

FORAGE SUITABILITY GROUP 1 - FSG No.: G-xxxxS001MN

Very deep, poorly drained or somewhat poorly drained soils that are neutral (pH 6.5 to 7.4), with an available water capacity greater than 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 1-S occurs in 5 MLRA's - 102A, 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, poorly drained or somewhat poorly drained and are on footslopes, flats, or in drainageways. The topsoil ranges from sandy loam to clay with 0-10 percent rock fragments. Available water holding capacity is 6-12 inches within 60 inches of the surface. Topsoil pH ranges from 5.6 to 7.8 with an average of 6.5 to 7.4. Organic matter content of the topsoil ranges from 2 to 10 percent. A seasonal high water table is at depths of 0 to 3 feet from the surface, with an average less than 2 feet. Slopes range from 0 to 6 percent with an average of less than 2 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitation for this group is wetness.

Available water holding capacity is moderate or high. Forage production on soils with moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The results can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet soil condition. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to slightly alkaline (7.8) but typically are near neutral. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (< 2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail
 Wheatgrass, Tall- Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western- Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil
 Clover, Alsike
 Clover, Kura
 Clover, Ladino
 Clover, Red - Adapted only on somewhat poorly drained soils.
 Clover, White
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass

Production Estimates of Forage Species at 3 Levels Of Management

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	4.1T or 6.6AUM	2.9T or 3.3AUM	1.4T or 1.1AUM
Trefoil/Clover/Grass	4.5T or 7.3AUM	3.2T or 3.6AUM	1.4T or 1.1AUM
Clover/Grass	5.3T or 8.6AUM	3.8T or 4.3AUM	1.7T or 1.3AUM
Reed Canarygrass	4.9T or 8.0AUM	3.5T or 4.0AUM	1.5T or 1.2AUM
Smooth Bromegrass	4.8T or 7.9AUM	3.4T or 3.9AUM	1.5T or 1.1AUM
Tall Fescue	4.4T or 7.2AUM	3.1T or 3.6AUM	1.1T or 0.8AUM
Timothy	4.2T or 6.9AUM	3.0T or 3.4AUM	1.0T or 0.8AUM
Ky Bluegrass	2.2T or 3.6AUM	1.6T or 1.8AUM	0.8T or 0.6AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves

see **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 1 - FSG No.: G-xxxxxN001MN

Very deep, poorly drained or somewhat poorly drained soils that are neutral (pH 6.5 to 7.4), with an available water capacity greater than 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 1-N occurs in 6 MLRA's - 56, 57, 88, 90, 91, 92.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, poorly drained or somewhat poorly drained and are on footslopes, flats, or in drainageways. The texture of the topsoil ranges from loamy sand to clay with 0-10 percent rock fragments. Available water holding capacity is 6-12 inches within 60 inches of the surface. Topsoil pH ranges from 5.6 to 7.8 with an average of 6.5 to 7.4. Organic matter content of the topsoil ranges from 2 to 10 percent. A seasonal high water table is at depths of 0 to 3 feet with an average less than 2 feet from the surface. Slopes range from 0 to 6 percent but average less than 2 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness.

Available water capacity is moderate or high. Forage production on soils with moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The results can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet soil conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to slightly alkaline (7.8) but typically are near neutral. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet Soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool Season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall- Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western- Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike

Clover, Kura

Clover, Ladino

Clover, Red - Adapted only on somewhat poorly drained soils.

Clover, White

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Production Estimates of Forage Species at 3 Levels of Management

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.8T or 6.2AUM	2.7T or 3.1AUM	1.6T or 1.2AUM
Trefoil/Clover/Grass	3.8T or 6.2AUM	2.7T or 3.1AUM	1.6T or 1.2AUM
Clover/Grass	5.3T or 8.7AUM	3.8T or 4.3AUM	1.9T or 1.4AUM
Reed Canarygrass	4.8T or 7.8AUM	3.4T or 3.9AUM	1.2T or 0.9AUM
Smooth Bromegrass	4.3T or 7.0AUM	3.1T or 3.5AUM	1.1T or 0.8AUM
Tall Fescue	3.9T or 6.5AUM	2.8T or 3.2AUM	0.8T or 0.6AUM
Timothy	3.7T or 6.1AUM	2.7T or 3.0AUM	1.0T or 0.8AUM
Ky Bluegrass	2.0T or 3.2AUM	1.4T or 1.6AUM	0.7T or 0.5AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture growth Curves

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 2 - FSG No.: G-xxxxS002MN

Very deep, moderately well and better drained soils that are neutral (pH 6.5-7.4), with an available water holding capacity greater than 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 2-S occurs in 5 MLRA's - 102A, 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to gently rolling, very deep, moderately well to well drained soils on sideslopes, shoulders and summits. The topsoil ranges from loamy sand to clay with 0 to 10 percent rock fragments. Available water holding capacity ranges from 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 5.6 to 7.8 but averages from 6.5 to 7.4. Organic matter content of the topsoil ranges from 1 to 7 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes are 0 to 15 percent and average from 2 to 12 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is slope. Slopes range from 0 to 15 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

These soils range from moderately acid to slightly alkaline but average in the neutral range.

Available water capacity is moderate to high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening

walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to slightly alkaline (7.8) but typically are near neutral. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site

conditions.

Cool season Grasses

Bromegrass, Smooth
Orchardgrass - Subject to winter injury.
Tall Fescue - Subject to winter injury. May not persist in the stand.
Timothy - May not persist in the stand.
Bluegrass, Kentucky
Reed Canarygrass
Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.
Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes- Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.
Birdsfoot Trefoil
Clover, Alsike
Clover, Kura
Clover, Ladino
Clover, Red
Clover, White
Crownvetch
Cicer Milkvetch

Warm Season Grasses

Big Bluestem
Indiangrass
Switchgrass
Little Bluestem
Sideoats Grama

Production Estimates of Forage Species at 3 Levels of Management

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	5.4T or 8.8AUM	3.8T or 4.4AUM	1.8T or 1.4AUM
Trefoil or Trefoil/Grass	4.3T or 7.1AUM	3.1T or 3.5AUM	1.5T or 1.1AUM
Trefoil/Clover/Grass	4.7T or 7.8AUM	3.4T or 3.8AUM	1.5T or 1.1AUM
Clover/Grass	5.6T or 9.2AUM	4.0T or 4.5AUM	1.8T or 1.4AUM
Brome/Orchard	5.2T or 8.5AUM	3.7T or 4.2AUM	1.5T or 1.1AUM
Ky Bluegrass	2.1T or 3.4AUM	1.5T or 1.7AUM	0.7T or 0.5AUM
Reed Canarygrass	5.2T or 8.5AUM	3.7T or 4.2AUM	1.6T or 1.2AUM
Smooth Bromegrass	5.1T or 8.4AUM	3.7T or 4.1AUM	1.6T or 1.2AUM
Tall Fescue	4.7T or 7.7AUM	3.3T or 3.8AUM	1.2T or 0.9AUM
Timothy	3.9T or 6.5AUM	2.8T or 3.2AUM	1.1T or 0.8AUM
Big Bluestem	4.2T or 6.9AUM	3.0T or 3.4AUM	1.5T or 1.1AUM
Switchgrass	4.2T or 6.9AUM	3.0T or 3.4AUM	1.5T or 1.1AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected

to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

PASTURE GROWTH CURVES

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 2 - FSG No.: G-xxxxN002MN

Very deep, moderately well and better drained soils that are neutral (pH 6.5-7.4), with an available water holding capacity greater than 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 2-N occurs in 5 MLRA's - 56, 57, 88, 90, 91.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to gently rolling, very deep, moderately well to well drained soils on sideslopes, shoulders and summits. The topsoil ranges from loamy sand to clay with 0 to 10 percent rock fragments. Available water holding capacity ranges from 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 5.6 to 7.8 but averages from 6.5 to 7.4. Organic matter content of the topsoil ranges from 1 to 7 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes are 0 to 15 percent and average from 2 to 12 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is slope. Slopes range from 0 to 15 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

These soils range from moderately acid to slightly alkaline but average in the neutral range.

Available water capacity is moderate to high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help

manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards increase as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to slightly alkaline (7.8) but typically are near neutral. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth
Orchardgrass - Subject to winter injury.
Tall Fescue - Subject to winter injury. May not persist in the stand.
Timothy
Bluegrass, Kentucky
Reed Canarygrass
Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.
Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.
Birdsfoot Trefoil
Clover, Alsike
Clover, Kura
Clover, Ladino
Clover, Red
Clover, White
Crownvetch
Cicer Milkvetch

Warm Season Grasses

Big Bluestem
Indiangrass
Switchgrass
Little Bluestem
Sideoats Grama

Production Estimates of Forage Species at 3 Levels of Management

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
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Trefoil/Clover/Grass	4.1T or 6.6AUM	2.9T or 3.3AUM	1.4T or 1.0AUM
Clover/Grass	5.5T or 9.1AUM	4.1T or 4.4AUM	1.7T or 1.3AUM
Brome/Orchard	5.0T or 8.2AUM	3.6T or 4.1AUM	1.1T or 0.8AUM
Ky Bluegrass	2.0T or 3.3AUM	1.4T or 1.6AUM	0.6T or 0.4AUM
Reed Canarygrass	5.1T or 8.4AUM	3.7T or 4.2AUM	1.3T or 1.0AUM
Smooth Bromegrass	4.6T or 7.5AUM	3.3T or 3.7AUM	1.2T or 0.9AUM
Tall Fescue	4.2T or 6.9AUM	3.0T or 3.4AUM	0.9T or 0.7AUM
Timothy	3.8T or 6.4AUM	2.3T or 3.1AUM	1.0T or 0.8AUM
Big Bluestem	3.3T or 5.4AUM	2.4T or 2.7AUM	1.4T or 1.0AUM
Switchgrass	4.1T or 6.8AUM	3.0T or 3.3AUM	1.4T or 1.0AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3

cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

PASTURE GROWTH CURVES

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 3 - FSG No.: G-xxxxS003MN

Very deep, poorly drained or somewhat poorly drained soils that are neutral (pH 6.5-7.4), with an available water of 3 to 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 3-S occurs in 3 MLRA's - 102A, 103, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, poorly drained or somewhat poorly drained on broad flats and in drainageways. The topsoil ranges from loamy sand to loam with 0 to 15 percent rock fragments. Available water holding capacity is 3 to 8 inches within 60 inches of the surface but averages less than 6 inches. Topsoil pH ranges from 5.6 to 8.4 but averages 6.5 to 7.4. Organic matter content of the topsoil ranges from 1 to 6 percent. A seasonal high water table is at depths of 0 to 3 feet but averages less than 2 feet from the surface. Slopes are 0 to 2 percent.

County Soils Map Unit List: - See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness in the spring and droughtiness in late summer.

Available water capacity is low to moderate. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The results can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet soil conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) to moderate (6-9 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to moderately alkaline (8.4) but typically are near neutral. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike

Clover, Kura

Clover, Ladino

Clover, Red - Adapted only on somewhat poorly drained soils.

Clover, White

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Production Estimates of Forage Species at 3 Levels of Management

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM). The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT					
	HIGH ^{1/}		MEDIUM ^{2/}		LOW ^{3/}	
Trefoil or Trefoil/Grass	3.4T or	5.5AUM	2.4T or	2.7AUM	1.2T or	0.9AUM
Trefoil/Clover/Grass	3.7T or	6.1AUM	2.7T or	3.0AUM	1.2T or	0.9AUM
Clover/Grass	4.4T or	7.2AUM	3.1T or	3.6AUM	1.4T or	1.1AUM
Reed Canarygrass	4.1T or	6.7AUM	2.9T or	3.3AUM	1.3T or	1.0AUM
Smooth Bromegrass	4.0T or	6.6AUM	2.9T or	3.2AUM	1.2T or	0.9AUM
Tall Fescue	3.7T or	6.0AUM	2.6T or	3.0AUM	0.9T or	0.7AUM
Timothy	3.1T or	5.1AUM	2.2T or	2.5AUM	0.8T or	0.6AUM
Ky Bluegrass	1.7T or	2.7AUM	1.3T or	1.7AUM	0.6T or	0.4AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

PASTURE GROWTH CURVES

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 3 - FSG No.: G-xxxxN003MN

Very deep, poorly drained or somewhat poorly drained soils that are neutral (pH 6.5-7.4), with an available water of 3 to 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 3-N occurs in 5 MLRA's - 56, 57, 88, 90, 91.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, poorly drained or somewhat poorly drained on broad flats and in drainageways. The topsoil ranges from loamy sand to loam with 0 to 15 percent rock fragments. Available water holding capacity is 3 to 9 inches within 60 inches of the surface but averages less than 6 inches. Topsoil pH ranges from 5.6 to 8.4 but averages 6.5 to 7.4. Organic matter content of the topsoil ranges from 1 to 6 percent. A seasonal high water table is at depths of 0 to 3 feet but averages less than 2 feet from the surface. Slopes are 0 to 4 percent but average less than 2 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness in the spring and droughtiness in late summer.

Available water capacity is low to moderate. Forage production on soils of low water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The results can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet soil conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) to moderate (6-9 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to moderately alkaline (8.4) but typically are near neutral. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium, and key micro nutrients. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

- Birdsfoot Trefoil
- Clover, Alsike
- Clover, Kura
- Clover, Ladino
- Clover, Red - Adapted only on somewhat poorly drained soils.
- Clover, White
- Cicer Milkvetch

Warm Season Grasses

- Big Bluestem
- Indiangrass
- Switchgrass

Production Estimates of Forage Species at 3 Levels of Management

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM). The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	2.0T or 3.3AUM	1.4T or 1.6AUM	0.8T or 0.6AUM
Trefoil/Clover/Grass	2.0T or 3.3AUM	1.4T or 1.6AUM	0.8T or 0.6AUM
Clover/Grass	2.8T or 4.6AUM	2.0T or 2.3AUM	1.0T or 0.8AUM
Reed Canarygrass	2.5T or 4.1AUM	1.8T or 2.0AUM	0.6T or 0.5AUM
Smooth Bromegrass	2.3T or 3.7AUM	1.6T or 1.8AUM	0.6T or 0.4AUM
Tall Fescue	2.1T or 3.4AUM	1.5T or 1.7AUM	0.4T or 0.3AUM
Timothy	2.2T or 3.6AUM	1.6T or 1.8AUM	0.5T or 0.4AUM
Ky Bluegrass	1.2T or 1.9AUM	0.8T or 0.9AUM	0.4T or 0.3AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

PASTURE GROWTH CURVES

see **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 4 - FSG No.: G-xxxxS004MN

Very deep, moderately well and better drained soils that are neutral (pH 6.5-7.4), with an available water capacity 3 to 6 inches and an average slope percent 2 to 12 percent.

