Reclamation Success

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Environmental & Natural Resource Management
Consulting & Construction Services

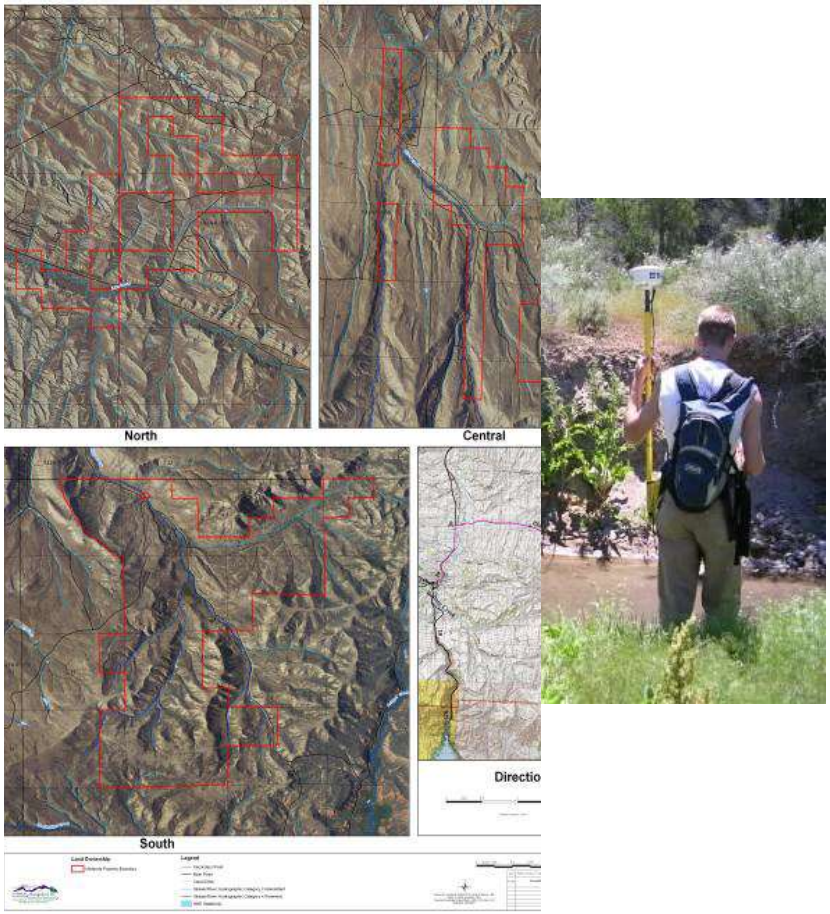
BSC BISMARCK STATE COLLEGE

SALTED LANDS COUNCIL

Planning is Key to Success

- Before Disturbance
  - Vegetation Communities Mapping
  - Soil Mapping & Soil Testing
  - Wildlife Uses
  - Surface Water Hydrology
  - Geology & Groundwater
  - Infrastructure Mapping
  - Develop Plans for Soil Handling, Grading, Surface Water Management & Reclamation
  - Obtain Regulatory Approval

Project Mapping



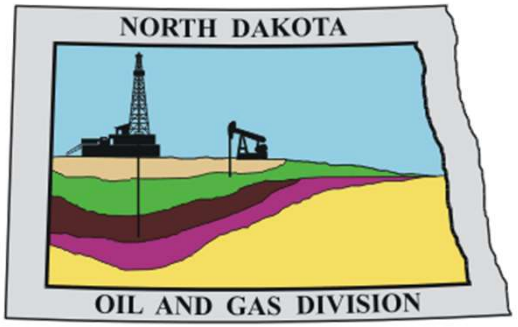
- Before Disturbance
  - GIS Databases Development & Management
  - Google Earth, ESRI, Fixed Wing & Drone Imagery
  - Project Assets: Pipelines, Well Pads, Tank Batteries
  - Environmental Sensitivity Analysis
  - Ground GPS Surveys

Infrastructure Mapping and Protection

- 811 CaLL SYSTEM: Setup/maintenance

- Complete setup and maintenance of your underground assets in the 1-call system.
- You provide your underground assets in any of the popular formats: shp, FGDB, MDB, MapInfo, kmz, dxf, dwg, dgn.
- Updates are maintained on a regular basis, depending on the level of frequency as determined by the user.

