September 17, 2024

Dan Peterson
Environmental Specialist
Chevron Rockies Business Unit
2115 117th Avenue
Greeley, CO 80631

Re: **Shable USX AB 11-04P**
Reclamation Plan
NWNW, Section 11, Township 7 N, Range 64 W
Weld County, Colorado

Mr. Peterson:

Tasman, Inc. (Tasman) has prepared this Reclamation Plan (Plan) on behalf of Noble Energy, Inc. (Noble) for the Shable USX AB 11-04P in Weld County, Colorado (Site). The Colorado Energy and Carbon Management Commission (ECMC) has assigned this project Remediation Project No. 15910. Surface areas disturbed by remediation activities shall be reclaimed per ECMC Rules 1003 *Interim Reclamation* and 1004 *Final Reclamation of Well Sites and Associated Production Facilities*. Additional remedial activities and assessment results associated with this project were presented to and approved by the ECMC in previously submitted Form 27 reports. In anticipation of reclamation activities, Tasman completed a Site inspection on August 13, 2024; the associated field notes and photo logs are included as Attachment A.

Site Description

The Site is located in Weld County in northeastern Colorado, in the NWNW Quarter-Quarter of Section 11, Township 7 North, Range 64 West near the intersection of County Road (CR) 84 and CR 57, approximately 6 miles northeast of the town of Galeton (Figure 1). There are no surface waters or wetlands within 500 feet of the Site (Figure 2). The current landowner is Shable Homestead LLC.

Site Background

Facility and wellhead decommissioning activities were initiated by Fremont Environmental Inc. (Fremont) in September 2020. Following the ECMC approval of Supplemental Form 27 Document No. 402483363, an initial Site investigation was conducted by Fremont in November 2020 to delineate the horizontal and vertical extents of elevated electrical conductivity (EC) values observed during the wellhead and facility decommissioning activities. Five soil borings (SS-1 through SS-5) were advanced in native material via hand auger to approximately 3 feet below ground surface (bgs). Fifteen confirmation soil samples (SS-1 1Ft, SS-1 2Ft, SS-1 3Ft, SS-2 1Ft, SS-2 2Ft, SS-2 3Ft, SS-3 1Ft, SS-3 2Ft, SS-3 3Ft, SS-4 1Ft, SS-4 2Ft, SS-4 3Ft, SS-5 1Ft, SS-5 2Ft, and SS-5 3Ft) were collected and submitted to Summit Scientific Laboratory (Summit) for analysis of ECMC Table 915-1 Soil Suitability for Reclamation constituents. Analytical results indicated that the EC values in ten confirmation soil samples (SS-1 1Ft, SS-1 2Ft, SS-1 3Ft, SS-2 1Ft, SS-2 2Ft, SS-2 3Ft, SS-3 2Ft, SS-5 1Ft, SS-5 2Ft, and SS-5 3Ft) were above the applicable ECMC Table 915-1 regulatory standard. The remaining soil samples (SS-3 1Ft, SS-3 3Ft, SS-4 1Ft, SS-4 2Ft, and SS-4 3Ft) were in full compliance with ECMC Table 915-1 standards. Confirmation and background soil sample locations are illustrated on Figure 3. Analytical results are presented in Table 1.

A supplemental Site investigation was conducted in January 2021 to collect background soil samples to compare to the EC exceedances observed in soil samples SS-1 1Ft, SS-1 2Ft, SS-1 3Ft, SS-2 1Ft, SS-2 2Ft, SS-2 3Ft, SS-3 2Ft, SS-5 1Ft, SS-5 2Ft, and SS-5 3Ft. Four soil borings (SS-06 Composite through SS-09 Composite) were advanced in native material via hand auger to approximately 3 feet below ground surface (bgs). Four confirmation soil samples (SS-06 Composite, SS-07 Composite, SS-08 Composite, and SS-09 Composite) were collected and submitted to Summit for the analysis of ECMC Table 915-1 Soil Suitability for Reclamation constituents. Analytical results indicated that EC values observed during the September 2020 sampling event in delineation soil samples (SS-2 1Ft, SS-2 2Ft, SS-2 3Ft, and SS-5 2Ft) were above the regulatory standard and Site-specific background levels for EC. Analytical results indicated that EC values observed during the September 2022 sampling event in delineation soils samples (SS-1 1Ft, SS-1 2Ft, SS-1 3 Ft, SS-3 2Ft) were above the applicable regulatory standard but within Site-specific background concentrations. Soil sample locations from the supplemental Site investigation are illustrated on Figure 3 and analytical results are presented in Table 1.

Soils and Vegetation Information

The primary soil type at Site is Renohill Fine Sand Loam with a 6-9% slope (Attachment B). Renohill Fine Sandy Loam soils consist of moderately deep, well drained soils that formed in mixed alluvium, colluvium, and residuum. Renohill soils are found on bedrock-controlled plateaus, alluvial fans, hills, and ridges. Native vegetation in such soils are western wheatgrass, green needlegrass, blue gramma, and big sagebrush. Such soils are used for native rangeland or as dryland and irrigated crop production.

Tasman completed a Site inspection on August 13, 2024, to evaluate general soil and vegetive conditions. Current land use surrounding the Site is rangeland for livestock production, signs of visible grazing were observed with no livestock present. As such, background reference vegetation was collected to the east off-Site, sand bluestem, slender wheatgrass, blue gramma, smooth brome, downy brome, and *Kochia* were observed during the Site inspection. Existing vegetation on-Site is a mix of noxious and invasive weeds including *Kochia* and Downy Brome. Site will be seeded by Noble's reclamation contractor with the approved seed mix (Buffalo Brand Dryland Pasture Mix) per the communication between the landowner and Noble. A comprehensive list of the plants included in the approved seed mix is provided in Attachment C.

Reclamation Operations and Erosion Control

Reclamation seeding will be completed per ECMC series 1000 rules for Final Reclamation and will be completed by Noble's reclamation subcontractor. A third-party consultant will conduct the required annual inspection of the Site during the 2024 growing season after the seed mix has germinated.

Stormwater compliance to prevent soil erosion shall be maintained by a combination of earthwork practices and placement of non-erodible surfaces. No stormwater inspections related to remediation or reclamation activities will be required. If stormwater management is required, it will be implemented.

Annual Final Reclamation Monitoring

Annual Final Reclamation monitoring of the Site shall be conducted in accordance with ECMC 1000-Series guidance and regulations. As determined by rule 1004 c. (2), annual inspections will be completed during the growing season to ensure proper revegetation of the Site. The Site will be monitored until meeting ECMC 1004 *Final Reclamation of Well Sites and Associated Production Facilities*, reaching 80% of

background vegetation density. Once this has been formally verified, the Site will be eligible for a Form 4 submittal documenting the final reclamation closure. Any changes to the land use of the Site will be communicated to the ECMC.

Conclusion

Based on analytical results collected during the January 2021 supplemental Site investigation and understanding of selected dryland grasses and native soil conditions at the Site, there will be no long-term impacts to soil suitability and adjacent rangeland. Analytical results collected during the March 2024 supplemental Site investigation indicated that the EC exceedances recorded during the decommissioning activities investigation completed 2021 were horizontally and vertically delineated and located within the rooting zone. The native Renohill soils are highly effervescent to strongly effervescent from 7 to 60 inches bgs and are slightly saline to saline in nature. The reclamation seed mix selected has as an average 24 inch root structure and was selected for its adaptably to regional soil conditions. Reclamation operations at the Site will be overseen by Noble, working in collaboration with the surface owner, for management and growth of the pasture grasses. Once revegetation has been formally verified, a Form 4 *Closure Report* will be generated.

If you have any questions, do not hesitate to contact me at 303.726.9642 or acook@tasman-geo.com.

