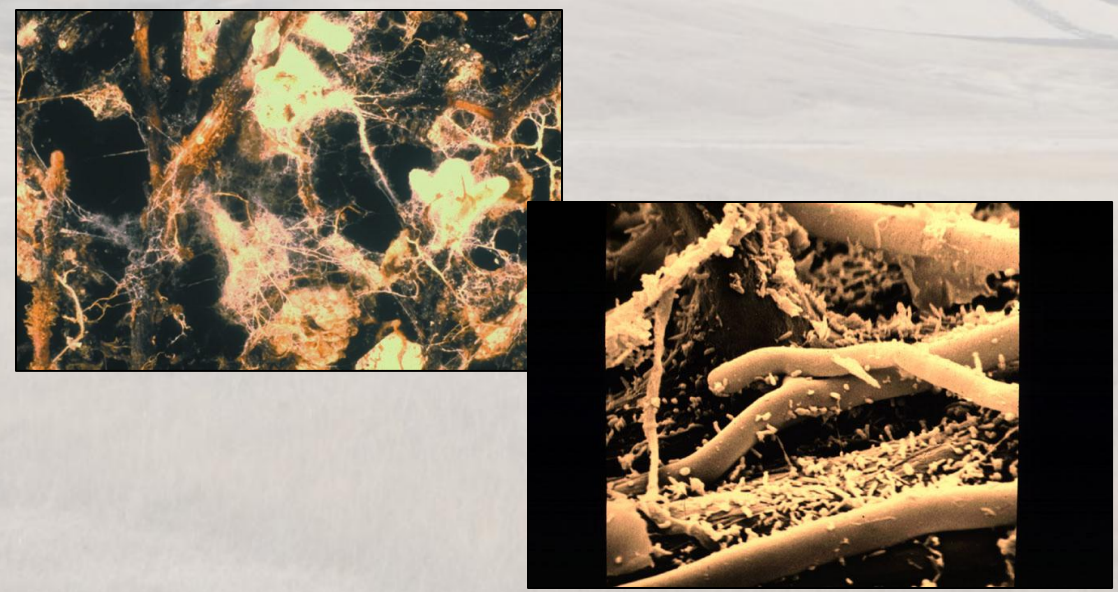
Importance of organic matter

- Provide soil fertility
- Provides energy sources for soil microorganisms
- Helps to kick start biogeochemical cycling
- Top horizon material can be a seed source (both good and bad)

A little bit goes a long way

Biological Properties

- Last but certainly not least
- Generally soil microbial populations or biota
- Biogeochemical cycles (nutrient cycling)



Climate Maps of the US

Mean Annual Precipitation

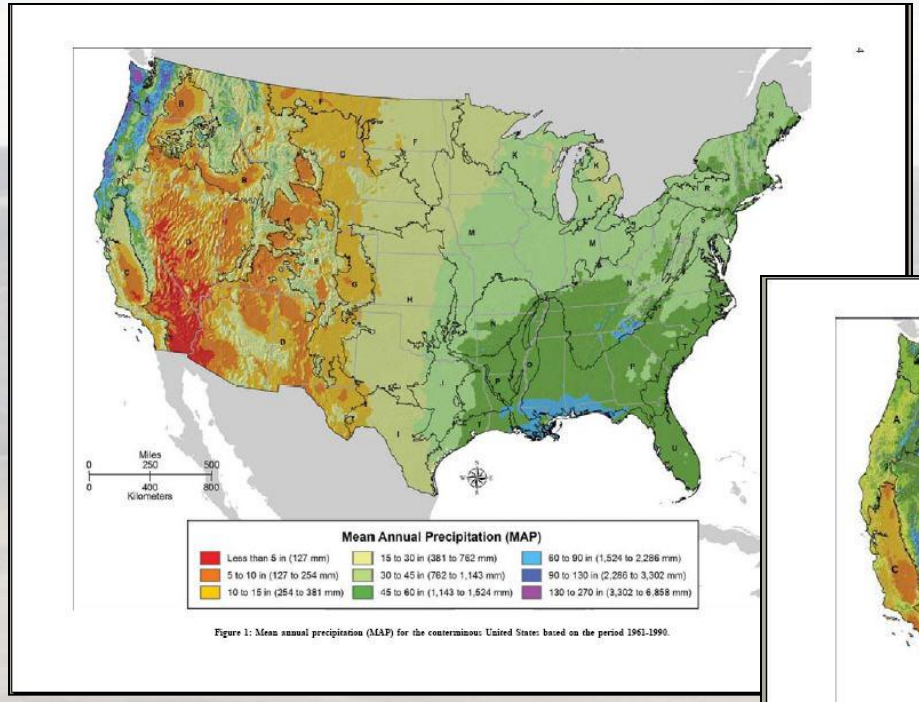


Figure 1: Mean annual precipitation (MAP) for the conterminous United States based on the period 1961-1990.

