



Ecozone Reclamation Plans Demicks Lake Pipeline



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Reclamation Guidelines for the Demicks Lake Pipeline

The Demicks Lake Pipeline (DLP) is a pipeline project in McKenzie County, North Dakota and Richland County, Montana. Land use along the DLP right-of-way (ROW) includes cultivated cropland, hay/tame pasture, and native range/grassland. Vegetation consists predominantly of cereal grain crops, alfalfa/grass hay, and native/introduced grasses. Soils vary in chemical and physical composition, depth, drainage capability, and reclamation potential. Ecozone delineations along the DLP ROW considered dominant soil types, soil chemical characteristics, dominant vegetation, land use, and topography.

The ecozones present along the DLP are: Cultivated Crop Ecozone, Saline Ecozone, Badlands Ecozone, Loamy Ecozone, and Sandy Ecozone. Characteristics of each ecozone, along with associated reclamation techniques and recommendations, are detailed in each ecozone report. Fertility recommendations and seed mixes were developed based on soil sample analytical data and vegetation field surveys performed during the fall of 2018 and from data collected as part of the Garden Creek Loop project for ONEOK. Soil sample analytical data were used to make amendment recommendations based on the soil chemistry for most of the ROW. Recommendations are based on sample data analysis and Duraroot's interpretation of the soils along the alignment. All soil samples were collected by or under the supervision of a Certified Professional Soil Scientist (CPSS). A summary of all soil fertility data for DLP can be found in Attachment A.

Due to the nature and scale of the project, these reclamation guidelines have been developed using a broad-based approach to address reclamation across the project disturbance and to facilitate construction activities. Site-specific plans are recommended in areas with soil characteristics that could negatively impact revegetation, such as shallow soil resources or high/low pH and elevated salt concentrations (Attachment A). Soil sample data indicate that potentially challenging sites, in terms of reclamation success, are present along the pipeline route. It is likely that additional areas are present, but further sampling would be needed to more accurately delineate boundaries. Duraroot can provide site-specific reclamation plans for these locations at a small additional cost of \$500 per plan.



RECLAMATION PLAN

CULTIVATED CROP ECOZONE SITES

SITE DESCRIPTION

The Cultivated Crop Ecozone is comprised of managed row crops, hayfields, and tame pastures. The Cultivated Crop Ecozone makes up approximately forty-four (43.5) percent of the land use on Demicks Lake Pipeline. Following construction, the land will be returned to productive cropland. The Cultivated Crop Ecozone contains primarily medium textured loam soils, with grades less than 10 percent. Soil pH is predominately slightly alkaline (pH 7.4 to 7.8) to moderately alkaline (pH 7.9 to 8.4). One key factor in reclaiming the Cultivated Crop Ecozone sites will be the preservation of topsoil, which has the soil properties necessary for agricultural production. This ecozone should present minimal challenges for reclamation due to desirable ecozone characteristics.

Due to reclamation timing, a cover crop seed mix for the Cultivated Crop Ecozone is provided in Table 1. A cover crop should be seeded on all cultivated cropland when establishment of the crop will not occur within 45 days or less of reclamation activities. A cover crop will protect the soil from wind and water erosion, increase soil stabilization, improve soil structure, suppress weed establishment, and improve overall reclamation success. The cover crop seed mix below was developed to provide quick cover due to a rapid germination rate and to aid in accelerated soil stabilization by helping to prevent the migration of topsoil during periods of freeze/thaw and rain events. A cover crop seed mix recommendation for immediate vegetation cover is provided in Table 1. Landowner preferences should be identified prior to seeding to develop appropriate seed mixes for hayfields and tame pastures. The reclamation plan is provided on Page 2.

Table 1. Demicks Lake Pipeline Cultivated Crop Ecozone Site Cover Crop Seed Mix Recommendation.

Common Name	Scientific Name	# PLS/acre	PLS/sq ft	% of Mix
Quickguard-Sterile Triticale	<i>Triticum aestivum x Secale cereal</i>	60	18	90%
Nitro Radish	<i>Raphanus sativus</i>	3.5	2.0	10%
Total	--	64	20	100%

RECLAMATION PLAN

CULTIVATED CROP ECOZONE SITES



(1) SOIL AMENDMENTS

Soil and nutrient amendments within cultivated areas should be based on surface owner requests. If the surface owner does not have any tract specific requests, it is recommended that approximately 20 pounds of nitrogen and 50 pounds of phosphorus per acre be applied.

