

SALT MIGRATION

Bruce A. Buchanan, Ph.D

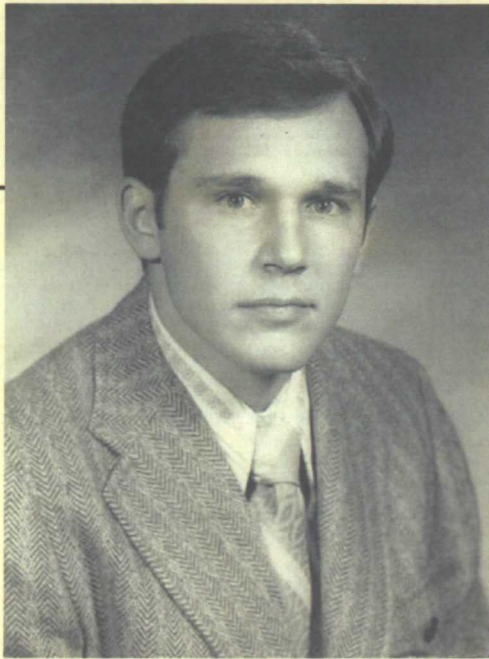
Buchanan Consultants, Ltd.

Oil Conservation Commission

May 2012



BEFORE THE OIL CONSERVATION COMMISSION
CASE NO. 14784 NMOGA EXHIBIT 17-1
HEARING DATE: MAY 14, 2012



1971



2011

Ph.D., Montana State University, 1971

Professor, NMSU, 1971 – 1991

President, Buchanan Consultants, 1991 – Present

President, American Society of Mining and Reclamation, 2012 – 2013

Certified Professional Soil Scientist

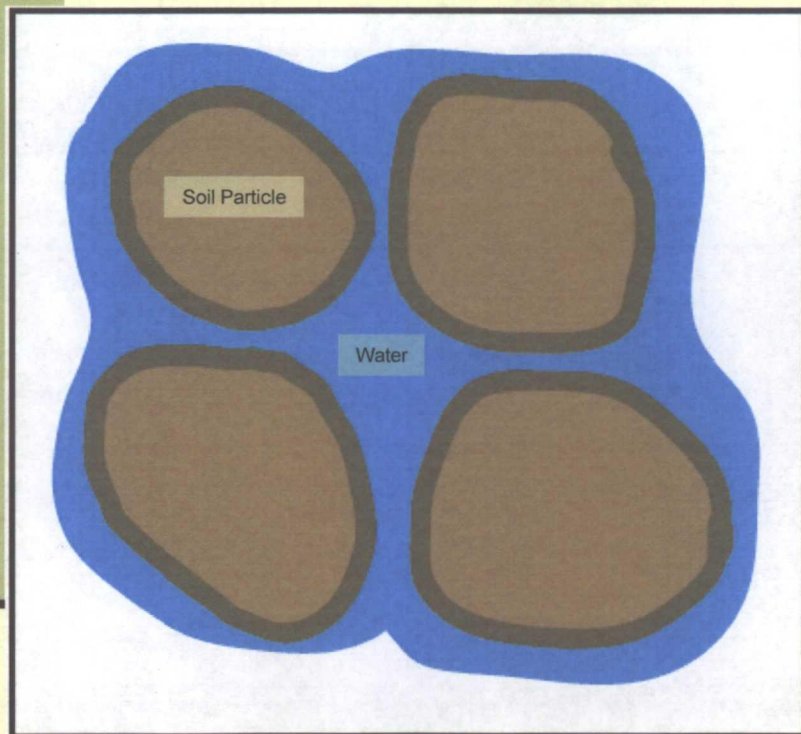
OBJECTIVE

To demonstrate that salts do not migrate to or accumulate at the soil surface when drilling pits are properly closed and reclaimed.

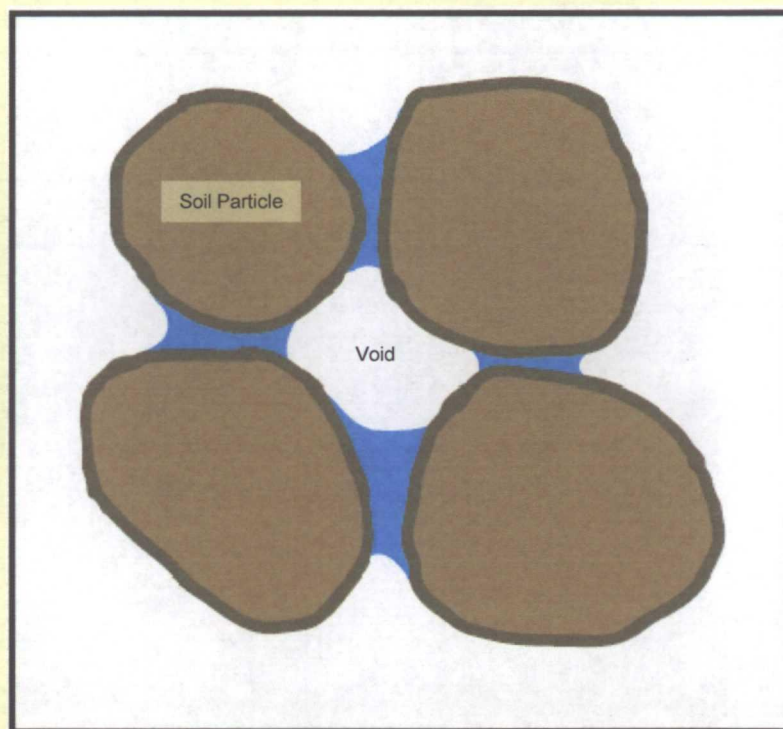
Statement

Research and practical experience from the fields of soil chemistry, soil physics and reclamation will be used to support the position that upward salt migration to the surface of closed drilling pits does not occur when the site is properly reclaimed.