Mean Annual Air Temperature

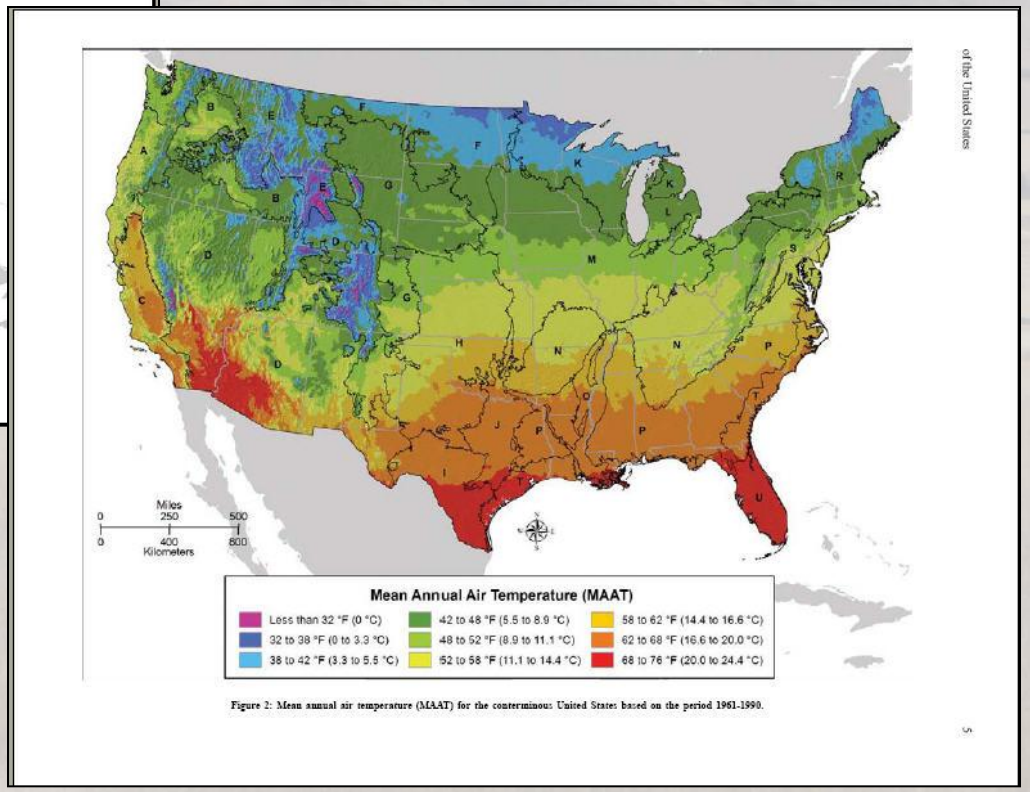
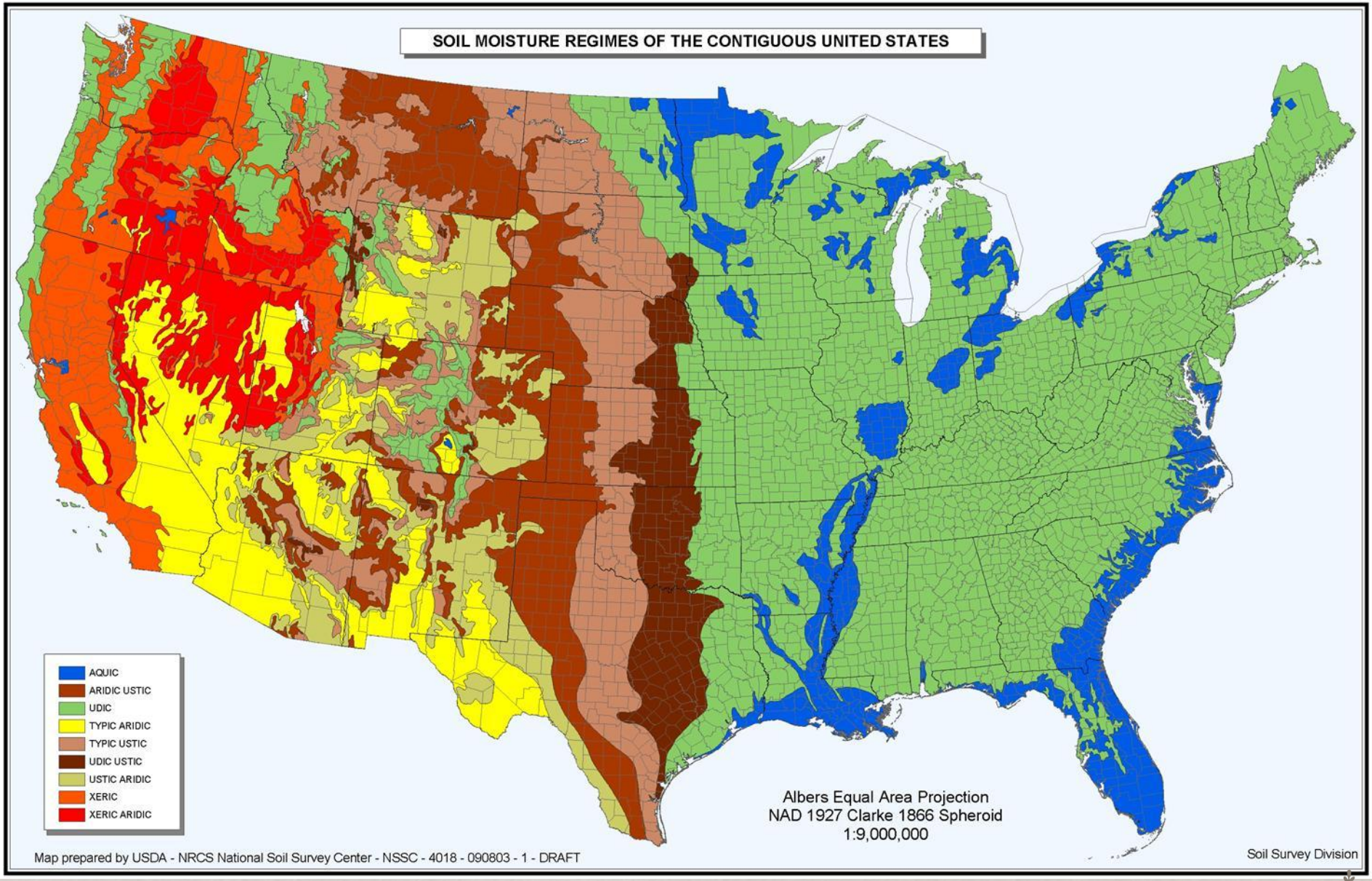


