FRAC SAND
MINING and RECLAMATION
in
WISCONSIN

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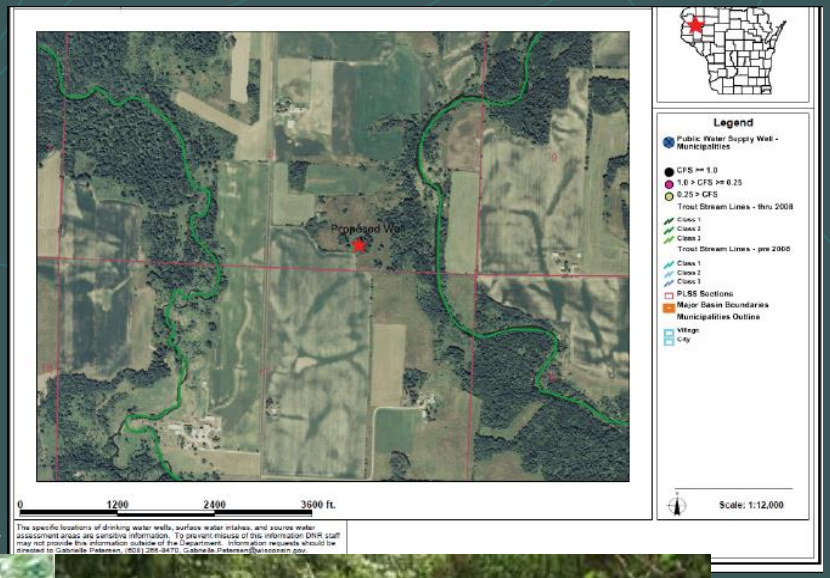
Frac Sand Mining in Wisconsin

- Wisconsin has abundant high-quality sand resources
- Sand typically processed (washed and separated) locally, then shipped out of state
- Mining requires a valid permit ch. NR 135, Wis. Adm. Code; typically locally administered
- Substantial rise in permit requests to mine
- Local regulatory authorities did not anticipate level and scale of activity