Soil Water

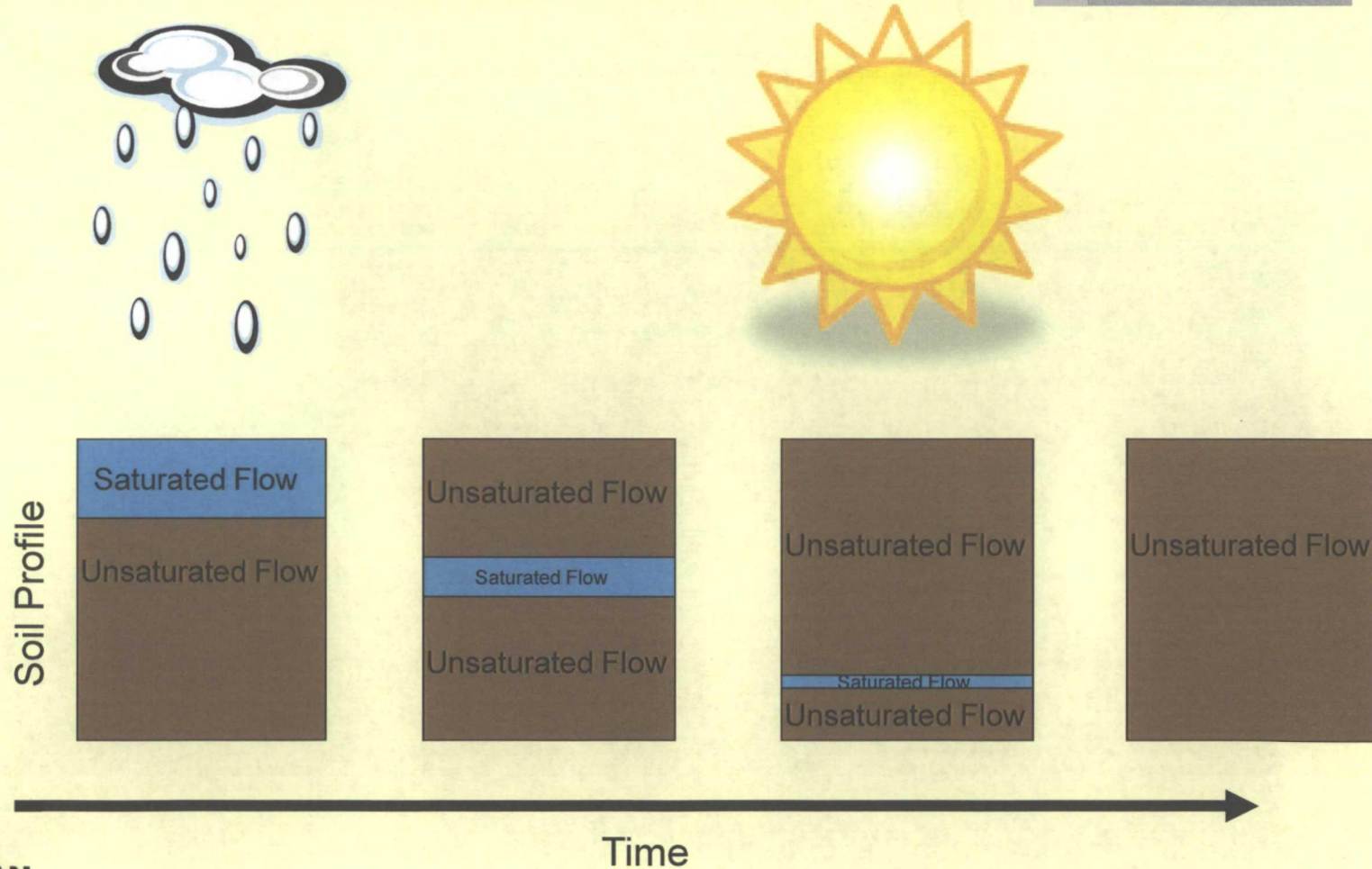


Saturated Flow

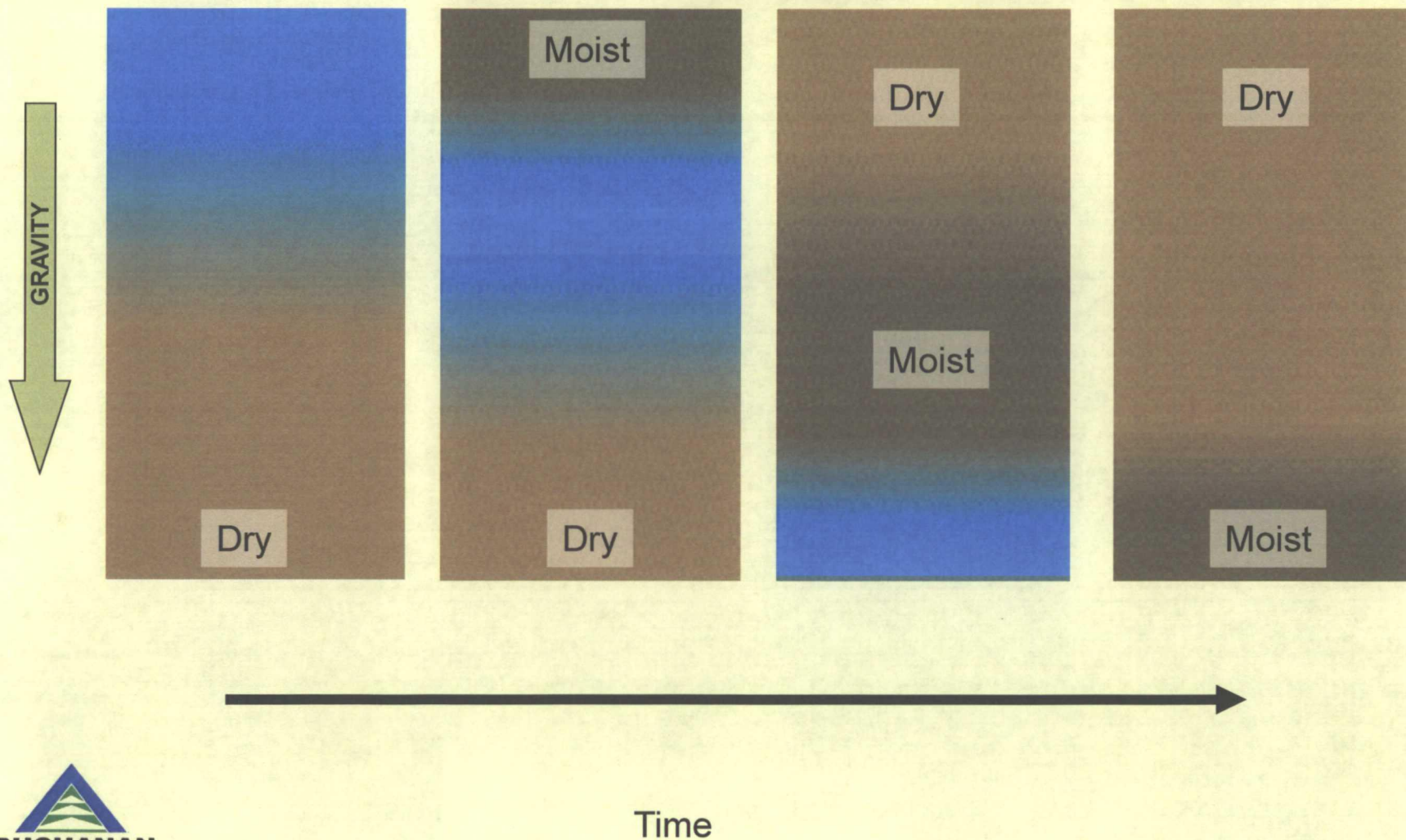


Unsaturated Flow

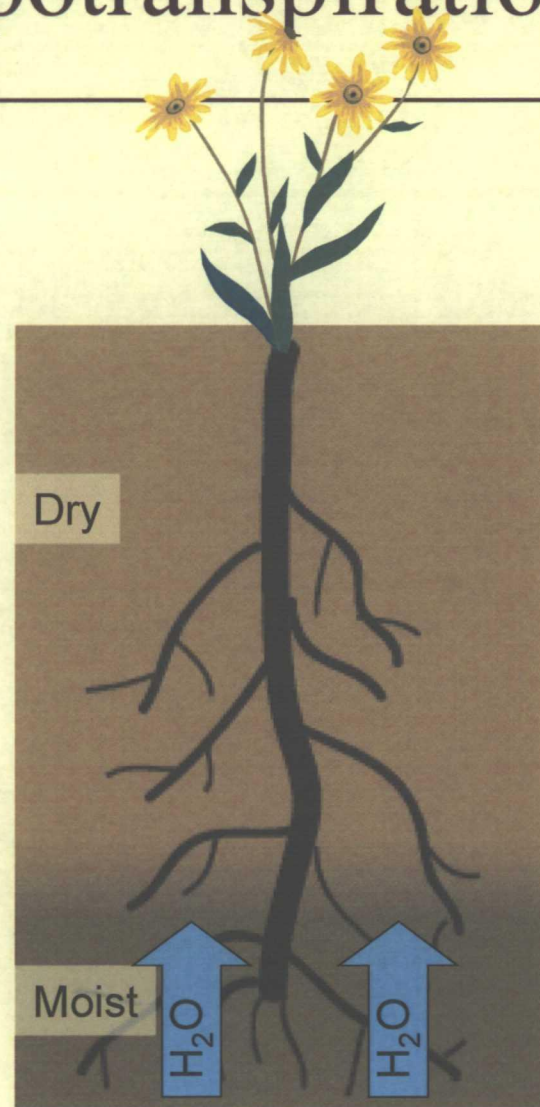
Water Flow



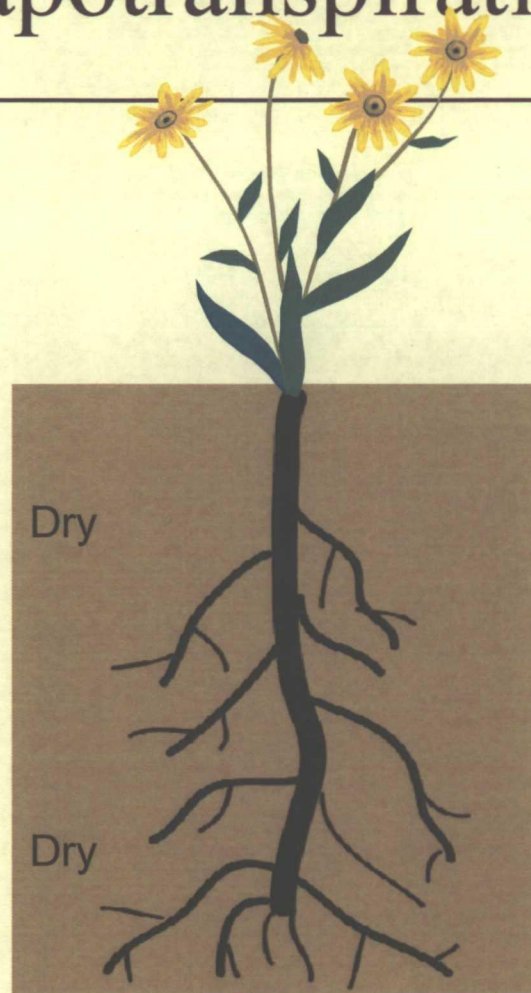
Soil Water Movement



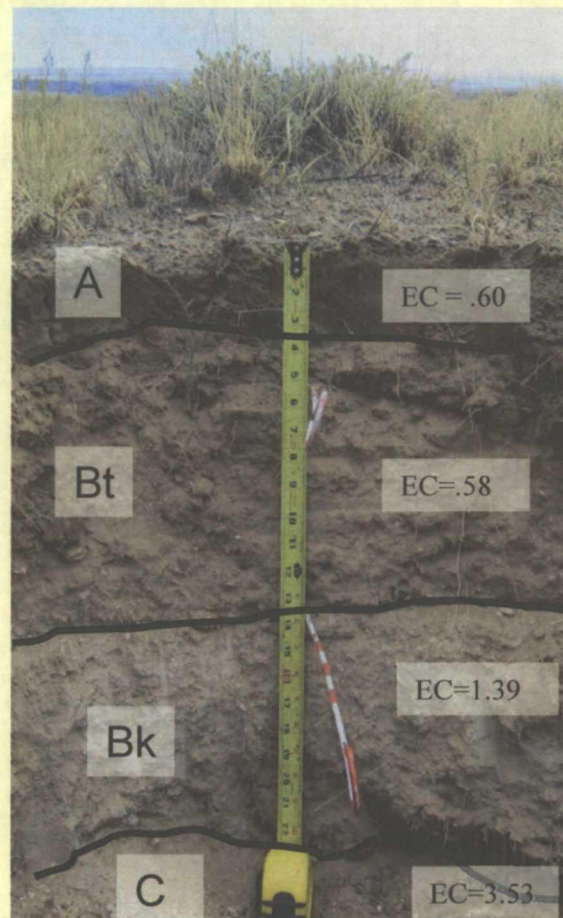
Plant Evapotranspiration



Plant Evapotranspiration



Semi-Arid Native Soil



Reclaimed Mine Spoils Stutz & Buchanan 1987

- ☐ New Mexico
- ☐ 12 years post-reclamation
- ☐ Spoil study
- ☐ No cover soil
- ☐ Salts migrated downward 10 to 30 inches

Reclaimed Mine Spoils

Buchanan 1998

- ☐ New Mexico
- ☐ 4 years post-reclamation
- ☐ 24 inches of cover soil over spoil
- ☐ No surface salts
- ☐ Salts migrated \leq 4 inches upward from spoil

Reclaimed Drilling Pits

McFarland et al. 1992

- Texas
- 20 months post-reclamation
- 36 inches of cover soil
- No surface salts
- 6 and 12 inches of upward salt migration from pit contents