Sincerely,

Alex Cook, TECS, QSM

Environmental Scientist

Figures:

1. Site Location Map
2. Site Overview Map
3. Inorganic Soil Chemistry Map

Table:

1. Summary of Inorganic Soil Chemistry Data – Noble Energy, Inc. – Shable USX AB 11-04P

Attachments:

A. Vegetation Monitoring Report
B. United States Department of Agriculture (USDA) Custom Soil Resource Report
C. United States Forest Service (USFS) and Natural Resources Conservation Service (NRCS) Reclamation Seed Mix Plant Data

FIGURE 1

Site Location Map

104°34'30"W 104°34'0"W 104°33'30"W 104°33'0"W 104°32'30"W 104°32'0"W 104°31'30"W 104°31'0"W 104°30'30"W 104°30'0"W 104°29'30"W 104°29'0"W 104°28'30"W 104°28'0"W

40°37'0"N 40°36'30"N 40°36'0"N 40°35'30"N 40°35'0"N 40°34'30"N

PAWNEE NATIONAL GRASSLAND

CO RD 86 CO RD 84 CO RD 59

32 33 34 35

5 4 3 2

8 9 10 11 12 7 8

17 16 15 14 13

Shable USX AB 11-04P

Legend

Site Location

N

0 2,000 4,000 Feet

1 inch = 2,000 feet

1:24,000

DATE: August 2024 DESIGNED BY: B. Nelson DRAWN BY: J. Woffinden	TASMAN EST. 2009	**Tasman, Inc.** **6855 W. 119th Ave** **Broomfield, CO 80020**	**Noble Energy Inc. - 100322 - DJ Basin** **Shable USX AB 11-04P** NWNW, Section 11, Township 7 North, Range 64 West Weld County, Colorado	Site Location Map	Figure 1

FIGURE 2

Site Overview Map

DATE: August 2024 DESIGNED BY: A. Cook DRAWN BY: J. Woffinden	**Tasman, Inc.** **6855 W. 119th Ave** **Broomfield, CO 80020**	**Noble Energy, Inc. – 100322 – DJ Basin** **Shable USX AB 11-04P** NWNW, Section 11, Township 7 North, Range 64 West Weld County, Colorado	Site Overview Map	Figure 2

FIGURE 3

Figure 3, Inorganic Soil Chemistry Map

LEGEND

SOIL SAMPLE LOCATION

ABOVE GROUND STORAGE TANK

FORMER FACILITY

FENCE LINE

CONTAINMENT BERM

CONTAINMENT WALL

SS-1 @ 1'
11/13/2020
EC 5.66
pH 7.72
SAR 1.12

SAMPLE ID & DEPTH (ft)
DATE SAMPLED
EC mmhos/cm
pH UNITS
SAR UNITS

Figure 3
INORGANIC SOIL CHEMISTRY MAP
November 13, 2020

NOBLE ENERGY, INC. ~ SHABLE USX AB 11-04P
NWNW Sec. 11, T7N, R64W ~ 40.593559°, -104.52351°
Weld County, Colorado

Project No.	Prepared by	Drawn by
CO20-084		**TA**
Date	Reviewed by	Filename
1/25/2021	**EB**	**20084Q**

FREMONT ENVIRONMENTAL

Table 1

Summary of Inorganic Soil Chemistry Data

TABLE 1
SUMMARY OF INORGANIC SOIL CHEMISTRY DATA
NOBLE ENERGY, INC.
SHABLE USX AB 11-04P, WELD COUNTY, COLORADO
FREMONT PROJECT NO. C020-084

SAMPLE LOCATION	DATE SAMPLED	DEPTH ft	EC mmhos/cm	pH pH units	SAR units
SS-1 1Ft	11/13/2020	1	**5.66**	7.72	1.12
SS-1 2Ft	11/13/2020	2	**5.36**	7.71	0.667
SS-1 3Ft	11/13/2020	3	**5.44**	7.72	0.474
SS-2 1Ft	11/13/2020	1	**16.2**	7.85	1.42
SS-2 2Ft	11/13/2020	2	**12.9**	8.13	4.17
SS-2 3Ft	11/13/2020	3	**11.7**	7.75	4.7
SS-3 1Ft	11/13/2020	1	2.61	8.05	2.95
SS-3 2Ft	11/13/2020	2	**6.78**	7.69	2.85
SS-3 3Ft	11/13/2020	3	2.18	7.79	3.14
SS-4 1Ft	11/13/2020	1	0.488	8.37	0.119
SS-4 2Ft	11/13/2020	2	1.18	8.23	2.01
SS-4 3Ft	11/13/2020	3	1.33	8.18	1.84
SS-5 1Ft	11/13/2020	1	**7.86**	7.87	2.7
SS-5 2Ft	11/13/2020	2	**14.2**	8.05	1.81
SS-5 3Ft	11/13/2020	3	**8.07**	8.1	4.84
SS-06 Composite	1/4/2021	Composite	**4.01**	7.87	1.34
SS-07 Composite	1/4/2021	Composite	1.47	8.06	1.63
SS-08 Composite	1/4/2021	Composite	**8.12**	8.01	3.31
SS-09 Composite	1/4/2021	Composite	**8.47**	7.79	3.97
Table 910-1 Limits			4	6-9	12

Bold face values exceed the COGCC Limits

ATTACHMENT A

Vegetation Monitoring Report

Vegetation Monitoring Report

Project: Shable USX AB 11-04P

Date & Time: 8/13/2024 11:45

Tasman Personnel: Alex Cook

Weather: Mostly Sunny, No Wind, 82F

Client: Noble Energy, Inc.

Stormwater Issues: None Observed

Debris/Trash On-Site: None Observed

Equipment On-Site: No, equipment has been removed.

Observations:

Site is planned for Final Reclamation seeding, a tractor staged On-Site. Background reference vegetation collected from the eastern
boundary of the Site. Vegetation observed is Sand Bluestem, Slender Wheatgrass, Blue Gramma, Smooth Brome, Downy Brome, and
Kochia. Proposed seed mix for the Site is (Insert Here).

	Site Status	Comments
Vegetation Present?	Yes	See observation section.
Noxious or invasive weeds present?	Yes	Kochia and Downy Brome
Have weeds been managed according to the narrative?	No	No, initial site assessment.

Photo Log (descriptions below)

P1 - Looking north across the Site, road base will be removed before reclamation seeding is completed.

P2 - Looking east across the Site, reclamation operations will re-contour the Site to the original landscape position.

P3 - Looking south across the Site, road base will be removed before reclamation seeding is completed.

Photo Log Continued (descriptions below)

P4 - Looking east across the Site, reclamation operations will re-contour the Site to the original landscape position.

P5 - The road base on Site will be removed as part of the reclamation process.

P6 - Reclamation equipment staged to complete re-contouring and reclamation seeding of the Site.

P7 - Looking north at background reference vegetation area, slender wheatgrass, downy brome, and *Kochia.*

P8 - Looking east at background reference vegetation area, slender wheatgrass, downy brome, and *Kochia.*

P9 - Looking south at background reference vegetation area, slender wheatgrass, blue gramma, and smooth brome..

P10 - Looking north at background reference vegetation area, blue gramma, downy brome, and *Kochia.*

P11 - Vegetation growth up close, blue gramma, smooth brome, and slender wheatgrass growth present.

P12 - Vegetation growth up close, blue gramma, downy brome, and *Kochia* growth present.

Notes

1) All locations are approximate unless otherwise noted.

GPS – Global Positioning System
PID – Photoionization Detector
ppm – Parts per million

0 ft. 75 ft. 150 ft.