Major Land Resource Areas: FSG 4-S occurs in 5 MLRA's - 102A, 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are gently undulating to rolling, moderately deep to very deep, moderately well to somewhat excessively drained on stream terraces, flats, sideslopes and summits. The topsoil ranges from loamy sand to silty clay loam. Available water holding capacity is 3 to 6 inches within 60 inches of the surface but averages less than 6 inches. Topsoil pH ranges from 5.1 to 8.4 but averages 6.5 to 7.4. Organic matter content of the topsoil ranges from 1 to 5 percent. A seasonal high water table is at depths of greater than 2.5 feet from the surface. Slopes are 0 to 16 percent but average from 2 to 12 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitations for this group is slope and droughtiness.

Slopes range from 0 to 16 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is low to moderate. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

Management: The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) to moderate (6-9 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from strongly acid (5.1) to moderately alkaline (8.4) but typically are near neutral. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth
 Orchardgrass - Subject to winter injury.
 Timothy - May not persist in the stand. Not adapted on the somewhat excessively drained soils in this group.
 Tall Fescue - Subject to winter injury. May not persist in the stand.
 Bluegrass, Kentucky
 Reed Canarygrass - Not on the somewhat excessively drained soils in this group.
 Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 - Not on the somewhat excessively drained soils in this group.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.
 - Not on the somewhat excessively drained soils in this group.

Legumes - Usually most successfully in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.
 Birdsfoot Trefoil - Not on the somewhat excessively drained soils in this group.
 Clover, Alsike - Not on the somewhat excessively drained soils in this group.
 Clover, Kura - Not on the somewhat excessively drained soils in this group.
 Clover, Ladino - Not on the somewhat excessively drained soils in this group.
 Clover, Red - Not on the somewhat excessively drained soils in this group.
 Clover, White - Not on the somewhat excessively drained soils in this group.
 Crownvetch
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem - Not on the somewhat excessively drained soils in this group.
 Indiangrass - Not on the somewhat excessively drained soils in this group.
 Switchgrass - Not on the somewhat excessively drained soils in this group.
 Little Bluestem
 Sideoats Grama

Production Estimates of Forage Species at 3 Levels of Management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	3.3T or 5.4AUM	2.4T or 2.7AUM	1.1T or 0.8AUM
Trefoil or Trefoil/Grass	2.7T or 4.3AUM	1.9T or 2.2AUM	0.9T or 0.7AUM
Brome/Orchard	3.2T or 5.3AUM	2.3T or 2.6AUM	0.9T or 0.7AUM
Reed Canarygrass	3.2T or 5.2AUM	2.3T or 2.6AUM	1.0T or 0.8AUM
Smooth Bromegrass	3.2T or 5.2AUM	2.3T or 2.6AUM	1.0T or 0.7AUM
Tall Fescue	2.9T or 4.7AUM	2.1T or 2.3AUM	0.7T or 0.5AUM
Big Bluestem	2.6T or 4.2AUM	1.9T or 2.1AUM	0.9T or 0.7AUM
Switchgrass	2.6T or 4.2AUM	1.9T or 2.1AUM	0.9T or 0.7AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is

practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 4 - FSG No.: G-xxxxN004MN

Very deep, moderately well and better drained soils that are neutral (pH 6.5-7.4), with an available water capacity 3 to 6 inches and an average slope percent 2 to 12 percent.

Major Land Resource Areas: FSG 4-N occurs in 5 MLRA's - 56, 57, 88, 90, 91.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are gently undulating to rolling, moderately deep to very deep, moderately well to somewhat excessively drained on stream terraces, flats, sideslopes and summits. The topsoil ranges from loamy sand to loam. Available water holding capacity is 3 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 5.1 to 7.8 but averages 6.5 to 7.4. Organic matter content of the topsoil ranges from 1 to 5 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes are 0 to 15 percent but average from 2 to 12 percent.

County Soils Map Unit List: - See **Legend**

Soil Limitations:

Primary soil limitations for this group is slope and droughtiness.

Slopes range from 0 to 15 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is low. Forage production on soils of low available water capacity will be noticeably affected by wet and dry growing seasons.

Management:

Management: The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from strongly acid (5.1) to moderately alkaline (7.8) but typically are near neutral. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - Not on the somewhat excessively drained soils in this group.
 Tall Fescue - Subject to winter injury. May not persist in the stand.
 Bluegrass, Kentucky
 Reed Canarygrass - Not on the somewhat excessively drained soils in this group.
 Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 - Not on the somewhat excessively drained soils in this group.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.
 - Not on the somewhat excessively drained soils in this group.

Legumes - Usually most successfully in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.
 Birdsfoot Trefoil - Not on the somewhat excessively drained soils in this group.
 Clover, Alsike - Not on the somewhat excessively drained soils in this group.
 Clover, Kura - Not on the somewhat excessively drained soils in this group.
 Clover, Ladino - Not on the somewhat excessively drained soils in this group.
 Clover, Red - Not on the somewhat excessively drained soils in this group.
 Clover, White - Not on the somewhat excessively drained soils in this group.
 Crownvetch
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem - Not on the somewhat excessively drained soils in this group.
 Indiangrass - Not on the somewhat excessively drained soils in this group.
 Switchgrass - Not on the somewhat excessively drained soils in this group.
 Little Bluestem
 Sideoats Grama

Production Estimates of Forage Species at 3 Levels of Management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	3.2T or 5.3AUM	2.3T or 2.6AUM	1.0T or 0.7AUM
Trefoil or Trefoil/Grass	2.6T or 4.2AUM	1.8T or 2.1AUM	0.8T or 0.6AUM
Brome/Orchard	3.1T or 5.2AUM	2.2T or 2.5AUM	0.8T or 0.6AUM
Reed Canarygrass	3.1T or 5.1AUM	2.2T or 2.5AUM	0.8T or 0.7AUM
Smooth Bromegrass	3.1T or 5.1AUM	2.2T or 2.5AUM	0.9T or 0.6AUM
Tall Fescue	2.8T or 4.6AUM	2.0T or 2.2AUM	0.6T or 0.4AUM
Big Bluestem	2.4T or 3.9AUM	1.7T or 1.9AUM	0.8T or 0.6AUM
Switchgrass	2.5T or 4.1AUM	1.8T or 2.0AUM	0.8T or 0.6AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient

levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 5 - FSG No.: G-xxxxS005MN

Very deep, poorly drained or somewhat poorly drained soils that are acid (pH < 6.5), with an available water capacity greater than 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 5-S occurs in 3 MLRA's - 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (see [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are nearly level to undulating, very deep, poorly drained or somewhat poorly drained on broad flats, in drainageways, and on lower sideslopes. The topsoil ranges from fine sandy loam to silty clay loam with 0 to 10 percent coarse fragments. Available water holding capacity is 6 to 15 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 7.3 and averages less than 6.5. Organic matter content of the topsoil ranges from 3 to 8 percent. A seasonal high water table is at depths of 0 to 3 feet from the surface but averages less than 2 feet. Slopes are 0 to 4 percent and average less than 2 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitations for this group are wetness and the acidic nature of the surface and subsurface layers. These soils may be near neutral to strongly acid, depending on soil type and liming practices.

Available water capacity is moderate to very high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this

condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to neutral (7.3) and typically are acid. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass
 Creeping Foxtail
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil
 Clover, Alsike
 Clover, Kura
 Clover, Ladino
 Clover, Red - Adapted on somewhat poorly drained soils.
 Clover, White
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass

Production Estimates of Forage Species at 3 Levels of Management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	4.7T or 7.6AUM	3.3T or 3.8AUM	1.6T or 1.2AUM
Trefoil/Clover/Grass	5.1T or 8.4AUM	3.7T or 4.2AUM	1.6T or 1.2AUM
Clover/Grass	6.1T or 9.9AUM	4.3T or 4.9AUM	2.0T or 1.5AUM
Reed Canarygrass	5.6T or 9.2AUM	4.0T or 4.6AUM	1.8T or 1.3AUM
Smooth Bromegrass	5.5T or 9.1AUM	4.0T or 4.5AUM	1.7T or 1.3AUM
Tall Fescue	5.1T or 8.3AUM	3.6T or 4.1AUM	1.3T or 0.9AUM
Timothy	4.3T or 7.0AUM	3.1T or 3.5AUM	1.1T or 0.9AUM
Ky Bluegrass	2.3T or 3.7AUM	1.6T or 1.8AUM	0.8T or 0.6AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 5 - FSG No.: G-xxxxN005MN

Very deep, poorly drained or somewhat poorly drained soils that are acid (pH < 6.5), with an available water capacity greater than 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 5-N occurs in 5 MLRA's - 57, 88, 90, 91, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (see [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are nearly level to gently undulating, very deep, poorly drained or somewhat poorly drained on broad flats, in drainageways, and on lower sideslopes. The topsoil ranges from loamy fine sand to clay with 0 to 10 percent coarse fragments. Available water holding capacity is 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 7.8 and averages less than 6.5. Organic matter content of the topsoil ranges from 3 to 8 percent. A seasonal high water table is at depths of 0 to 3 feet from the surface but averages less than 2 feet. Slopes are 0 to 4 percent and average less than 2 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitation for this group is wetness and the acidic nature of the surface and subsurface layers. These soils may be near neutral to strongly acid, depending on soil type and liming practices.

Available water capacity is moderate to high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition

exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to slightly alkaline (7.8) and typically are acid. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil
 Clover, Alsike
 Clover, Kura
 Clover, Ladino
 Clover, Red - Adapted only on somewhat poorly drained soils.
 Clover, White
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass

Production Estimates of Forage Species at 3 Levels of Management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.7T or 6.0AUM	2.6T or 3.0AUM	1.5T or 1.1AUM
Trefoil/Clover/Grass	3.7T or 6.0AUM	2.6T or 3.0AUM	1.5T or 1.1AUM
Clover/Grass	5.1T or 8.4AUM	3.7T or 4.2AUM	1.8T or 1.4AUM
Reed Canarygrass	4.6T or 7.6AUM	3.3T or 3.8AUM	1.2T or 0.9AUM
Smooth Bromegrass	4.2T or 6.8AUM	3.0T or 3.4AUM	1.1T or 0.8AUM
Tall Fescue	3.8T or 6.2AUM	2.7T or 3.1AUM	0.8T or 0.6AUM
Timothy	4.1T or 6.7AUM	2.9T or 3.3AUM	1.0T or 0.7AUM
Ky Bluegrass	2.1T or 3.5AUM	1.5T or 1.7AUM	0.7T or 0.6AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 6 - FSG No.: G-xxxxS006MN

Very deep, moderately well and better drained soils that are acid (pH < 6.5), with an available water capacity greater than 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 6-S occurs in 4 MLRA's - 102A, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (see [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are nearly level to rolling, very deep, moderately well drained to well drained on sideslopes, shoulders and summits. The topsoil ranges from silty clay to loamy fine sand with 0-8 percent rock fragments. Available water holding capacity is 6-13 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 7.3 with an average less than 6.5. Organic matter content of the topsoil ranges from 1 to 7 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes range from 0 to 15 percent, but average from 2 to 12 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitation for this group is the acidic nature of the surface and subsurface layers. These soils may be near neutral to strongly acid, depending on soil type and liming practices.

Slopes range from 0 to 15 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is moderate or high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for

concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to neutral (7.3) but typically are acid. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike

Clover, Kura

Clover, Ladino

Clover, Red

Clover, White

Crownvetch

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of Management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	5.1T or 8.4AUM	3.7T or 4.1AUM	1.7T or 1.3AUM
Trefoil or Trefoil/Grass	4.1T or 6.7AUM	2.9T or 3.3AUM	1.4T or 1.1AUM
Alfalfa/Clover/Grass	5.1T or 8.4AUM	3.7T or 4.1AUM	1.7T or 1.3AUM
Trefoil/Clover/Grass	4.5T or 7.4AUM	3.2T or 3.6AUM	1.4T or 1.1AUM
Clover/Grass	5.3T or 8.7AUM	3.8T or 4.3AUM	1.7T or 1.3AUM
Brome/Orchard	5.0T or 8.1AUM	3.5T or 4.0AUM	1.4T or 1.0AUM
Ky Bluegrass	2.0T or 3.3AUM	1.4T or 1.6AUM	0.7T or 0.5AUM
Reed Canarygrass	4.9T or 8.1AUM	3.5T or 4.0AUM	1.6T or 1.2AUM
Smooth Bromegrass	4.9T or 8.0AUM	3.5T or 3.9AUM	1.5T or 1.1AUM
Tall Fescue	4.4T or 7.3AUM	3.2T or 3.6AUM	1.1T or 0.8AUM
Timothy	3.8T or 6.1AUM	2.7T or 3.0AUM	1.0T or 0.8AUM
Big Bluestem	4.0T or 6.5AUM	2.9T or 3.2AUM	1.4T or 1.1AUM
Switchgrass	4.0T or 6.5AUM	2.9T or 3.2AUM	1.4T or 1.1AUM

^{1/} HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production.

Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 6 - FSG No.: G-xxxxN006MN

Very deep, moderately well and better drained soils that are acid (pH < 6.5), with an available water capacity greater than 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 6-N occurs in 7 MLRA's - 56, 57, 88, 90, 91, 92, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. ([See Appendix C](#))

Soil Suitability Group Description:

The soils in this group are nearly level to rolling, very deep, moderately well drained to well drained on sideslopes, shoulders and summits. The topsoil ranges from silty clay to loamy sand with 0-10 percent rock fragments. Available water holding capacity is 4-12 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 7.3 with an average less than 6.5. Organic matter content of the topsoil ranges from 1 to 7 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes range from 0 to 18 percent, with an average of 2 to 12 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitation for this group is the acidic nature of the surface and subsurface layers. These soils may be near neutral to strongly acid, depending on soil type and liming practices.

Slopes range from 0 to 18 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is low, moderate or high. Forage production on soils of low or moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for

concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) to high (9-12 in). Soils with a rating of low or moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to neutral (7.3) but typically are acid. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

- Birdsfoot Trefoil
- Clover, Alsike
- Clover, Kura
- Clover, Ladino
- Clover, Red
- Clover, White
- Crownvetch
- Cicer Milkvetch

Warm Season Grasses

- Big Bluestem
- Indiangrass
- Switchgrass
- Little Bluestem
- Sideoats Grama

Production Estimates of Forage Species at 3 Levels of Management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	3.6T or 5.9AUM	2.6T or 2.9AUM	1.4T or 1.1AUM
Trefoil or Trefoil/Grass	2.8T or 4.6AUM	2.0T or 2.3AUM	1.2T or 0.9AUM
Alfalfa/Clover/Grass	3.6T or 5.9AUM	2.6T or 2.9AUM	1.4T or 1.1AUM
Trefoil/Clover/Grass	2.8T or 4.6AUM	2.0T or 2.3AUM	1.2T or 0.9AUM
Clover/Grass	3.9T or 6.5AUM	2.8T or 3.2AUM	1.4T or 1.1AUM
Brome/Orchard	3.5T or 5.7AUM	2.5T or 2.8AUM	0.8T or 0.6AUM
Ky Bluegrass	1.6T or 2.7AUM	1.2T or 1.3AUM	0.6T or 0.4AUM
Reed Canarygrass	3.6T or 5.8AUM	2.5T or 2.9AUM	0.9T or 0.7AUM
Smooth Bromegrass	3.2T or 5.2AUM	2.3T or 2.6AUM	0.8T or 0.6AUM
Tall Fescue	2.9T or 4.8AUM	2.1T or 2.4AUM	0.6T or 0.5AUM
Timothy	3.1T or 5.1AUM	2.2T or 2.5AUM	0.7T or 0.6AUM
Big Bluestem	2.3T or 3.7AUM	1.6T or 1.8AUM	1.2T or 0.9AUM
Switchgrass	3.1T or 5.2AUM	2.3T or 2.6AUM	1.0T or 0.8AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are

controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 7 - FSG No.: G-xxxxS007MN

Very deep, poorly drained or somewhat poorly drained soils that are acid (pH < 6.5), with an available water capacity from 3 to 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 7-S occurs in 1 MLRA - 103.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, poorly drained or somewhat poorly drained and are on footslopes, flats, or are in drainageways. The topsoil ranges from sandy loam to silty clay loam with 0 to 10 percent rock fragments. Available water holding capacity is 3 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 5.1 to 7.8 but averages less than 6.5. Organic matter content of the topsoil ranges from 3 to 10 percent. A seasonal high water table is at depths of 0 to 1.5 feet from the surface. Slopes are 0 to 2 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitations for this group is wetness and the acidic nature of the surface and subsurface layers. These soils may be near neutral to strongly acid, depending on soil type and liming practices.

Available water capacity is low. Forage production on soils of low water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the

growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from strongly acid (5.1) to slightly alkaline (7.8) but typically are acid. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil
 Clover, Alsike
 Clover, Kura
 Clover, Ladino
 Clover, Red - Adapted only on somewhat poorly drained soils.
 Clover, White
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil	3.2T or 5.2AUM	2.3T or 2.6AUM	1.1T or 0.8AUM
Trefoil/Grass	3.2T or 5.2AUM	2.3T or 2.6AUM	1.1T or 0.8AUM
Trefoil/Clover/Grass	3.5T or 5.7AUM	2.5T or 2.8AUM	1.1T or 0.8AUM
Clover/Grass	4.1T or 6.7AUM	2.9T or 3.3AUM	1.3T or 1.0AUM
Reed Canarygrass	3.8T or 6.2AUM	2.7T or 3.1AUM	1.2T or 0.9AUM
Smooth Bromegrass	3.8T or 6.1AUM	2.7T or 3.0AUM	1.2T or 0.9AUM
Tall Fescue	3.4T or 5.6AUM	2.5T or 2.8AUM	0.8T or 0.6AUM
Timothy	2.9T or 4.7AUM	2.1T or 2.3AUM	0.8T or 0.6AUM
KY Bluegrass	1.5T or 2.5AUM	1.1T or 1.3AUM	0.5T or 0.4AUM

^{1/} HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

^{2/} MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

^{3/} LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 7 - FSG No.: G-xxxxN007MN

Very deep, poorly drained or somewhat poorly drained soils that are acid (pH < 6.5), with an available water capacity from 3 to 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 7-N occurs in 7 MLRA's - 57, 88, 90, 91, 92, 93, 94A.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (see [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, poorly drained or somewhat poorly drained and are on footslopes, flats, or are in drainageways. The topsoil ranges from fine sandy loam to loamy sand with 0 to 10 percent rock fragments. Available water holding capacity is 3 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 7.8 but averages less than 6.5. Organic matter content of the topsoil ranges from 3 to 10 percent. A seasonal high water table is at depths of 0 to 3 feet from the surface. Slopes range from 0 to 3 percent, but average less than 2 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitations for this group is wetness and the acidic nature of the surface and subsurface layers. These soils may be near neutral to very strongly acid, depending on soil type and liming practices.

Available water capacity is low. Forage production on soils of low water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the

growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to slightly alkaline (7.8) but typically are acid. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils.

Bluegrass Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successfully in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike

Clover, Kura

Clover, Ladino

Clover, Red - Adapted only on somewhat poorly drained soils.

Clover, White

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil	2.7T or 4.4AUM	1.9T or 2.2AUM	1.0T or 0.7AUM
Trefoil/Grass	2.7T or 4.4AUM	1.9T or 2.2AUM	1.0T or 0.7AUM
Trefoil/Clover/Grass	2.7T or 4.4AUM	1.9T or 2.2AUM	1.0T or 0.7AUM
Clover/Grass	3.7T or 6.1AUM	2.7T or 3.0AUM	1.2T or 0.9AUM
Reed Canarygrass	3.4T or 5.5AUM	2.4T or 2.7AUM	0.9T or 0.6AUM
Smooth Bromegrass	3.0T or 4.9AUM	2.2T or 2.5AUM	0.8T or 0.6AUM
Tall Fescue	2.8T or 4.5AUM	2.0T or 2.3AUM	0.6T or 0.4AUM
Timothy	2.8T or 4.6AUM	2.1T or 2.2AUM	0.7T or 0.5AUM
Ky Bluegrass	1.5T or 2.5AUM	1.1T or 1.3AUM	0.5T or 0.4AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 8 - FSG No.: G-xxxxS008MN

Shallow to very deep, moderately well and better drained soils that are acid (pH < 6.5), with an available water capacity from 3 to 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 8-S occurs in 4 MLRA's - 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to steep, shallow to very deep, moderately well and better drained and are on sideslopes, shoulders and summits. The topsoil ranges from sand to silt loam with 0 to 20 percent rock fragments. Available water holding capacity ranges from 3 to 9 inches within 60 inches of the surface, and averages from 3 to 6 inches. Topsoil pH ranges from 3.5 to 7.8 but averages less than 6.5. Organic matter content of the topsoil ranges from 0 to 5 percent. A seasonal high water table is at depths of greater than 2.5 feet from the surface in most years. Slopes range from 0 to 15 percent but average from 2 to 12 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is the acidic nature of the surface and subsurface layers. These soils may be extremely acid to slightly alkaline, depending on soil type and liming practices.

Slopes range from 0 to 15 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is low or moderate. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) or moderate (6-9) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to slightly alkaline (7.8) but typically are acid. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - Not adapted on somewhat excessively drained soils. May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass - Not adapted on somewhat excessively drained soils.

Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted on somewhat excessively drained soils. Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted on somewhat excessively drained soils. Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil - Not adapted on somewhat excessively drained soils.

Clover, Alsike - Not adapted on somewhat excessively drained soils.

Clover, Kura - Not adapted on somewhat excessively drained soils.

Clover, Ladino - Not adapted on somewhat excessively drained soils.

Clover, Red - Not adapted on somewhat excessively drained soils.

Clover, White - Not adapted on somewhat excessively drained soils.

Crownvetch

Cicer Milkvetch

Warm Season Grasses

Big Bluestem - Not adapted on somewhat excessively drained soils.

Indiangrass - Not adapted on somewhat excessively drained soils.

Switchgrass - Not adapted on somewhat excessively drained soils.

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	3.6T or 5.9AUM	2.6T or 2.9AUM	1.2T or 0.9AUM
Trefoil or Trefoil/Grass	2.9T or 4.7AUM	2.1T or 2.3AUM	1.0T or 0.8AUM
Clover/Grass	3.7T or 6.1AUM	2.7T or 3.0AUM	1.2T or 0.9AUM
Brome/Orchard	3.5T or 5.7AUM	2.5T or 2.8AUM	1.0T or 0.7AUM
Reed Canarygrass	3.5T or 5.7AUM	2.5T or 2.8AUM	1.1T or 0.8AUM
Smooth Bromegrass	3.4T or 5.6AUM	2.4T or 2.8AUM	1.1T or 0.8AUM
Tall Fescue	3.1T or 5.1AUM	2.2T or 2.5AUM	0.8T or 0.6AUM
Timothy	2.6T or 4.3AUM	1.9T or 2.1AUM	0.7T or 0.5AUM
KY Bluegrass	1.4T or 2.3AUM	1.0T or 1.1AUM	0.5T or 0.4AUM
Big Bluestem	2.8T or 4.6AUM	2.0T or 2.3AUM	1.0T or 0.8AUM
Switchgrass	2.8T or 4.6AUM	2.0T or 2.3AUM	1.0T or 0.8AUM

^{1/} HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production.

Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 8 - FSG No.: G-xxxxN008MN

Shallow to very deep, moderately well and better drained soils that are acid (pH < 6.5), with an available water capacity from 3 to 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 8-N occurs in 8 MLRA's - 56, 57, 88, 90, 91, 92, 93, 94A.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to rolling, moderately deep to very deep, moderately well and better drained and are on sideslopes, shoulders and summits. The topsoil ranges from loamy coarse sand to silt loam with 0 to 15 percent rock fragments. Available water holding capacity ranges from 3 to 9 inches within 60 inches of the surface, and averages from 3 to 6 inches. Topsoil pH ranges from 3.5 to 7.8 but averages less than 6.5. Organic matter content of the topsoil ranges from 0 to 5 percent. A seasonal high water table is at depths of greater than 2 feet from the surface in most years. Slopes range from 0 to 18 percent but average from 2 to 12 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is the acidic nature of the surface and subsurface layers. These soils may be near extremely acid to slightly alkaline, depending on soil type and liming practices.

Slopes range from 0 to 18 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is low to moderate. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) to moderate (6-9 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to slightly alkaline (7.8) but typically are acid. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - Not adapted on somewhat excessively drained soils.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass - Not adapted on somewhat excessively drained soils.

Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted on somewhat excessively drained soils. Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted on somewhat excessively drained soils. Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil - Not adapted on somewhat excessively drained soils.

Clover, Alsike - Not adapted on somewhat excessively drained soils.

Clover, Kura - Not adapted on somewhat excessively drained soils.

Clover, Ladino - Not adapted on somewhat excessively drained soils.

Clover, Red - Not adapted on somewhat excessively drained soils.

Clover, White - Not adapted on somewhat excessively drained soils.

Crownvetch

Cicer Milkvetch

Warm Season Grasses

Big Bluestem - Not adapted on somewhat excessively drained soils.

Indiangrass - Not adapted on somewhat excessively drained soils.

Switchgrass - Not adapted on somewhat excessively drained soils.

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	3.3T or 5.3AUM	2.3T or 2.6AUM	1.1T or 0.8AUM
Trefoil or Trefoil/Grass	2.5T or 4.2AUM	1.8T or 2.1AUM	1.1T or 0.8AUM
Clover/Grass	3.6T or 5.8AUM	2.5T or 2.9AUM	1.1T or 0.8AUM
Brome/Orchard	3.1T or 5.1AUM	2.2T or 2.5AUM	0.7T or 0.5AUM
Reed Canarygrass	3.2T or 5.3AUM	2.3T or 2.6AUM	0.8T or 0.6AUM
Smooth Bromegrass	2.9T or 4.7AUM	2.1T or 2.3AUM	0.8T or 0.6AUM
Tall Fescue	2.7T or 4.3AUM	1.9T or 2.1AUM	0.6T or 0.4AUM
Timothy	2.5T or 4.2AUM	1.8T or 2.0AUM	0.7T or 0.5AUM
Kentucky Bluegrass	1.3T or 2.2AUM	1.1T or 1.0AUM	0.5T or 0.4AUM
Big Bluestem	2.1T or 3.4AUM	1.5T or 1.7AUM	0.9T or 0.7AUM
Switchgrass	2.8T or 4.5AUM	2.0T or 2.3AUM	0.9T or 0.7AUM

^{1/} HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and

diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 9 - FSG No.: G-xxxxS009MN

Moderately deep to very deep, poorly drained or somewhat poorly drained soils that are calcareous (pH 7.4-8.4), with an available water capacity greater than 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 9-S occurs in 4 MLRA's - 102A, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, moderately deep to very deep, poorly drained or somewhat poorly drained and are on footslopes, flats, or in drainageways. The topsoil ranges from sandy loam to clay with 0 to 20 percent rock fragments. Available water holding capacity is 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 6.6 to 8.4 with an average of greater than 7.4. Organic matter content of the topsoil ranges from 2 to 10 percent. A seasonal high water table is at depths of 0 to 3 feet from the surface, with an average of less than 2 feet. Slopes are less than 2 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness and the calcareous nature of the surface and subsurface layers. These soils may be near neutral to moderately alkaline, depending on soil type.