(2) SEEDBED PREPARATION

These recommended seedbed preparation steps will aid in successful reclamation. Steps may be omitted, conducted in different order, or changed to optimize success and efficiency depending on field conditions, sub-soil properties, and local terrain.

- Rip subsurface soil, prior to topsoil spreading, to a minimum depth of 16 inches to reduce soil compaction and improve drainage. Ripping should be conducted using a double pass with a straight-shank agricultural ripper or parabolic ripper. The shanks on the back of a grader or dozer should NOT be used to alleviate soil compaction. Do not smooth the ROW with a dozer once ripped. It is beneficial to have an irregular surface to help tie the topsoil and subsoil horizons together. Tillage can be used to break soil clods apart prior to topsoil application.
- Apply topsoil and requested soil amendments, discussed above, to improve the soil's physical and chemical characteristics and to supplement soil nutrients.
- Finally, till the site to a depth of 4.0 to 6.0 inches to incorporate applied soil amendments and to create a seedbed conducive to seedling establishment (disk and harrow, field cultivator, vibra-shank, or other alternative suitable to site conditions).

(3) OPTIONAL COVER CROP SEEDING

Cover crop seeding should be conducted using a drill seeder suitable for the location's soils and capable of direct seed placement. Drill seeding should occur on the contour using a drill equipped with a double disc opener, wheel press, and depth bands to ensure proper seeding depth. Seed should be planted to the depth specified by the vendor to ensure proper germination and emergence. It is recommended that grain seed be placed 0.5 to 1.0 inches deep. The Cultivated Crop Ecozone recommended cover crop seed mix and rate is provided in Table 1.

(4) STRAW MULCHING

Application of straw mulch is recommended to reduce potential water and wind erosion when establishment of the crop will not occur within 45 days of reclamation activities and a cover crop will not be planted. Recommended straw mulch application rates are between 1.5 to 2.0 tons per acre. This will provide ground coverage of approximately 80 to 90 percent of the ground surface prior to crimping. Once applied the straw mulch should be crimped into the soil using a straight disc crimper with approximate 8.0-inch spaced tines. Upon successful crimping the straw mulch should be standing vertically with approximately 40 to 60 percent of the ground surface covered. Straw mulch should be at least 6.0 inches in length. Straw mulch should be crimped sufficiently to cause vertical cover that will not be dislodged by light breezes. Straw mulch should be applied based on surface owner preference in crop areas.

(5) WEED MANAGEMENT

A site-specific Integrated Weed Management Plan (IWMP) should be developed once weedy species can be identified and regular crop rotation has begun. Sites could be mowed prior to flowering and seed head production of weedy species. Mowing will reduce competition with desirable species and allow greater opportunity for reclamation success. In addition to mowing, herbicides appropriate for the identified weedy species could be implemented into the weed management plan to eradicate any problematic species. If herbicides are intended to be used, they should be applied in consultation with the surface owner to ensure that the application of herbicides is appropriate for the subsequent agricultural crop. Application timing and rates should follow the manufacturer's recommendations.

RECLAMATION PLAN

BADLANDS ECOZONE SITES



SITE DESCRIPTION

The Badlands Ecozone occurs in uplands on barren shoulders and backslopes of ridges and bluffs, as well as topographically low areas including alluvial fans and stream terraces. This ecozone covers approximately four (3.9) percent of the Demicks Lake Pipeline. The Badlands Ecozone typically consists of moderately steep to steep slopes greater than 25 percent and can contain a restrictive layer in soil depths less than 10 inches. Soil formation is minimal with variable soil texture and high erosion potential. The Badlands Ecozone includes rocky outcrops with three percent or more of the ground surface covered by rock and contains little to no vegetative cover. Additionally, this ecozone can include fine textured soils (clay loams and clays) with characteristically elevated soil electrical conductivity (EC) and soil sodium adsorption ratio (SAR). These sites will be returned to similar pre-disturbance land use following construction.

A recommended seed mix is provided for the Badlands Ecozone in Table 1. The Badlands seed mix was developed using 80 pure live seeds (PLS) per square foot. This seed mix considers seed availability, original site composition, and desirable species for quick stabilization in erosive, shallow soils.

Key obstacles for reclamation in the Badlands Ecozone are steep slopes with high potential for erosion and shallow soils with potentially elevated soil salinity and soil attributes associated with sodic soils (soil dispersion, poor soil structure, hard surface crust formation, and reduced infiltration) and low water holding potential. Ecozone appropriate erosion control measures, seedbed preparation methods, suitable seed mixes, seeding practices, and a site specific Integrated Weed Management Plan (IWMP) should help expedite reclamation success. The Badlands Ecozone reclamation plan is provided on Page 2.