N

Image Source: Google Earth; Google 2021
Projection: WGS 1984, UTM Zone 13 North

DATE:	August 15, 2024
DESIGNED BY:	A. Cook
DRAWN BY:	A. Cook

Tasman, Inc.
6855 W 119th Avenue
Broomfield, CO 80020

Noble Energy, Inc. – 100322 – DJ Basin
Shable USX AB 11-04P
NWNW, Section 11, Township 7 North, Range 64 West
Weld County, Colorado

Site Overview

FIGURE
1

ATTACHMENT B

UDSA Custom Soil Resources Map and Report

United States Department of Agriculture

NRCS

Natural Resources Conservation Service

A product of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local participants

Custom Soil Resource Report for Weld County, Colorado, Northern Part

Shable USX AB 11-04P

August 12, 2024

Preface

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (https://offices.sc.egov.usda.gov/locator/app?agency=nrcs) or your NRCS State Soil Scientist (http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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Contents

How Soil Surveys Are Made

Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil

scientists classified and named the soils in the survey area, they compared the individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and

identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

Soil Map

The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.


104° 31' 40" W
104° 31' 4" W
40° 35' 46" N
40° 35' 28" N
539960
540050
540140
540230
540320
540410
540500
540590
540680
540770
4494030
4493940
4493850
4493760
4493670
4493580
4493490
56
55
Soil Map may not be valid at this scale.
Map Scale: 1:3,930 if printed on A landscape (11" x 8.5") sheet.
N
0 50 100 200 300 Meters
0 150 300 600 900 Feet
Map projection: Web Mercator Corner coordinates: WGS84 Edge tics: UTM Zone 13N WGS84

MAP LEGEND

Area of Interest (AOI)
- Area of Interest (AOI)

Soils
- Soil Map Unit Polygons
- Soil Map Unit Lines
- Soil Map Unit Points

Special Point Features
- Blowout
- Borrow Pit
- Clay Spot
- Closed Depression
- Gravel Pit
- Gravelly Spot
- Landfill
- Lava Flow
- Marsh or swamp
- Mine or Quarry
- Miscellaneous Water
- Perennial Water
- Rock Outcrop
- Saline Spot
- Sandy Spot
- Severely Eroded Spot
- Sinkhole
- Slide or Slip
- Sodic Spot
- Spoil Area
- Stony Spot
- Very Stony Spot
- Wet Spot
- Other
- Special Line Features

Water Features
- Streams and Canals

Transportation
- Rails
- Interstate Highways
- US Routes
- Major Roads
- Local Roads

Background
- Aerial Photography

MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:24,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service
Web Soil Survey URL:
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Weld County, Colorado, Northern Part
Survey Area Data: Version 18, Aug 24, 2023

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Jun 8, 2021—Jun 12, 2021

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend (Shable USX AB 11-04P)

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
55	Renohill fine sandy loam, 0 to 6 percent slopes	4.9	8.2%
56	Renohill fine sandy loam, 6 to 9 percent slopes	54.4	91.8%
Totals for Area of Interest		**59.2**	**100.0%**

Map Unit Descriptions (Shable USX AB 11-04P)

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The

delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.

Weld County, Colorado, Northern Part

55—Renohill fine sandy loam, 0 to 6 percent slopes

Map Unit Setting

National map unit symbol: 360b
Elevation: 3,600 to 6,200 feet
Mean annual precipitation: 11 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 100 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Renohill and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Renohill

Setting

Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous, clayey loamy residuum weathered from shale

Typical profile

H1 - 0 to 5 inches: fine sandy loam
H2 - 5 to 18 inches: clay
H3 - 18 to 32 inches: clay loam
H4 - 32 to 36 inches: unweathered bedrock

Properties and qualities

Slope: 0 to 6 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.4 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: D
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Minor Components

Shingle

Percent of map unit: 5 percent

Hydric soil rating: No

Midway

Percent of map unit: 4 percent
Hydric soil rating: No

Ulm

Percent of map unit: 3 percent
Hydric soil rating: No

Other soils

Percent of map unit: 3 percent
Hydric soil rating: No

56—Renohill fine sandy loam, 6 to 9 percent slopes

Map Unit Setting

National map unit symbol: 360c
Elevation: 3,600 to 6,200 feet
Mean annual precipitation: 11 to 16 inches
Mean annual air temperature: 46 to 48 degrees F
Frost-free period: 100 to 160 days
Farmland classification: Not prime farmland

Map Unit Composition

Renohill and similar soils: 85 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Renohill

Setting

Landform: Plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Calcareous, clayey loamy residuum weathered from shale

Typical profile

H1 - 0 to 4 inches: fine sandy loam
H2 - 4 to 17 inches: clay
H3 - 17 to 29 inches: clay loam
H4 - 29 to 33 inches: unweathered bedrock

Properties and qualities

Slope: 6 to 9 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None

Frequency of ponding: None
Calcium carbonate, maximum content: 15 percent
Maximum salinity: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water supply, 0 to 60 inches: Low (about 5.0 inches)

Interpretive groups

Land capability classification (irrigated): None specified
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: D
Ecological site: R067BY002CO - Loamy Plains
Hydric soil rating: No

Minor Components

Platner

Percent of map unit: 5 percent
Hydric soil rating: No

Midway

Percent of map unit: 5 percent
Hydric soil rating: No

Other soils

Percent of map unit: 3 percent
Hydric soil rating: No

Ulm

Percent of map unit: 2 percent
Hydric soil rating: No

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Attachment C

USFS and NRCS Reclamation Seed Mix Plant Data

Attachment C: Reclamation Seed Mix Plant Data, United States Forest Service (USFS) and Natural Resources Conservation Service (NRCS)

Buffalo Brand Dryland Pasture Mix from Buffalo Brand Seed

Included Species:

1. Smooth Bromegrass (*Bromus inermis*)
2. Forage Perennial Ryegrass (*Agropyron fragile*)
3. Orchardgrass (*Lolium perenne*)
4. Pubescent Wheatgrass (*Dactylis glomerata*)
5. Thickspike Wheatgrass (*Elymus lanceolatus*)
6. Intermediate Wheatgrass (*Thinopyrum intermedium*)

Currie and Smith [36] reported that smooth brome planted on low-fertility ponderosa pine (Pinus ponderosa) forest soils in Colorado declined under even light-intensity cattle grazing. They speculated that smooth brome is more likely to persist under cattle grazing on fertile soils.

Laycock and Conrad [77] used cattle to test several grazing systems on rangeland seeded to crested wheatgrasses (Agropyron cristatum and A. desertorum) and smooth brome in mountain big sagebrush (Artemisia tridentata spp. vaseyana) habitat in Utah. They found that average cattle weight gain was the same under all systems, but heavy June grazing in alternate years best promoted grass production.

Ungulates in Yellowstone National Park utilized smooth brome growing in association with other graminoids and forbs, but did not graze smooth brome where it grew in a monoculture [48].

Forestry: In British Columbia, height and biomass of lodgepole pine (Pinus contorta var. latifolia) seedlings established from a mix of lodgepole pine seed and smooth brome and other grass seed were less than height and biomass of lodgepole pine seedlings established from lodgepole pine seed sown alone [28].

Native grassland restoration: Smooth brome dominates many native grasslands and old fields [2]. Masters and Vogel [82] stated that on tallgrass prairie, it is usually found in areas with a history of overgrazing and/or fire exclusion. Grassland restoration efforts often include controlling smooth brome with cool-season grass herbicides such as atrazine and glyphosate, mowing, and/or prescribed fire [73].

Anderson [2] found that near Lincoln, Nebraska, fall application of glyphosate helped control smooth brome. Atrazine may not be as effective; other studies [83,96] have reported that while atrazine controlled other exotic cool-season grasses, it did not significantly reduce smooth brome.

Establishment and maintenance: Seed handling and planting guidelines for smooth brome are available [49,116,117]. Cultivars adapted to selected environments and/or regions are sold commercially [56,103,104,108,119,123].

Smooth brome requires fertile soil in order to maintain nutritional quality. On infertile soils it needs periodic fertilization or a companion nitrogen fixer. On rangelands smooth brome is usually planted in a mix with alfalfa (Medicago sativa), yellow sweet clover (Melilotus officinalis), or other legume species. Fertilization affects growth allocation: Watkins [120] found that fertilizers increased leaf and shoot growth but reduced rhizome and root growth.