Mertz Drilling Pit Study Site

	EC (mmhos/cm)	Na (mmols/L)	Cl (mmols/L)	
36"	0.6	0.9	1.1	Soil Surface Cover Soil
30"	0.5	1.1	1.0	
24"	0.5	1.3	1.0	
12"	0.4	1.4	1.1	
6"	1.8	7.5	14.4	
0"				
12"	169	1913	2085	Drilling Pit Contents

1 Month

	EC (mmhos/cm)	Na (mmols/L)	Cl (mmols/L)
	0.5	0.7	1.6
	0.5	0.8	1.7
	0.4	1.1	0.9
	0.5	1.4	1.6
	8.1	44.3	81

20 Months

Weatherby Drilling Pit Study Site

	EC (mmhos/cm)	Na (mmols/L)	Cl (mmols/L)	
36"	0.8	1.4	1.1	Soil Surface C o v e r S o i l
30"	0.6	1.3	1.6	
24"				
12"	0.5	1.5	1.1	
6"	0.5	1.1	1.4	
0"	2.2	14.6	8.1	
12"	180	1609	2011	Drilling Pit Contents

1 Month

	EC (mmhos/cm)	Na (mmols/L)	Cl (mmols/L)
	0.5	0.4	0.8
	0.4	0.7	0.7
	0.7	2.3	0.8
	5.2	13.7	36.0
	19.5	166.9	202.9

20 Months

Conoco/Phillips Study

Buchanan et al. 2007

- ❑ New Mexico
- ❑ 40 years post-reclamation
- ❑ No pit liner
- ❑ 20 inches of cover soil over pit contents