Available water capacity is moderate or high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal

precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from near neutral (6.6) to moderately alkaline (8.4) but typically are calcareous. On high pH soils species should be selected that are tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil
 Clover, Alsike - Adapted on sites with pH less than 7.3.
 Clover, Kura - Adapted on sites with pH less than 7.3.
 Clover, Ladino
 Clover, Red - Adapted only on somewhat poorly drained soils.
 Clover, White
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.7T or 6.1AUM	2.6T or 3.0AUM	1.3T or 1.0AUM
Clover/Grass	4.8T or 7.9AUM	3.4T or 3.9AUM	1.6T or 1.2AUM
Reed Canarygrass	4.5T or 7.3AUM	3.2T or 3.6AUM	1.4T or 1.1AUM
Smooth Bromegrass	4.4T or 7.2AUM	3.1T or 3.6AUM	1.4T or 1.0AUM
Tall Fescue	4.0T or 6.6AUM	2.9T or 3.3AUM	1.0T or 0.7AUM
Timothy	3.4T or 5.5AUM	2.4T or 2.7AUM	0.9T or 0.7AUM
KY Bluegrass	1.8T or 3.0AUM	1.3T or 1.5AUM	0.6T or 0.5AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 9 - FSG No.: G-xxxxN009MN

Moderately deep to very deep, poorly drained or somewhat poorly drained soils that are calcareous (pH 7.4-8.4), with an available water capacity greater than 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 9-N occurs in 4 MLRA's - 56, 57, 88, 90.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, moderately deep to very deep, poorly drained or somewhat poorly drained and are on footslopes, flats, or in drainageways. The topsoil ranges from sandy loam to clay with 0 to 15 percent rock fragments. Available water holding capacity is 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 5.6 to 8.4 with an average of greater than 7.4. Organic matter content of the topsoil ranges from 2 to 10 percent. A seasonal high water table is at depths of 0 to 3 feet from the surface, with an average of less than 2 feet. Slopes are less than 2 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness and the calcareous nature of the surface and subsurface layers. These soils may be near neutral to moderately alkaline, depending on soil type.

Available water capacity is moderate or high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal

precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to moderately alkaline (8.4) but typically are calcareous. On high pH soils select species tolerant of this condition. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.
 Timothy - Adapted only on somewhat poorly drained soils.
 Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.
 Reed Canarygrass
 Creeping Foxtail
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful when in stands with grass species.

Birdsfoot Trefoil
 Clover, Alsike - Adapted only on sites with pH less than 7.3.
 Clover, Kura - Adapted only on sites with pH less than 7.3.
 Clover, Ladino
 Clover, Red - Adapted only on somewhat poorly drained soils.
 Clover, White
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.6T or 5.8AUM	2.5T or 2.9AUM	1.2T or 0.9AUM
Clover/Grass	4.7T or 7.8AUM	3.3T or 3.8AUM	1.5T or 1.1AUM
Reed Canarygrass	4.4T or 7.2AUM	3.1T or 3.6AUM	1.1T or 0.9AUM
Smooth Bromegrass	4.1T or 6.6AUM	2.9T or 3.3AUM	1.1T or 0.8AUM
Tall Fescue	3.7T or 6.1AUM	2.7T or 3.0AUM	0.8T or 0.6AUM
Timothy	3.3T or 5.4AUM	2.8T or 3.2AUM	0.8T or 0.6AUM
Ky Bluegrass	1.7T or 2.9AUM	1.7T or 1.4AUM	0.5T or 0.4AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 10 - FSG No.: G-xxxxS010MN

Very deep, moderately well and better drained soils that are calcareous (pH 7.4-8.4), with an available water capacity greater than 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 10-S occurs in 4 MLRA's - 102A, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to very steep, very deep, moderately well to well drained and are on summits, sideslopes, and shoulders. The topsoil ranges from loamy fine sand to clay with 0 to 10 percent rock fragments. Available water holding capacity is 6 to 13 inches within 60 inches of the surface. Topsoil pH ranges from 5.6 to 9.0 but averages from 7.4 to 8.4. Organic matter content of the topsoil ranges from 1 to 7 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes range from 0 to 50 percent and average from 2 to 12 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is the calcareous nature of the surface and subsurface layers. These soils may be near neutral to strongly alkaline depending on the soil type.

Slopes range from 0 to 50 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is moderate to very high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for

concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to strongly alkaline (9.0) but typically are slightly to moderately alkaline (7.4-8.4). On high pH soils species should be selected that are tolerant of these conditions. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky - Adapted on soils with pH less than 7.3.

Reed Canarygrass

Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH less than 7.3.

Clover, Kura - Adapted on soils with pH less than 7.3.

Clover, Ladino

Clover, Red

Clover, White

Crownvetch - Adapted on soils with pH less than 7.3

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	5.4T or 8.9AUM	3.9T or 4.4AUM	1.8T or 1.4AUM
Trefoil or Trefoil/Grass	4.3T or 7.1AUM	3.1T or 3.5AUM	1.5T or 1.1AUM
Clover/Grass	5.6T or 9.2AUM	4.0T or 4.6AUM	1.8T or 1.4AUM
Brome/Orchard	5.3T or 8.6AUM	3.8T or 4.3AUM	1.5T or 1.1AUM
Reed Canarygrass	5.2T or 8.6AUM	3.7T or 4.2AUM	1.7T or 1.2AUM
Smooth Bromegrass	5.2T or 8.4AUM	3.7T or 4.2AUM	1.6T or 1.2AUM
Tall Fescue	4.7T or 7.7AUM	3.4T or 3.8AUM	1.2T or 0.9AUM
Timothy	4.0T or 6.5AUM	2.8T or 3.2AUM	1.1T or 0.8AUM
Ky Bluegrass	2.1T or 3.5AUM	1.5T or 1.7AUM	0.7T or 0.6AUM
Big Bluestem	4.2T or 6.9AUM	3.0T or 3.4AUM	1.5T or 1.2AUM
Switchgrass	4.2T or 6.9AUM	3.0T or 3.4AUM	1.5T or 1.1AUM

^{1/} HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing

that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 10 - FSG No.: G-xxxxN010MN

Very deep, moderately well and better drained soils that are calcareous (pH 7.4-8.4), with an available water capacity greater than 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 10-N occurs in 6 MLRA's - 56, 57, 88, 90, 91, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to very steep, very deep, moderately well to well drained and are on summits, sideslopes, and shoulders. The topsoil ranges from fine sandy loam to clay with 0 to 10 percent rock fragments. Available water holding capacity is 6 to 13 inches within 60 inches of the surface. Topsoil pH ranges from 6.6 to 9.0 but averages form 7.4 to 8.4. Organic matter content of the topsoil ranges from 1 to 7 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes range from 0 to 50 percent and average from 2 to 12 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is the calcareous nature of the surface and subsurface layers. These soils may be near neutral to strongly alkaline depending on the soil type.

Slopes range from 0 to 50 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is moderate to very high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for

concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from neutral (6.6) to strongly alkaline (9.0) but typically are slightly to moderately alkaline (7.4-8.4). On high pH soils species should be selected that are tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth
 Orchardgrass - Subject to winter injury.
 Timothy
 Tall Fescue - Subject to winter injury. May not persist in the stand.
 Bluegrass, Kentucky - Adapted on soils with pH less than 7.3.
 Reed Canarygrass
 Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.
 Birdsfoot Trefoil
 Clover, Alsike - Adapted on soils with pH less than 7.3.
 Clover, Kura - Adapted on soils with pH less than 7.3.
 Clover, Ladino
 Clover, Red
 Clover, White
 Crownvetch - Adapted on soils with pH less than 7.3
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass
 Little Bluestem
 Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	4.7T or 7.7AUM	3.3T or 3.8AUM	1.7T or 1.3AUM
Trefoil or Trefoil/Grass	3.7T or 6.0AUM	2.5T or 3.0AUM	1.4T or 1.0AUM
Clover/Grass	5.1T or 8.4AUM	3.7T or 4.2AUM	1.7T or 1.3AUM
Brome/Orchard	4.5T or 7.4AUM	3.2T or 3.7AUM	1.0T or 0.8AUM
Reed Canarygrass	4.6T or 7.6AUM	3.3T or 3.8AUM	1.2T or 0.9AUM
Smooth Bromegrass	4.1T or 6.8AUM	3.0T or 3.4AUM	1.1T or 0.8AUM
Tall Fescue	3.8T or 6.2AUM	2.7T or 3.1AUM	0.8T or 0.6AUM
Timothy	3.9T or 6.4AUM	2.9T or 3.1AUM	1.0T or 0.7AUM
Ky Bluegrass	2.0T or 3.4AUM	1.4T or 1.6AUM	0.6T or 0.5AUM
Big Bluestem	3.0T or 4.9AUM	2.1T or 2.4AUM	1.4T or 1.1AUM
Switchgrass	4.1T or 6.7AUM	2.9T or 3.3AUM	1.3T or 1.0AUM

^{1/} HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 11 - FSG No.: G-xxxxS011MN

Very deep, poorly drained or somewhat poorly drained soils that are calcareous (pH 7.4-8.4), with an available water capacity from 3 to 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 11-S occurs in 3 MLRA's - 102A, 103, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in.
(See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to undulating, very deep, poorly drained or somewhat poorly drained and are on footslopes, flats, or in drainageways. The topsoil ranges from sandy loam to clay with 0 to 15 percent rock fragments. Available water holding capacity is 3 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 6.6 to 8.4 with an average of greater than 7.4. Organic matter content of the topsoil ranges from 0 to 10 percent. A seasonal high water table is at depths of 0 to 2 feet from the surface. Slopes are less than 0 to 8 percent, with an average of less than 2 percent

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness and the calcareous nature of the surface and subsurface layers. These soils may be near neutral to moderately alkaline, depending on soil type.

Available water capacity is low. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the

growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from neutral (6.6) to moderately alkaline (8.4) but typically are slightly to moderately alkaline. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH less than 7.3.

Clover, Kura - Adapted on soils with pH less than 7.3.

Clover, Ladino

Clover, Red - Adapted only on somewhat poorly drained soils.

Clover, White

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	2.9T or 4.8AUM	2.1T or 2.4AUM	1.1T or 0.8AUM
Clover/Grass	3.8T or 6.2AUM	2.7T or 3.1AUM	1.2T or 0.9AUM
Reed Canarygrass	3.5T or 5.7AUM	2.5T or 2.8AUM	1.1T or 0.8AUM
Smooth Bromegrass	3.5T or 5.7AUM	2.5T or 2.8AUM	1.1T or 0.8AUM
Tall Fescue	3.2T or 5.2AUM	2.3T or 2.6AUM	0.8T or 0.6AUM
Timothy	2.7T or 4.4AUM	1.9T or 2.2AUM	0.7T or 0.5AUM
Ky Bluegrass	1.4T or 2.3AUM	1.0T or 1.2AUM	0.5T or 0.4AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 11 - FSG No.: G-xxxxN011MN

Very deep, poorly drained or somewhat poorly drained soils that are calcareous (pH 7.4-8.4), with an available water capacity from 3 to 6 inches and an average slope percent less than 2.

Major Land Resource Areas: FSG 11-N occurs in 4 MLRA's - 56, 57, 88, 90.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in.
(See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to undulating, very deep, poorly drained or somewhat poorly drained and are on footslopes, flats, or in drainageways. The topsoil ranges from fine sandy loam to clay with 0 to 15 percent rock fragments. Available water holding capacity is 3 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 6.6 to 8.4 with an average of greater than 7.4. Organic matter content of the topsoil ranges from 0 to 10 percent. A seasonal high water table is at depths of 0 to 3 feet from the surface, but averages less than 2 feet. Slopes are less than 5 percent, with an average of less than 2 percent

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness and the calcareous nature of the surface and subsurface layers. These soils may be near neutral to moderately alkaline, depending on soil type.

Available water capacity is low. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the

growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from neutral (6.6) to moderately alkaline (8.4) but typically are slightly to moderately alkaline. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH less than 7.3.

Clover, Kura - Adapted on soils with pH less than 7.3.

Clover, Ladino

Clover, Red - Adapted only on somewhat poorly drained soils.

Clover, White

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	2.5T or 4.0AUM	1.8T or 2.0AUM	1.0T or 0.7AUM
Clover/Grass	3.4T or 5.6AUM	2.5T or 2.8AUM	1.1T or 0.8AUM
Reed Canarygrass	3.1T or 5.1AUM	2.2T or 2.5AUM	0.8T or 0.6AUM
Smooth Bromegrass	2.8T or 4.6AUM	2.0T or 2.3AUM	0.7T or 0.5AUM
Tall Fescue	2.6T or 4.2AUM	1.8T or 2.1AUM	0.5T or 0.4AUM
Timothy	2.6T or 4.3AUM	1.8T or 2.1AUM	0.6T or 0.4AUM
Ky Bluegrass	1.3T or 2.2AUM	0.9T or 1.1AUM	0.4T or 0.3AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 12 - FSG No.: G-xxxxS012MN

Very deep, moderately well and better drained soils that are calcareous (pH 7.4-8.4), with an available water capacity from 3 to 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 12-S occurs in 2 MLRA's - 103, 104.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are gently undulating to gently rolling, deep to very deep, well drained and are on summits, sideslopes, and shoulders. The topsoil ranges from loamy fine sand to loam with 0 to 10 percent rock fragments. Available water holding capacity is 3 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 6.6 to 8.4 but averages form 7.4 to 8.4. Organic matter content of the topsoil ranges from 2 to 6 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes range from 2 to 12 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is the calcareous nature of the surface and subsurface layers. These soils may be near neutral to strongly alkaline depending on the soil type.