Rhizomatous cultivars become sod-bound after several years unless litter is removed by grazing and/or fire [56,110].

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Bromus inermis

GENERAL BOTANICAL CHARACTERISTICS :
Smooth brome is an exotic, cool-season grass from 1.3 to 3.2 feet (0.4-1.0 m) tall. Blades are flat. The inflorescence is an open panicle from 2.4 to 6.8 inches (6-17 cm) long bearing 6 to 11-flowered spikelets. Lemmas have short awns (<2 mm) or are unawned [53,54,61].

Two principle types of smooth brome are recognized, the northern and southern. The northern type is weakly rhizomatous, with leaves well up on the stem and short glumes. A few northern cultivars are actually bunchgrasses. The southern type is strongly rhizomatous, with leaves near the base of the stem and long glumes. Other notable differences are earlier spring growth of the southern type and more even growth of the northern type through the growing season [55].

In a meadow in West Virginia on shallow silty loam, smooth brome roots grew to a depth of 18 inches (46 cm), with most of the root biomass occurring in the first 3 inches (7.6) of soil. (Average root

productivity was 717.7 lbs/acre inch at 0-3 inches below ground [52].) Witte [127] found roots as long as 9.4 feet (2.87 m).

Due to cloning, smooth brome is a long-lived species. Plantings have persisted for at least 60 years [98].

RAUNKIAER LIFE FORM :
Hemicryptophyte

REGENERATION PROCESSES :
Smooth brome reproduces by seed, rhizomes, and tillers. Spread by seed has been rated moderate, and vegetative spread has been rated good [97].

Smooth brome is usually cross-pollinated [72,86], although it may self-fertilize from different spikelets of the same plant [86]. McKone [72] found that seed set was significantly lower in smooth brome than in other brome species. Insect herbivory has been cited as a factor reducing seed set in smooth brome [86,91]. Seed yield of smooth brome broadcast-planted in Michigan 174 pounds per acre when grown with alfalfa and 121 pounds per acre when grown alone [122]. Seed has remained viable for 22 months to over 14 years [49,55]. Seed stored in a shed for 19 years showed 20 percent germination [66]. Seed requires stratification to germinate. Germinative capacity of fresh, stratified seed has varied from 83 to above 95 percent in the laboratory [49]. Optimal temperatures for germination in the greenhouse were from 68 to 86 degrees Fahrenheit (20-30 deg C) [49]. Like all cool-season species, however, smooth brome can germinate at lower temperatures. Bleak [17] reported that smooth brome seed sown in late fall to early winter in central Utah germinated and produced roots and shoots under deep snow cover. Light enhances germination but is not required [49].

Seedling growth is rapid [56,59]. Knobloch [72], who described germination and seedling development in detail, reported that 54 days after sowing, greenhouse-grown seedlings had 150-millimeter-long roots, five leaves, and had begun tillering. Baker and Jung [9] found that under greenhouse conditions, the optimal day temperature for growth was between 64.9 and 76.8 degrees Fahrenheit (18.3-24.9 deg C), and that food reserves were depleted less with low night temperatures than with warm night temperatures. Cultivars differ in rate of growth and drought tolerance [30].

SITE CHARACTERISTICS :
Smooth brome is widely adapted to a variety of sites. It is common in riparian zones, valley bottoms, and dryland sites. [48,56,119]. It is adapted to all soil textures [49,55,90], although it may not thrive on sand or heavy clay [119]. Smooth brome tolerates acid soils; it comprised the dominant cover on a coal spoil of pH 4.5 in British Columbia [56]. It does not grow on soils that are more than moderately alkaline [55]. It is fairly saline tolerant [56]. Smooth brome grows best on moist, well-drained soils [49], but tolerates poorly drained soils [32]. Smooth brome is best adapted to regions receiving more than 15 inches (380 mm) of annual precipitation [98,119]. Eleven inches (280 mm) of annual precipitation is the minimum that will support smooth brome without irrigation [98].

Some cultivars of smooth brome are adapted to northern latitudes and high elevations [60,102]. Smooth brome persists to about 9,000 feet (2,743 m) elevation in the northern Rocky Mountains [24,119] and to about 11,000 feet (3,300 m) in the central and southern Rocky Mountains [119]. General elevational ranges in several states are:

from 7,000 to 10,000 feet (2,134-3,048 m) in Arizona [69]
below 8,900 feet (2,700 m) in California [61]
from 4,500 to 10,000 feet (1,372-3,048 m) in Colorado [57]
from 4,096 to 10,352 feet (1,280-3,235 m) in Utah [121]

SUCCESSIONAL STATUS :
Smooth brome generally invades after disturbance and persists [19,20,37]. It is a common invader of disturbed prairie throughout the Great Plains [112,125,126]. In Yellowstone National Park, Wyoming, smooth brome cover was similar in young eastern cottonwood (Populus deltoides), mature eastern cottonwood, and grassland areas [19]. Boggs and Weaver [20] reported that along the Yellowstone River, moderate grazing increased the occurrence of shrubs in mature eastern cottonwood, and severe grazing converted the area to smooth brome, timothy (Phleum

pratense), and Kentucky bluegrass (Poa pratensis).

Smooth brome tolerates moderate shade to full sun [49,56]

SEASONAL DEVELOPMENT :
Smooth brome undergoes fall green-up. Inflorescences are initiated during cool, short fall days [90]. In colder climates, smooth brome is dormant in winter. It may remain green year-round in southern climates [76]. Spring growth begins early in the season [110,107]. Lengthening culms expose the panicles in late spring to early summer [90], and smooth brome flowers in summer. In Minnesota, flowering occurred from early to late June [80,86]. It occurred in late May or early June in Ames, Iowa, with later, sporadic flowering [72]. Phenology is delayed in northern latitudes and high elevations. Smooth brome on the Wasatch Plateau of Utah flowers 85 to 102 days after snowmelt [44]. Seed matures in early to late summer [49]. Smooth brome grows throughout the growing season when soil water is adequate. Under dry soil conditions it becomes dormant, but it resumes growth when soils moisten [16].

FIRE ECOLOGY

SPECIES: Bromus inermis

FIRE ECOLOGY OR ADAPTATIONS :
Most smooth brome cultivars are rhizomatous [56,110], and survive fire by sprouting from rhizomes. Weakly rhizomatous or bunchgrass types probably regenerate after fire primarily by tillering. Rates of postfire recovery probably differ between cultivars, with rhizomatous types recovering more quickly than bunchgrass types, but such differences have not been documented in the literature.

Periodic early spring or fall fire promotes rhizomatous smooth brome by removing litter from sod-bound plants [56,110].

FIRE REGIMES :
Find fire regime information for the plant communities in which this species may occur by entering the species name in the FEIS home page under "Find Fire Regimes".

POSTFIRE REGENERATION STRATEGY :
Rhizomatous herb, rhizome in soil
Tussock graminoid

FIRE EFFECTS

SPECIES: Bromus inermis

IMMEDIATE FIRE EFFECT ON PLANT :
Smooth brome is probably top-killed by fire.

PLANT RESPONSE TO FIRE :
Early spring (late March-April) or late-season (late summer-fall) fire can increase smooth brome productivity [62,65], especially when smooth brome has become sod-bound. Late spring fire generally damages cool-season grasses such as smooth brome [8,82]. Old [93], Kirsch and Kruse [71], and Blankespoor [15] have reported reductions in smooth brome with late spring burning.

Old [93] attributed decreases in smooth brome after late April fire to the advanced stage of development of smooth brome. Rate of smooth brome regrowth after fire cannot always be predicted based solely upon season of burning and attendant phenological stage, however. Blankenspoor and Larson [16] cited soil moisture and nutrient levels and soil texture as factors other than phenological stage that may affect smooth brome rate of recovery.