Conoco/Phillips Study

Buchanan et al. 2007



DC Federal #3

Reclaimed circa 1967

Conoco/Phillips Study

Buchanan et al. 2007

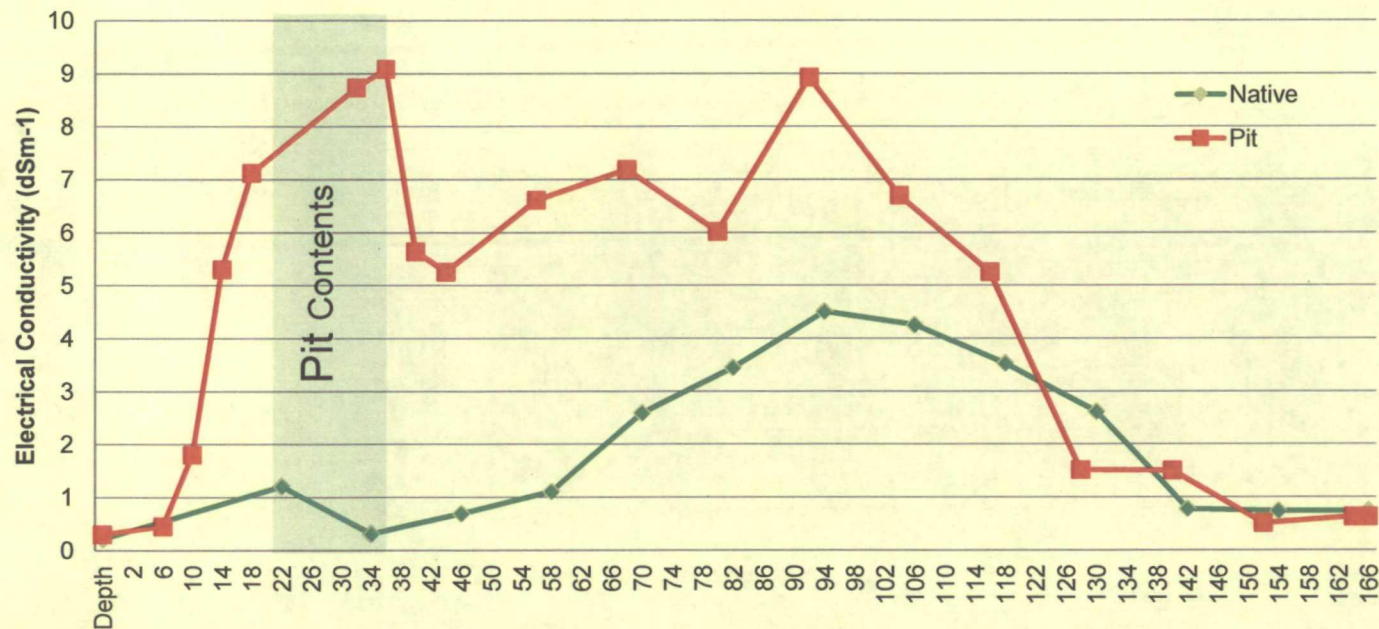


DC Federal #3



Conoco/Phillips Study

Buchanan et al. 2007



Conoco/Phillips Study

Buchanan et al. 2007

- ☐ New Mexico
- ☐ 25 years post-reclamation
- ☐ No pit liner
- ☐ 20 inches of cover soil over pit contents
- ☐ No surface salts
- ☐ Salts migrated upward \approx 12 inches from pit contents
- ☐ Salts migrated downward \approx 7 feet from pit contents

Summary: Salt Migration

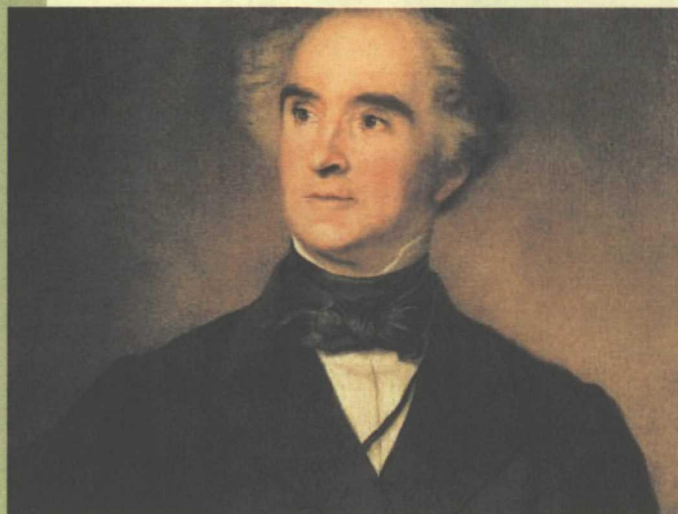
- ☐ Salts migrate upward into cover soils.
 - ☐ Salts do not migrate to the soil surface.
 - ☐ Salts migrate downward below pit contents.
-
- ☐ Current Rule 17 requires 48 inches of cover soil.
 - ☐ Cover depth of 48 inches is sufficient for successful reclamation and salt management.



Reclamation

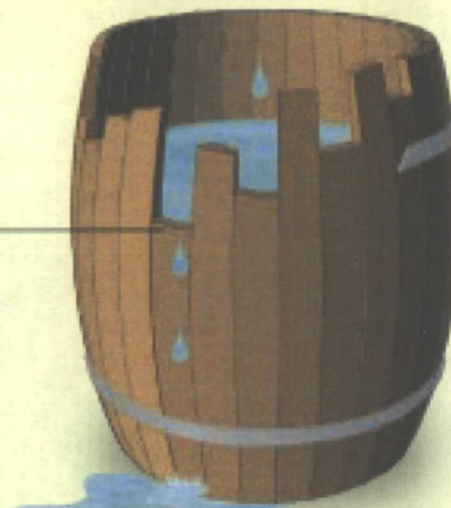
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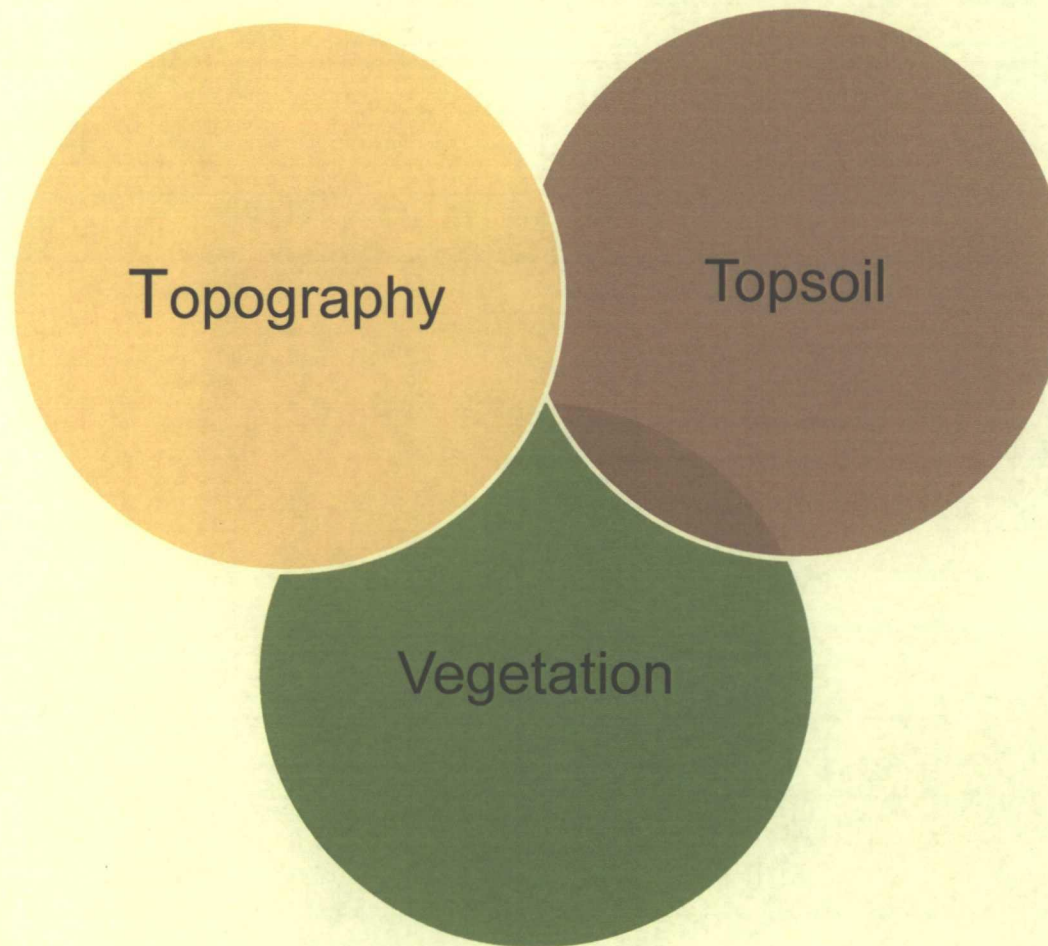
Liebig Law of Minimum