Figure 2: Mean annual air temperature (MAAT) for the conterminous United States based on the period 1961-1990.


SOIL MOISTURE REGIMES OF THE CONTIGUOUS UNITED STATES
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NAD 1927 Clarke 1866 Spheroid
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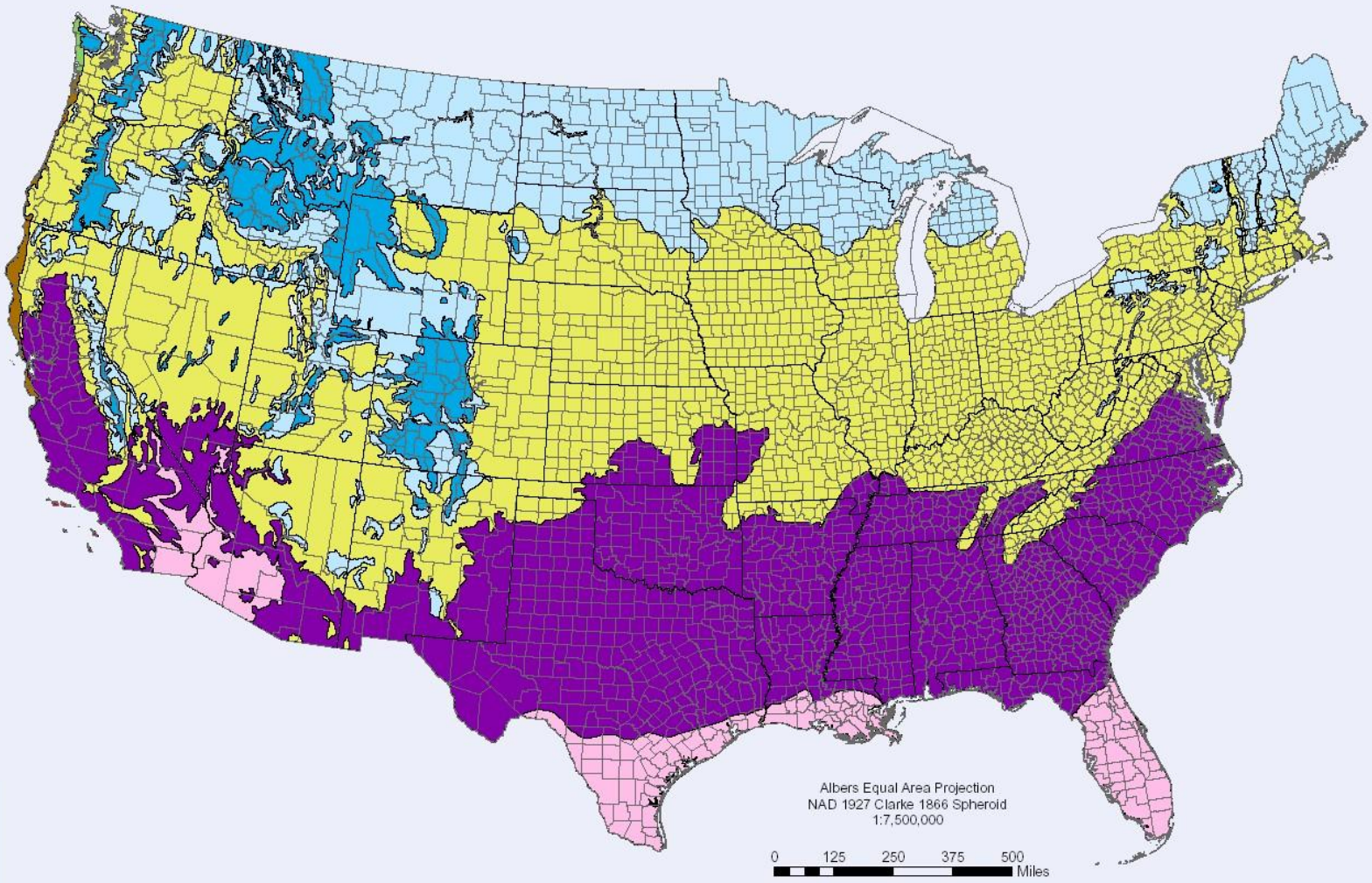
Map prepared by USDA - NRCS National Soil Survey Center - NSSC - 4018 - 090803 - 1 - DRAFT
Soil Survey Division