Slopes range from 2 to 12 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is low. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for

concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from near neutral (6.6) to moderately alkaline (8.4) but typically is slightly to moderately alkaline (7.4-8.4). On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - May not persist in the stand.
 Tall Fescue - Subject to winter injury. May not persist in the stand.
 Bluegrass, Kentucky - Adapted on soils with pH of less than 7.3.
 Reed Canarygrass
 Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.
 Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.
 Birdsfoot Trefoil
 Clover, Alsike - Adapted on soils with pH of less than 7.3.
 Clover, Kura - Adapted on soils with pH of less than 7.3.
 Clover, Ladino
 Clover, Red
 Clover, White
 Crownvetch - Adapted on soils with pH of less than 7.3.
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass
 Little Bluestem
 Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	3.2T or 5.2AUM	2.3T or 2.6AUM	1.1T or 0.8AUM
Trefoil or Trefoil/Grass	2.5T or 4.2AUM	1.8T or 2.1AUM	0.9T or 0.7AUM
Clover/Grass	3.3T or 5.4AUM	2.4T or 2.7AUM	1.1T or 0.8AUM
Brome/Orchard	3.1T or 5.1AUM	2.2T or 2.5AUM	0.9T or 0.7AUM
Reed Canarygrass	3.1T or 5.0AUM	2.2T or 2.5AUM	1.0T or 0.7AUM
Smooth Bromegrass	3.0T or 5.0AUM	2.2T or 2.5AUM	0.9T or 0.7AUM
Tall Fescue	2.8T or 4.5AUM	2.0T or 2.2AUM	0.7T or 0.5AUM
Big Bluestem	2.5T or 4.1AUM	1.8T or 2.0AUM	0.9T or 0.7AUM
Switchgrass	2.5T or 4.1AUM	1.8T or 2.0AUM	0.9T or 0.7AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 12 - FSG No.: G-xxxxN012MN

Very deep, moderately well and better drained soils that are calcareous (pH 7.4-8.4), with an available water capacity from 3 to 6 inches and an average slope percent from 2 to 12.

Major Land Resource Areas: FSG 12-N occurs in 3 MLRA's - 56, 90, 91.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in.
(See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to very steep, deep to very deep, moderately well drained and are on summits, sideslopes, and shoulders. The topsoil ranges from loamy coarse sand to fine sandy loam with 0 to 10 percent rock fragments. Available water holding capacity is 3 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 6.6 to 8.4 but averages from 7.4 to 8.4. Organic matter content of the topsoil ranges from 2 to 8 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes range from 0 to 50 percent, but average from 2 to 12 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is the calcareous nature of the surface and subsurface layers. These soils may be near neutral to strongly alkaline depending on the soil type.

Slopes range from 0 to 50 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

Available water capacity is low. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 2-12% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for

concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from near neutral (6.6) to moderately alkaline (8.4) but typically is slightly to moderately alkaline (7.4-8.4). On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky - Adapted on soils with pH of less than 7.3.

Reed Canarygrass

Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH of less than 7.3.

Clover, Kura - Adapted on soils with pH of less than 7.3.

Clover, Ladino

Clover, Red

Clover, White

Crownvetch - Adapted on soils with pH of less than 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	2.9T or 4.7AUM	2.1T or 2.3AUM	1.0T or 0.7AUM
Trefoil or Trefoil/Grass	2.2T or 3.7AUM	1.6T or 1.8AUM	0.8T or 0.6AUM
Clover/Grass	3.1T or 5.1AUM	2.2T or 2.5AUM	1.0T or 0.7AUM
Brome/Orchard	2.8T or 4.5AUM	2.0T or 2.2AUM	0.6T or 0.5AUM
Reed Canarygrass	2.8T or 4.6AUM	2.0T or 2.3AUM	0.7T or 0.5AUM
Smooth Bromegrass	2.5T or 4.2AUM	1.8T or 2.1AUM	0.7T or 0.5AUM
Tall Fescue	2.3T or 3.8AUM	1.7T or 1.9AUM	0.5T or 0.4AUM
Big Bluestem	1.8T or 3.0AUM	1.3T or 1.5AUM	0.8T or 0.6AUM
Switchgrass	2.4T or 4.0AUM	1.7T or 1.9AUM	0.8T or 0.6AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 13 - FSG No.: G-xxxxS013MN

Very deep, very poorly drained soils with a water table at or above the soil surface at some time during the year. Most areas have some type of artificial drainage. Average slope percent is less than 2.

Major Land Resource Areas: FSG 13-S occurs in 4 MLRA's - 102A, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, very poorly drained on broad flats, in depressions, or in sluggish drainageways. The topsoil ranges from sandy loam to clay with 0 to 4 percent rock fragments. Available water holding capacity is 6 to 13 inches within 60 inches of the surface. Topsoil pH ranges from 5.6 to 8.4. Organic matter content of the topsoil ranges from 3 to 20 percent. A seasonal high water table is at depths of 1 foot above to 3 feet below the soil surface. Slopes are 0 to 2 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness in the spring and ponding during the growing season after heavy or prolonged rainfall.

Available water capacity is moderate to very high. Forage production will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are very poorly drained which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this

condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Ponding:

Soils in this group are subject to ponding that will adversely impact forage production when it occurs during the growing season. The time period plants are under water and the soil temperature while ponding occurs are important for the survival of forage crops. Dormant forages are little affected by ponded waters unless the water turns to ice. Selection of species tolerant of ponding is the most effective method for dealing with this hazard.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet conditions impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Reed Canarygrass

Creeping Foxtail

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should

always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Reed Canarygrass	4.3T or 7.1AUM	3.1T or 3.5AUM	1.4T or 1.0AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 13 - FSG No.: G-xxxxN013MN

Very deep, very poorly drained soils with a water table at or above the soil surface at some time during the year. Most areas have some type of artificial drainage. Average slope percent is less than 2.

Major Land Resource Areas: FSG 13-N occurs in 7 MLRA's - 56, 57, 88, 90, 91, 93, 94A.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, very poorly drained on broad flats, in depressions, and in sluggish drainageways. The topsoil ranges from loamy sand to clay with 0 to 4 percent rock fragments. Available water holding capacity is 6 to 14 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 8.4. Organic matter content of the topsoil ranges from 3 to 20 percent. A seasonal high water table is at depths of 2 feet above to 2 feet below the soil surface. Slopes are 0 to 2 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness in the spring and ponding during the growing season after heavy or prolonged rainfall.

Available water capacity is moderate to very high. Forage production will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are very poorly drained which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this

condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Ponding:

Soils in this group are subject to ponding that will adversely impact forage production when it occurs during the growing season. The time period plants are under water and the soil temperature while ponding occurs are important for the survival of forage crops. Dormant forages are little affected by ponded waters unless the water turns to ice. Selection of species tolerant of ponding is the most effective method for dealing with this hazard.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Reed Canarygrass

Creeping Foxtail

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should

always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Reed Canarygrass	3.8T or 6.3AUM	2.7T or 3.1AUM	1.0T or 0.7AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 14 - FSG No.: G-xxxxS014MN

Very deep, very poorly drained soils that are organic with an available water capacity greater than 10 inches and an average slope percent less than 2. The water table is at or above the soil surface at some time during the year. Most areas have some type of artificial drainage. Slopes range from 0 to 15 percent.

Major Land Resource Areas: FSG 14-S occurs in 4 MLRA's - 102A, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to moderately sloping, very deep, very poorly drained on broad flats, in depressions, and in sluggish drainageways. The topsoil ranges from muck to peat with 0 to 2 percent rock fragments. Available water holding capacity is greater than 10 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 8.4. Organic matter content of the topsoil is greater than 20 percent. A seasonal high water table is at depths of 2 foot above to 2 feet below the soil surface. Slopes are 0 to 15 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is wetness in the spring and ponding during the growing season after heavy or prolonged rainfall.

Organic matter content and available water holding capacity are very high, which can cause problems with fertility and weed control.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are very poorly drained which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated high (9-12 in) or very high (>12 in) and will adversely impact plant growth and forage production during periods of above normal precipitation. Select and manage

plant species that can tolerate wet conditions on sites where this problem exists.

Ponding:

Soils in this group are subject to ponding that will adversely impact forage production when it occurs during the growing season. The time period plants are under water and the soil temperature while ponding occurs are important for the survival of forage crops. Dormant forages are little affected by ponded waters unless the water turns to ice. Selection of species tolerant of ponding is the most effective method for dealing with this hazard.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to slightly alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Reed Canarygrass
Creeping Foxtail

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENTS		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Reed Canarygrass	3.1T or 5.0AUM	2.2T or 2.5AUM	1.0T or 0.7AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 14 - FSG No.: G-xxxxN014MN

Very deep, very poorly drained soils that are organic with an available water capacity greater than 10 inches and an average slope percent less than 2. The water table is at or above the soil surface at some time during the year. Most areas have some type of artificial drainage. Slopes range from 0 to 15 percent.

Major Land Resource Areas: FSG 14-N occurs in 6 MLRA's - 56, 57, 88, 90, 91, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are nearly level to moderately sloping, very deep, very poorly drained on broad flats, in depressions, and in sluggish drainageways. The topsoil ranges from muck to peat with 0 to 2 percent rock fragments. Available water holding capacity is greater than 11 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 8.4. Organic matter content of the topsoil is greater than 20 percent. A seasonal high water table is at depths of 2 foot above to 2 feet below the soil surface. Slopes are 0 to 10 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitation for this group is wetness in the spring and ponding during the growing season after heavy or prolonged rainfall.

Organic matter content and available water holding capacity are very high, which can cause problems with fertility and weed control.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are very poorly drained which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated high (9-12 in) or very high (>12 in) and will adversely impact plant growth and forage production during periods of above normal precipitation. Select and manage

plant species that can tolerate wet conditions on sites where this problem exists.

Ponding:

Soils in this group are subject to ponding that will adversely impact forage production when it occurs during the growing season. The time period plants are under water and the soil temperature while ponding occurs are important for the survival of forage crops. Dormant forages are little affected by ponded waters unless the water turns to ice. Selection of species tolerant of ponding is the most effective method for dealing with this hazard.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to slightly alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Reed Canarygrass

Creeping Foxtail

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Reed Canarygrass	3.0T or 4.9AUM	2.1T or 2.4AUM	0.9T or 0.6AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 15 - FSG No.: G-xxxxS015MN

Very deep, moderately well and better drained soils that flood frequently (greater than 50 out of 100 years). The water table is greater than 2 feet from the soil surface. Slopes range from 0 to 6 percent.

Major Land Resource Areas: FSG 15-S occurs in 4 MLRA's - 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to gently sloping, very deep, moderately well to well drained on flood plains. The topsoil ranges from sandy loam to silt loam with 0 to 2 percent rock fragments. Available water holding capacity is 6 to 13 inches within 60 inches of the surface. Topsoil pH ranges from 5.6 to 8.4. Organic matter content of the topsoil is 0 to 4 percent. A seasonal high water table is at depths greater than 2.5 feet below the soil surface. Slopes are 0 to 6 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is frequent periods of flooding in the spring and after heavy or prolonged rainfall.

Available water holding capacity is moderate to very high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Flooding:

Soils in this group are subject to frequent flooding that will adversely impact forage production when it occurs during the spring or the growing season. Flooding duration or the time period plants are under water is more important than flooding frequency for the survival of forage crops. Dormant forages are little affected by flood waters unless the water turns to ice. Legumes species are most susceptible to smothering under ice.

Selection of species tolerant of the flooding duration is the most effective method for dealing with this hazard.

Soil pH:

Soil map units in this group range in pH from moderately acid (5.6) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year. Avoid nutrient applications prior to expected flooding periods.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system will tend to insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted unless soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted unless soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike - Tolerance to flooding is poor.
 Clover, Kura - Tolerance to flooding is poor.
 Clover, Ladino - Tolerance to flooding is poor.
 Clover, Red - Tolerance to flooding is poor.
 Clover, White - Tolerance to flooding is poor.

Warm Season Grasses

Big Bluestem
 Switchgrass
 Indiangrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.0T or 4.9AUM	2.1T or 2.4AUM	1.0T or 0.8AUM
Ky Bluegrass	1.5T or 2.4AUM	1.0T or 1.2AUM	0.5T or 0.4AUM
Other Cool Season Species	3.0T or 5.0AUM	2.2T or 2.5AUM	0.9T or 0.7AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 16 - FSG No.: G-xxxxS016MN

Very deep, poorly drained or somewhat poorly drained soils that flood frequently (greater than 50 out of 100 years). The water table is less than 2 feet from the soil surface. Slopes are less than 4 percent.

Major Land Resource Areas: FSG 16-S occurs in 4 MLRA's - 102A, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to gently sloping, moderately deep to very deep, poorly drained or somewhat poorly drained on flood plains. The topsoil ranges from sand to silty clay with 0 to 2 percent rock fragments. Available water holding capacity is 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 8.4. Organic matter content of the topsoil is 1 to 8 percent. A seasonal high water table is at 1 foot above to 3 feet below the soil surface. Slopes are 0 to 4 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is frequent periods of flooding in the spring and after heavy or prolonged rainfall and wetness.

Available water holding capacity is moderate or high. Forage production will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) or high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected

during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Flooding:

Soils in this group are subject to frequent flooding that will adversely impact forage production when it occurs during the growing season. Flooding duration or the time period plants are under water is more important than flooding frequency for the survival of forage crops. Dormant forages are little affected by flood waters unless the water turns to ice. Legumes species are most susceptible to smothering under ice. Selection of species tolerant of the flooding duration is the most effective method for dealing with this hazard.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of this condition.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year. Avoid nutrient applications prior to expected flooding periods.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils with soil pH less than 7.3.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall - Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike - Tolerance to flooding is poor.