1803-1873

Minimum







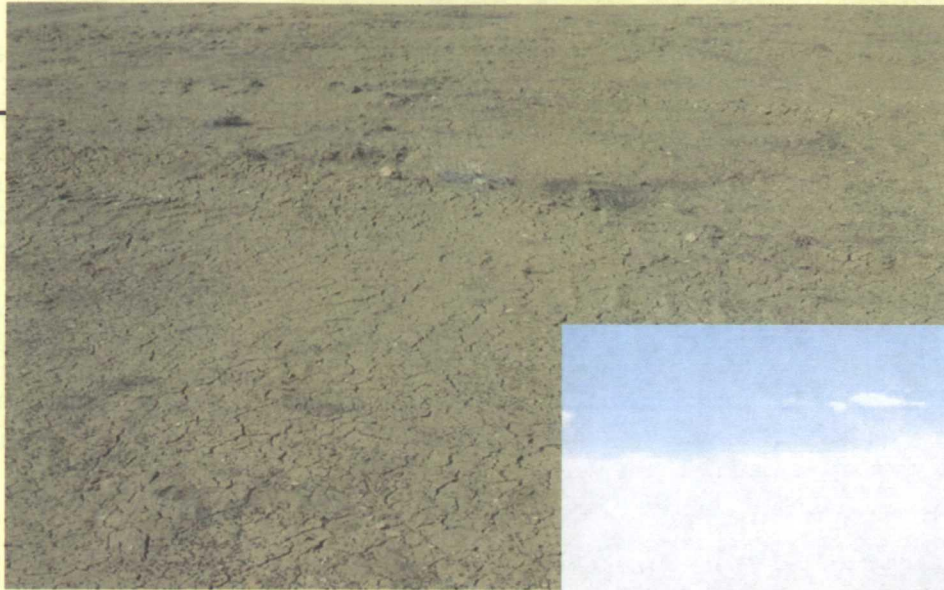
A Venn diagram consisting of three overlapping circles. The top-left circle is orange and labeled 'Topography'. The top-right circle is brown and labeled 'Topsoil'. The bottom circle is dark green and labeled 'Vegetation'. The circles overlap in the center, creating a common intersection for all three. The background is a light yellowish-green. There are decorative elements: a vertical olive-green bar on the left, a horizontal black line across the top, and a horizontal grey bar on the right.