SOIL TEMPERATURE REGIMES OF THE CONTIGUOUS UNITED STATES



Map prepared by USDA - NRCS National Soil Survey Center - NSSC - 4018 - 102703 - 1 - DRAFT

Soil Survey Division

Western North Dakota

- Near Dickinson (Williston, Watford City, Minot)
- Mean Annual PPCT – 14-18 (15.5)
- Seasonal PPCT – May-July highest
- Mean Annual Air Temp – 38-46 ^{o}F (42)
- Native and cropped areas

Humid Continental Climates

- Warm, humid summers
- Cold, wet winters
- Fertile, high organic matter soils
  - Classified as Mollisols
- Dominant soil order in ND

Mollisol Landscapes

Mollisol Profile

Semi-Arid Climates

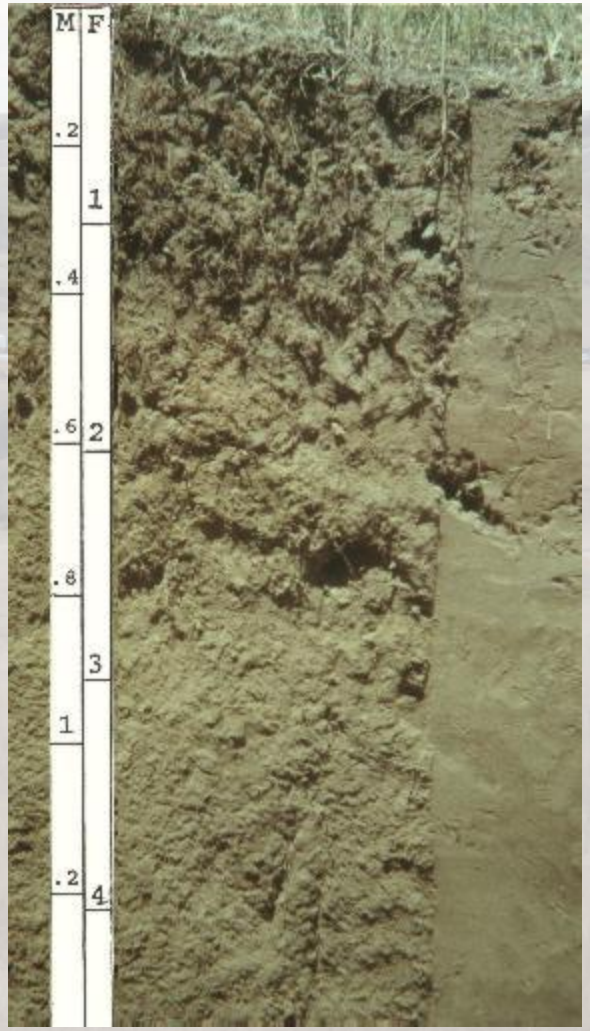
- Less precipitation than potential evapotranspiration
- Dominated by other soil orders
  - Likely Aridisols, Entisols, Inceptisols