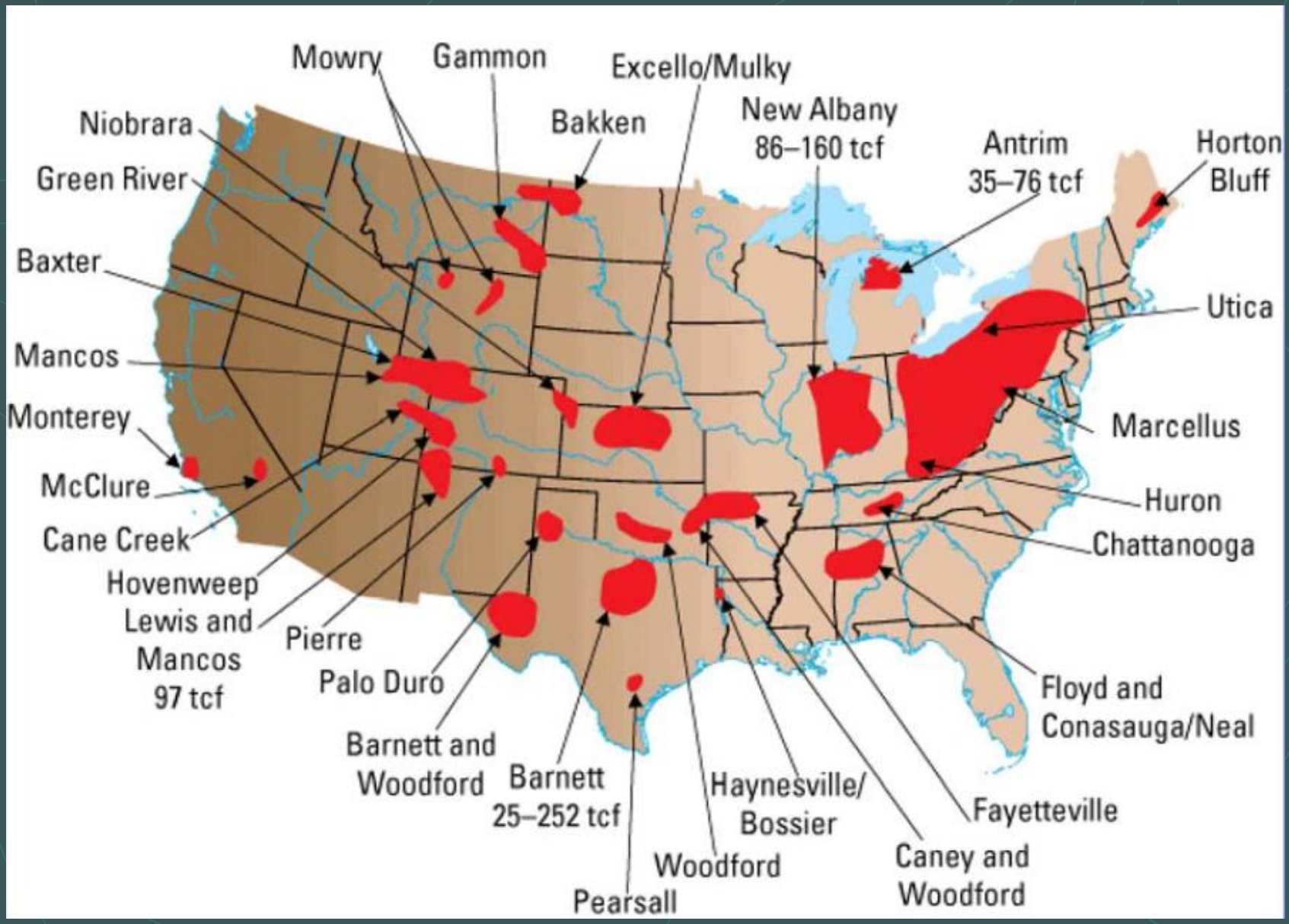
Tourism, Recreation, Property Values

- **PROPERTY VALUE GUARANTY**
  - Upon the execution of the attached Agreement (“Effective Date”) and until (“Termination Date”), ABC Resources, Inc. will provide property value Guaranty to the owners of parcels of land, identified on the attached Exhibit X