Topography

Topsoil

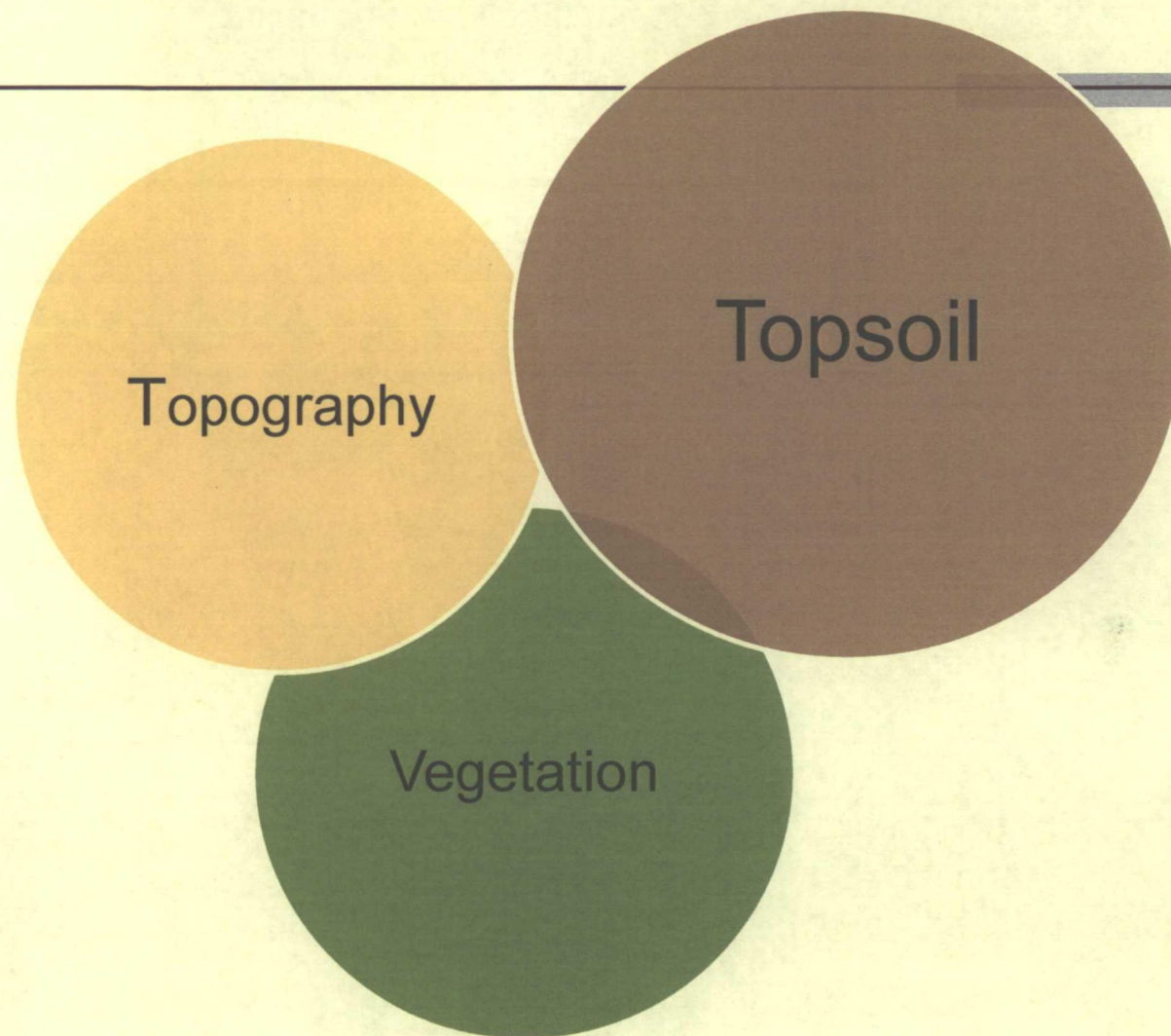
Vegetation

Stable Topography





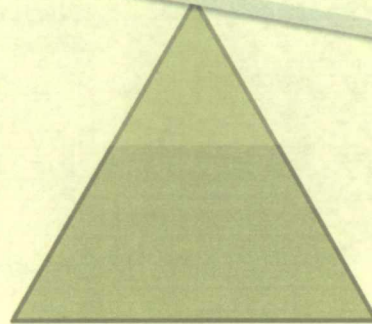
Erosion



Topsoil Standards

Agriculture

Reclamation



Topsoil Standards



Low Sodicity

Low Salinity

Low Gravel

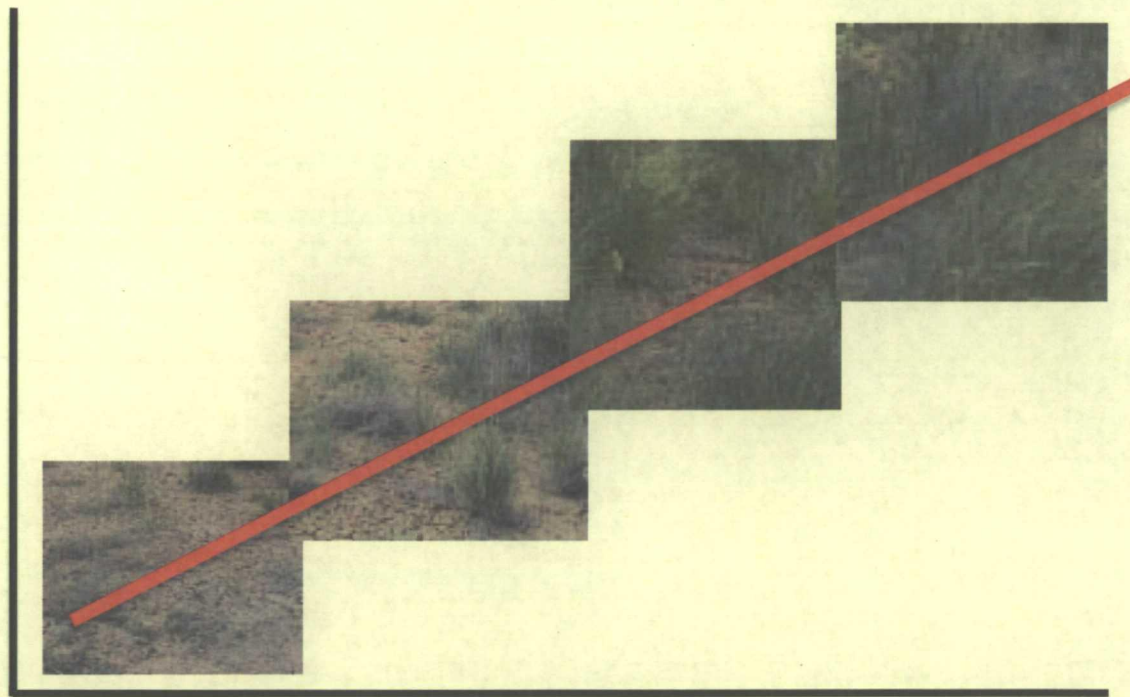
High Sodicity

High Salinity

High Gravel

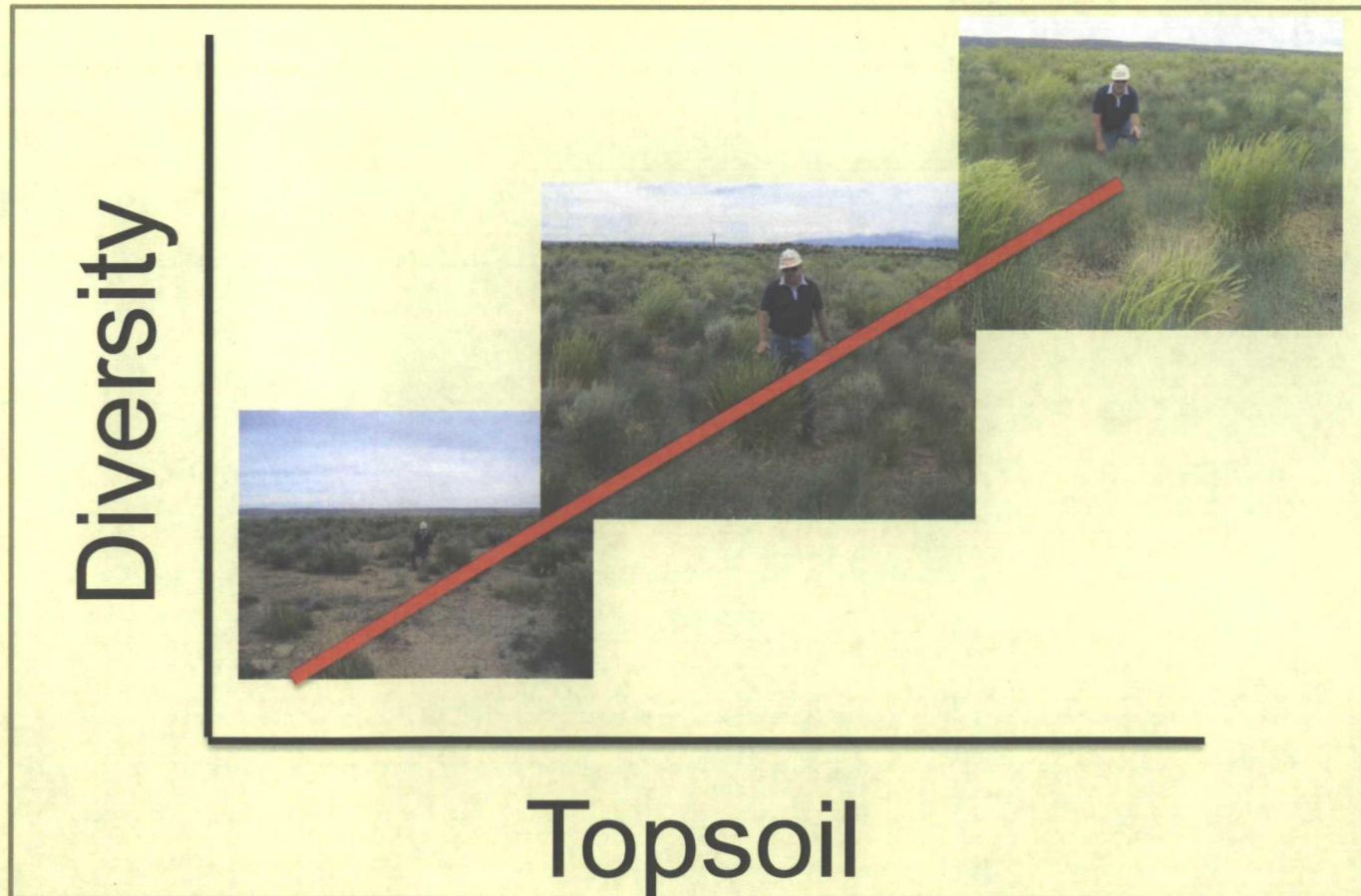
Topsoil Depth

Cover



Depth

Topsoil Depth



Compaction



BEFORE THE OIL CONSERVATION COMMISSION
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Chisel