Typical Aridisol Landscape

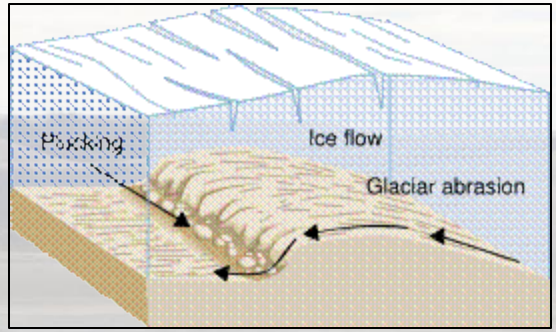
Aridisol Profile

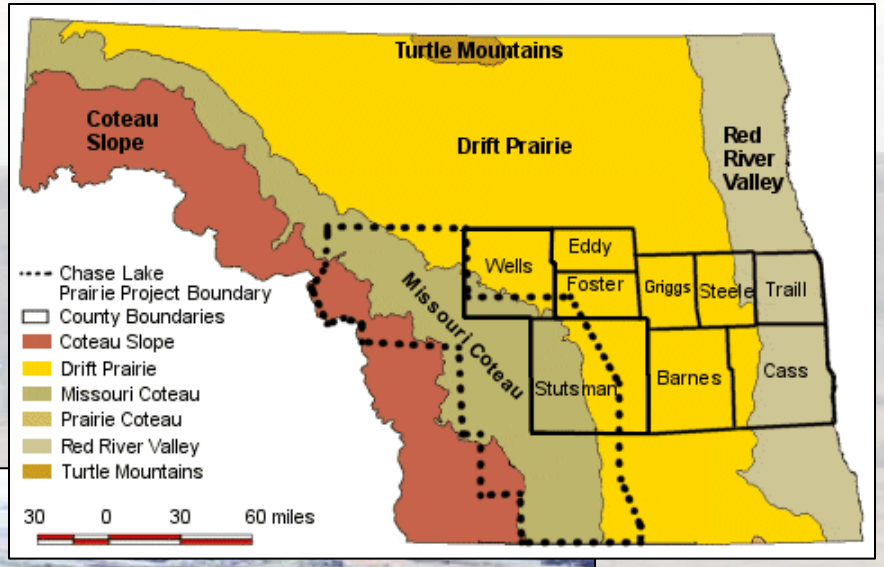
Typical Entisol Landscape

Entisol Profile



Glacial Impacts in ND



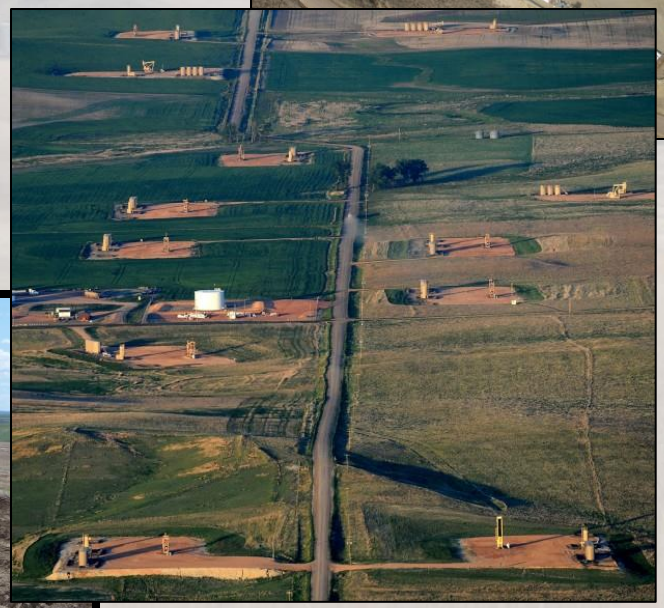


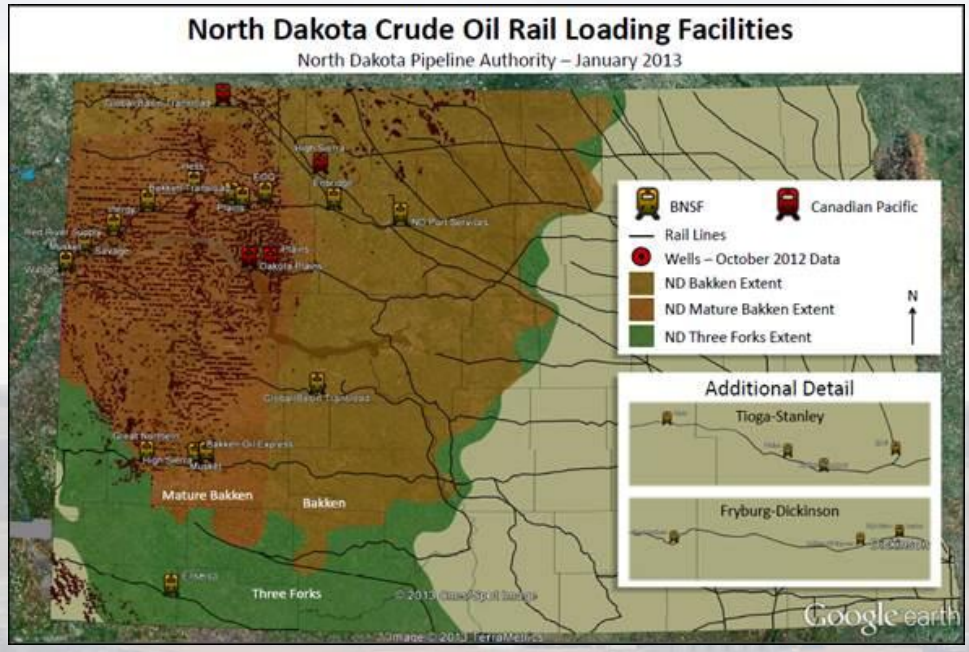
Types of Large Scale Man-made Disturbance

