REVEGETATION OF A PETROLEUM CONTAMINATED SITE ON NEW MEXICO STATE TRUST LAND IN THE PERMIAN BASIN[1]

by

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Abstract: The New Mexico State Land Office is one of the largest surface and mineral owners in the Permian Basin of southeast New Mexico. The Permian Basin has been explored and developed for crude oil since the late 1920's. Sites on State Land surface have been contaminated with crude oil and produced brine water. The soils are typically very shallow loams and sands, very low in organic matter, high pH and underlain by indurated caliche (limestone). The State Land Office is developing a revegetation program to return these surface contaminated sites back into production for grazing livestock and wildlife habitat. Due to the arid climate where yearly rainfall comes in the form of brief and heavy thunderstorms during the summer months, revegetation is difficult. The Land Office is attempting to devise a revegetation guideline that is practical for the operator and successful given the climate and soil conditions. A recent project conducted after a spill on State Trust lands indicates that the addition of organic matter may be the minimum soil amendment that will make a difference with the revegetation attempts. We hope to develop demonstration projects on disturbed lands in southeast New Mexico to further test this finding.

Additional Key Words: restoring grasslands, revegetation criteria, seed selection, Blue grama (*Bouteloua gracilis*), Plains bristlegrass (*Setaria leucopila*), Sideoats grama (*Bouteloua curtipendula*), Four-wing saltbush (*Atriplex canescens*).

Introduction

The Permian Basin, also called the West Texas Basin, is a large sedimentary basin in western Texas and southeastern New Mexico that is noted for its rich petroleum and natural gas deposits. It originated as a shallow, tropical marine sea bordered by extensive deltas during the Permian and Triassic periods when North America lay at equatorial latitudes. Due to a great subsidence during the Permian, coupled with the isolation from major oceans, the area evolved with high concentrations of salts. The shallow marine depression made the basin ideal for diverse fauna and flora resulting in the development of petroleum products collecting in the porous limestone formations. Today, the Permian Basin is still characterized as a slight depression with surfaces of predominately shallow gravelly loams to deep sand aridisols underlain by indurated limestone. Soil permeability is moderate to fast, but the soil water capacity is low, averaging between .05 to .14 inch/inch of soil, partly due to the inherently low organic content of less than 1 percent. The soil reaction is 7.4 to 8.4 pH where gypsiferous subsoils are encountered. These soils do give rise to fertile, short to midgrass prairies; however, once disturbed, the revegetation efforts are costly and often unproductive requiring lengthy establishment periods. Southeast New Mexico average total rainfall is 11 to 13 inches per year with an evaporation rate of 105 to 110 inches. The highest rainfall months are July, August and September where average rainfall accumulations per month are 2.31 inches. This rainfall period is referred to as the monsoon season and the rainfall is usually in the form of hard and fast thunderstorms that sweep across the area from the southwest. It is important to note that the average number of days, during the monsoon, that receive .10 inches or more of rain is less than 5. The average number of days that receive .25 inches or more, during this period, is less than 3. Although soil temperatures are adequate for seed germination during spring and early summer, the average rainfall is less than 1.50

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inches per month, for April, May and June (John Hills, 1984).

State Trust lands in the Permian Basin are often leased for oil and gas development. When spills and leaks occur, the oil and gas operator has a responsibility to restore the damaged property to a condition consistent with the undisturbed and adjacent lands. The operator is not required to reseed the affected land until an evaluation after the second growing season. Currently, the Land Office does not have revegetation criteria.

A basic problem with restoring grasslands in this region due to the harsh conditions is to develop a minimum revegetation treatment for the oil and gas operator to use at a reasonable cost per acre. On-going meetings are scheduled with an operator group involving Texaco, Conoco, Chevron and independent operators to develop a revegetation agreement and demonstrate cost-effective approaches. A recent effort conducted by one oil and gas operator may serve as a demonstration for effective revegetation practices.

Method

Our case study involved a small crude oil spill from an old tank battery in Lea County, New Mexico. The tank battery was removed and the area was land-farmed to enhance bioremediation of the hydrocarbons. Approximately 5 acres was disturbed in the process. The area is mapped as Pyote loamy fine sand soil series and a deep sand rangesite (United States Department of Agriculture, Soil Conservation Service 1974). The soil profile is a uniform loamy sand and sandy loam to 60 inches. The final seedbed was firm, yet soft enough that a shovel could penetrate the top 12 inches very easily. Calcium salts crusted the top .125 inch. The organic content was less than 1 percent. Nitrogen (less than 2 pounds per acre) and phosphorus (less than 20 pounds per acre) were very low and as expected, potassium (greater than 355 pounds per acre) was high. A soil test provided by the operator revealed that the soil reaction was pH 8.1 with a cation exchange capacity of 12.3 meq/100grams.