Clover, Kura - Tolerance to flooding is poor.

Clover, Ladino - Tolerance to flooding is poor.

Clover, Red - Tolerance to flooding is poor.

Clover, White - Tolerance to flooding is poor.

Warm Season Grasses

Big Bluestem

Switchgrass

Indiangrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.1T or 5.1AUM	2.2T or 2.5AUM	1.1T or 0.8AUM
Reed Canarygrass	3.7T or 6.1AUM	2.7T or 3.0AUM	1.2T or 0.9AUM
Other Tall Cool Season Grass	3.1T or 5.1AUM	2.2T or 2.5AUM	0.9T or 0.7AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species

maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 16 - FSG No.: G-xxxxN016MN

Very deep, poorly drained or somewhat poorly drained soils that flood frequently (greater than 50 out of 100 years). The water table is less than 2 feet from the soil surface. Slopes are less than 4 percent.

Major Land Resource Areas: FSG 16-N occurs in 6 MLRA's - 56, 57, 88, 90, 91, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, moderately deep to very deep, poorly drained or somewhat poorly drained on flood plains. The topsoil ranges from loamy sand to silty clay loam with 0 to 2 percent rock fragments. Available water holding capacity is 3 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 8.4. Organic matter content of the topsoil is 1 to 8 percent. A seasonal high water table is at 1 foot above to 3 feet below the soil surface. Slopes are 0 to 2 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is frequent periods of flooding in the spring and after heavy or prolonged rainfall and wetness.

Available water holding capacity is low to high. Forage production will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) to high (9-12 in). Soils with a rating of low or moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during

periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Flooding:

Soils in this group are subject to frequent flooding that will adversely impact forage production when it occurs during the growing season. Flooding duration or the time period plants are under water is more important than flooding frequency for the survival of forage crops. Dormant forages are little affected by flood waters unless the water turns to ice. Legumes species are most susceptible to smothering under ice. Selection of species tolerant of the flooding duration is the most effective method for dealing with this hazard.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of this condition.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year. Avoid nutrient applications prior to expected flooding periods.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils with soil pH less than 7.3.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall - Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike - Tolerance to flooding is poor.

Clover, Kura - Tolerance to flooding is poor.

Clover, Ladino - Tolerance to flooding is poor.

Clover, Red - Tolerance to flooding is poor.

Clover, White - Tolerance to flooding is poor.

Warm Season Grasses

Big Bluestem

Switchgrass

Indiangrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	2.7T or 4.4AUM	1.9T or 2.2AUM	1.0T or 0.7AUM
Reed Canarygrass	3.4T or 5.5AUM	2.4T or 2.7AUM	1.0T or 0.6AUM
Other Tall Cool Season Grass	2.8T or 4.6AUM	2.0T or 2.3AUM	0.7T or 0.5AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species

maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 17 - FSG No.: G-xxxxS017MN

Very deep, fine textured, moderately well and better drained soils that have an average slope ranging from 18 to 25 percent and a water holding capacity greater than 6 inches.

Major Land Resource Areas: FSG 17-S occurs in 5 MLRA's - 102A, 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are rolling to steep, very deep, moderately well to well drained soils on sideslopes, shoulders and summits. The topsoil ranges from fine sand to clay loam with 0 to 10 percent rock fragments. Available water holding capacity ranges from 6 to 13 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 8.4. Organic matter content of the topsoil ranges from 0 to 4 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes are 12 to 40 percent and average from 18 to 25 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is slope. Slopes range from 12 to 40 percent. Potential for cattle trail erosion is very high.

These soils range from very strongly acid to moderately alkaline.

Available water capacity is moderate to very high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units are typically 18-25%. This is considered a moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and help improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard.

Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On soils with a high pH select species adapted to these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to steep slopes. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Steep land slopes impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Wheatgrass, Tall - Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH below 7.3.

Clover, Kura - Adapted on soils with pH below 7.3.

Clover, Ladino

Clover, Red

Clover, White

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	4.0T or 6.5AUM	2.9T or 3.2AUM	1.3T or 1.0AUM
Trefoil or Trefoil/Grass	3.2T or 5.2AUM	2.3T or 2.6AUM	1.1T or 0.8AUM
Clover/Grass	4.2T or 6.8AUM	3.0T or 3.4AUM	1.4T or 1.0AUM
Ky Bluegrass	1.6T or 2.6AUM	1.1T or 1.3AUM	0.5T or 0.4AUM
Other Cool Season Species	3.2T or 5.3AUM	2.3T or 2.6AUM	0.9T or 0.7AUM
Big Bluestem	3.1T or 5.1AUM	2.2T or 2.5AUM	1.1T or 0.8AUM
Switchgrass	3.1T or 5.1AUM	2.2T or 2.5AUM	1.1T or 0.8AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 17 - FSG No.: G-xxxxN017MN

Very deep, fine textured, moderately well and better drained soils that have an average slope ranging from 18 to 25 percent and a water holding capacity greater than 6 inches.

Major Land Resource Areas: FSG 17-N occurs in 6 MLRA's - 57, 88, 90, 91, 92, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are rolling to steep, very deep, moderately well to well drained soils on sideslopes, shoulders and summits. The topsoil ranges from loamy sand to silty clay with 0 to 10 percent rock fragments. Available water holding capacity ranges from 6 to 11 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 8.4. Organic matter content of the topsoil ranges from 0 to 4 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes are 12 to 40 percent and average from 18 to 25 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is slope. Slopes range from 12 to 40 percent. Potential for cattle trail erosion increases with slopes over 6 percent.

These soils range from extremely acid to moderately alkaline.

Available water capacity is moderate or high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units are typically 18-25%. This is considered a moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and help improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard.

Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) or high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH will require that the soil pH be maintained within an acceptable range for persistence and acceptable production. On soils with a high pH select species adapted to these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to steeper slopes. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Steep land slopes impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Wheatgrass, Tall - Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH below 7.3.

Clover, Kura - Adapted on soils with pH below 7.3.

Clover, Ladino

Clover, Red

Clover, White

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Trefoil/Grass	1.7T or 2.8AUM	1.2T or 1.4AUM	0.7T or 0.5AUM
Trefoil or Trefoil/Grass	1.3T or 2.2AUM	1.0T or 1.1AUM	0.6T or 0.4AUM
Clover/Grass	1.9T or 3.1AUM	1.3T or 1.5AUM	0.7T or 0.5AUM
Ky Bluegrass	0.8T or 1.3AUM	0.6T or 0.6AUM	0.3T or 0.2AUM
Other Cool Season Species	1.4T or 2.3AUM	1.0T or 1.1AUM	0.4T or 0.3AUM
Big Bluestem	1.1T or 1.8AUM	0.8T or 0.9AUM	0.6T or 0.4AUM
Switchgrass	1.5T or 2.4AUM	1.1T or 1.2AUM	0.5T or 0.4AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 18 - FSG No.: G-xxxxS018MN

Very deep, coarse textured, better drained soils that have an average slope ranging from 18 to 25 percent and a water holding capacity less than 6 inches.

Major Land Resource Areas: FSG 18-S occurs in 5 MLRA's - 102A, 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are gently rolling to steep, very deep, well to excessively drained soils on sideslopes, shoulders and summits. The topsoil ranges from gravelly coarse sand to silty clay loam with 1 to 20 percent rock fragments. Available water holding capacity ranges from 1 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 8.4. Organic matter content of the topsoil ranges from 0 to 4 percent. A seasonal high water table is at depths of greater than 6 feet from the surface. Slopes are 2 to 40 percent and average from 18 to 25 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is slope. Slopes range from 2 to 40 percent. Potential for cattle trail erosion is very high.

These soils range from extremely acid to moderately alkaline.

Available water capacity is very low to low. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units is typically 18-25% and is considered a moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and help improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard.

Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated very low (0-3 in) to low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to moderately alkaline (8.4). Low soil pH can be adjusted with soil amendments. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to steeper slopes. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Steep land slopes impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Wheatgrass, Tall - Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH below 7.3.

Clover, Kura - Adapted on soils with pH below 7.3.

Clover, Ladino - Not adapted on somewhat excessively or excessively drained soils.

Clover, Red - Not adapted on somewhat excessively or excessively drained soils.

Clover, White - Not adapted on somewhat excessively or excessively drained soils.

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	2.6T or 4.2AUM	1.8T or 2.1AUM	0.9T or 0.6AUM
Trefoil or Trefoil/Grass	2.0T or 3.3AUM	1.5T or 1.7AUM	0.7T or 0.5AUM
Clover/Grass	2.7T or 4.4AUM	1.9T or 2.2AUM	0.9T or 0.7AUM
Other Cool Season Species	2.1T or 3.4AUM	1.5T or 1.7AUM	0.6T or 0.5AUM
Ky Bluegrass	1.0T or 1.6AUM	0.7T or 0.8AUM	0.3T or 0.3AUM
Big Bluestem	2.0T or 3.3AUM	1.4T or 1.6AUM	0.7T or 0.5AUM
Switchgrass	2.0T or 3.3AUM	1.4T or 1.6AUM	0.7T or 0.5AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 18 - FSG No.: G-xxxxN018MN

Very deep, coarse textured, better drained soils that have an average slope ranging from 18 to 25 percent and a water holding capacity less than 6 inches.

Major Land Resource Area: FSG 18-N occurs in 6 MLRA's - 56, 57, 88, 90, 91, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are gently rolling to steep, very deep, well to excessively drained soils on sideslopes, shoulders and summits. The topsoil ranges from sand to loam with 2 to 20 percent rock fragments. Available water holding capacity ranges from 1 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 8.4. Organic matter content of the topsoil ranges from 0 to 4 percent. A seasonal high water table is at depths of greater than 6 feet from the surface. Slopes are 1 to 30 percent and average from 18 to 25 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is slope. Slopes range from 1 to 30 percent. Potential for cattle trail erosion increases with slopes over 6 percent.

These soils range from extremely acid to moderately alkaline.

Available water capacity is very low to low. Forage production on These soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units is typically 18-25% and is considered a moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and help improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface

water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated very low (0-3 in) to low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to moderately alkaline (8.4). Low soil pH can be adjusted with soil amendments. The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to steeper slopes. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Steep land slopes impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Wheatgrass, Tall - Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH below 7.3.

Clover, Kura - Adapted on soils with pH below 7.3.

Clover, Ladino - Not adapted on somewhat excessively or excessively drained soils.

Clover, Red - Not adapted on somewhat excessively or excessively drained soils.

Clover, White - Not adapted on somewhat excessively or excessively drained soils.

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	2.5T or 4.1AUM	1.7T or 2.0AUM	0.8T or 0.5AUM
Trefoil or Trefoil/Grass	1.9T or 3.2AUM	1.4T or 1.6AUM	0.6T or 0.4AUM
Clover/Grass	2.6T or 4.3AUM	1.8T or 2.1AUM	0.8T or 0.6AUM
Other Cool Season Species	2.0T or 3.3AUM	1.4T or 1.6AUM	0.5T or 0.4AUM
Ky Bluegrass	0.9T or 1.5AUM	0.6T or 0.7AUM	0.2T or 0.2AUM
Big Bluestem	1.9T or 3.1AUM	1.3T or 1.5AUM	0.6T or 0.4AUM
Switchgrass	1.9T or 4.3AUM	1.3T or 1.5AUM	0.6T or 0.4AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 19 - FSG No.: G-xxxxS019MN

Very shallow to very deep, moderately well and better drained soils that have stony, rubbly, rocky, channery, cobbly, or a bouldery modifier in the map unit name, or are quarries or rock outcrop map units.

Major Land Resource Areas: FSG 19-S occurs in 5 MLRA's - 102A, 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to very steep, very shallow to very deep, moderately well to better drained soils on sideslopes, shoulders and summits. The topsoil ranges from loamy fine sand to silty clay loam with 4 to 50 percent rock fragments. Available water holding capacity ranges from 0 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 8.4. Organic matter content of the topsoil ranges from 0 to 5 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes are 0 to 80 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is depth or the presence of boulders, cobbles, rocks, or stones at or near the soil surface.

These soils range from very acid to moderately alkaline.

Slopes range from 0 to 80 percent. Potential for cattle trail erosion increases with slopes over 6 percent.

Available water holding capacity is very low to high. Forage production on soils with low or moderate available water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from nearly level to very steep. The steeper slopes are considered a moderate or severe hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock

walkway design will facilitate providing water and help improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated very low (0-3in) to very high (>12 in). Soils with a rating of low to moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Utilize forage production early in the grazing season. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH will require that the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant to these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to steep slopes and/or surface stones (4-50%). Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. These conditions impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky - Adapted only on somewhat poorly drained soils with pH above 7.3.

Reed Canarygrass - Not adapted on somewhat excessively or excessively drained soils.

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted on somewhat excessively or excessively drained soils. Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted on somewhat excessively or excessively drained soils. Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil - Not adapted on somewhat excessively or excessively drained soils.

Clover, Alsike - Not adapted on somewhat excessively or excessively drained soils. Adapted on soils with pH below 7.3.

Clover, Kura - Not adapted on somewhat excessively or excessively drained soils. Adapted on soils with pH below 7.3.

Clover, Ladino - Not adapted on somewhat excessively or excessively drained soils.

Clover, Red - Not adapted on somewhat excessively or excessively drained soils.

Clover, White - Not adapted on somewhat excessively or excessively drained soils.

