BEAVER VALLEY RANCH
IRRIGATION EVALUATION AND
IMPROVEMENT RECOMMENDATIONS

PREPARED FOR

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Appendices

I. PROJECT OVERVIEW - SCOPE OF SERVICES

A. Review Existing Water Rights Information

Upon execution of the signed contract for this project, Nelson Engineering (NE) received a property report prepared by David Geible titled "Mineral Ownership Status Performed for Jason King, Grand Real Estate" from the client, Jason King. This report detailed deeded property ownership, mineral rights, and water rights associated with the property, subsequently referred to in this report as Beaver Valley Ranch (BVR). The water rights permit numbers, associated acreage, and legal descriptions were used to compile a catalog of maps which NE utilized to create comprehensive maps of the existing water rights appurtenant to the property.

B. Prepare Water Rights Exhibit

After reviewing the information compiled in the Geible report, Nelson Engineering utilized the State Engineer's Office (SEO) online database to find additional information for the water rights on the property. Nearly every recorded water right for the Beaver Valley Ranch included a map of survey from the original filing. NE was able to download all of the available maps for each of the water rights studied during this project. These maps were then used to create a drawing of the existing water rights for the property that included all of the land area indicated by the original water rights filings.

C. Compile and Analyze Existing Groundwater Data

Nelson Engineering also utilized the State Engineer's online database to investigate groundwater rights in the vicinity of Beaver Valley Ranch. Unfortunately, there are very few existing permits in the area and those that were identified were very shallow spring sources or very deep wells with low flow rates.

D. Visit Project Site with Owner

Ty Ross traveled to the site on September 16th, 2019 and met with Jason King at the ranch. Ty and Jason toured the ranch area and Jason identified some of the aging irrigation infrastructure and locations for potential irrigated fields.

E. Springs Base Flow Measurement

Following approval from Jason King, Strike Consulting Group was hired as a sub consultant to perform streamflow measurements of the existing springs that surface near the main ranch house. This exercise was employed to understand the year-round base flow for the Middle Fork of Cottonwood Creek downstream of the springs convergence point, by obtaining what was considered the minimum anticipated, winter-time flow rate.

F. Review Existing Climate Data

Nelson Engineering utilized web-based soils data provided by the Natural Resources Conservation Service (NRCS) and conversations with the local NRCS to analyze potentially viable hay field locations. NRCS data was also used in a very limited capacity to evaluate seepage at the potential reservoir sites. Additionally, NE utilized information from the Wyoming Climate Atlas to estimate evaporation losses for the ranch site.

G. Investigate Making Changes to Existing Water Rights

NE made contact with the SEO and discussed the feasibility and procedure for amending the existing water rights held by the Beaver Valley Ranch. During preliminary discussions, it seems that the most viable option for developing additional lands for irrigation would be to file for new water rights.

H. Prepare Irrigation Improvements Exhibit

Nelson Engineering has created exhibits indicating some potential locations for center pivot sprinkler structures. Exhibits delineating potential locations for water storage reservoirs have also been created.

I. Provide Report to Owner

II. WATER RIGHTS RESEARCH

Overview maps depicting the locations of existing water rights are found in Appendix A.

A. Johnson Ditches #1-#5

The Johnson Ditch water rights are the original surface water rights for BVR. Ditches #1, #3 and #4 are assigned to the east side of the Middle Fork of Cottonwood Creek and Ditches #2 and #5 are assigned to the west side of the creek. These water rights areas were transcribed onto the exhibits found in Appendix A through utilization of the original mapping from the State Engineer's records. The springs that supply the ranch house drinking water and converge in the Middle Fork drainage do not appear to be appropriated for irrigation or other uses, including domestic supply for the ranch house, based on the information available through the SEO website.

After creating a composite map of the existing water rights for this area, it became apparent that the existing surface water rights do not cover the entire area of the main ranch site. Some locations that have been historically irrigated are not appropriated for irrigation, and some locations that are covered by surface water rights appear not to be historically irrigated. In addition, some small portions of the water rights and historically irrigated area lie off the fee simple property on adjacent public lands.

The Johnson Supply Ditch water right (P13058) is a fully adjudicated supply water right on East Cottonwood Creek that is in place to augment the Middle Fork Cottonwood Creek drainage and related irrigation flows for the Johnson Ditch #1-#5 water rights. It appears that this ditch has not been maintained in some time. However, if reliable, supplemental flow from East Cottonwood Creek could be re-established, a great deal more water could be made available for irrigation along the Middle Fork drainage.