In order to determine at which stage of growth smooth brome is most susceptible to fire, Willson [124] prescribe-burned smooth brome at tiller emergence (late March at the Mead, Nebraska, study site), tiller

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

Plant Fact Sheet

PERENNIAL RYEGRASS

Lolium perenne L.

Plant Symbol = LOPE

Contributed by: USDA NRCS Northeast Plant Materials Program

Britton & Brown 1913
Illustrated Flora of the Northern States and Canada
@ PLANTS

Uses
Perennial ryegrass is a valuable forage and soil stabilization plant. This species is the predominant forage grass in Europe, and has been used in the United States for forage and lawns. Generally speaking, the tetraploid cultivars are used for forage, and diploid cultivars are for lawns and conservation plantings. Users should double check the intended use of the available cultivars before buying seed. Italian ryegrass is primarily used for quick cover in erosion control plantings.

Status
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status (e.g. threatened or endangered species, state noxious status, and wetland indicator values).

Description
Perennial ryegrass grows from 1 to 2 feet tall with a bunchy form, and has medium longevity. Some turf varieties are longer lived. There are numerous long, narrow, stiff leaves near the base of the plant. The under surfaces of leaves are bright, glossy, and smooth. Inflorescence stems are nearly naked. Seedheads are spikes with spikelets growing edgewise to the seedhead stem. Seeds do not have awns (bristles). There are approximately 230,000 seeds per pound.

Italian ryegrass is quite similar to perennial ryegrass except it is an annual or biennial, depending on climate and/or length of growing season. It may grow a little taller than perennial ryegrass: from 2 to 3 feet tall. The seeds of this sub-species have awns.

Adaptation
These grasses have a wide range of adaptability to soils, but thrive best on dark rich soils in regions having mild climates. They do not withstand hot, dry weather or severe winters. They will stand fairly wet soils with reasonably good surface drainage.

Perennial ryegrass is distributed throughout the entire United States. For a current distribution map, please consult the Plant Profile page for this species on the PLANTS Website.

Establishment
A fine, firm seedbed gives the best results. Mulched seedings on graded soil germinate readily. Spring seedings of ryegrass may occur in March, April, or May. Perennial ryegrass may also be seeded mid-August to early September. Seeding rates will vary with local conditions and purpose of plantings. Generally, a rate of 20 to 25 pounds per acre is used if ryegrass is seeded alone. Lesser amounts per acre are used in mixtures, depending upon uses and companion species. Do not exceed 4 pounds per acre in mixes with alfalfa.

Management
Ryegrass is generally cut for hay when seed is in the soft-dough stage. Ryegrass responds well to good management, such as intensive rotational grazing and fertilizer applications.

seeding is compatible with the establishment of tree seedlings [61]. Seedling survival of trees planted in established stands of orchardgrass can be greatly enhanced (depending on soil type) by the application of herbicide before planting.

On sites where growth of tree seedlings is desirable, grazing by cattle and wildlife improves tree growth compared with no grazing or grazing by wildlife alone. The degree of forage use and timing of grazing are critical to tree growth/cattle use compatibility; light, early season grazing is the most beneficial [36,47].

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Dactylis glomerata

GENERAL BOTANICAL CHARACTERISTICS :
Orchardgrass is a cool-season, perennial bunchgrass, 1.4 to 4 feet (0.5-1.2 m) tall with erect, glabrous culms and blades 4 to 16 inches (10-40 cm) long and 0.1 to 0.5 inch (0.2-1.1 cm) wide. The inflorescence is a panicle with two to six florets per spikelet, with the spikelets tightly clustered on one side of the branch. Orchardgrass is nonrhizomatous [21]. Most root development is in the upper 3 inches (8 cm) of soil but extends to at least 18 inches (46 cm) below the surface [23], producing a dense sod of medium-sized roots [26].

RAUNKIAER LIFE FORM :

Hemicryptophyte

REGENERATION PROCESSES :
Orchardgrass reproduces largely by seed and by tiller formation. The relatively large seed does not have an innate dormancy [24]. Seed can germinate in either light or darkness; germination is largely controlled by moisture availability, and most seed germinates in the fall. Thus, orchardgrass does not tend to build up seedbanks in the soil [24].

SITE CHARACTERISTICS :
Orchardgrass is best adapted to well-drained, rich or moderately fertile soils with an adequate water regime (12 inches or more annual precipitation [30 cm]) [24,28,62,71] and temperatures that are not extreme [4,28]. Optimum top growth is achieved at temperatures of approximately 70 degrees Fahrenheit (21 deg C) [72]. Orchardgrass is shade tolerant and does well at higher elevations in the western United States and Canada (4,900 to 6,200 feet [1,500-1,900,m]) [28]. It is widely planted in the eastern United States, most notably in Pennsylvania, Maryland, and West Virginia [13].

SUCCESSIONAL STATUS :
Facultative Seral Species

Orchardgrass is shade tolerant. It is often seeded on disturbed areas and is naturalized to fields, meadows, and waste places [67]. It is long-lived but susceptible to replacement by native species, especially in drier areas, and does not usually persist past 1 or 2 decades [12,42,43].

Stands of orchardgrass tend to become clumpier with age, especially

under high nitrogen conditions. This may be best explained by the relative amounts of competition among tillers and among plants [72].

SEASONAL DEVELOPMENT :
Orchardgrass begins growth early in spring and flowers from May to September or October. In dry areas it is dormant in summer, but will add new growth in the fall, and will flower again in fall under appropriate conditions. Most European populations are obligately dormant in the summer, showing no growth even when irrigated. Some Mediterranean populations do not have this obligate dormancy [16]. A green basal rosette is maintained through winter [14]. Flowering appears to be temperature rather than light dependent [20]. Seed shattering takes place in late summer; most seed will germinate in fall as there is no innate dormancy [24].

FIRE ECOLOGY

SPECIES: Dactylis glomerata

FIRE ECOLOGY OR ADAPTATIONS :
NO-ENTRY

FIRE REGIMES :
Find fire regime information for the plant communities in which this species may occur by entering the species name in the FEIS home page under "Find Fire Regimes".

POSTFIRE REGENERATION STRATEGY :
Tussock graminoid
Caudex, growing points in soil
Ground residual colonizer (onsite, initial community)
Secondary colonizer - offsite seed

FIRE EFFECTS

SPECIES: Dactylis glomerata

IMMEDIATE FIRE EFFECT ON PLANT :
In general, bunchgrasses with large accumulations of dead material can generate high temperatures for long periods of time after the fire has passed. This can reduce fire survival for older plants [73].

DISCUSSION AND QUALIFICATION OF FIRE EFFECT :
NO-ENTRY

PLANT RESPONSE TO FIRE :
Orchardgrass is reported to increase or remain stable after burning [11,52].

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE :
NO-ENTRY

Pests and Potential Problems
This section is under development.

Cultivars, Improved, and Selected Materials (and area of origin)
Ryegrasses cross-pollinate freely so many types have developed. It is difficult to maintain their genetic purity; consequently, Italian ryegrass is marketed as common ryegrass or domestic ryegrass, and it is often a mixture of annual and perennial species. There is no certification of this seed since pure varieties of Italian ryegrass are almost non-existent.

There are many cultivars of perennial ryegrass available for turf application. Newer turf-type cultivars are often intentionally infected with an endophytic fungus to improve stress-tolerance. Tetraploid forage cultivars also abound.

Seed of cultivars and common annual ryegrass is readily available from local commercial suppliers.