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

LEVEL OF MANAGEMENT

SPECIES	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	2.1T or 3.4AUM	1.5T or 1.7AUM	0.7T or 0.5AUM
Trefoil or Trefoil/Grass	1.7T or 2.7AUM	1.2T or 1.3AUM	0.6T or 0.4AUM
Clover/Grass	2.1T or 3.5AUM	1.5T or 1.7AUM	0.7T or 0.5AUM
Ky Bluegrass	0.8T or 1.3AUM	0.6T or 0.7AUM	0.3T or 0.2AUM
Big Bluestem	1.6T or 2.6AUM	1.2T or 1.3AUM	0.6T or 0.4AUM
Switchgrass	1.6T or 2.6AUM	1.2T or 1.3AUM	0.6T or 0.4AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 19 - FSG No.: G-xxxxN019MN

Very shallow to very deep, moderately well and better drained soils that have stony, rubbly, rocky, channery, cobbly, or a bouldery modifier in the map unit name, or are quarries or rock outcrop map units.

Major Land Resource Areas: FSG 19-N occurs in 6 MLRA's - 56, 57, 88, 90, 91, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to very steep, very shallow to very deep, moderately well and better drained soils on sideslopes, summits or shoulders. The topsoil ranges from loamy coarse sand to silt loam with 2 to 50 percent rock fragments. Available water holding capacity ranges from 0 to 11 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 8.4. Organic matter content of the topsoil ranges from 0 to 5 percent. A seasonal high water table is at depths of greater than 2 feet from the surface. Slopes are 0 to 65 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is depth or the presence of boulders, cobbles, rocks, or stones at or near the soil surface.

These soils range from very acid to moderately alkaline.

Slopes range from 0 to 65 percent. Potential for cattle trail erosion increases with slopes over 6 percent.

Available water holding capacity is very low to high. Forage production on soils with low or moderate available water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from nearly level to very steep. The steeper slopes are considered a moderate or severe hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock

walkway design will facilitate providing water and help improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated very low (0-3 in) to high (9-12 in). Soils with a rating of low to moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Utilize forage production early in the grazing season. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant to these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to steep slopes and/or surface stones (2-50%). Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. These conditions impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See Appendix A for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - Adapted on somewhat poorly drained soils. May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky - Adapted on somewhat poorly drained soils with pH below 7.3.

Reed Canarygrass - Not adapted on somewhat excessively or excessively drained soils.

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Wheatgrass, Tall - Not adapted on somewhat excessively or excessively drained soils. Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Not adapted on somewhat excessively or excessively drained soils. Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil - Not adapted on somewhat excessively or excessively drained soils.

Clover, Alsike - Not adapted on somewhat excessively or excessively drained soils. Adapted on soils with pH below 7.3.

Clover, Kura - Not adapted on somewhat excessively or excessively drained soils. Adapted on soils with pH below 7.3.

Clover, Ladino - Not adapted on somewhat excessively or excessively drained soils.

Clover, Red - Not adapted on somewhat excessively or excessively drained soils.

Clover, White - Not adapted on somewhat excessively or excessively drained soils.

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}

Alfalfa or Alfalfa/Grass	2.0T or 3.3AUM	1.4T or 1.6AUM	0.6T or 0.4AUM
Trefoil or Trefoil/Grass	1.5T or 2.6AUM	1.1T or 1.2AUM	0.5T or 0.3AUM
Clover/Grass	2.0T or 3.4AUM	1.4T or 1.6AUM	0.6T or 0.4AUM
Ky Bluegrass	0.7T or 1.2AUM	0.5T or 0.6AUM	0.2T or 0.1AUM
Big Bluestem	1.5T or 2.5AUM	1.0T or 1.2AUM	0.5T or 0.3AUM
Switchgrass	1.5T or 2.5AUM	1.0T or 1.2AUM	0.5T or 0.3AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 20 - FSG No.: G-xxxxS020MN

Very shallow to very deep, poorly drained or somewhat poorly drained soils that have stony, rubbly, rocky, channery, cobbly, or a bouldery modifier in the map unit name, or are quarries or rock outcrop map units.

Major Land Resource Areas: FSG 20-S occurs in 2 MLRA's - 102A, 103.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to gently undulating, very shallow to very deep, poorly drained or somewhat poorly drained soils on flats, flood plains and in drainageways. The topsoil ranges from loam to clay loam with 4 to 60 percent rock fragments. Available water holding capacity ranges from 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 6.6 to 8.4. Organic matter content of the topsoil ranges from 2 to 10 percent. A seasonal high water table is at depths of less than 2 feet from the surface. Slopes are 0 to 3 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitations for this group are depth, wetness or the presence of boulders, cobbles, rocks, or stones at or near the soil surface.

These soils range from neutral to moderately alkaline.

Available water holding capacity is moderate or high. Forage production on soils with moderate available water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The results can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from neutral (6.6) to moderately alkaline (8.4). On high pH soils select species that are tolerant to these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to surface stones (4-60%) and poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. These conditions impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Brome grass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Reed Canarygrass
 Creeping Foxtail
 Wheatgrass, Tall - Adapted on soils with pH greater than 7.0.
 Wheatgrass, Western - Adapted on soils with pH greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil
 Clover, Alsike - Adapted on soils with pH less than 7.3.
 Clover, Kura - Adapted on soils with pH less than 7.3.
 Clover, Ladino
 Clover, Red
 Clover, White
 Cicer Milkvetch

Warm Season Grasses

Big Bluestem
 Indiangrass
 Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.1T or 5.1AUM	2.2T or 2.5AUM	1.1T or 0.8AUM
Clover/Grass	4.0T or 6.6AUM	2.9T or 3.3AUM	1.3T or 1.0AUM
Reed Canarygrass	3.7T or 6.1AUM	2.7T or 3.0AUM	1.2T or 0.9AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 20 - FSG No.: G-xxxxN020MN

Very shallow to very deep, poorly drained or somewhat poorly drained soils that have stony, rubbly, rocky, channery, cobbly, or a bouldery modifier in the map unit name, or are quarries or rock outcrop map units.

Major Land Resource Areas: FSG 20-N occurs in 5 MLRA's - 56, 57, 88, 90, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to undulating, very shallow to very deep, poorly and somewhat poorly drained soils on flats, or in drainageways. The topsoil ranges from loamy fine sand to silt loam with 2 to 60 percent rock fragments. Available water holding capacity ranges from 4 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 4.5 to 8.4. Organic matter content of the topsoil ranges from 2 to 10 percent. A seasonal high water table is at depths of less than 2 feet from the surface. Slopes are 0 to 4 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is depth, wetness or the presence of boulders, cobbles, rocks, or stones at or near the soil surface.

These soils range from very acid to moderately alkaline.

Available water holding capacity is low to high. Forage production on soils with low or moderate available water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly drained or are somewhat poorly drained with a seasonal high water table which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The results can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated low (3-6 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from very strongly acid (4.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding liming materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species that are tolerant to these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to surface stones (4-60%) and poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. These conditions impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. **See Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Tall Fescue - Subject to winter injury. May not persist in the stand. Not adapted on somewhat excessively or excessively drained soils.

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.

Reed Canarygrass

Creeping Foxtail

Wheatgrass, Tall - Adapted on soils with pH greater than 7.0.

Wheatgrass, Western - Adapted on soils with pH greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH less than 7.3.

Clover, Kura - Adapted on soils with pH less than 7.3.

Clover, Ladino

Clover, Red

Clover, White

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.0T or 5.0AUM	2.1T or 2.4AUM	1.0T or 0.7AUM
Clover/Grass	3.9T or 6.5AUM	2.8T or 3.2AUM	1.2T or 0.9AUM
Reed Canarygrass	3.6T or 6.0AUM	2.6T or 2.9AUM	1.1T or 0.8AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 21 - FSG No.: G-xxxxS021MN

Very deep, poorly and somewhat poorly drained soils that are saline with greater than 4 mmhos/cm of electrical conductivity and soil pH is greater than 7.4.

Major Land Resource Areas: FSG 21-S occurs in MLRA 103.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to gently undulating, very deep, poorly and somewhat poorly drained soils on flats, and low summits. The topsoil is clay loam with 3 to 8 percent rock fragments. Available water holding capacity ranges from 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 7.4 to 9.0. Organic matter content of the topsoil ranges from 2 to 6 percent. A seasonal high water table is at depths of less than 3 feet from the surface. Slopes are 1 to 4 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is soil reaction and excess salt at or near the soil surface. Wetness may be a limitation in the spring or after heavy or prolonged rainfall.

These soils range from moderately to strongly alkaline.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are somewhat poorly and poorly drained which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to high (9-12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on

sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from slightly alkaline (7.4) to strongly alkaline (9.0). On high pH soils select species tolerant of these conditions.

Salinity:

Soils in this group have excessive salt concentrations (> 4 mmhos/cm of electrical conductivity) in the rooting zone. The degree of salinity needs to be determined using a soil test. Forage species vary in their tolerance to saline conditions. Species tolerant of the determined saline level should be selected.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.
 Tall Fescue - Subject to winter injury. May not persist in the stand.
 Reed Canarygrass
 Creeping Foxtail
 Wheatgrass, Tall - Adapted on soils with pH below 7.0.
 Wheatgrass, Western - Adapted on soils with pH below 7.0.

Legumes - Usually most successful in stands with grass species.
 Birdsfoot Trefoil
 Cicer Milkvetch

Warm Season Grasses
 Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	4.1T or 6.7AUM	2.9T or 3.3AUM	1.4T or 1.1AUM
Reed Canarygrass	4.9T or 8.1AUM	3.5T or 4.0AUM	1.6T or 1.2AUM
Other Cool Season Grass	4.2T or 6.8AUM	3.0T or 3.4AUM	1.2T or 0.9AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 21 - FSG No.: G-xxxxN021MN

Very deep, poorly and somewhat poorly drained soils that are saline with greater than 4 mmhos/cm of electrical conductivity and soil pH is greater than 7.4.

Major Land Resource Areas: FSG 21-N occurs in MLRA 56.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level, very deep, poorly and somewhat poorly drained soils on flats, and low summits. The topsoil ranges from fine sandy loam to clay. Available water holding capacity ranges from 7 to 13 inches within 60 inches of the surface. Topsoil pH ranges from 7.8 to 9.0. Organic matter content of the topsoil ranges from 2 to 6 percent. A seasonal high water table is at depths of less than 3 feet from the surface. Slopes are 0 to 3 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is soil reaction and excess salt at or near the soil surface. Wetness may be a limitation in the spring or after heavy or prolonged rainfall.

These soils range from moderately to strongly alkaline.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Soil Wetness:

These soil map units are poorly and somewhat poorly drained which severely limits management of forage crops. Wet soils delay planting and harvesting forage crops or result in wheeltrack ruts or livestock poach marks from hooves. The result can be soil compaction, injury to plants, poor soil aeration affecting plant growth, and problems with movement of machinery and livestock. Select plant species adapted to wet conditions. Avoid or minimize use during wet periods.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9 in) to very high (>12 in). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can

tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from moderately alkaline (7.8) to strongly alkaline (9.0). On high pH soils select species tolerant of these conditions.

Salinity:

Soils in this group have excessive salt concentrations (> 4 mmhos/cm of electrical conductivity) in the rooting zone. The degree of salinity needs to be determined using a soil test. Forage species vary in their tolerance to saline conditions. Species tolerant of the determined saline level should be selected.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to poor drainage conditions. Trafficability is any condition that influences the ease of movement by livestock and machinery over the soil surface. Wet soils impact livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Timothy - Adapted only on somewhat poorly drained soils. May not persist in the stand.
 Tall Fescue - Subject to winter injury. May not persist in the stand.
 Reed Canarygrass
 Creeping Foxtail
 Wheatgrass, Tall - Adapted on soils with pH below 7.0.
 Wheatgrass, Western - Adapted on soils with pH below 7.0.

Legumes - Usually most successful in stands with grass species.
 Birdsfoot Trefoil
 Cicer Milkvetch

Warm Season Grasses
 Switchgrass

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Trefoil or Trefoil/Grass	3.5T or 5.7AUM	2.5T or 2.8AUM	1.3T or 1.0AUM
Reed Canarygrass	4.4T or 7.1AUM	3.1T or 3.5AUM	1.1T or 0.8AUM
Other Cool Season Grass	3.7T or 6.0AUM	2.6T or 3.0AUM	0.9T or 0.7AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 22 - FSG No.: G-xxxxS022MN

All soils with an available water capacity less than 3 inches and those somewhat excessive or excessively drained soils with an available water capacity from 3 to 6 inches. The average slope percent less than 18.

Major Land Resource Areas: FSG 22-S occurs in 5 MLRA' - 102A, 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to steep, shallow to very deep, better drained soils on flats, sideslopes and summits. The topsoil ranges from course sand to silty clay loam. Available water holding capacity ranges from 0 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 8.4. Organic matter content of the topsoil ranges from 0 to 4 percent. A seasonal high water table is at depths of greater than 6 feet from the surface. Slopes are 0 to 35 percent but average less than 18 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is droughtiness.

Slope is a limitation on some units. Slopes range from 0 to 35 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

These soils range from extremely acid to moderately alkaline.

Available water capacity is very low or low. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units is typically less than 18% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated very low (0-3 in) or low (3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky - Adapted on the somewhat poorly drained soils.

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	2.2T or 3.7AUM	1.6T or 1.8AUM	0.8T or 0.6AUM
Brome/Orchard	2.2T or 3.6AUM	1.6T or 1.8AUM	0.6T or 0.5AUM
Smooth Bromegrass	2.1T or 3.5AUM	1.5T or 1.7AUM	0.7T or 0.5AUM
Tall Fescue	2.0T or 3.2AUM	1.4T or 1.6AUM	0.5T or 0.4AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 22 - FSG No.: G-xxxxN022MN

All soils with an available water capacity less than 3 inches and those somewhat excessive or excessively drained soils with an available water capacity from 3 to 6 inches. The average slope percent less than 18.