Oil & Gas: Regulatory



United States Department of Transportation

PHMSA

Pipeline and Hazardous Materials Safety Administration

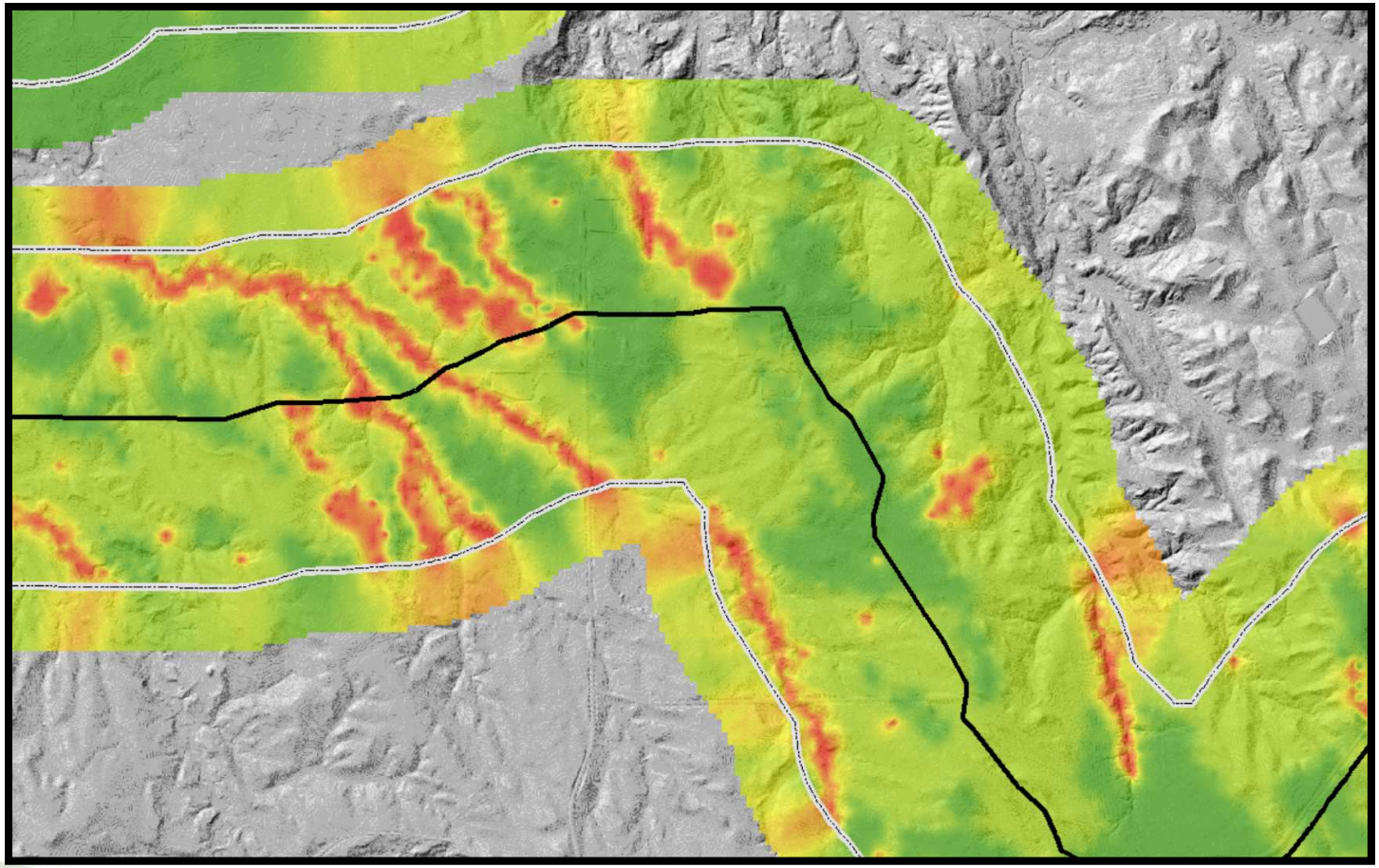
North Dakota Industrial Commission (NDIC)