Trout Water



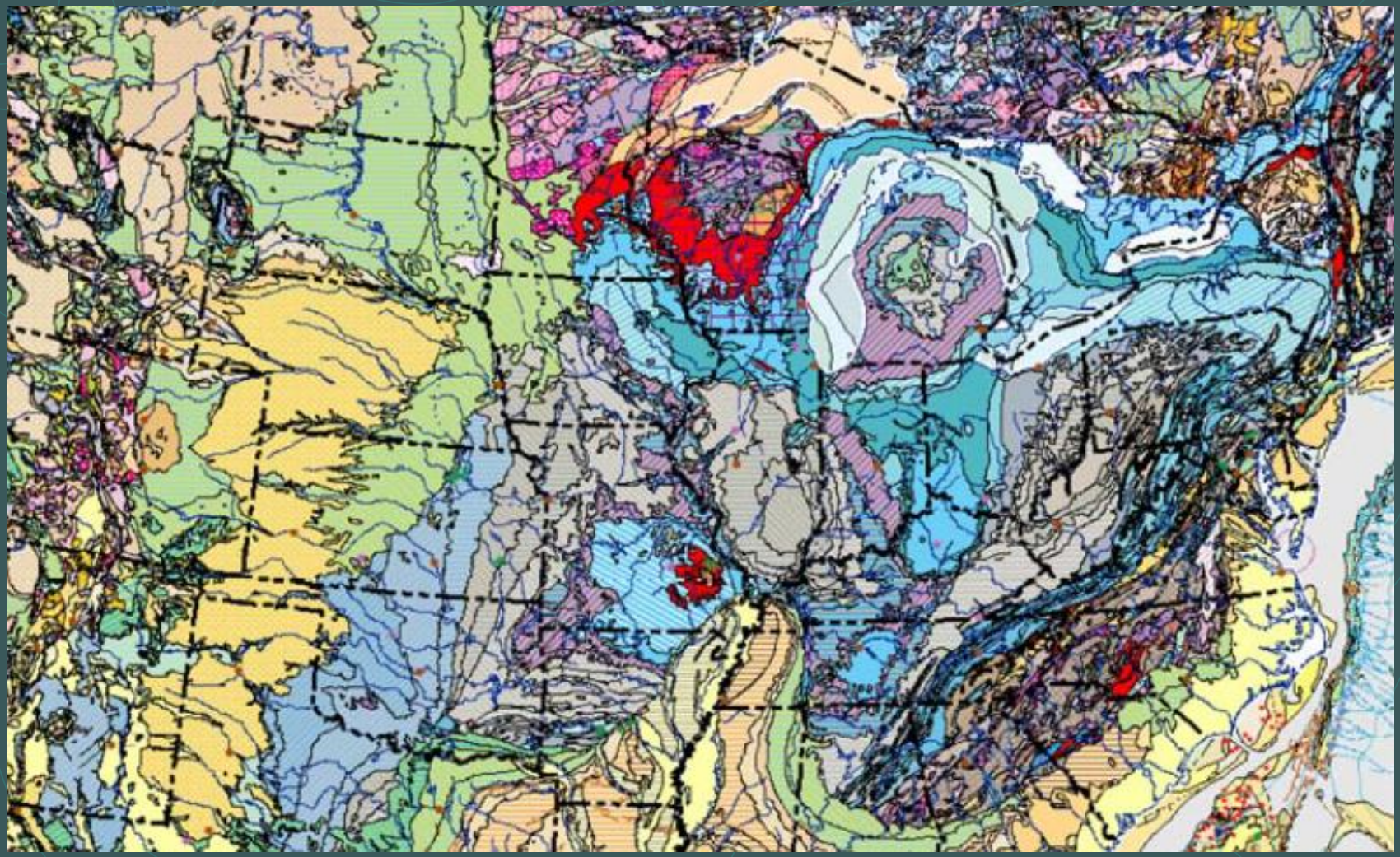
Where the Gas is Located



HYDROFRACKING A WELL

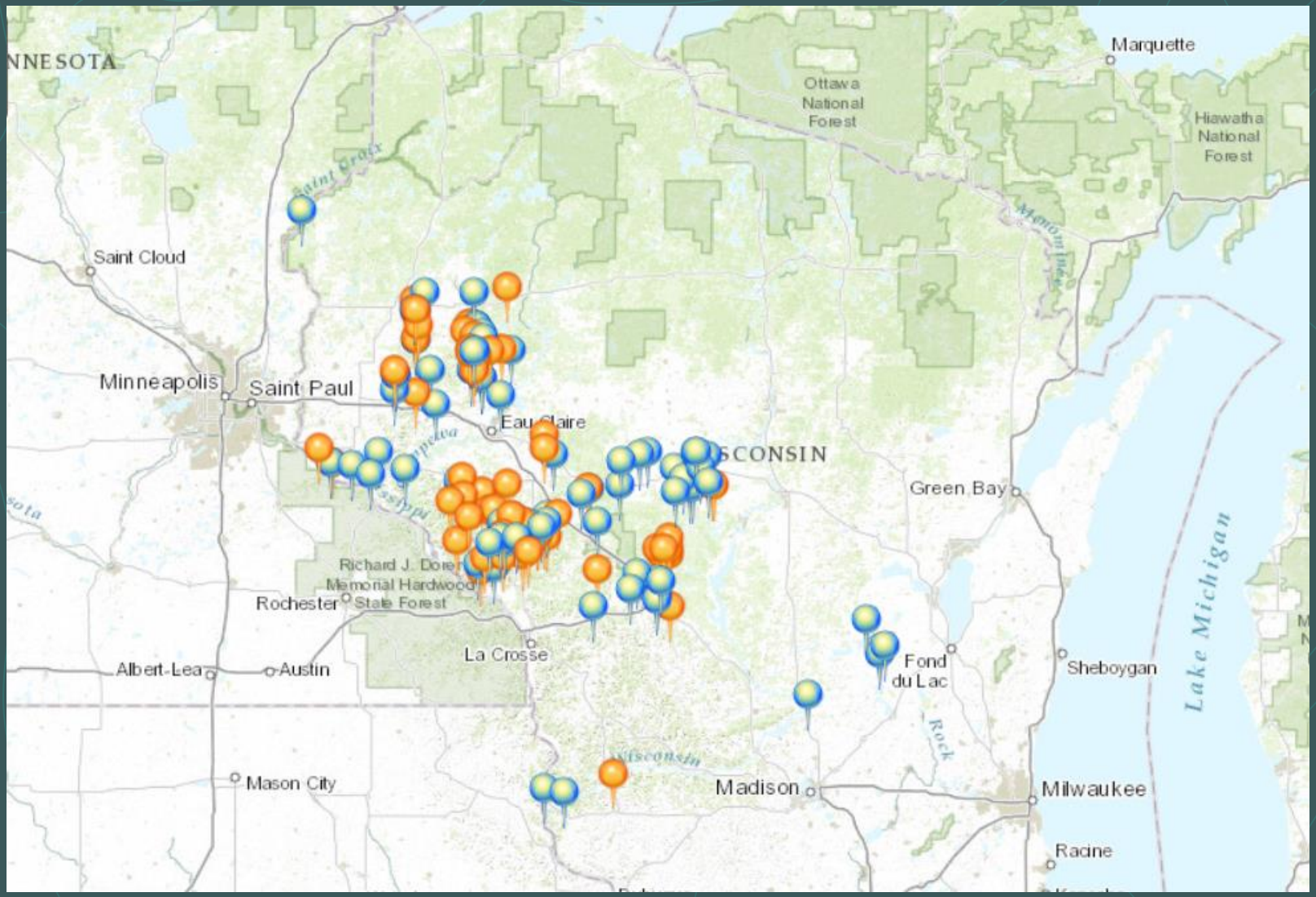
Fluid pressure fractures the rock, sand grains keep the fractures open

Best Frac Sand Locations (red)



Alluvial – Bedrock aka Cransand

Industrial Sand Mine Locations in Wisconsin



http://dnr.wi.gov/topic/Mines/ISMMap.html accessed 10/21/2014

Planning mining operations tailored toward the approved post mining land use to avoid 11th hour calamities

- NR 135.03 (14) land use specified in approved nonmetallic mining reclamation plan
  - removal or reuse of nonmetallic mining refuse
  - grading of the nonmetallic mining site
  - removal, storage and replacement of topsoil
  - stabilization of soil conditions
  - reestablishment of vegetative cover
  - control of surface water and groundwater
  - prevention of environmental pollution
  - restoration of plant, fish and wildlife habitat

Seamless integration of the four Rs – the right materials at the right time in the right amount in the right place ensure successful reclamation