Table 1. Demicks Lake Pipeline Badlands Ecozone Sites Seed Mix Recommendation.

Common Name	Scientific Name	# PLS/acre	PLS/sq ft	% of Mix
Blue Grama	<i>Bouteloua gracilis</i>	0.42	8.0	10%
Green Needlegrass	<i>Nassella viridula</i>	2.9	12	15%
Little Bluestem	<i>Schizachyrium scoparium</i>	2.0	12	15%
Western Wheatgrass	<i>Pascopyrum smithii</i>	6.3	16	20%
Bluebunch Wheatgrass	<i>Pseudoroegneria spicata</i>	3.7	12	15%
Inland Saltgrass	<i>Distichlis spicata</i>	1.0	12	15%
Slender Wheatgrass	<i>Elymus trachycaulus</i>	2.2	8.0	10%
Total	--	19	80	100%

Notes:
1. Seed mix was developed for badlands soil conditions based on vegetation data. Seed mix may be adjusted based on landowner preferences.

RECLAMATION PLAN

BADLANDS ECOZONE SITES



(1) SOIL AMENDMENTS

Soil amendment recommendations are based on recent soil chemical analysis. It is recommended that the following fertilizer amounts be applied to areas within the Badlands Ecozone:

- Nitrogen – 20 pounds per acre
- P₂O₅ – 50 pounds per acre
- K₂O – 0 pounds per acre

(2) SEEDBED PREPARATION

These recommended seedbed preparation steps will aid in successful reclamation. Steps may be omitted, conducted in different order, or changed to optimize success and efficiency depending on field conditions, sub-soil properties, and local terrain.

- When topographical slope allows, shallow rip subsurface soil prior to topsoil application to the maximum depth allowed to reduce soil compaction and improve drainage.
- Apply topsoil and soil amendments, discussed above, to supplement soil nutrients.
- Finally, till the site to a depth of 4.0 to 6.0 inches to create a seedbed conducive to seedling establishment (disk and harrow, field cultivator, vibra-shank, or other alternative suitable to site conditions). Tillage is dependent on topographical slope. If slopes are too steep, implement minimal till practices.

(3) SEEDING

Seeding should be conducted on the contour using either an imprint seeder or a drill seeder, depending on slope limitations for safe equipment operation. Drill seeders should be equipped with an agitator, double disc opener, wheel press, and depth bands to mix seed and ensure proper seeding depths. Seeds should be planted to the depth specified by the vendor to ensure proper germination and emergence. It is recommended that the seed be placed no deeper than ½ inch. The Badlands Ecozone seed mix and rate are provided in Table 1.

(4) EROSION CONTROL

Because of steep slope gradients and high erosion potential, all disturbances in the Badlands Ecozone should be hydro-mulched using a bonded fiber matrix (BFM) or flexible growth medium (FGM). Hydro-mulch application will stabilize slopes during reclamation and protect seed until vegetation can successfully establish. A synthetic polymer product, such as polyacrylamide (PAM), could be added to the hydro-mulch solution to encourage soil aggregation and further reduce erosion potential. In areas with limited available soil material a Biotic Soil Media (BSM) can be used to improve grass establishment.

Additional erosion control devices (ECDs) appropriate for specific site conditions should be installed and maintained during all construction and reclamation activities through final site stabilization. Implementing ECDs will minimize erosion of disturbed soils and prevent the transportation of sediment outside the construction ROW and into environmentally sensitive areas such as wetlands, waterbodies, and agricultural lands. Erosion control devices should be employed as needed.

(5) WEED MANAGEMENT

A site specific IWMP should be developed once weedy species can be identified. Locations could be mowed, slope permitting, prior to flowering and seed head production of weedy species. Mowing will reduce competition with desirable species and allow greater opportunity for reclamation success. In addition to mowing, herbicides appropriate for the identified weedy species could be applied to eradicate any problematic species. Application timing and rates should follow the manufacturer's recommendations. Herbicide applications should be selective and avoid desirable native grass, forb, and shrub species.

RECLAMATION PLAN

LOAMY ECOZONE SITES



SITE DESCRIPTION

The Loamy Ecozone consists primarily of grassland used for livestock grazing, forage production, and wildlife. This ecozone covers approximately thirty-two (32.4) percent of the Demicks Lake Pipeline. The Loamy Ecozone is composed of tall and short/mid grasslands. Fine to medium soil textures characterize the Loamy Ecozone, which consists predominantly of clay loams, loams, silt loams, and silty clay loams over varying topography. Vegetation within this ecozone consists of diverse herbaceous plant communities where the dominant vegetation is grass. Pastures consist primarily of an alfalfa/grass mix and native range is primarily native and introduced grasses and forbs. These sites will be returned to a similar pre-disturbance land use following construction.