- Mining
  - Surface Coal
  - Underground Coal
  - Surface Uranium
  - In-situ Uranium
  - Bentonite
  - Gravel
  - Abandoned mines

Types of Large Scale Man-made Disturbance (continued…)

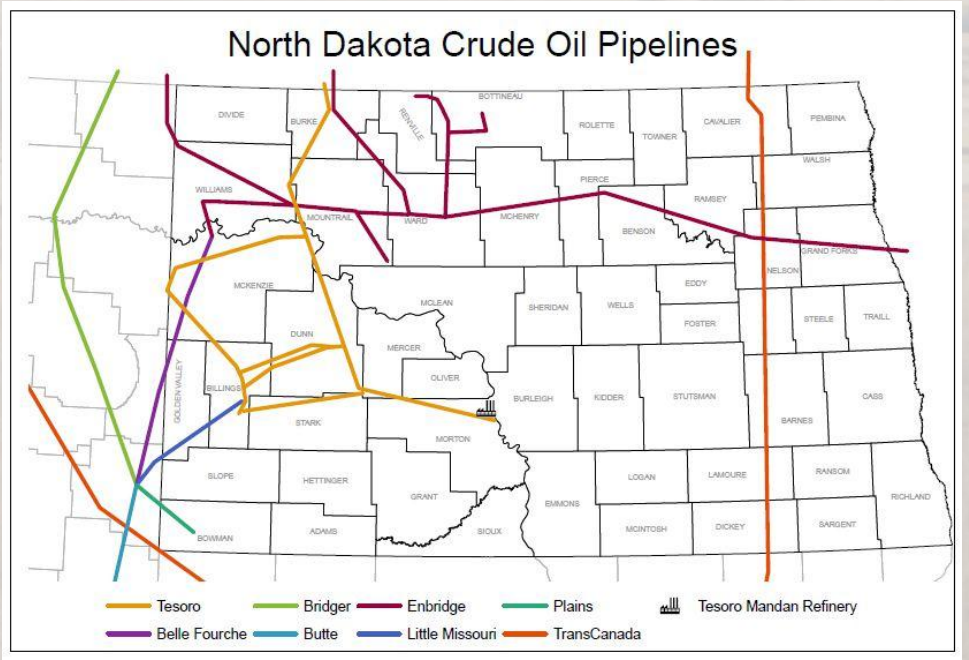
- Oil and Gas pads
  - Coalbed methane
  - Tight oil shales
  - Deep gas
- Roads
- Pipelines