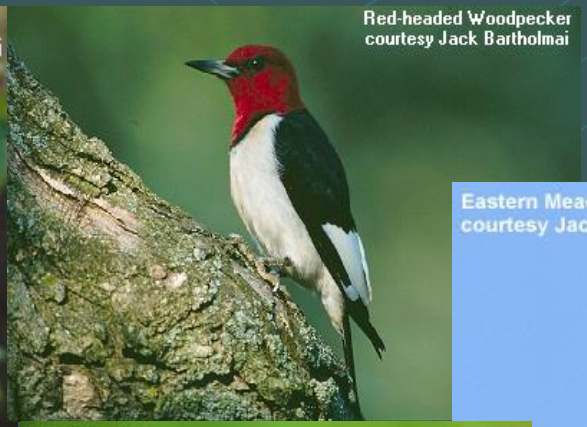
- AESTHETICS
- FISH & WILDLIFE HABITAT
- ACCELERATE SUCCESSIONAL TRAJECTORY
- CREATE RESILIENT SYSTEMS (biodiversity)
- SOIL HEALTH (building/rebuilding soil)
- PHYTOREMDIATION
- EROSION CONTROL
- **LEGAL REQUIREMENT**
- GEOMORPHIC FUNCTION & STABILITY (hydrology & materials)
- ECOSYSTEM SERVICES (O_2, pollinators, temperature modulation, water purification…)

Residential/Commercial

Wildlife Habitat

Upland Game Birds

Non-game Song Birds



Mudd/Chikowski BMC

Agriculture/Forestry

POOP & STOMP

Site analysis/resource inventory realizes reclamation possibilities; hydrology is a principal consideration

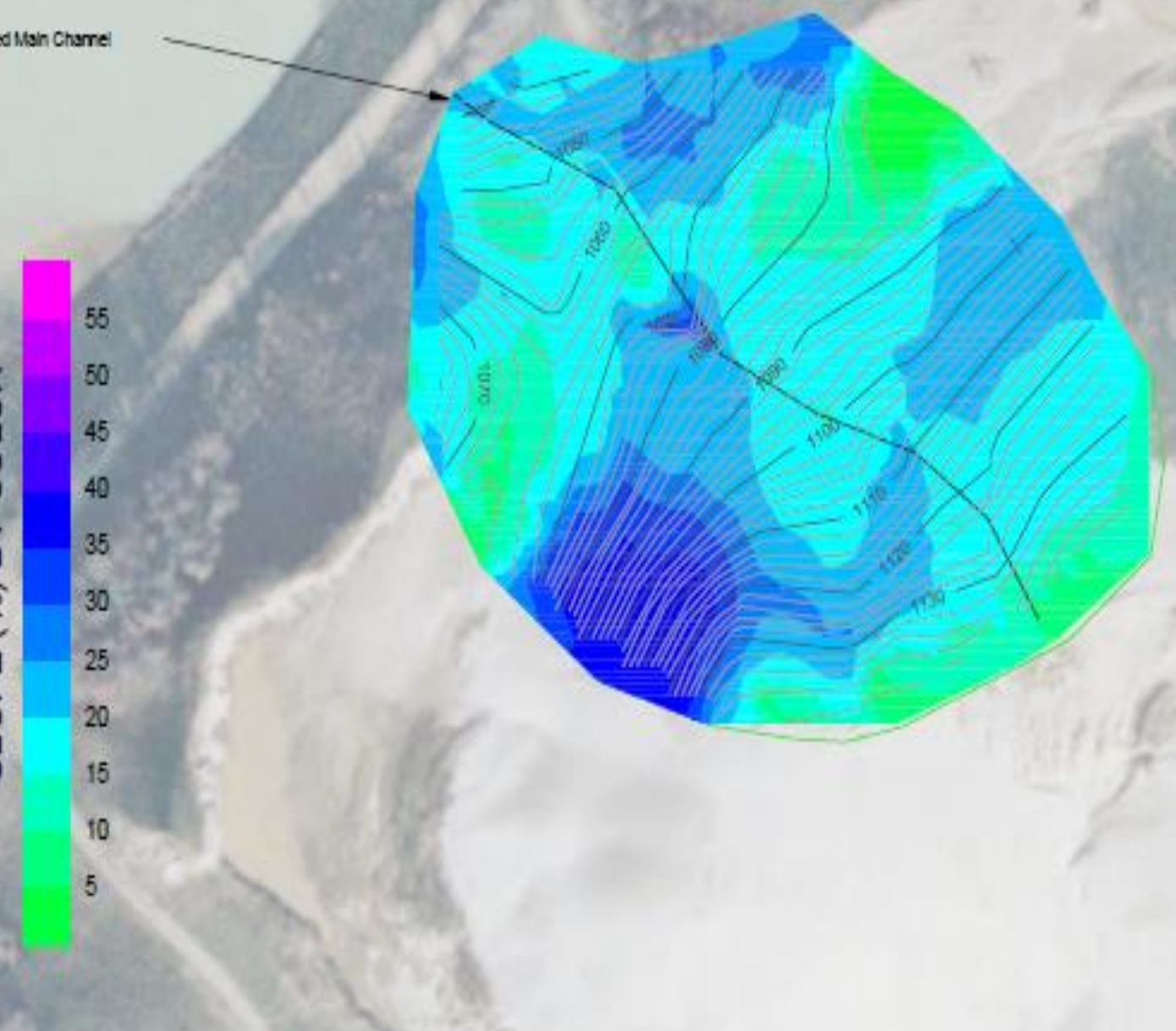
- Climate
  - Weather patterns, hardiness zones, microclimate
- Hydrology
  - Resilient reclamation = water, water, water
- Geomorphic Features
  - Topography, slope, aspect, relief, erosivity, shaping
- Soils
  - Characteristics, topsoil, subsoil, distribution, handling
- Made structures
  - Roads, highways, rail, ports
- Biota
  - T&E species
  - Habitat
- Extensional landscape compatibility