B. Rock Cut Ditch and Wales #1

The Rock Cut Ditch and Wales #1 (Enlarged) are diversions from Middle Cottonwood Creek. The majority of the land area that has been adjudicated for irrigation purposes is predominantly located within section 15, which is south of the main ranch area. The land area covered by these water rights carries a NRCS Capability Class 6, which presents significant difficulties for developing a viable field, in addition to challenging topography. The ideal scenario for the water rights covering this area would be abandonment and re-assignment of the adjudicated land area to preferable locations near the main ranch area identified for potential fields in subsequent sections of this report.

C. Johnson Ditch and East Cottonwood Ditch

The Johnson Ditch (P7759) and East Cottonwood Ditch (P8998) are water rights that are adjudicated for irrigation use in section 35. These water rights are dedicated to the area just east of the confluence of West Cottonwood Creek and Middle Cottonwood Creek. Although the irrigated lands for these water

rights are located near Middle Cottonwood Creek, the diversion for the 25-acre East Cottonwood water right is located on East Cottonwood Creek in Section 2 east of the main ranch area. These areas are limited to the narrow creek bottom and are not ideal for implementing modern irrigation infrastructure. Additionally, these water rights are located in the same area of the largest potential water storage reservoir (discussed in Section VII of this report).

D. Wash Ditch #1, #2, and #3

The Wash Ditch water rights are located on West Cottonwood Creek within a portion of the Beaver Valley Rach property that is not contiguous with the main ranch fee simple land. The associated land areas appear to be restricted to the narrow creek bottom. The distance from the main ranch site and the limited arable land in this location make this site undesirable for irrigation development. However, portions of fee simple land exist in the vicinity that are quality candidates for potential land swaps with the Bureau of Land Management (BLM) to increase the amount of higher quality, arable land nearer to the main ranch.

E. Ole Ditch #1 and #2

Ole Ditch #1 and #2 are diversions on West Cottonwood Creek, reported by Jason King to be more so an intermittent drainage, as opposed to Middle and East Cottonwood drainages exhibiting perennial streamflow characteristics. The land area assigned in these water rights are situated, again, on property that is non-contiguous with the main ranch land. Due to the distance from the main ranch, the extensive amount of large rocks noted by Jason King and observed in the field and on aerial imagery, and the limited available streamflow, this location was deemed ineligible for potential irrigation improvements. However, the adjudicated areas associated with these water rights, totaling 82 acres, do exhibit vegetative growth and may be capable of limited hay production, despite the intermittent supply source and limited land capability reported by the NRCS.

F. Wales Ditch #2

The Wales Ditch #2 water right is located on East Cottonwood creek. The land area associated with this water right is limited to a narrow section adjacent to the creek. The remoteness of this location and associated land mass (10 acres) do not present a practical beneficial use toward crop production. NE recommends that the irrigation flow associated with this water right be allocated elsewhere within BVR, to a region of higher arable efficacy. Irrigation improvements were not considered for this site.

G. Sheep Creek Ditch #1 and #2

These water rights are located approximately 6 miles away from the main ranch and in another township. Although these water rights are adjudicated for a significant amount of land, this area was not studied for irrigation improvements, at the request of Jason King.

H. Green Mountain Spring

The Green Mountain Spring was developed by the BLM on public land for stock watering purposes at a rate of less than 10 gallons per minute (gpm). The statement of completion indicates that this is a shallow well and was installed with a long plastic delivery pipe. There are no apparent locations that indicate that this spring is being, or has been utilized for irrigation purposes. Since the well is off property and relatively distant from fee simple and/or viable cropland, it was not considered as a potential contributor to the overall main ranch irrigation system.

I. Boulder Spring

The Boulder Spring was also constructed by the BLM for stock watering, albeit on fee simple BVR land. It appears to be a shallow well and aerial imagery indicates that there may be a watering structure in place. This spring is located on a small, remote parcel, and while it certainly may be useful for grazing operations, it was not considered for irrigation uses.

III. GROUNDWATER RESEARCH

Nelson Engineering utilized the State Engineer's online water rights database to research existing wells near the ranch site. Unfortunately, there are not any groundwater permits that present a viable groundwater source within several miles of the main ranch site. The nearest, and most informative permit is located approximately 3 miles north of the ranch house. This well was drilled in 1943 to a depth of 322ft and is appropriated for 5 gpm. Water is conveyed to the surface via windmill. Other wells in the area include very shallow wells that have been utilized for springs development and very deep monitoring wells that were put in place during uranium exploration in the valley. Please refer to Appendix B for well permit documentation associated with the "Victory Well" north of the ranch.