A recommended seed mix is provided for the Loamy Ecozone sites in Table 1. The native grass seed mix was developed using 60 pure live seed (PLS) per square foot, respectively. The Loamy Ecozone seed mix considers seed availability, original site composition, and the ability of species to thrive in this specific ecozone.

The Loamy Ecozone should present minimal challenges for reclamation due to desirable ecozone characteristics. Appropriate seedbed preparation methods, seeding practices, a suitable seed mix, and a site specific Integrated Weed Management Plan (IWMP) should help expedite reclamation success. The reclamation plan is provided on Page 2.

Table 1. Demicks Lake Pipeline Loamy Ecozone Site Seed Mix Recommendation.

Common Name	Scientific Name	# PLS/acre	PLS/sq ft	% of Mix
Western Wheatgrass	<i>Pascopyrum smithii</i>	4.8	12	20%
Needle-and-Thread	<i>Hesperostipa comata</i>	3.4	9.0	15%
Blue Grama	<i>Bouteloua gracilis</i>	0.48	9.0	15%
Green Needlegrass	<i>Nassella viridula</i>	2.2	9.0	15%
Sidecoats Grama	<i>Bouteloua curtipendula</i>	2.1	9.0	15%
Little Bluestem	<i>Schizachyrium scoparium</i>	1.0	6.0	10%
Slender Wheatgrass	<i>Elymus trachycaulus</i>	1.6	6.0	10%
Total	--	16	60	100%

Notes:

1. Seed mix was developed for loamy soil conditions and fine to medium soil textures based on vegetation data. Seed mix may be adjusted based landowner preferences.

RECLAMATION PLAN

LOAMY ECOZONE SITES



(1) SOIL AMENDMENTS

Soil amendment recommendations are based on recent soil chemical analysis. It is recommended that the following fertilizer amounts be applied to areas within the Loamy Ecozone:

- Nitrogen – 20 pounds per acre
- P₂O₅ – 50 pounds per acre
- K₂O – 0 pounds per acre

(2) SEEDBED PREPARATION

These recommended seedbed preparation steps will aid in successful reclamation. Steps may be omitted, conducted in different order, or changed to optimize success and efficiency depending on field conditions, sub-soil properties, and local terrain.

- Rip subsurface soil, prior to topsoil application, to a minimum of 16 inches to reduce soil compaction and improve drainage. Ripping should be conducted using a double pass with a straight-shank agricultural ripper or parabolic ripper. The shanks on the back of a grader or dozer should NOT be used to alleviate soil compaction. Do not smooth the ROW with a dozer once ripped it is beneficial to have an irregular surface to help tie the topsoil and subsoil horizons together. Tillage can be used to break soil clods apart prior to topsoil application.
- Apply topsoil and soil amendments, discussed above, to improve the soil chemical characteristics and to supplement soil nutrients.
- Finally, till the site to a depth of 4.0 to 6.0 inches to incorporate soil amendments and to create a seedbed conducive to seedling establishment (disk and harrow, field cultivator, vibra-shank, or other alternative suitable to site conditions).

(3) SEEDING

Seeding should be conducted using a drill seeder suitable for the location's soils and capable of direct seed placement. Drill seeding should occur on the contour using a drill equipped with an agitator, double disc opener, wheel press, and depth bands to mix seed and ensure proper seeding depths. Seeds should be planted to the depth specified by the vendor to ensure proper germination and emergence. It is recommended that the seed be placed 1/8 to 1/2 inch deep. The Loamy Ecozone seed mix and rate are provided in Table 1.

(4) STRAW MULCHING

Application of straw mulch is recommended to reduce potential water and wind erosion. Recommended straw mulch application rates are between 1.5 to 2.0 tons per acre. This will provide ground coverage of approximately 80 to 90 percent of the ground surface prior to crimping. Once applied the straw mulch should be crimped into the soil using a straight disc crimper with approximate 8.0-inch spaced tines. Upon successful crimping the straw mulch should be standing vertically with approximately 40 to 60 percent of the ground surface covered. Straw mulch should be at least 6.0 inches in length. Straw mulch should be crimped sufficiently to cause vertical cover that will not be dislodged by light breezes.