8” Resolution IR *Multi-Spectral* 8” Resolution RGB

High Quality Imagery is Necessity

Topographic Mapping and Volume Estimating

Slope and Topographic Position Index (TPI)



Slope Repad

Surface File: 100511 Duck Blind Reclaim
Number of 3DFaces analyzed: 1240

Zone	Range	Horizontal Surface Area S.F.	Acres	%%
1	5.00%	6,967.5	0.205	3.5
2	10.00%	23,525.0	0.540	9.2
3	15.00%	40,562.5	0.931	15.9
4	20.00%	64,587.5	1.483	25.4
5	25.00%	65,237.5	1.498	25.6
6	30.00%	26,112.5	0.599	10.3
7	35.00%	7,267.5	0.167	2.9
8	40.00%	17,750.0	0.407	7.0
9	45.00%	0.0	0.000	0.0
10		400.0	0.009	0.2
Total		254,450.0	5.841	

Average Slope: 19.4%
Minimum Slope: 0.4%
Maximum Slope: 48.2%

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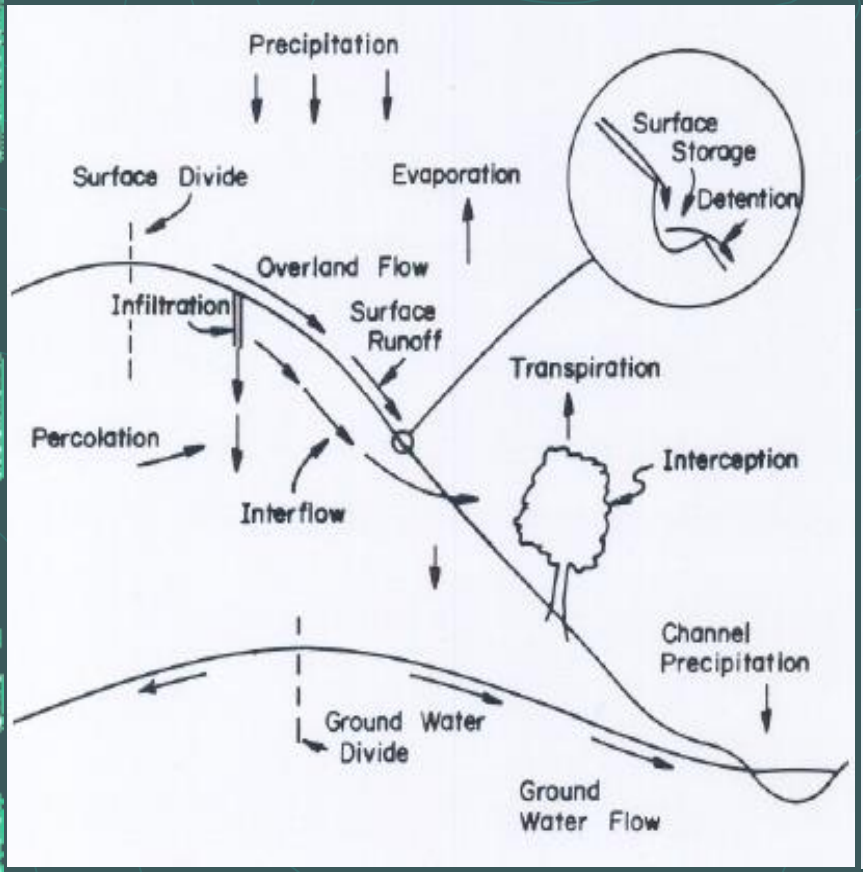
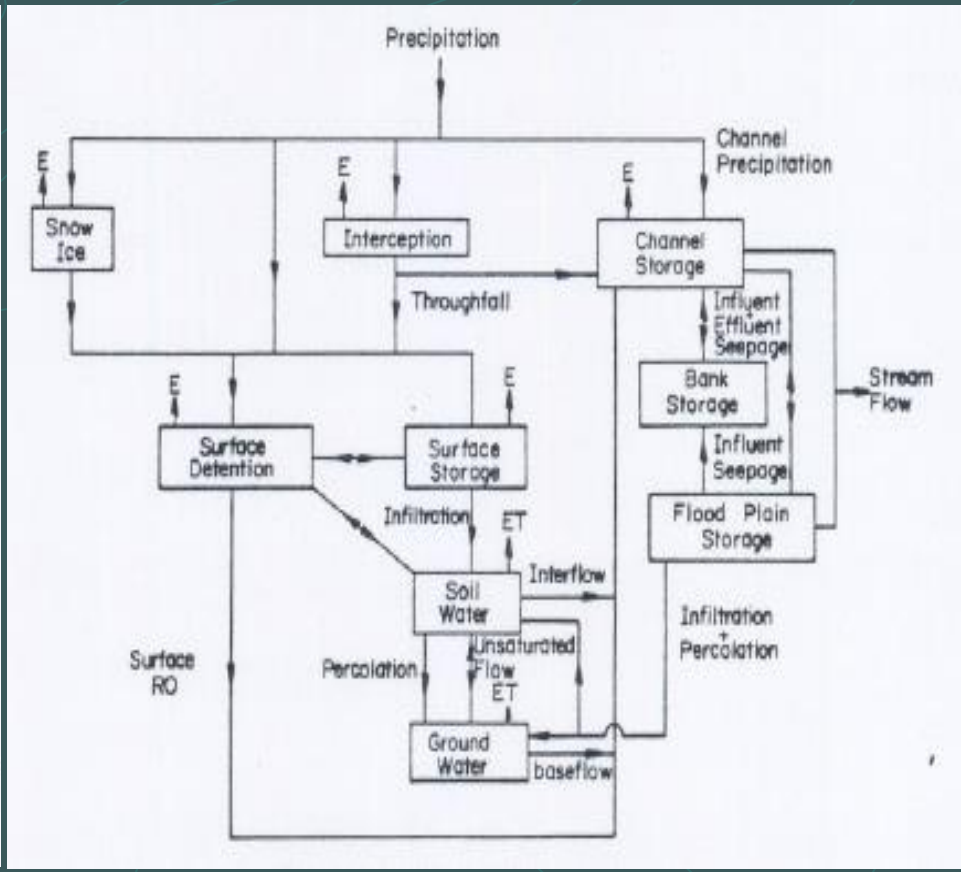
Hydrology: Watershed/Catchment