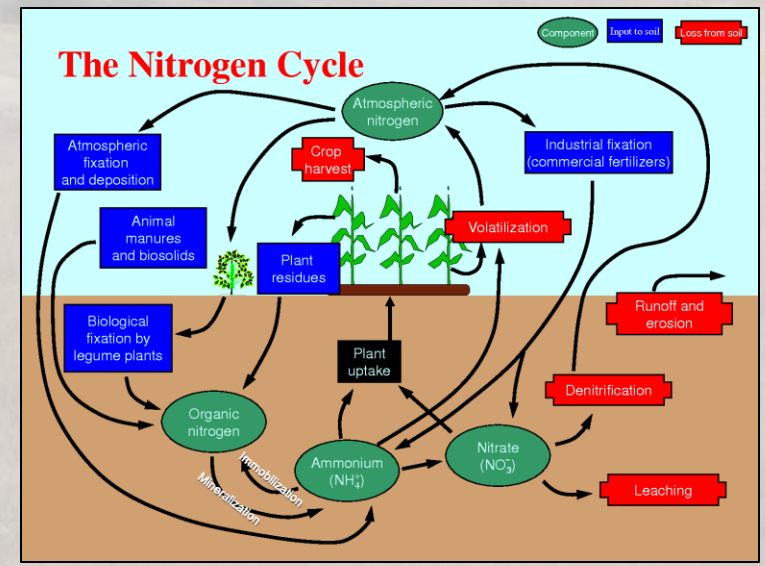
Support Facilities

Pipelines



Undisturbed Soils – General

- High biological diversity
- Horizonation
- Organic layer intact
- Defined chemistry
- Greatest resilience to stress
- Always in flux, but generally stable



Major Disturbed Soils – General

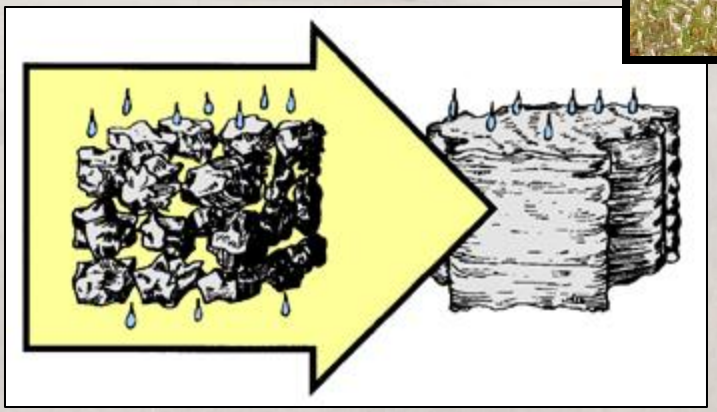
- Low biological diversity
- No horizonation; could be inverted or totally mixed
- Organic layer diluted
- Changes in chemistry
- More open to erosion, both wind and water
- Unstable

Soils under Disturbance

- Increased bulk density
- Decreased soil structure
- Decreased aeration
- Decreased infiltration and moisture holding capacity
- Reduced nutrient cycling
- Reduced microbial activity

Hydraulic implications

- Decreased infiltration, percolation, water holding capacity
- Increased rates of erosion



Ways to minimize impact of oil and gas activity to the soil

Ways to minimize impacts – 4 phases

- Planning
- Salvage
- Storage
- Replacement

Map your soils for suitable seedbed material

Look in 3-D

Suitability line will likely vary over the landscape.

Look for unstable slopes

Ways to minimize impact

- Planning
- Salvage
- Storage
- Replacement

Ways to minimize impact

- Know what you are dealing with prior to disturbance…back to planning
- Segregate true topsoil from suitable subsoil to minimize dilution
- Salvage under optimal conditions… not when wet

Look around…POTENTIAL SEDIMENT LOAD IN DRAINAGES

Don’t do this!

Note when the frost goes out of the ground! Important with seismic activity too.

Understand that suitable soil depth varies…uniform soil depth removal is not optimal use of a resource. Suitable soil may be salvaged with heavy equipment…..

…..or a SPOON!

Ways to minimize impact

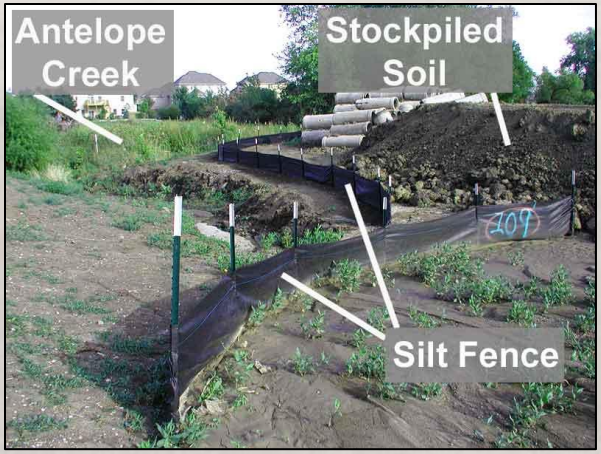
- Planning
- Salvage
- Storage
- Replacement

Ways to minimize impact

- Direct haul and replace, if possible, rather than stockpiling
- Minimize storage time
- Salvage during colder, drier months

Ways to minimize impact

- Protect from wind and water erosion
  - Important in residential and commercial development
- Seed stockpiles to add organic matter, aid microbial populations, and reduce weeds