(5) WEED MANAGEMENT

A site-specific IWMP should be developed once weedy species can be identified. Sites could be mowed prior to flowering and seed head production of weedy species. Mowing will reduce competition with desirable species and allow greater opportunity for reclamation success. In addition to mowing, herbicides appropriate for the identified weedy species should be implemented into the weed management plan to eradicate any problematic species. Application timing and rates should follow the manufacturer's recommendations. Herbicide applications should be selective and avoid desirable native grass, forb, and shrub species. It is recommended to avoid overgrazing during the establishment period to minimize competitive weedy species establishment.

RECLAMATION PLAN

SALINE ECOZONE SITES



SITE DESCRIPTION

The Saline Ecozone consists of land used primarily for forage production and grazing. The Saline Ecozone makes up approximately fourteen (13.8) percent of the Demicks Lake Pipeline. This ecozone occurs in topographically low areas, including alluvial fans and stream terraces, as well as on hillsides. This ecozone consists of fine textured soils (clay loams and clays) with characteristically elevated soil electrical conductivity (EC) and soil sodium adsorption ratio (SAR). Soils are moderately deep to deep (> 20 inches) and slope typically ranges from 0 to 8 percent. Vegetation of the Saline Ecozone is predominantly native/introduced rangeland grasses. These sites will be returned to a similar pre-disturbance land use following construction.

A recommended seed mix is provided for the Saline Ecozone in Table 1. The seed mix was developed using 80 pure live seeds (PLS) per square foot. This seed mix considers inherent soil properties and includes saline tolerant grass species to improve reclamation success.

One key obstacle in reclaiming the Saline Ecozone sites will be the elevated soil salinity and potential soil attributes associated with sodic soils (soil dispersion, poor soil structure, hard surface crust formation, and reduced infiltration). Additionally, fine textured soils with elevated soil clay contents can contribute to greater potential soil erosion and deteriorated soil structure. Deteriorated soil structure may result in hard, compacted soils that will limit infiltration and root growth. Ecozone appropriate soil amendments, seedbed preparation methods, seeding practices, a suitable seed mix, and a site specific Integrated Weed Management Plan (IWMP) should help expedite reclamation success. The reclamation plan is provided on Page 2.

Table 1. Demicks Lake Pipeline Saline Ecozone Sites Seed Mix Recommendation.

Common Name	Scientific Name	# PLS/acre	PLS/sq ft	% of Mix
Beardless Wildrye	<i>Leymus triticoides</i>	3.4	12	15%
Inland Saltgrass	<i>Distichlis spicata</i>	1.3	16	20%
Western Wheatgrass	<i>Pascopyrum smithii</i>	6.3	16	20%
Nuttall's Alkaligrass	<i>Puccinellia nuttalliana</i>	0.33	16	20%
Green Needlegrass	<i>Nassella viridula</i>	2.0	8.0	10%
Slender Wheatgrass	<i>Elymus trachycaulus</i>	3.3	12	15%
Total	--	17	80	100%

Notes:

1. Seed mix was developed for saline and fine textured soil conditions based on vegetation data. Seed mix may be adjusted based on landowner preferences.

RECLAMATION PLAN

SALINE ECOZONE SITES



(1) SOIL AMENDMENTS

Soil amendments are recommended to expedite reclamation success and create conditions that can better support seed germination and plant growth. Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$) is recommended to improve potential saline/sodic soil conditions within the Saline Ecozone and to reduce potential soil dispersion. It is recommended that 1.5 tons per acre gypsum be applied to soils within the Saline Ecozone. In addition, 5.0 tons per acre of cornstalks should be applied to the Saline Ecozone sites to improve soil structure and reduce potential soil dispersion of saline/sodic soils. To offset nitrogen immobilization due to the organic carbon additions, it is recommended that 75 pounds per acre of nitrogen be applied. Soil amendments should be incorporated post topsoil application to a depth of 4.0 to 6.0 inches.

- Gypsum – 1.5 tons per acre
- Cornstalks – 5.0 tons per acre
- Nitrogen – 75 pounds per acre
- P_2O_5 – 50 pounds per acre

(2) SEEDBED PREPARATION

These recommended seedbed preparation steps will aid in successful reclamation. Steps may be omitted, conducted in different order, or changed to optimize success and efficiency depending on field conditions, sub-soil properties, and local terrain.

- Rip subsurface soil, prior to topsoil application, to a minimum of 16 inches to reduce soil compaction and improve drainage. Ripping should be conducted using a double pass with a straight-shank agricultural ripper or parabolic ripper. The shanks on the back of a grader or dozer should NOT be used to alleviate soil compaction. Do not smooth the ROW with a dozer once ripped. It is beneficial to have an irregular surface to help tie the topsoil and subsoil horizons together. Tillage can be used to break soil clods apart prior to topsoil application.
- Apply topsoil and soil amendments, discussed above, to improve the soil physical and chemical characteristics and to supplement soil nutrients.
- Finally, till the site to a depth of 4.0 to 6.0 inches to incorporate soil amendments and to create a seedbed conducive to seedling establishment (disk and harrow, field cultivator, vibra-shank, or other alternative suitable to site conditions).