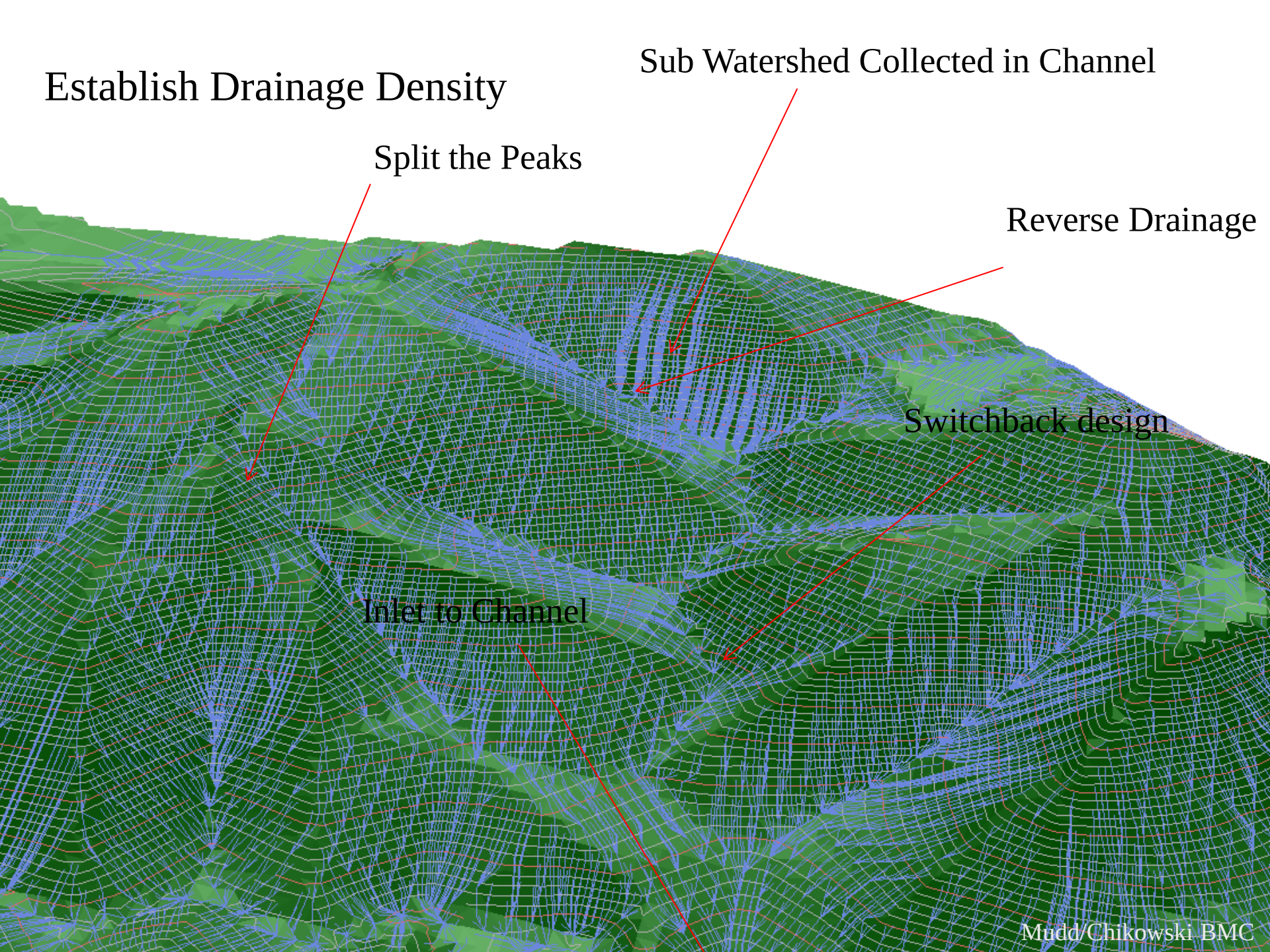
appropriate hydrologic unit of analysis



Portion of watershed showing process of rainfall, interception, evaporation, transpiration, infiltration, percolation, groundwater flow, overland flow, subsurface flow, surface storage, detention storage, and channel precipitation