Stockpile Height and Size

40 foot stockpile

25 foot stock pile

3 foot stockpile

- Minimize depth of stockpiles, if possible
- Consider space needed and length of time in storage

Large vs. Small Stockpiles

- Large piles – Common in coal industry
  - Less exposed surface area
    - Overall, less susceptible to erosion
  - Overall smaller disturbance footprint
  - Likely longer term if not direct hauled
- Small piles – Preferred by BLM on O&G sites
  - More exposed surface area
    - More susceptible to erosion
  - Overall greater disturbance footprint
  - More of a temporary nature

Stockpile Placement

- On site storage piles vs. reclaimed replacement area on the O&G pad/road
- Minimize re-use of reclaimed area,

  if replaced on the pad

Stockpile seeding

- Seed topsoil stockpile immediately
  - Reduce erosion potential
  - Reduce weed establishment
- Annual cover crop

(different term in agriculture)

- Erosion control methods
  - Earthen berms
  - Limit slope percentage
  - Channels/Ditches

Research findings

- 15-20 year old topsoil piles still biologically healthy
  - Contrary to common thought of "dead" piles
- Microbes in semi-arid and arid climates enter dormancy when stressed
  - Very adaptive to droughts
  - Quickly rejuvenate in proper conditions
  - Reseeding (timing, mix, etc.) and available moisture
- Keep movement and disturbance to stockpiles to a minimum
  - Quality degraded during transportation

Ways to minimize impact

- Planning
- Salvage
- Storage
- Replacement

Ways to minimize impact

- Similar to seeding of storage areas
- Deep rip compacted areas
- Lightly rip or roughen underlying material
  - Especially on slopes
- Avoid handling wet material
- Stabilize replaced material prior to seeding, e.g., rough

Replaced Topsoil on Pad Prior to Seeding

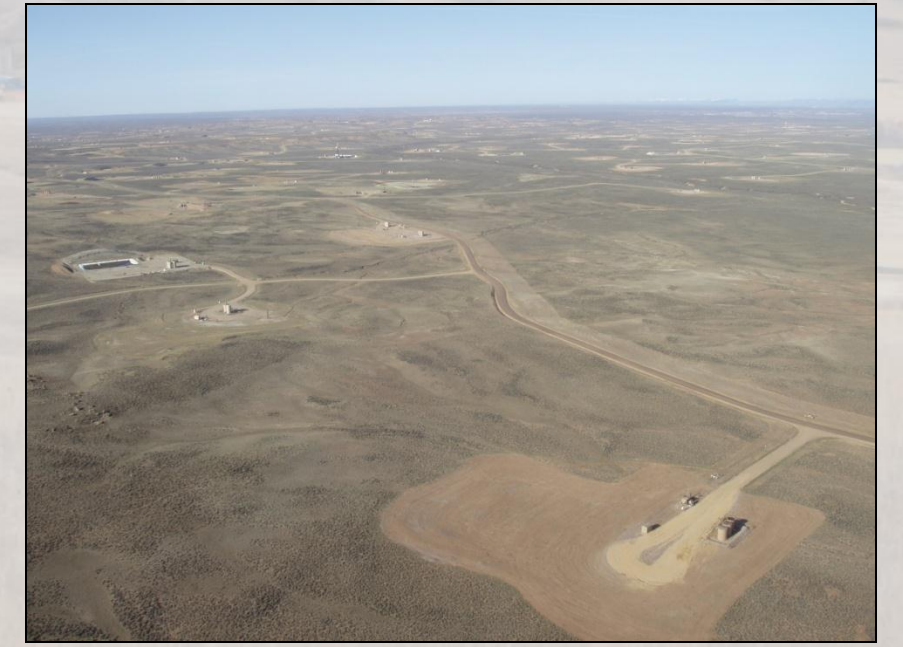
Need to handle large rocks…

Likely Chemistry Changes

Seeding Respread Topsoil

Seeded Topsoil

Interim Reclamation



Reduces the disturbance footprint!

Reseeding

- Timing
  - Conditions
    - Seasonal
    - Moisture
    - Drought?
- Seed mix
- Interim stabilization
- Inoculation of soil microbial activity
  - Local source
  - Wind/Dust

Pipeline Considerations

Challenges include crossing multiple soil types, land uses, plant communities, producers, etc.

Potential soil problems on the backend

- Metal toxicity
- Salinity or sodicity or both
- Compaction
- Instability
- pH issues
- Fertility

Pay Now or Pay Later!!!

Words to the Wise

- Don't ignore soils…it begins and ends with the soils
- Understand the scale of the information you have or need
- Pay attention early in the planning process
- Avoid areas that will give you problems
- Understand the economics of NOT doing the previous points

QUESTIONS?????

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