(3) SEEDING

Seeding should be conducted using a drill seeder suitable for the location's soils and capable of direct seed placement into fine textured soils. Drill seeding should occur on the contour using a drill equipped with an agitator, double disc opener, wheel press, and depth bands to mix seed and ensure proper seeding depths. Seeds should be planted to the depth specified by the vendor to ensure proper germination and emergence. It is recommended that the seed be placed $\frac{1}{8}$ to $\frac{1}{2}$ inch deep. The Saline Ecozone seed mix and rate are provided in Table 1.

(4) STRAW MULCHING

Application of straw mulch is recommended to reduce potential water and wind erosion. Recommended straw mulch application rates are between 1.5 to 2.0 tons per acre. This will provide ground coverage of approximately 80 to 90 percent of the ground surface prior to crimping. Once applied the straw mulch should be crimped into the soil using a straight disc crimper with approximate 8.0-inch spaced tines. Upon successful crimping, the straw mulch should be standing vertically with approximately 40 to 60 percent of the ground surface covered. Straw mulch should be at least 6.0 inches in length. Straw mulch should be crimped sufficiently to cause vertical cover that will not be dislodged by light breezes.

(5) WEED MANAGEMENT

A site-specific IWMP should be developed once weedy species can be identified. Sites could be mowed prior to flowering and seed head production of weedy species. Mowing will reduce competition with desirable species and allow greater opportunity for reclamation success. In addition to mowing, herbicides appropriate for the identified weedy species should be implemented into the weed management plan to eradicate any problematic species. Application timing and rates should follow the manufacturer's recommendations. Herbicide applications should be selective and avoid desirable native grass, forb, and shrub species. It is recommended to avoid overgrazing during the establishment period to minimize competitive weedy species establishment.

RECLAMATION PLAN

SANDY ECOZONE SITES



SITE DESCRIPTION

The dominant characteristic of the Sandy Ecozone is coarse soil textures consisting primarily of sandy loams. The Sandy Ecozone covers approximately six (6.3) percent of Demicks Lake Pipeline. These soils can be found on slopes ranging from 0 to 30 percent and tend to be well- to excessively drained. Vegetation and land use within the Sandy Ecozone includes pasture and native range consisting of both native and introduced grasses and forbs. These sites will be returned to a similar pre-disturbance land use following construction.

A recommended seed mix is provided for the Sandy Ecozone in Table 1. The seed mix was developed using 60 pure live seeds (PLS) per square foot and considers seed availability, original site composition, and the ability of species to thrive in this specific ecozone.

One key obstacle in reclaiming the Sandy Ecozone sites will be elevated sand contents and coarse soil textures, which will contribute to lower soil water holding capacity and moisture availability for seed germination and seedling establishment. Ecozone appropriate soil amendments, seedbed preparation methods, suitable seed mixes, seeding practices, and a site specific Integrated Weed Management Plan (IWMP) should help expedite reclamation success. The reclamation plan is provided on Page 2.

Table 1. Demicks Lake Pipeline Sandy Ecozone Sites Seed Mix Recommendation.

Common Name	Scientific Name	# PLS/acre	PLS/sq ft	% of Mix
Western Wheatgrass	<i>Pascopyrum smithii</i>	4.8	12	20%
Sideoats Grama	<i>Bouteloua curtipendula</i>	2.1	9.0	15%
Canada Wildrye	<i>Elymus canadensis</i>	2.3	6.0	10%
Needle-and-Thread	<i>Hesperostipa comata</i>	3.4	9.0	15%
Sand Dropseed	<i>Sporobolus cryptandrus</i>	0.10	12	20%
Little Bluestem	<i>Schizachyrium scoparium</i>	1.0	6.0	10%
Slender Wheatgrass	<i>Elymus trachycaulus</i>	1.6	6.0	10%
Total	--	15	60	100%

Notes:

1. Seed mix was developed for sandy soil conditions and coarse soil textures based on vegetation data. Seed mix may be adjusted based on landowner preferences.