Depicts series of storage and flow processes: boxes are storage, arrows are flow: illustrates terms and simple mathematical modeling


Establish Drainage Density
Sub Watershed Collected in Channel
Split the Peaks
Reverse Drainage
Switchback design
Inlet to Channel
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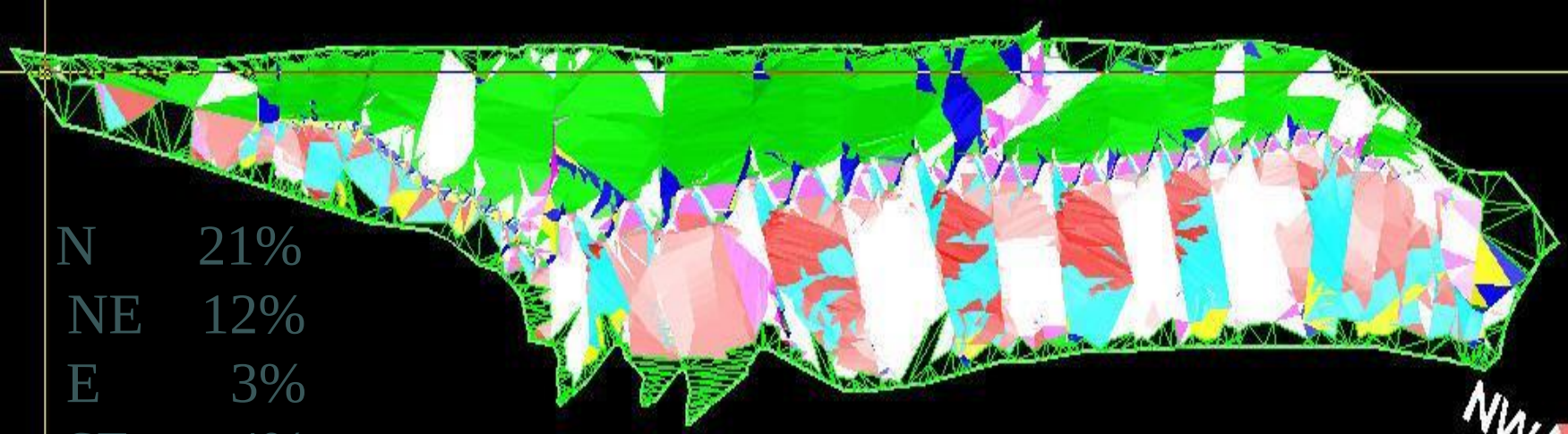
Mudd/Chikowski BMC