NORTH Dakota | Environmental Quality

Be Legendary.™

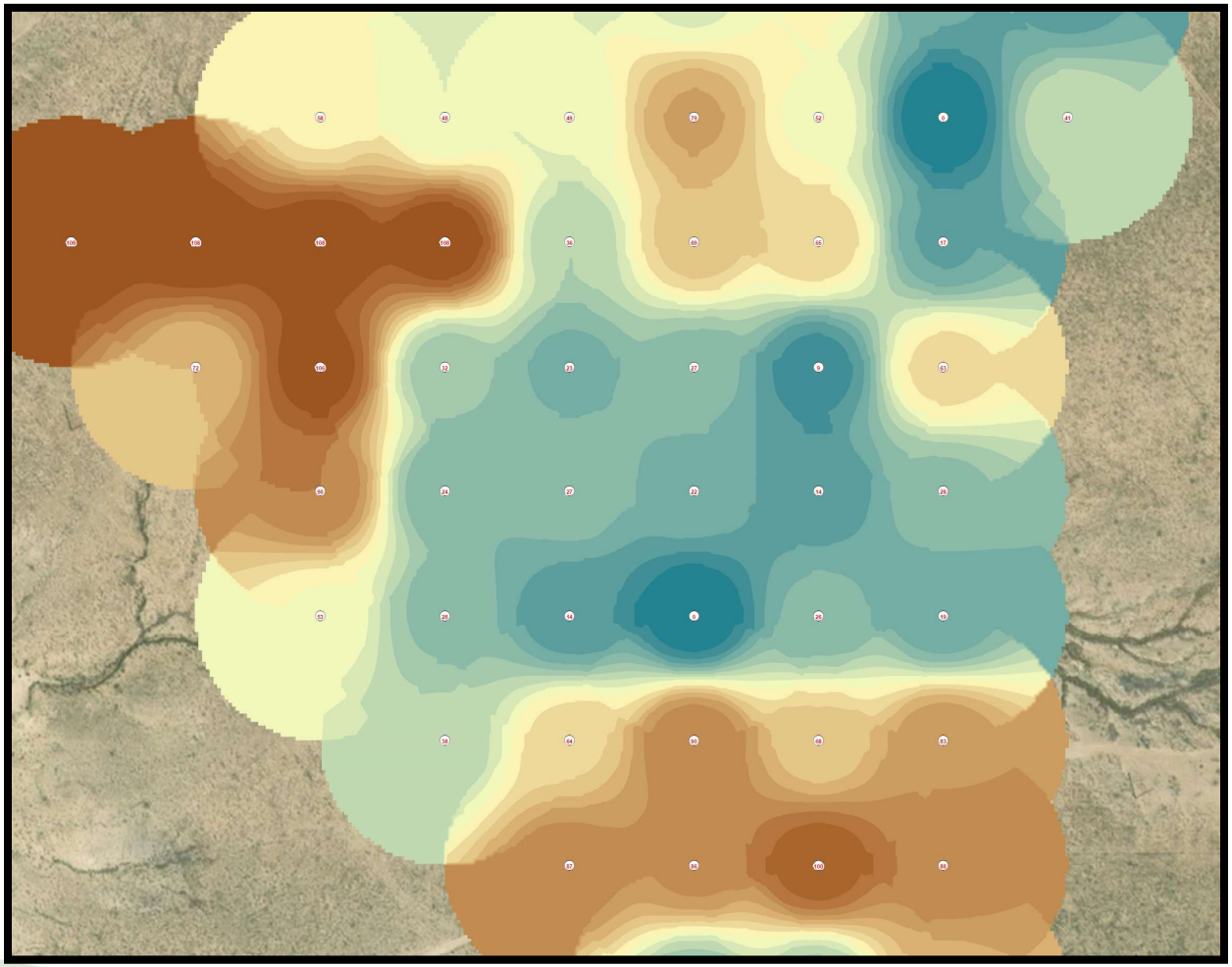
Geographic Modeling

- Modeling Environmental Sensitivity



Geographic Modeling

- Modeling Soil Parameters



Considerations for Vegetation Establishment

- Landuse Objective
- Environmental and Site Factors
- Soil Testing Results
- Species Selection
- Seeding Rate
- Site Limitations

Understand Your Site Limitations

- Climate
- Aspect / Exposure
- Slope
- Soils
- Wildlife
- Regulatory
- Infrastructure

Infrastructure Diversity

- Gas Pipelines
  - Long linear features irrespective of slope
  - Multi county and state jurisdictions
  - Deeper disturbance
  - Short duration disturbance
- Access Roads
  - Linear features that are more landowner, topographic and well specific
  - Road areas greater than infrastructure area

Infrastructure Diversity

- Well Pads & Mud Pits
  - Smaller in Size
  - Directional Drilling
  - Connector pipelines to the compressor facilities
- Compressor Facilities
- Produced Water Impoundments

Reclamation Plan

- Entire Field vs. Individual Well Pad Reclamation Plans
- Soil Mitigation
  - Determined by impacts
  - Determined by soil testing
  - High SAR, EC, Chloride, Compaction
  - In-situ vs. haul and replace
  - Post mitigation soil testing

Reclamation Plan

- Entire Field vs. Individual Well Pad Reclamation Plans
- Seed Mix Development
  - Determined by vegetation community
  - Determined by soil type and chemistry
  - Native vs. Introduced Pasture/Cropland
  - Grass, Forb and Shrub Diversity
  - Wildlife Habitat