Major Land Resource Areas: FSG 22-N occurs in 6 MLRA's - 56, 57, 88, 90, 91, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are nearly level to steep, shallow to very deep, better drained soils on flats, sideslopes and summits. The topsoil ranges from sand to silt loam. Available water holding capacity ranges from 0 to 6 inches within 60 inches of the surface. Topsoil pH ranges from 3.5 to 8.4. Organic matter content of the topsoil ranges from 0 to 4 percent. A seasonal high water table is at depths of greater than 6 feet from the surface. Slopes are 0 to 30 percent but average less than 18 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitation for this group is droughtiness.

Slope is a limitation on some units. Slopes range from 0 to 30 percent. Potential for cattle trail erosion increases on slopes greater than 6 percent.

These soils range from extremely acid to moderately alkaline.

Available water capacity is very low or low. Forage production on these soils will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically is less than 18% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard. Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated very low(0-3 in) or low(3-6 in) and will adversely impact plant growth and forage production unless above normal precipitation occurs during the summer months. Select and manage plant species that are most tolerant to dry conditions. Utilize forage production from these areas early in the growing season to take advantage of early precipitation or later in the growing season after late summer precipitation.

Soil pH:

Soil map units in this group range in pH from extremely acid (3.5) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species tolerant of these conditions.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system will insulate the soil.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See **Appendix A** for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky - Adapted on somewhat poorly drained soils.

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	1.9T or 3.1AUM	1.3T or 1.5AUM	0.7T or 0.5AUM
Brome/Orchard	1.8T or 2.9AUM	1.3T or 1.5AUM	0.4T or 0.3AUM
Smooth Bromegrass	1.7T or 2.7AUM	1.2T or 1.3AUM	0.4T or 0.3AUM
Tall Fescue	1.5T or 2.5AUM	1.1T or 1.2AUM	0.3T or 0.2AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See **Appendix B** for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 23 - FSG No.: G-xxxxS023MN

Very deep, fine textured, moderately well and better drained soils with an available water capacity greater than 6 inches and an average slope percent of 12 to 18.

Major Land Resource Areas: FSG 23-S occurs in 5 MLRA's - 102A, 102B, 103, 104, 105.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See [Appendix C](#))

Soil Suitability Group Description:

The soils in this group are gently rolling to hilly, very deep, moderately well to well drained soils on sideslopes, shoulders and summits. The topsoil ranges from sandy loam to clay with 0 to 10 percent rock fragments. Available water holding capacity ranges from 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 5.1 to 8.4. Organic matter content of the topsoil ranges from 0 to 5 percent. A seasonal high water table is at depths of greater than 2.5 feet from the surface. Slopes are 10 to 20 percent and average from 12 to 18 percent.

County Soils Map Unit List: See [Legend](#)

Soil Limitations:

Primary soil limitation for this group is slope. Slopes range from 10 to 20 percent. Potential for cattle trail erosion is high.

These soils range from very acid to moderately alkaline.

Available water capacity is moderate to high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 12-18% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard.

Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9) to high (9-12). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from strongly acid (5.1) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species adapted to this condition.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to steeper slopes. Trafficability is any condition that influences the ease of movement by livestock or machinery over the soil surface. Steep land slope impacts livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitation(s) for species adaptation are identified. See Appendix A for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Wheatgrass, Tall - Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH below 7.3.

Clover, Kura - Adapted on soils with pH below 7.3.

Clover, Ladino

Clover, Red

Clover, White

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

SPECIES	LEVEL OF MANAGEMENT		
	HIGH ^{1/}	MEDIUM ^{2/}	LOW ^{3/}
Alfalfa or Alfalfa/Grass	4.6T or 7.6AUM	3.3T or 3.7AUM	1.6T or 1.2AUM
Alfalfa/Clover/Grass	4.6T or 7.6AUM	3.3T or 3.7AUM	1.5T or 1.2AUM
Trefoil or Trefoil/Grass	3.7T or 6.1AUM	2.6T or 3.0AUM	1.3T or 1.0AUM
Trefoil/Clover/Grass	4.1T or 6.7AUM	2.9T or 3.3AUM	1.3T or 1.0AUM
Clover/Grass	4.8T or 7.9AUM	3.4T or 3.9AUM	1.6T or 1.2AUM
Brome/Orchard	4.5T or 7.3AUM	3.2T or 3.6AUM	1.3T or 0.9AUM
Smooth Bromegrass	4.4T or 7.2AUM	3.1T or 3.6AUM	1.4T or 1.0AUM
Tall Fescue	4.0T or 6.6AUM	2.9T or 3.3AUM	1.0T or 0.7AUM

Timothy	3.4T or 5.5AUM	2.4T or 2.7AUM	0.9T or 0.7AUM
Reed Canarygrass	4.5T or 7.3AUM	3.2T or 3.6AUM	1.4T or 1.1AUM
Big Bluestem	3.6T or 5.9AUM	2.6T or 2.9AUM	1.3T or 1.0AUM
Switchgrass	3.6T or 5.9AUM	2.6T or 2.9AUM	1.3T or 1.0AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

2/ MEDIUM - Lime and fertilizer are applied to provide 75% of nutrient levels. Most pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize long term stand persistence. Mechanical harvest is limited to 2-3 cuttings per season. Rotational Grazing that achieves 45% animal utilization is practiced.

3/ LOW - Lime and fertilizer are applied to provide less than 50% of nutrient levels. Only noxious weeds are controlled. Varieties are selected based on cost and tradition. Mechanical harvest is completed near species maturity. Continuous grazing that achieves 30% animal utilization is practiced.

Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 23 - FSG No.: G-xxxxN023MN

Very deep, fine textured, moderately well and better drained soils with an available water capacity greater than 6 inches and an average slope percent of 12 to 18.

Major Land Resource Areas: FSG 23-N occurs in 7 MLRA's - 56, 57, 88, 90, 91, 92, 93.

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are gently rolling to hilly, very deep, moderately well to well drained soils on sideslopes, shoulders and summits. The topsoil ranges from loamy sand to clay with 0 to 10 percent rock fragments. Available water holding capacity ranges from 6 to 12 inches within 60 inches of the surface. Topsoil pH ranges from 5.1 to 8.4. Organic matter content of the topsoil ranges from 0 to 5 percent. A seasonal high water table is at depths of greater than 2.5 feet from the surface. Slopes are 8 to 25 percent and average from 12 to 18 percent.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Primary soil limitation for this group is slope. Slopes range from 8 to 25 percent. Potential for cattle trail erosion is high.

These soils range from very acid to moderately alkaline.

Available water capacity is moderate to high. Forage production on soils of moderate water holding capacity will be noticeably affected by wet and dry growing seasons.

Management:

The following management considerations address the soil limitations identified for soil map units included in this Forage Suitability Group.

Slope:

Land slope for these soil map units typically ranges from 12-18% and is generally considered a slight to moderate hazard for management of forage crops. As land slope increases, livestock tend to decrease movement during grazing and favor areas easily accessible. This can result in uneven grazing distribution.

Watering facilities need to be designed considering land slope and may need to be located closer together as topography becomes more severe. The use of pipelines and troughs along with fencing and livestock walkway design will facilitate providing water and improve grazing patterns.

As land slope exceeds 6%, livestock trailing along fences and in walkways increases the hazard for concentrated flow erosion. Fence layout and construction for pastures and walkways can reduce this hazard.

Lengthening walkways to reduce grade and the use of waterbars to shorten slopes will help manage surface water flows. In extreme cases surfacing walkways may be required.

Soil erosion hazards are greater as land slope increases when land is tilled for reseeding fields to introduce new plant species. Use erosion reduction practices during species reestablishment.

Available Water:

Available water holding capacity of these soils is rated moderate (6-9) to high (9-12). Soils with a rating of moderate will have plant growth and forage production adversely affected during periods of below normal precipitation. Select and manage plant species that can tolerate dry conditions on sites where this condition exists. Soils with a rating of high or very high will have plant growth and forage production adversely affected during periods of above normal precipitation. Select and manage plant species that can tolerate wet conditions on sites where this condition exists.

Soil pH:

Soil map units in this group range in pH from strongly acid (5.1) to moderately alkaline (8.4). The pH of acid soils can be raised by adding lime materials. The amount of lime material required will need to be determined by a soil test. Species sensitive to pH require the soil pH be maintained within an acceptable range for persistence and acceptable production. On high pH soils select species adapted to this condition.

Fertility:

An adequate level and balance of nutrients is required for optimum forage species productivity. A soil test is required to determine the need for phosphorous and potassium. Nitrogen is essential for forage grass species. Mixed species stands with one-third or more legume will usually not require nitrogen fertilizer. Mixed stands with less than one-third legume or grass stands will require additions of nitrogen. On soils rated moderately low (<2%) in organic matter and where high rates of nitrogen are recommended on other soils, apply nitrogen as a split application during the production year.

Frost Heave:

Frost heave is a hazard on silty and finer textured soils in this group. The potential for frost heave occurs following a fall with ample rainfall, a winter with little snow cover, and several late winter freeze thaw cycles. Tap rooted legume species can be forced out of the soil surface resulting in the tap root being snapped thereby killing the plant. Frost heave should not be confused with winter kill. Winter kill also affects legume species and occurs from an adverse climatic condition (i.e. formation of ice sheets, warm mid-winter temperatures followed by extreme cold periods, etc.), poor fertility management programs, improper cutting management, and/or selection of varieties not adapted to northern climates.

Planting a grass/legume mixture can reduce the hazard for frost heave since the grass ground cover and grass root system insulate the soil.

Trafficability:

Soils in this group have reduced trafficability due to steeper slopes. Trafficability is any condition that influences the ease of movement by livestock or machinery over the soil surface. Steep land slope impacts livestock movement and grazing efficiency, machine operation for harvest and management, plant productivity, fence construction, and water pipeline installation.

Adapted Forage Species List:

Forage species listed below are considered adapted to this Forage Suitability Group but are not listed in order of preference. Major limitations for species adaptation are identified. See [Appendix A](#) for a list of most forage species common to Minnesota including adaptation considerations for important site conditions.

Cool season Grasses

Bromegrass, Smooth

Orchardgrass - Subject to winter injury.

Timothy - May not persist in the stand.

Tall Fescue - Subject to winter injury. May not persist in the stand.

Bluegrass, Kentucky

Reed Canarygrass

Wheatgrass, Intermediate - Adapted where soil pH is greater than 7.0.

Wheatgrass, Tall - Adapted where soil pH is greater than 7.0.

Wheatgrass, Western - Adapted where soil pH is greater than 7.0.

Legumes - Usually most successful in stands with grass species.

Alfalfa - Adapted on soils with pH above 6.7.

Birdsfoot Trefoil

Clover, Alsike - Adapted on soils with pH below 7.3.

Clover, Kura - Adapted on soils with pH below 7.3.

Clover, Ladino

Clover, Red

Clover, White

Crownvetch - Adapted on soils with pH below 7.3.

Cicer Milkvetch

Warm Season Grasses

Big Bluestem

Indiangrass

Switchgrass

Little Bluestem

Sideoats Grama

Production Estimates of Forage Species at 3 Levels of management:

The production levels shown below are an estimate for soils in this Forage Suitability Group. They should only be used for making general management recommendations. Onsite production information should always be used for making detailed management recommendations.

Production levels are shown as both Ton/Ac (T) and Animal Unit Months/AC (AUM).

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Trefoil or Trefoil/Grass	2.2T or 3.7AUM	1.6T or 1.8AUM	0.9T or 0.7AUM
Trefoil/Clover/Grass	2.2T or 3.7AUM	1.6T or 1.8AUM	0.9T or 0.7AUM
Clover/Grass	3.1T or 5.1AUM	2.2T or 2.5AUM	1.1T or 0.8AUM
Brome/Orchard	2.8T or 4.5AUM	2.0T or 2.2AUM	0.6T or 0.5AUM
Smooth Bromegrass	2.5T or 4.2AUM	1.8T or 2.1AUM	0.7T or 0.5AUM

Tall Fescue	2.3T or 3.8AUM	1.7T or 1.9AUM	0.5T or 0.4AUM
Timothy	2.5T or 4.1AUM	1.8T or 2.0AUM	0.6T or 0.4AUM
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Big Bluestem	1.8T or 3.0AUM	1.3T or 1.5AUM	0.9T or 0.7AUM
Switchgrass	2.5T or 4.1AUM	1.8T or 2.0AUM	0.8T or 0.6AUM

1/ HIGH - Lime and fertilizer are applied to provide optimum nutrient levels. Pests (weeds, insects, and diseases) are controlled. Varieties are selected to maximize and balance quantity and quality of production. Mechanical harvest is completed to optimize number of cuttings per season. Management Intensive Grazing that achieves 65% animal utilization is practiced.

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Pasture Growth Curves:

See [Appendix B](#) for Growth Curves of pasture species.

FORAGE SUITABILITY GROUP 24 - FSG No.: G-xxxxS024MN

These soils are not suited to forage production because they either pond for prolonged periods during the growing season, are quarries, pits, rock outcrop units, or have a slope percent greater than 25.

Major Land Resource Areas: FSG 24 occurs in all MLRA's

Climate: Refer to the climate section at the end of these groups for the MLRA you are working in. (See **Appendix C**)

Soil Suitability Group Description:

The soils in this group are nearly level to very steep, very shallow to very deep, ponded to excessively drained soils on a wide range of landscape positions. Soil properties are quite variable due to the diversity of soils placed in this group. The key factor is why they are unsuitable for forage production. They are either too wet, too shallow, too steep, or too disturbed.

County Soils Map Unit List: See **Legend**

Soil Limitations:

Soil limitations for this group are ponding, soil depth, slope or soil disturbance.

These soils range from extremely acid to moderately alkaline.

Slopes range from 0 to 80 percent. If used for pasture where slopes are greater than 6 percent, the potential for cattle trail erosion is very high.

Disturbed areas such as gravel pits can be reclaimed but the available water capacity still may be low. Forage production on these areas will be noticeably affected by wet and dry growing seasons.

Management:

Soils in this Group are generally unsuitable for the production and management of forage crops due to ponded water, steep slopes, shallow soil depth, or soil disturbance.

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