Prepared By & Species Coordinator:
USDA NRCS Northeast Plant Materials Program

Edited: 05Feb2002 JLK; 060802 jsp

For more information about this and other plants, please contact your local NRCS field office or Conservation District, and visit the PLANTS Web site<http://plants.usda.gov> or the Plant Materials Program Web site <http://Plant-Materials.nrcs.usda.gov>

United States Department of Agriculture
Natural Resources Conservation Service
Plant Materials Program

'Manska' Pubescent Wheatgrass

Thinopyrum intermedium

A Conservation Plant Release by USDA NRCS Plant Materials Center, Bismarck, North Dakota

'Manska' pubescent wheatgrass (*Thinopyrum intermedium* [Host] Barkworth & D.R. Dewey) was released cooperatively in April 1992 by the USDA Agricultural Research Service, the USDA Natural Resources Conservation Service, the North Dakota Agricultural Experiment Station, and the University of Nebraska. The cultivar is high in nutritive value and is recommended for pasture and hay in regions of the northern and central Great Plains that average at least 14 inches of annual precipitation.

Description

Pubescent wheatgrass is a cool-season, sod-forming grass introduced from Eurasia, where it is widely distributed. Plant is 2.4 to 4 feet tall; seed head has short, stiff hairs and has a spike 4 to 8 inches long that matures in August. Leaf blade is flat and veined, broad at the base and tapered to a point. Auricles are of medium length and clasping. Ligule is short. It is similar in appearance and production to intermediate wheatgrass. Pubescent wheatgrass, however, is a subspecies of intermediate wheatgrass that is distinguished by the presence of short, stiff hairs on the seed head. Approximately 70% of the plants from Manska are pubescent. Manska is moderately rhizomatous and heads 7 to 8 weeks after spring green up. Nearly all (85-90%) of the tillers produce seed heads. Plant height is intermediate between slender and tall wheatgrass.

Source

The source population for Manska consisted of plants selected from diverse seed lots of Mandan 759, an experimental strain of pubescent wheatgrass that has had wide commercial use but has never been formally released as a cultivar. This selection was tested as Mandan I 2781 (PI 562527). The plants were evaluated at the Northern Great Plains Research Laboratory, Mandan, North Dakota, to determine resistance to leaf-spot disease, spring recovery, nutritional quality, and forage and seed yields.

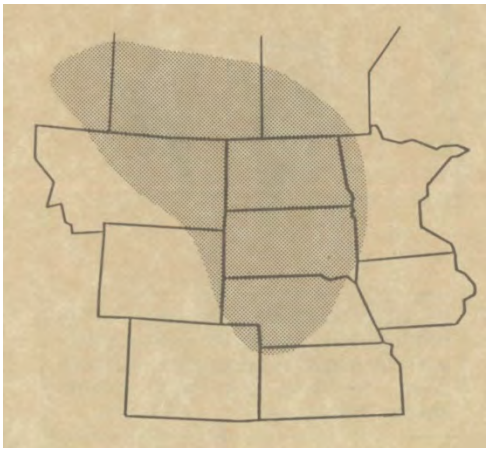
Conservation Uses

Manska is recommended for pasture and hay. High nutritive value is the primary advantage of Manska over other cultivars of pubescent and intermediate wheatgrass. In tests at Mandan, North Dakota, in vitro digestible organic matter at flowering averaged 62% and 56% for Manska and 'Oahe', respectively. At Meade, Nebraska, daily gains from yearling steers averaged 2.7 lb for Manska and 2.3 for Oahe over two grazing periods at a high stocking rate of three steers per acre. Weight gains for the two grazing periods averaged 266 and 230 lb/ac, respectively, for Manska and Oahe. Dry matter yields of hay averaged over 13 station years at four test sites in North Dakota were 3774 and 3776 lb/ac, respectively, for Manska and the most commonly grown intermediate wheatgrass cultivar, Oahe. In Nebraska, dry matter yields from 8 station years at 3 test sites averaged 5135 and 5403 lb/ac, respectively, for Manska and Oahe, a 5% yield advantage for Oahe. No data exist on long-term persistence of Manska under grazing. Based on performance of other pubescent and intermediate wheatgrass cultivars, maintenance of Manska at a high stand density under grazing would likely require prudent management to assure adequate fall-season recovery, especially when stressed from drought or exposed to high levels of winter stress in the northern Great Plains.

Area of Adaptation and Use

Manska is adapted over a relatively large geographic area of the northern and central Great Plains. Pubescent wheatgrass becomes dormant under hot, dry conditions, and Manska is not recommended for areas that average less than 14 inches of annual precipitation. Manska is adapted to a wide range of coarse and fine-textured soils,

but has only moderate tolerance to soil salinity. The primary area of adaptation for Manska is indicated on the map below.



Establishment and Management for Conservation Plantings

Pubescent wheatgrass has good seedling vigor compared with other commonly grown grasses. Stand establishment is enhanced by seeding into a well-packed, weed-free seedbed. Shallow seed depth (less than 1 inch) is desirable. Chemical weed control after grass seedlings have reached the three-leaf stage will hasten stand establishment. Successful stands are obtained by seeding in early spring, late summer if soil water is adequate, or by use of a dormant seeding in late fall when soil temperature is maintained below 40 degrees F. A seeding rate of 20-25 pure live seeds (PLS) per square foot (10-12 lb/ac PLS) is recommended when pubescent wheatgrass is seeded alone.

Seed and Plant Production

Seed heads of pubescent and intermediate wheatgrasses do not shatter as readily as many other grass species, and seed maturation among tillers is usually quite uniform. The seed crop is usually swathed because shattering may result in serious yield losses if seed matures under dry, windy conditions. Seed yields of Manska from 12 station years at 4 dryland test sites in North Dakota and Saskatchewan averaged 380 lb/ac.

Availability

For conservation use: For more information on availability and use of Manska pubescent wheatgrass, contact your local NRCS field office or the Bismarck Plant Materials Center.

For seed or plant increase: Foundation seed of Manska is available for certified seed increase from the USDA NRCS Plant Materials Center, Bismarck, North Dakota and the Foundation Seed Division, Department of Agronomy, University of Nebraska, Lincoln, Nebraska.

For more information, contact:
USDA-NRCS Plant Materials Center
3308 University Drive
Bismarck, ND 58504
Phone: (701) 250-4330
http://Plant-Materials.nrcs.usda.gov

Citation

Release brochure for Manska pubescent wheatgrass (*Thinopyrum intermedium*). USDA Natural Resources Conservation Service, Plant Materials Center. Bismarck, North Dakota 58504. Published March 1993, revised January 2014.

For additional information about this and other plants, please contact your local USDA Service Center, NRCS field office, or Conservation District <http://www.nrcs.usda.gov/>, and visit the PLANTS Web site <http://plants.usda.gov> or the Plant Materials Program Web site <http://www.plant-materials.nrcs.usda.gov>

USDA NRCS
United States Department of Agriculture
Natural Resources Conservation Service

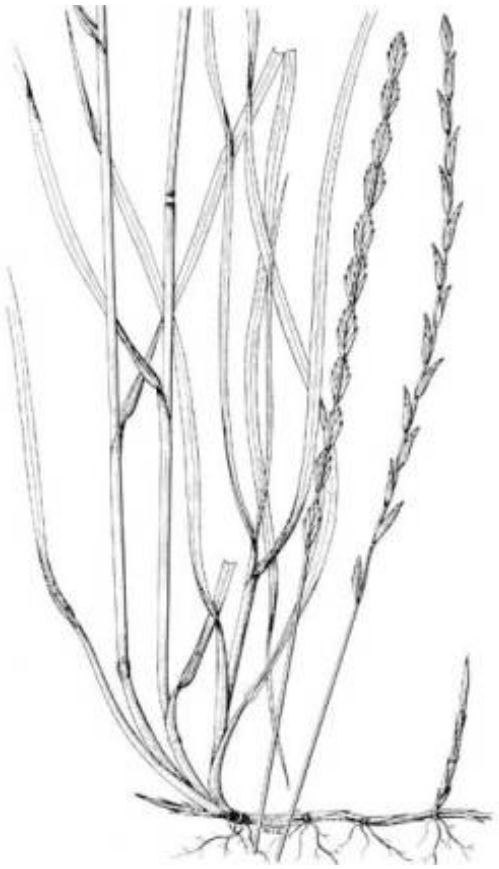
Plant Guide

INTERMEDIATE WHEATGRASS

Thinopyrum intermedium (Host) Barkworth & D.R. Dewey

Plant Symbol = THIN6

Contributed by: USDA NRCS Idaho State Office



Hitchcock (1950)

Alternate Names

Agropyron intermedium, *Elytrigia intermedia*, pubescent wheatgrass, *Agropyron trichophorum*, *Thinopyrum intermedium* ssp. *barbulatum*

Uses

Grazing/pastureland/hayland: This is an introduced species used for hay and pasture in the northern Great Plains, west to eastern Washington, and south into Colorado and Kansas. It produces good hay yields, both individually and with alfalfa (*Medicago* spp.), where stiff stems tend to keep alfalfa from lodging.