Due to the low fertility, low cation exchange capacity and low organic matter, the operator added 5 dry tons per acre of local dairy manure, with a disc, to the last seedbed preparation. This left the seedbed very soft with additional organic matter left on the surface. Seed was drilled into the seedbed during the first week of June 1999. Species selected were Blue grama (*Bouteloua gracilis)*, Plains bristlegrass (*Setaria leucopila)*, Sideoats grama (*Bouteloua curtipendula)* and Four-wing saltbush (*Atriplex canescens)*. It is suggested in our draft guidelines to use only pure live seed with a drill rate that is double what is recommended in the United States Department of Agriculture, Natural Resource Conservation Service range seeding guideline. All seed selections are based on the current vegetation found on adjacent undisturbed lands. A one-wire electric fence was installed to protect the site from grazing until sufficient establishment.

Seeding occurred in June 1999. The revegetated area was visually inspected in August 1999 to assess seedling establishment and weed invasion. In July of 2000, the site was visually inspected again.

Results and Discussion

In August 1999, seedlings could be found in the drill rows in over 70 percent of the disturbed area. Approximately 90 percent of the seedlings were *Setaria leucopila*. There were very few competitive weeds in the planted area.

In July of 2000, the site was inspected again. Coverage of the disturbed area remained over 70 percent. *Setaria leucopila* was the predominate grass in the reclaimed area, with *Bouteloua curtipendula* producing better the second year and *Bouteloua gracilis* showing very little. *Atriplex canescens* is not evident on the site. The livestock fence will not keep wildlife from grazing the area and we feel that *Atriplex* has possibly been selected out due to its palatability during the seedling stages.

The manure application was approximately 40 percent of the total project cost of $565 per acre or $912.00.

The National Weather Service has a weather station about 6 miles north of our study site. The recorded total for June 1999 was twice the average normal, 3.26 inches. Year 2000 started out with a dry spring, but June 2000 rainfall was 6.74 inches. Year 2000 did receive its annual average rainfall by October 31.

A successful method for revegetation is dependent on climate interacting with man made amendments to the planting medium. We have found that successful revegetation can occur given the climate that was described in the Permian Basin. We hope to build on this success to develop effective revegetation guidelines for oil and gas operators working on State Trust land.

Several factors have had more influence in our guidelines than others. First, the selection of plant species that have proven capable of thriving in

disturbed areas and harsh climatic conditions is crucial. Second, seedbed preparation is likely the most important aspect of assuring that the seed has been planted at the right depth, the planting medium is firm and yet the air space is optimum for chemical interactions to occur. Proper seedbed preparation also enables soil movement from wind and water to stay within tolerance and increases the ability of the remediated area to capture rainfall and prevent evaporation. Third, native soil fertility is inherently low in this area and the addition of manure or commercial fertilizers is recommended. Dairy manure has about 25 to 30 pounds of total nitrogen per dry ton. A rule of thumb is 40 percent of the nitrogen in the manure is available the first year for the use by the grass. However, this is dependent on the soil moisture, soil temperature and soil texture. Phosphorus (P_2O_5) and potassium (K_2O) content of dairy manure varies quite a bit but the range is usually from 14 to 41 pounds per dry ton for P_2O_5 and 34 to 86 pounds per ton for K_2O (Flynn, 1998).

The draft Land Office revegetation guidelines also suggest that the seedbed be finished a year before planting with a minimum of 2000 pounds of mulch material per acre crimped on the top. This gives the seedbed time to collect moisture over the year and the combination of surface crusting with the mulch restricts soil water loss from evaporation.

Conclusions

We attribute the revegetation success (number of seedlings in the drill rows and overall growth) to the addition of the manure, a source of nitrogen, phosphorus and potassium, and additional rainfall. The added organic content increases the rainfall infiltration rate, soil moisture holding capacity and retention, increases the microbial action along with the cation exchange capacity and it also acts as an inhibitor to soil moisture evaporation. It is also the design and production outcome of the reclaimed site that determines when the area can be returned back to grazing, a must for all sites due to the importance of revenues on State Trust land.

At this point we feel that an additional 2 growing seasons will be necessary for proper establishment. Based on initial success at this site, the Land Office will continue developing additional demonstration projects with oil and gas operators with the ultimate goal of assuring successful revegetation of disturbed Trust lands in the Permian Basin.

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