Reclamation Plan

- Soil Handling
  - Topsoil Segregation
  - Stockpiling vs. Direct Hauling & Placement
- Soil Amendments
- Site Grading
- Revegetation Methods
- Surface Water Control
- Weed Control

Implementation

- Seed Source
- Timing
- Soil Amendments & Topsoil
- Seedbed Preparation
- Mulching & Erosion Control
- Long Term Maintenance Considerations
- Weed Management

Limitations to Success

- Soil
  - Chemistry: Saline, Sodic
  - Low fertility
  - Low Organic Matter
  - Topsoil Quality & Quantity
  - Texture & rock content
  - Steep slopes
  - Aspect

Limitations to Success

- Soil
  - Chemistry: Salinity-EC<8 mmhos SAR-<14 to 18 depending on texture and crop
  - Low fertility: N - <=20#/acre to minimize weeds
  - Low Organic Matter:>= 2%
  - Texture: Sand, Clay, Silty Clay
  - Rock content: <35% Coarse Fragments

Limitations to Success

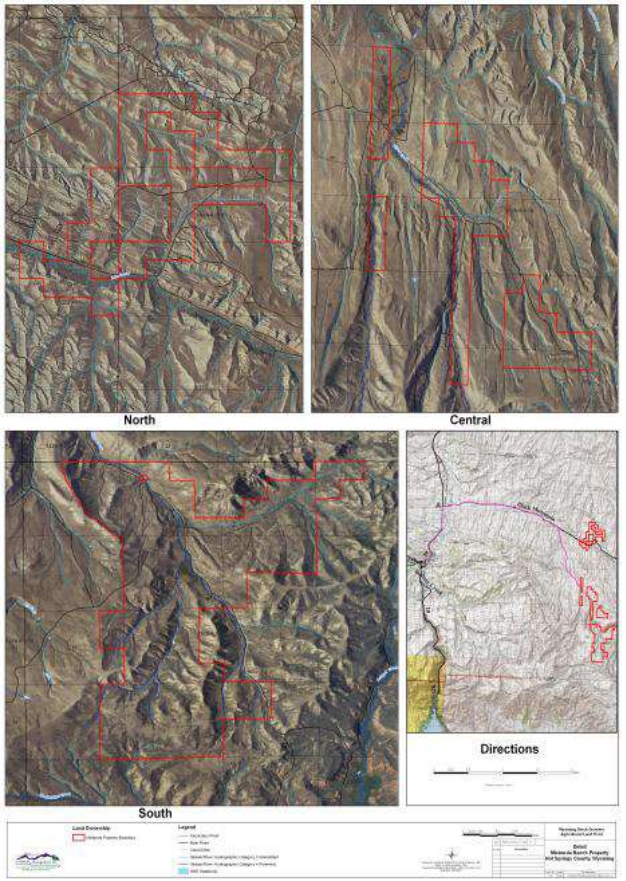
- Vegetation
  - Seed mix composition and selection
  - Competition between aggressive cool season & warm season species (forbs & shrubs)
  - Weeds & competition
  - Poor expression of seed mix, seed quality
  - Climate Impacts-rainfall distribution
  - Grazing

Limitations to Success

- Surface Water Control and Erosion
  - Erosive soils and steep slopes
  - Traffic patterns down slope
  - Offsite drainage
  - Mulching
  - Poor BMP installation & maintenance
  - Inadequate inspections after storm events

Limitations to Success

- Inadequate GIS and Data Management Information to Track Vegetation Success
  - Seeding history: date, season applied
  - Seed mix used
  - Soil amendments applied
  - Landowner and/or regulatory vegetation success requirements
  - Accurate Mapping of Infrastructure



Keys to Reclamation Success

- Alleviate Compaction
- Testing for soil chemical and physical limitations
- Control erosion
- Evaluate and utilize the best management practices for each site
- Avoid a mandated cookie-cutter approach
- Be inventive but keep track of what you have done
- Adaptive Management by site

Keys to Reclamation Success

- Seeding Rate
  - Pure Live Seeds vs. Pounds/Acre
  - Appropriate Seeding Rate (Low)
  - 20-50 PLS/sq. ft.
  - Balance cool and warm season species diversity

Opportunities to Improve Success

- Use interim monitoring data to adjust reclamation plan
- Company needs the latitude to rapidly adjust reclamation plan to meet success standards
- Latitude to try new technology and methods
- Patience with reclamation – it takes time to establish
- Flexibility with seeding dates

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