Intermediate wheatgrass has fairly slow re-growth following clipping and is best adapted to single crop-haying situations. Intermediate wheatgrass responds very well to irrigation with production nearing the level of 'Regar' meadow brome (*Bromus biebersteinii*) and orchardgrass and exceeding smooth brome (*Bromus inermis*) under full irrigation. 'Regar' and orchardgrass (*Dactylis glomeratus*) will normally out produce intermediate wheatgrass hay production in multiple cutting situations. Intermediate wheatgrass responds well to limited irrigation. It is able to tolerate droughty conditions when irrigation ceases as long as about 12 inches of total moisture is provided. It provides excellent spring, early summer, and fall pasture, but must be carefully managed to ensure maintenance of the stand and high production.

Intermediate wheatgrass is palatable to all classes of livestock and wildlife. It is a preferred feed for cattle, sheep, horses, deer, antelope, and elk in spring, early summer and fall. It is considered a desirable feed for cattle, sheep, horses, and elk in summer and winter.

Erosion control/reclamation: Intermediate wheatgrass is well adapted to the stabilization of disturbed soils. This grass can be used in critical and urban areas where irrigation water is limited and to stabilize ditchbanks, dikes, and roadsides. This grass can also be use to build soils because of its heavy root production. Levels as high as 7000 pounds (dry weight) per acre of root production in the upper 8 inches of soil have been measured in five-year-old stands.

Wildlife: Strips of this grass ungrazed provide good nesting cover for game birds and migratory waterfowl.

Status

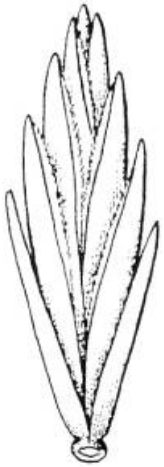
Please consult the PLANTS Web site and your State Department of Natural Resources for this plant's current status, such as, state noxious status and wetland indicator values.

Description

General: Grass Family (Poaceae). As one of the common names implies, the spikes, spikelets, glumes, lemmas, and leaves of what was considered pubescent wheatgrass were densely covered with hairs, whereas intermediate wheatgrass vegetative structures are for the most part smooth, but may have ciliate hairs on the leaf margins. The materials of both are now considered to be encompassed by the species *Thinopyrum intermedium*.

Intermediate wheatgrass grows to 3 to 4 feet tall. It is a long-lived, cool season grass with short rhizomes and a deep feeding root system. The seed spikes may be up to 4 to 8 inches long. Leaves are 4-8 mm wide and green to blue-green in color and sometimes drooping. The lemmas, paleas, and glumes are smooth to pubescent. The glumes are acute to blunt, generally five nerved, awnless to awn tipped. The florets are usually fewer than seven. Intermediate wheatgrass commercial seed often contains both pubescent and glabrous forms.

Distribution: Intermediate wheatgrass is a perennial grass introduced in 1932 from Europe and Asia. Included in this group is a form that was known as pubescent wheatgrass (*Agropyron trichophorum*), which was introduced in 1934 from Europe and Asia and considered slightly more drought tolerant and winter hardy. For current U.S. distribution, please consult the Plant Profile page for this species on the PLANTS Web site.



Hitchcock (1950)

Establishment

Adaptation: Intermediate wheatgrass is adapted to areas with 12 to 13 inches of annual rainfall or greater. The pubescent form can tolerate slightly more droughty conditions of about 11 to 12 inches of rainfall or greater. It performs best above 3500 and up to 9000 feet elevation. It can be seeded at lower elevations, but its moisture requirement is greater. It is not as drought tolerant as 'Hycrest', 'Nordan', 'Ephraim', 'Douglas', 'Fairway' crested wheatgrasses (*Agropyron cristatum*); 'P27', 'Vavilov' Siberian wheatgrasses (*Agropyron fragile*); or 'Bozoisky-Select', 'Mankota' Russian wildrye (*Psathyrostachys juncea*).

Intermediate wheatgrass prefers well drained loamy to clayey textured soils. The pubescent form performs best on loamy to sandy to shallow soils. It will tolerate slightly acidic to mildly saline conditions, is cold tolerant, can withstand moderate periodic flooding in the spring, and is very tolerant of fire. The pubescent form can tolerate lower fertility, more alkaline soils, higher elevations, and drier conditions than glabrous form. It performs poorly on wet, poorly drained, and moderately saline to alkaline soils with prolonged inundation.

Planting: It should be seeded with a drill at a depth of 1/2 inch or less on medium to fine textured soils and no more than 1 inch deep on coarse textured soils. Recommended seeding rates are 10 to 12 pounds Pure Live Seed (PLS) per acre or 21 to 25 PLS seeds per square foot. A firm weed free seedbed enhances stand establishment. It is compatible with other species, particularly alfalfa (*Medicago* spp.). Stand longevity and seeding with alfalfa can enhance productivity. If used as a component of a mix, adjust to percent of mix desired. The best dryland results are obtained from seeding in very early spring on heavy to medium textured soils and in late fall (dormant) on medium to light textured soils. Irrigated lands should be seeded in spring through summer. Late summer (August - mid September) seedings are not recommended unless irrigation is available.

For mind lands, roadsides, and other harsh critical areas, the seeding rate should be increased to 15 to 18 pounds PLS per acre or 31 to 38 PLS seeds per square foot.

Intermediate wheatgrass establishes fairly quickly, more quickly than 'Regar' meadow brome or smooth brome varieties. Seedling vigor is good to excellent. Under favorable conditions intermediate wheatgrass provides good noxious weed suppression. It makes good spring growth, fair summer growth, and good fall growth, if moisture is available. Light, frequent irrigation is beneficial for stand establishment.

Protect a new seeding until it is fully established and are able to withstand pulling by grazing animals without being uprooted. It is desirable to cut at least one hay crop prior to grazing.

Stands may require weed control measures during establishment. Application of 2,4-D should not be made until plants have reached the four to six leaf stages. Mow weeds at or prior to their bloom stage. Grasshoppers and other insects may also damage new stands and pesticides may be needed.

Classifications describing communities in which thickspike wheatgrass is dominant are as follows:
Idaho [108]
Nevada [126]
North Dakota [102]
Utah [126]
Wyoming [113]
Alberta [27,28,29]
Saskatchewan [27,28,29]

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Elymus lanceolatus

GENERAL BOTANICAL CHARACTERISTICS:
Thickspike wheatgrass is a long-lived [119], cool-season, North American native grass. Culms are erect and hollow, 6 to 50 inches (15-130 cm) tall [31,54,57,65,67,85,91,98,118]. Blades are flat or involute, 0.04 to 0.20 inch (0.1-0.5 cm) wide and 0.8 to10 inches (2-25 cm) long [31,54,57,64,65,67,85,98,118,125]. Inflorescences are terminal, erect, compact spikes, 1 to 9 inches (3-22 cm) tall. Solitary or occasionally paired spikelets have 2 to11 flowers that are 0.2 to 0.9 inch (0.6-2.4 cm) long [31,54,57,64,67,98,118,125]. The plant produces a 1-seeded, indehiscent caryopsis fruit [48,66,101]. Hallsten and others [57], Hitchcock and Cronquist [66], and Welsh and others [125] provide detailed morphological descriptions and identification keys for thickspike wheatgrass.