RECLAMATION PLAN

SANDY ECOZONE SITES



(1) SOIL AMENDMENTS

Soil amendments are recommended to expedite reclamation success and create conditions that can better support seed germination and plant growth. To improve soil structure and organic matter content it is recommended that 5.0 tons per acre of cornstalks be applied to sandy sites. Improved soil structure and organic matter content in coarse textured soils will increase the soil's water holding capacity and nutrient retention. The use of corn stalk mulch can be omitted in some areas of the Sandy Ecozone if it is determined that sand content does not warrant the use. To offset nitrogen immobilization due to the organic carbon additions, it is recommended that 75 pounds per acre of nitrogen be applied. The cornstalks and nitrogen should be applied and incorporated post topsoil application to a depth of 4.0 to 6.0 inches.

- Nitrogen – 75 pounds per acre or 20 pounds per acre without cornstalks
- P₂O₅ – 50 pounds per acre
- K₂O – 0 pounds per acre

(2) SEEDBED PREPARATION

These recommended seedbed preparation steps will aid in successful reclamation. Steps may be omitted, conducted in different order, or changed to optimize success and efficiency depending on field conditions, sub-soil properties, and local terrain.

- Rip subsurface soil, prior to topsoil application, to a minimum depth of 16 inches to reduce soil compaction and improve drainage. Ripping should be conducted using a double pass with a straight-shank agricultural ripper or parabolic ripper. The shanks on the back of a grader or dozer should NOT be used to reduce soil compaction. Do not smooth the ROW with a dozer once ripped it is beneficial to have an irregular surface to help tie the topsoil and subsoil horizons together. Tillage can be used to break soil clods apart prior to topsoil application.
- Apply topsoil and soil amendments, discussed above, to improve soil structure and to supplement soil nutrients.
- Finally, till the site to a depth of 4.0 to 6.0 inches to incorporate soil amendments and to create a seedbed conducive to seedling establishment (disk and harrow, field cultivator, vibra-shank, or other alternative suitable to site conditions).

(3) SEEDING

Seeding should be conducted using equipment appropriate for soil conditions. On coarse textured soils of moderate slope an imprint seeder could be used to establish microclimates for seed placement and water retention. Any method that would encourage water retention will benefit seedling establishment in coarse textured soils. Imprint seeding will also help protect young newly emerged plants from wind damage and moving sand particles. If imprint seeding is not an option, seeding should be conducted using a drill seeder capable of direct seed placement in coarse soil textures. Drill seeding should occur on the contour using a drill equipped with an agitator, double disc opener, wheel press, and depth bands to mix seed and ensure proper seeding depths. Seeds should be planted to the depth specified by the vendor to ensure proper germination and emergence. It is recommended that the seed be placed no deeper than ½ inch. The Sandy Ecozone seed mix and rate are provided in Table 1.

(4) STRAW MULCHING

Application of straw mulch is recommended to reduce potential water and wind erosion and to stabilize soils. Recommended straw mulch application rates are between 1.5 to 2.0 tons per acre. This will provide ground coverage of approximately 80 to 90 percent of the ground surface prior to crimping. Once applied the straw mulch should be crimped into the soil using a straight disc crimper with approximate 8.0-inch spaced tines. Upon successful crimping the straw mulch should be standing vertically with approximately 40 to 60 percent of the ground surface covered. Straw mulch should be at least 6.0 inches in length. Straw mulch should be crimped sufficiently to cause vertical cover that will not be dislodged by light breezes. Straw mulch should not be used in areas where seed is imprinted.

(5) WEED MANAGEMENT

A site specific IWMP should be developed once weedy species can be identified. Problematic locations could be mowed prior to flowering and seed head production of weedy species. Mowing will reduce competition with desirable species and allow greater opportunity for reclamation success. In addition to mowing, herbicides appropriate for the identified weedy species could be applied to eradicate any problematic species. Application timing and rates should follow the manufacturer's recommendations. Herbicide applications should be selective and avoid desirable native grass, forb, and shrub species.