N	21%
NE	12%
E	3%
SE	4%
S	30%
SW	9%
W	5%
NW	16%

NATURAL LANDFORM
Creates Landscape Resilience

CONVENTIONAL LANDFORM

N	5%
NE	4%
E	5%
SE	0%
S	24%
SW	9%

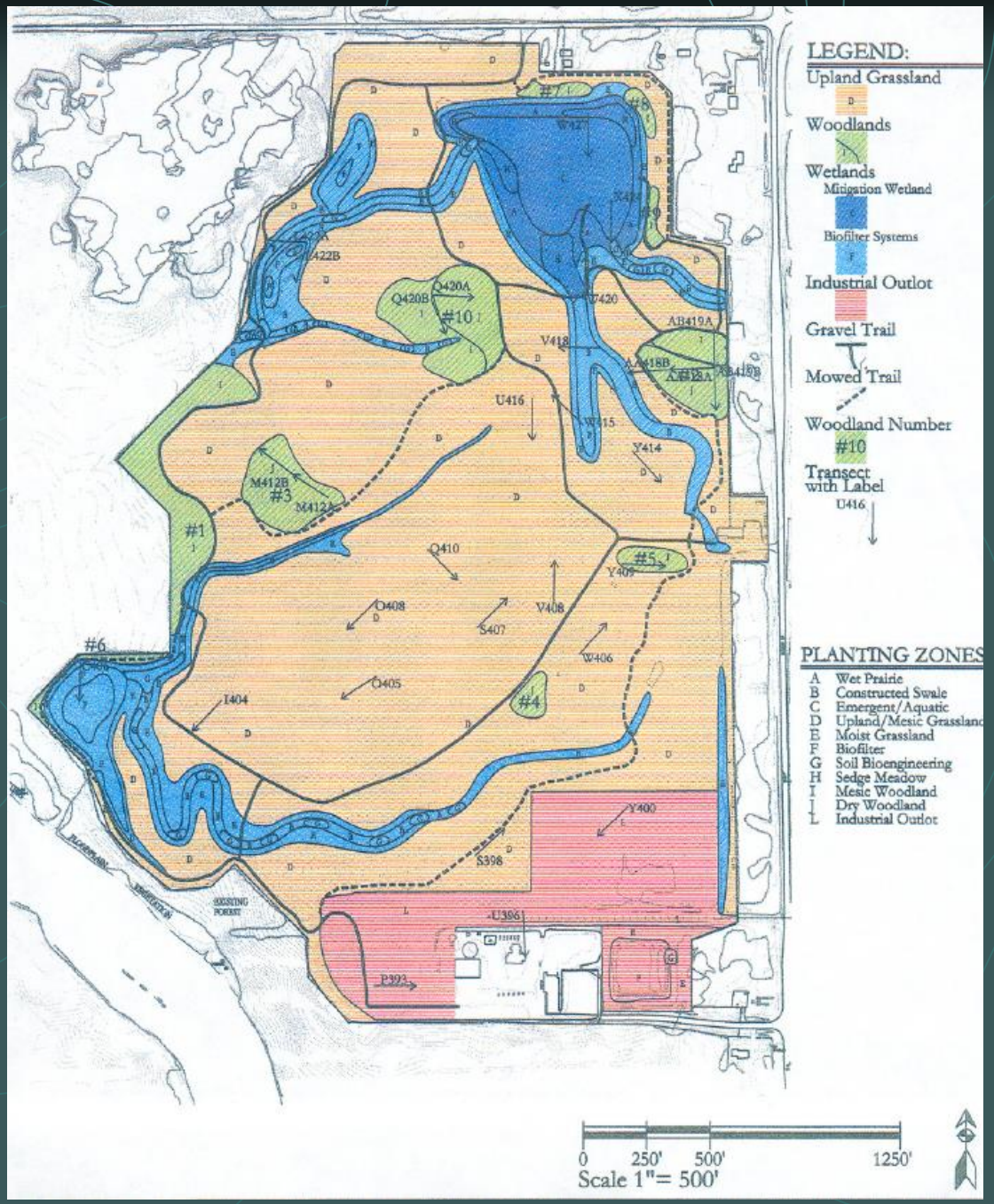
LAND ASPECT: DIVERSE vs MONOTYPIC

Geomorphic Drainage Swale

Zone Planting Technique

Biota – Resilient Habitat Design

- Establish baseline information
- Develop bio-criteria for assessment of ecosystem health
- Establishing habitat goals and objectives aimed at reclaiming an ecosystem
- Determining if current and future reclamation efforts are promoting a "more natural" or "unnatural" assemblage of plant and animal communities



Soil Density
Nuclear Density Probe

Soil Prep
Vibratory Ripper

Mulch Stockpile, Research Plots & Tree Nursery

Hydric Soil Storage

Experimental Wetland

Revegetation Techniques

Drilling & Mulching

Revegetation Techniques

Tree Spade & Whips/Tree Guards

Revegetation Techniques

Plugging Hydric Species

Reclamation Monitoring:

long-term quality control

Assessing Revegetation Success

NR 135.13 (4) determined by:

(a) Comparison to reference area
(b) Comparison to baseline data
(c) Comparison to a technical standard.

(5) Revegetation using a variety of plants indigenous to the area is favored.

Restored Wetland Biofilter

NR 135.13 Assessing success

(3) post mining land use specifies return of the mining site to a pre−mining condition, the operator shall obtain baseline data on the existing plant community for use in the evaluation of reclamation success

Habitat Restoration

NR 135.06 (4)**. When the land use** requires plant, fish or wildlife habitat, it shall be restored

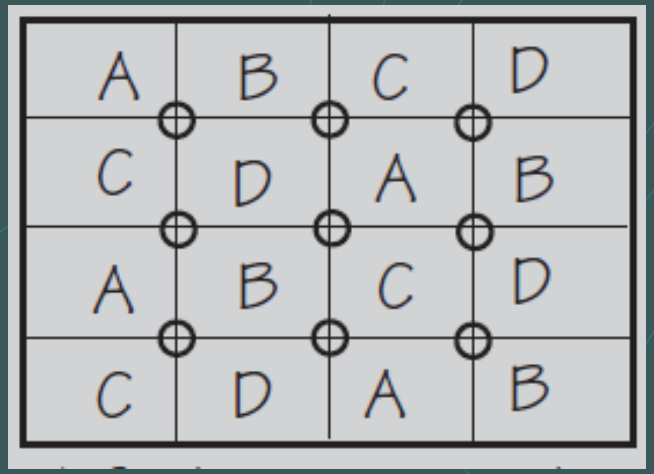
Goals describe the habitat

Objectives describe the parameters and life cycle of target species

Design criteria describe look and feel of the habitat

Criteria for Ruffed Grouse Habitat

- Expand aspen stands.
- Target three age classes: <5 yrs for brood; 6-25 yrs for nesting, cover, and wintering adults; and >25 yrs for winter food and brood cover.
- Develop dense vertical thickets of hazelnut, sumac, black berries, and young oaks.
- Consider conifers for winter cover.
- Intersperse stands.



UWEX G3578

Landscape Context & Compatibility

Auburn Mine Chippewa County Wisconsin

Dr. Holly Dolliver UWRF w permission Superior Silica Sands

Mining: A Transitional Land Use