This perennial, sod-forming grass [8,10,31,54,65,67,80,119,125] has an extensive creeping rhizome system [54,57,64,65,67,91,118,119,124] with a few deep roots [119]. Average maximum root depth of mature, well-developed thickspike wheatgrass is approximately 15 inches (38 cm). Most of the root mass is confined to the upper 8 inches (24 cm) of soil and is so dense in well-established plants that percolation through the root system is slow and encroachment of other species with deeper root systems may be inhibited [118].

Thickspike wheatgrass is often dominant in its habitat, and it may appear in small, pure stands over localized areas [118]. However, large, pure stands are rare [10,118].

RAUNKIAER [103] LIFE FORM:
Hemicryptophyte
Geophyte

REGENERATION PROCESSES:
Breeding system: Thickspike wheatgrass reproduces vegetatively through long, creeping rhizomes and sexually by seeds [131]. On sand dunes and sandy soils, it spreads mainly by rhizomes, but under favorable conditions it may establish from shattered seeds [132].

Pollination: Unlike most other species of its genus, thickspike wheatgrass is an outcrossing species [11,61].

Seed production: Thickspike wheatgrass has excellent seed production. Production rates range from 200 pounds per acre (270 kg/ha) on dryland [110] to 350 to 400 pounds per acre (480-540 kg/ha) under irrigation [56,109,110]. Increased production is associated with higher rainfall or irrigation [109,110].

Seed dispersal: No information

Seed banking: Persistent seed banks appear to be important for thickspike wheatgrass populations' survival. Thickspike wheatgrass seeds in dune systems along Lake Erie and Lake Huron accumulated in unevenly spaced depressions after dispersal. Seeds were not dormant at maturity. Nearly all buried thickspike wheatgrass seeds were capable of immediate germination in favorable conditions; few were dead. Average seed life was 3 to 4 years [132]. A study of effects of sand burial on thickspike wheatgrass seeds reported that both percent germination and percent emergence of buried seeds were negatively correlated with burial depth. Burial of young seedlings up to 2.4 inches (6 cm) deep enhanced growth in height, leaf and tiller production, and overall dry weight of thickspike wheatgrass [131].

A study of the effects of fire on ecosystem seed banks in Yellowstone National Park reported thickspike wheatgrass seeds were present in the seed banks of undisturbed Douglas-fir (*Pseudotsuga menziesii*)/common snowberry (*Symphoricarpos albus*) habitat types and in burned areas of Idaho fescue (*Festuca idahoensis*)/bluebunch wheatgrass habitat types [26].

Germination: Under ideal conditions, germination of thickspike wheatgrass occurs in 21 days [123]. Prechilling appears to improve germination [119,123].

Seedling establishment/growth: Thickspike wheatgrass seedlings sprout and grow vigorously, and the species spreads rapidly via rhizomes once the population is established [19,70,119].

Asexual regeneration: Thickspike wheatgrass spreads primarily via vegetative reproduction from rhizomes [70]. Several shoots may arise from 1 node of the rhizome [28], and the plant may produce numerous vegetative stems [45,77,78]. Rhizomes may be up to 6 inches (15 cm) long [72,73].

The clonal plasticity of thickspike wheatgrass's rhizome systems is important in foraging for favorable sites as well as for interacting with neighboring root systems [69]. The plant may produce numerous short rhizomes in high-nutrient patches, allowing more efficient foraging in soil with patchy nutrient availability [72]. Under competition from other plants, it tends to produce fewer rather than shorter rhizomes [73]. Thickspike wheatgrass had more closely-spaced stems when surrounded by a high density of neighboring plants [74].

SITE CHARACTERISTICS:
Soil: Thickspike wheatgrass is usually found in dry, medium- to coarse-textured, sandy to gravelly to loamy soils in open areas and dunes [10,19,31,47,110,118]. It tolerates soil pH of 6.0 to 9.5 [61]. Preferred substrate types of thickspike wheatgrass for some states in its range are as follows:

California	dry, sandy [98]
Colorado	sandy or gravelly soil [63]; rocky slopes and moist borrow pits [124]
Idaho	loess soils in southern part of state
Montana	glacial outwash fans
Washington	stabilized sand dunes in eastern part of state [119]
Wisconsin	sand dunes and beaches along Lake Michigan [46]
Wyoming	shay or gravelly soil [57]

Elevation: The natural geographic range of thickspike wheatgrass is from near sea level in the Great Lakes region to 11,000 feet (3,350 m) in the Rocky Mountains [119,125]. Elevation ranges for some states are as follows:

California	1,640-4,000 feet (500-1,200 m) [64,98]
Colorado	5,000-10,000 feet (1,520-3,050 m) [63]

Idaho	up to 10,000 feet (3,050 m) [118]
New Mexico	6,000-8,000 feet (1,830-2,440 m) [91]
Utah	4,000-11,000 feet (1,220-3,350 m) [125]

Topography/aspect: Thickspike wheatgrass favors north-east slopes in the coulees of the Oldman River, Alberta [90] and north-facing slopes in southern Alberta grasslands [30].

Moisture regimes: Thickspike wheatgrass prefers moist, well-drained soils [70] and is most abundant in areas that receive 8-20 inches (200-500 mm) of precipitation annually [68,109]. The species can withstand moderate flooding, but will not tolerate long periods of inundation, poorly drained soils, or excessive irrigation [61,119]. Thickspike wheatgrass is known for its drought resistance [8,23,34,70]; in extreme drought conditions, the plant becomes dormant but recovers quickly when watered. Under severe water stress, it can develop negative turgor pressure, and in hot, dry conditions, the leaves roll into a tight, cylindrical shape [92].

Tolerance for harsh environments: Thickspike wheatgrass will tolerate slightly acidic to moderately saline conditions. It is cold tolerant, moderately tolerant to intolerant of shade, highly tolerant of grazing, and very tolerant of fire [61,119]. Its relatively low nutrient requirements allow it to establish on mine spoils, depleted rangelands, and other disturbed areas [61].

SUCCESSIONAL STATUS:
Thickspike wheatgrass is found in all successional stages. A study of primary succession on coastal Lake Michigan sand dunes aged 25-2,375 years old reported occurrence of thickspike wheatgrass on dunes aged 55-225 years, with a peak occurrence on dunes 145-175 years old [89]. It is found in early-succession as well as mid- to late-succession communities in the Great Lakes area of Wisconsin [20]. Thickspike wheatgrass is listed as a dominant species in the climax vegetation of the eastern glaciated plains and the western sedimentary plains of Montana [105]. It is a dominant in the climax communities of two ungrazed mesas in western North Dakota [102].

A postfire succession study in southeastern Idaho reported that thickspike wheatgrass was most abundant in earlier successional stages, though it was common in all stages. Its tolerance of competition accounts for its presence in later stages of postfire vegetation development [71].

SEASONAL DEVELOPMENT:
Thickspike wheatgrass flowers in the Pacific Northwest from May through July [67] and from June through August in the Intermountain region [31] and Great Plains [54]. It flowers in June and July in California [98] and New Mexico [91]. Seeds mature from July to early August [131]. In Canada, growth begins mid-April, flowering occurs in early July, seeds mature from July to September, and foliage remains partially green until late September or early October [28].

Infection of thickspike wheatgrass root systems by mycorrhizal fungi may delay phenology [2]. Defoliation, which results from grazing, may also alter the phenology [94]. Cooler temperatures and less droughty conditions may prolong later stages of growth in Canada [28].

The following phenology data are averages from a study in the Snake River Plains, Idaho [18]:

Growth starts	4/1
Flower stalks appear	5/21
Heads fully out	6/16
Flowers in bloom	6/27
Seed ripe	7/27