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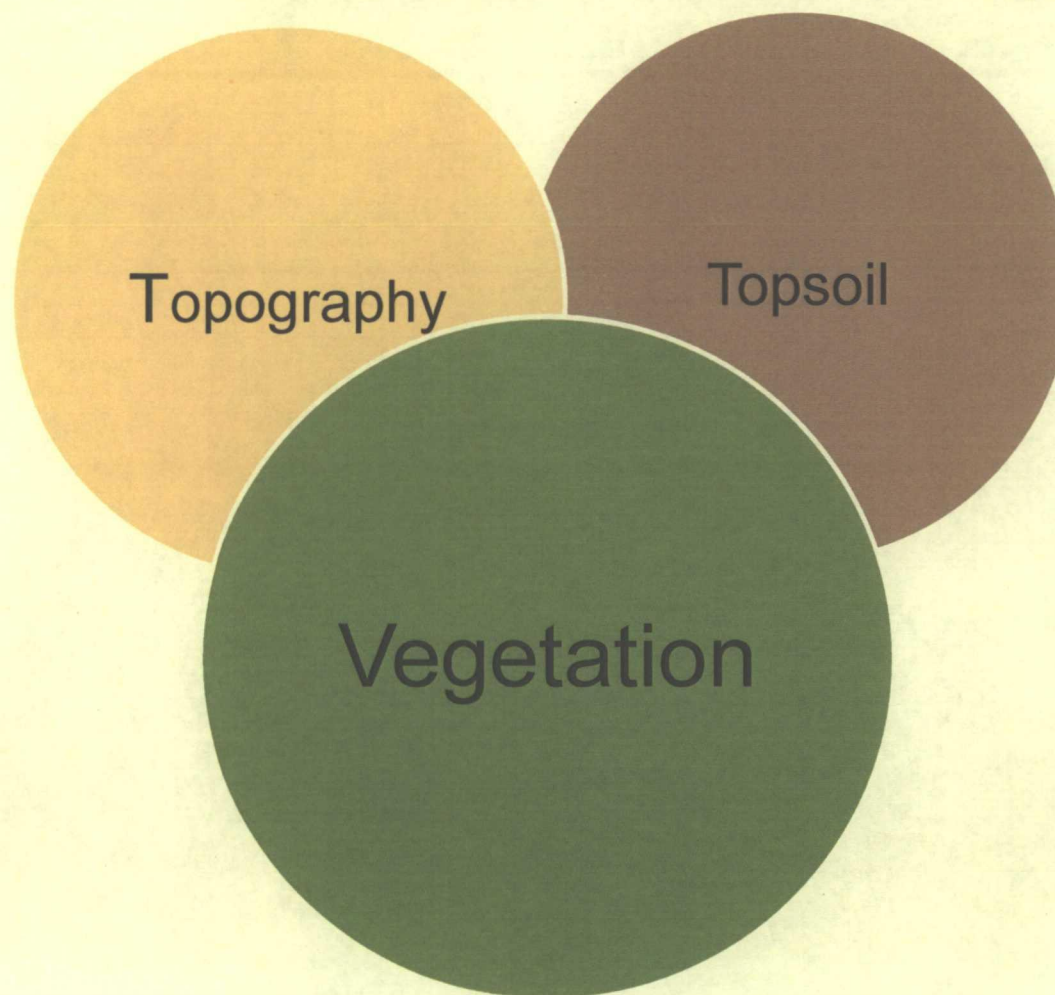
Seed Bed Preparation