ATTACHMENT A

Soil Data Demicks Lake Pipeline

Sample ID	pH	Ec _e	SAR	N	P	K	OM
		dS/m		lb/acre	ppm		%
0001	8.0	0.71	0.03	5	2	174	3.7
0007	8.1	0.58	0.52	8	2	181	3.9
0014	7.3	0.61	0.03	10	3	452	4.9
0021	8.0	0.64	0	4	2	221	3.9
0029	7.6	0.52	0	6	4	229	3.8
0035	8.0	1.0	0	16	13	361	4.8
0042	7.9	0.86	0	10	2	257	3.9
0049	8.9	1.2	8.3	3	2	159	1.5
0056	7.2	0.64	0	12	11	335	5.3
0063	7.7	1.01	0	17	6	403	7.9
0070	7.9	0.95	0	17	5	286	3.1
0077	7.1	0.61	0.03	16	6	266	7.6
0084	7.8	0.74	0	12	4	280	5.3
0091	7.9	0.77	0	8	4	175	3.8
0098	7.7	0.58	0	4	4	141	4.7
0099	8.0	0.83	0	8	3	240	4
0104	8.2	0.89	0	6	3	187	3.3
0113	8.5	0.61	4.0	13	4	186	2.3
0121	9.0	5.5	22	9	4	157	2.2
0126	6.9	0.64	0.03	11	5	281	4.3
0133	7.6	0.77	0	8	4	228	4.7
0140	7.2	0.58	0.03	3	3	219	3.8
0147	7.8	1.0	0.65	5	3	223	3.1
0161	7.8	0.8	0	7	4	222	4.5
0168	7.8	0.89	1.6	10	3	277	3.9
0175	8.6	1.1	9.1	7	2	162	1.8
0298	5.9	0.15	0	9	16	309	2.8
0364	7.5	0.80	0	13	3	217	3.2
0371	7.4	0.31	0.03	8	4	193	2.4
0378	7.3	0.22	0.03	4	3	152	1.5
0392	8.4	0.89	5.0	6	3	212	2.2
0399	7.9	0.64	0	11	3	131	2.2
0406	7.7	0.12	0.65	3	4	49	0.5
0413	7.6	0.64	3.6	18	43	326	3.9
0420	7.0	0.09	0.28	3	2	207	1.7
0427	7.9	0.52	0	14	3	56	1.4
0434	6.9	0.64	0.65	31	6	206	2.6
0438	6.4	0.58	1.5	30	9	218	2.5
0448	6.3	0.37	0	10	5	192	2

Sample ID	pH	Ec _e	SAR	N	P	K	OM
		dS/m		lb/acre	ppm		%
0455	5.7	0.64	0.03	56	8	476	4.3
0469	7.8	1.3	0	40	4	306	3.5
0470	8.0	1.0	0.15	22	5	291	3.9
0483	8.0	1.2	0.40	63	31	899	3.1
0490	6.7	0.71	0	34	3	316	3.2
0512	8.0	0.61	0	4	22	173	2.1
0518	7.7	1.4	0	83	14	331	3.1
0525	7.7	1.3	0	52	19	292	3.1
0532	8.0	0.77	0	14	5	180	2.7
0539	5.6	0.58	0.15	32	30	293	5
0541	7.7	11	25	4	16	227	4.3

Notes:

1. Soil sample analytical results from soil samples collected during the fall of 2018.
2. Red highlighted cells could potentially impair reclamation success.

Soil Data Demicks Lake Pipeline

Sample ID	pH	Ec _e	SAR	N	P	K
		dS/m		lb/acre	ppm	
BEISIGL-FLASHER-TELFER	7.8	0.63	0.60	16	13	185
BELFIELD-SAVAGE -DAGLUM	7.8	0.66	0.60	29	15	331
BRANDENBURG-CABBA-DOGTOOTH	7.4	0.74	0.50	26	9	329
CABBA-BADLAND	8.3	6.2	19	4	3	101
CABBA-CHAMA-SEN	7.7	0.83	0.70	44	10	279
CABBA-CHAMA-SHAMBO	7.8	1.1	0.90	35	7	211
CHAMA-SEN-CABBA	7.7	0.85	0.80	43	7	229
DAGLUM-BELFIED	7.8	1.2	1.6	8	7	229
DOGTOOTH-JANESBURG	7.8	1.4	3.8	10	7	255
DOGTOOTH-JANESBURG-CABBA	7.8	1.1	2.1	22	9	254
FARNUF	7.7	0.56	0.40	15	15	340
KORCHEA	7.7	0.90	0.60	30	14	477
LAWTHER	7.8	0.68	1.4	19	18	433
REEDER-FARNUF	7.8	0.63	1.0	13	11	239
REGENT-JANESBURG	7.8	1.3	1.7	12	6	174
RHOADES-DAGLUM	7.5	0.91	1.5	8	9	290
SAVAGE	7.7	0.90	0.60	32	15	348
VEBAR-COHAGEN	7.4	1.4	0.80	91	15	506
ZAHL-CABBA-WILLIAMS	7.2	0.94	0.30	17	6	310

Notes:

1. Soil sample analytical results from soil samples collected during the fall of 2015. Soil samples were collected as part of the Garden Creek Loop project for ONEOK.
2. Red highlighted cells could potentially impair reclamation success.