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Fertilizer



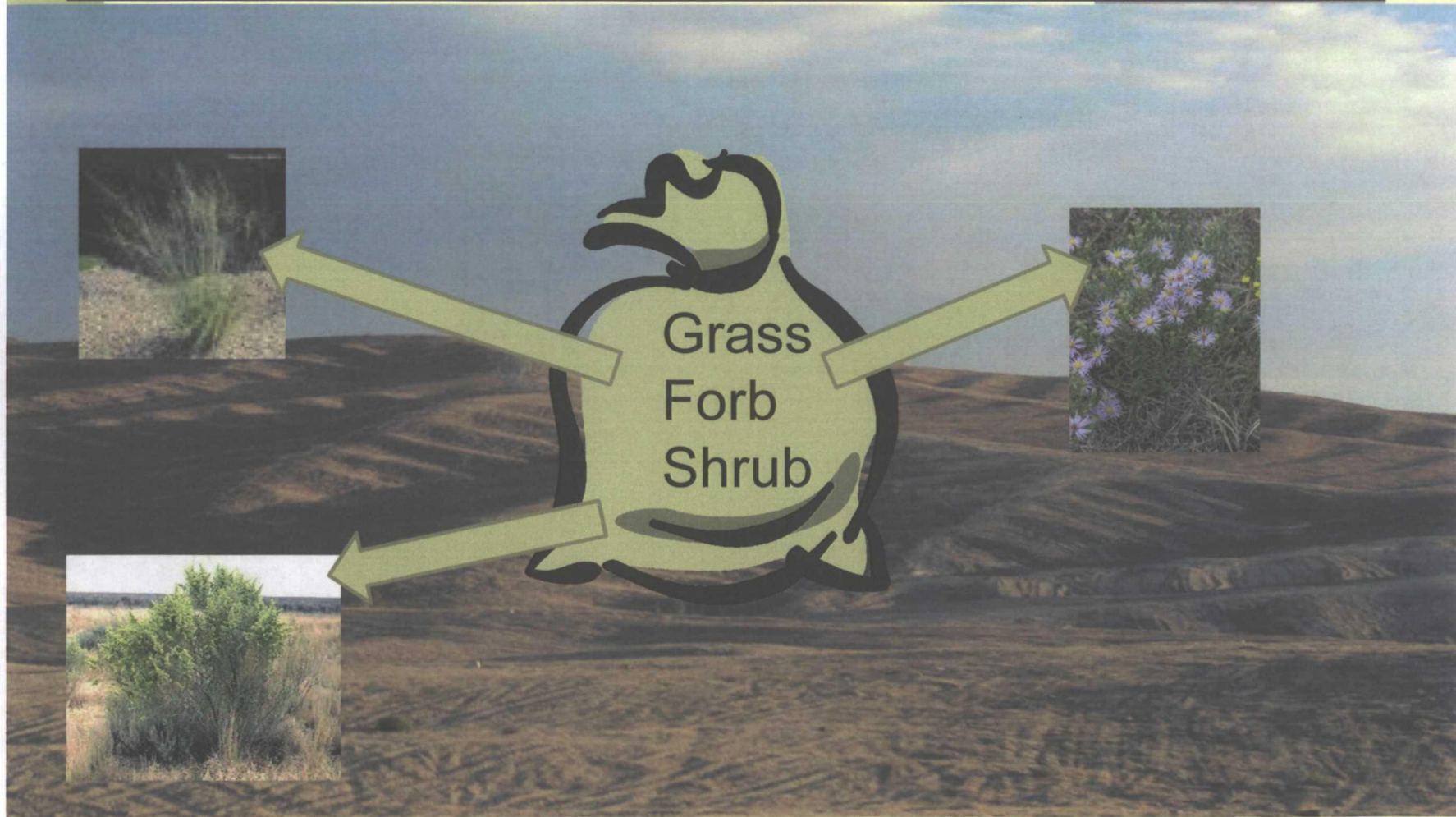


Seed Rate



PLS/sq ft

Seed Mix

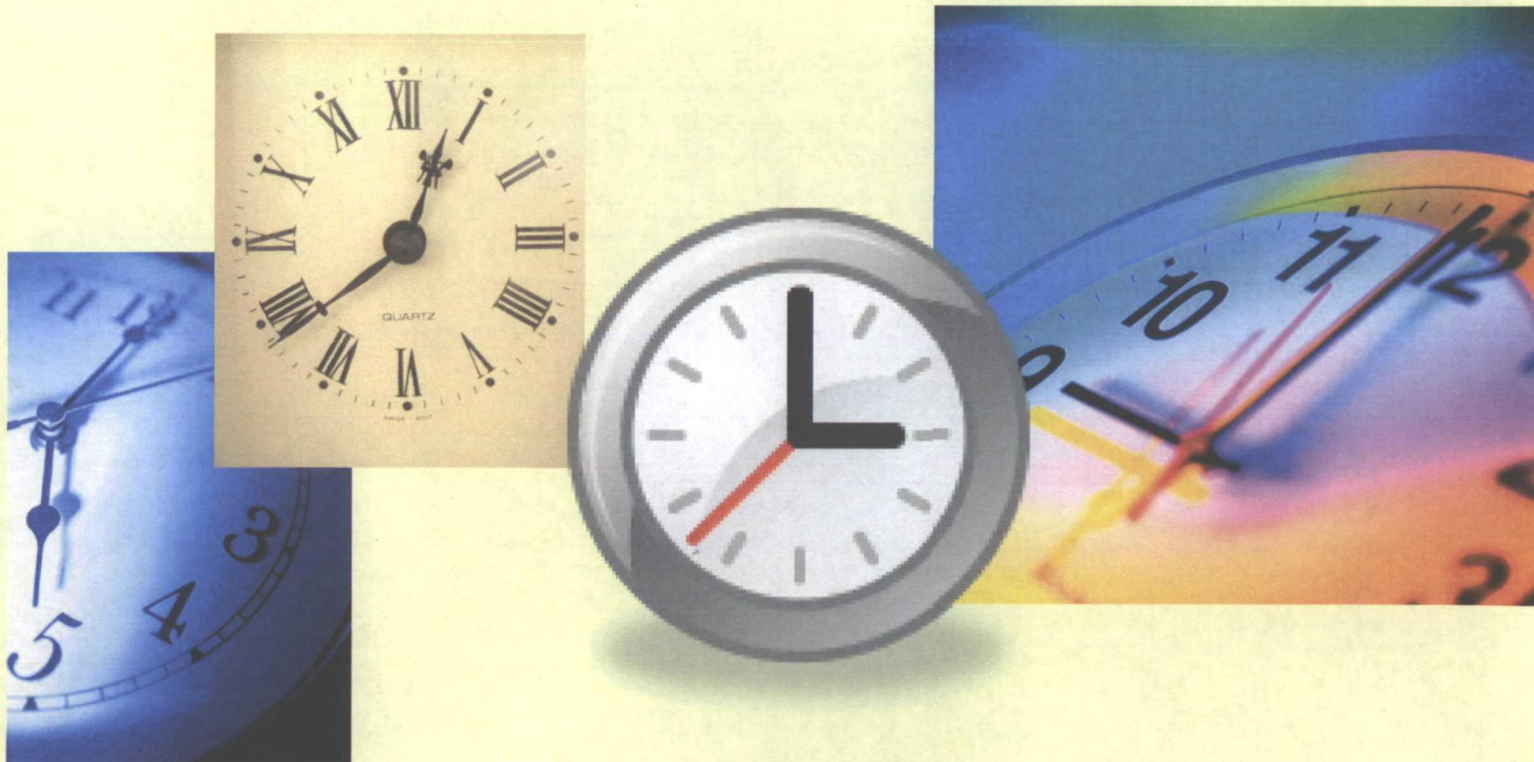


Seed Mix / Topography

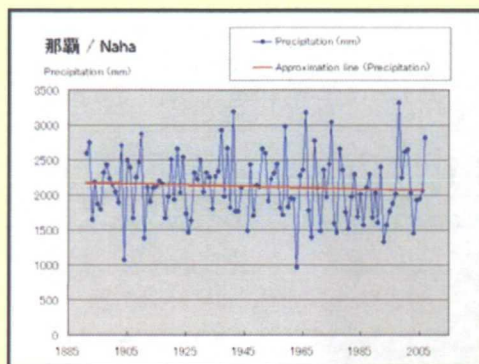


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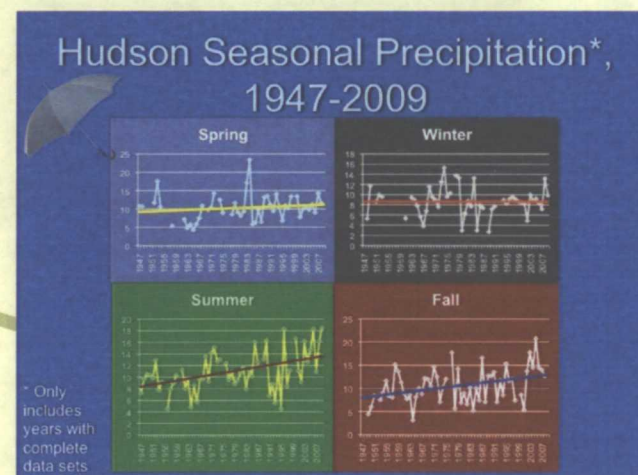
Seed Timing



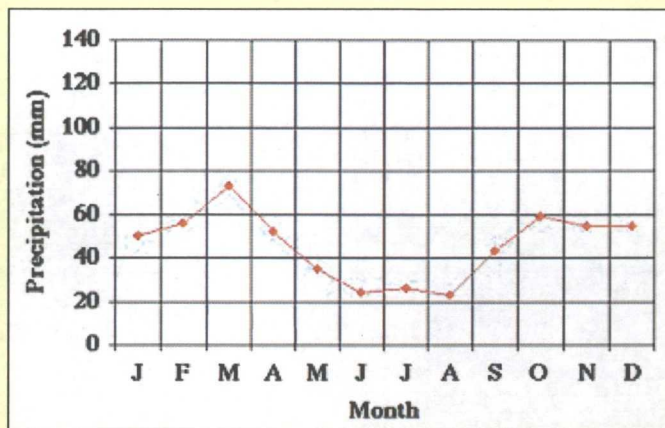
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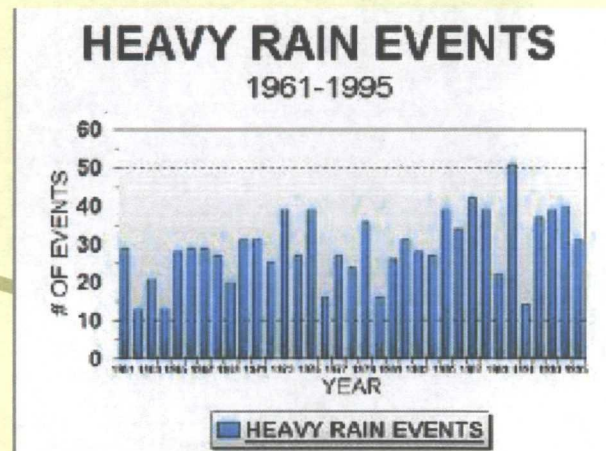
Annual



Seasonal



Amount



Event

Lifeform diversity



Sand dropseed



Alkali sacaton

Reclamation Summary

- ❑ Critical elements for success:
 - ❑ Stable topography (control erosion)
 - ❑ Cover depth \approx 3 feet and Topsoil depth \approx 1 foot
 - ❑ Compaction management (final reclamation)
 - ❑ Seed Mix (diversity)
 - ❑ Favorable growing season