The lack of any substantive well data in the region is likely an indication that development of a productive groundwater source carries a very low likelihood for success.

IV. SITE VISIT

On September 16th, 2019 Ty Ross, of Nelson Engineering, travelled to Beaver Valley Ranch to meet with Jason King and perform some initial reconnaissance and information gathering. Ty and Jason toured the existing irrigation network, the bulk of the main ranch site, and much of the adjacent public lands.

During the tour, Jason mentioned that West Cottonwood Creek is far less productive than Middle Cottonwood Creek, especially during the critical, latter part of the irrigation season. According to Jason, West Cottonwood is the least productive of the three forks of Cottonwood Creek, producing little more than a trickle following spring runoff from nearby Green Mountain.

The minimal baseflow of West Cottonwood Creek was observed and documented by Ty, but no attempt to approximately measure the flowrate was made. East and Middle Cottonwood Creeks are far more productive, and better source candidates for consideration of possible irrigation improvements. Nonetheless, the elevated area with minimal relative relief west of the West Cottonwood drainage was toured as a potential cropland location. It was noted during the site visit that due to the limited amount of flat ground immediately adjacent to the drainage, the presence of excessive large rocks, boulders, and poor underlying soil types on the mesa west of the drainage, and marginal late-season flows within the drainage itself, a potential hay meadow employing West Cottonwood Creek as a supply source was unlikely. However, vegetative growth along the fringe of the creek indicated limited hay production may be feasible, as attested by the Ole Ditch #1 and #2 water rights. A first cutting within a very defined, minimal area may be possible, but extensive production, even if irrigation improvements are attempted, would be dubious.

During the investigation of the home site, Ty noted that there are multiple spring rivulets materializing in a swampy, lowland area south of the ranch house and nearby barn, and an existing pond of limited size south of the primary access road. The multitude of individual rivulets culminate and flow through the property along the Middle Cottonwood Creek drainage northward. The primary water source for the ranch house originates within the lowland area where a corrugated metal pipe is installed vertically, functioning as cistern storage, and piped to the ranch house via gravity.

The convergent spring flow was observed north of the ranch house and Jason indicated he would like to take advantage of the perennial discharge for irrigation purposes. A rudimentary streamflow measurement was performed by timing the movement of a blade of grass along the approximate channel thalweg and conservatively estimating the dimensions of the channel. Subsequent calculations employing the field data indicated a base flow on the order of 0.5 cubic feet per second (cfs).

While on site, Ty and Jason viewed and discussed potential sites that may be suitable for small dams to create storage reservoirs. Ty had identified three locations potentially suitable for water storage applications prior to visiting the site, including the vicinity of the primary diversion structure located approximately one-half mile southwest of the ranch house. Jason indicated that ideally, he would prefer to locate a reservoir downstream of the springs convergence point, along the Middle Cottonwood drainage, so that both the spring flow and creek flow may be utilized to fill the water storage reservoir. A storage reservoir north of the house site would likely be a good central location to serve potential irrigation facilities in all directions, and Jason confirmed he was unconcerned about inundating a portion of the existing pastureland. Notes and sketches regarding the prospective locations of fields and reservoirs are annotated on a quadrangle map background in Appendix C.

Jason indicated that he intends to begin work on improving and revitalizing the existing irrigation ditches and diversion structures during the fall of 2019 and spring 2020 as weather allows. Lacking irrigation efforts by prior property owners over the last several years has resulted in severe dilapidation of most all related infrastructure.

V. CLIMATE AND SOILS DATA

The majority of the soils data for this project was obtained through the NRCS Web Soil Survey program. NE utilized the NRCS online data to create soils reports for various portions of BVR. Soils report inquiries focused on the main ranch area; however, preliminary research was done for the entire ranch region to discern whether there were some potentially highly productive fields in the surrounding area. Although multitudinous NRCS reports were generated, primary soil reports utilized for evaluating the potential hay field locations can be found in Appendix D.

The NRCS office in Riverton was consulted during the course of the study, and in those conversations, it was recommended that the potential for certain areas as future irrigated fields should be assessed with the “Land Capability” rating from the Web Soil Survey. The NRCS indicated that Land Capability ratings of 4 and lower are typically indicative of areas capable of being conditioned into productive fields. This exercise confirmed NE’s understanding that the locations with the greatest potential for hay production are north of the home site on either side of Middle Cottonwood Creek.

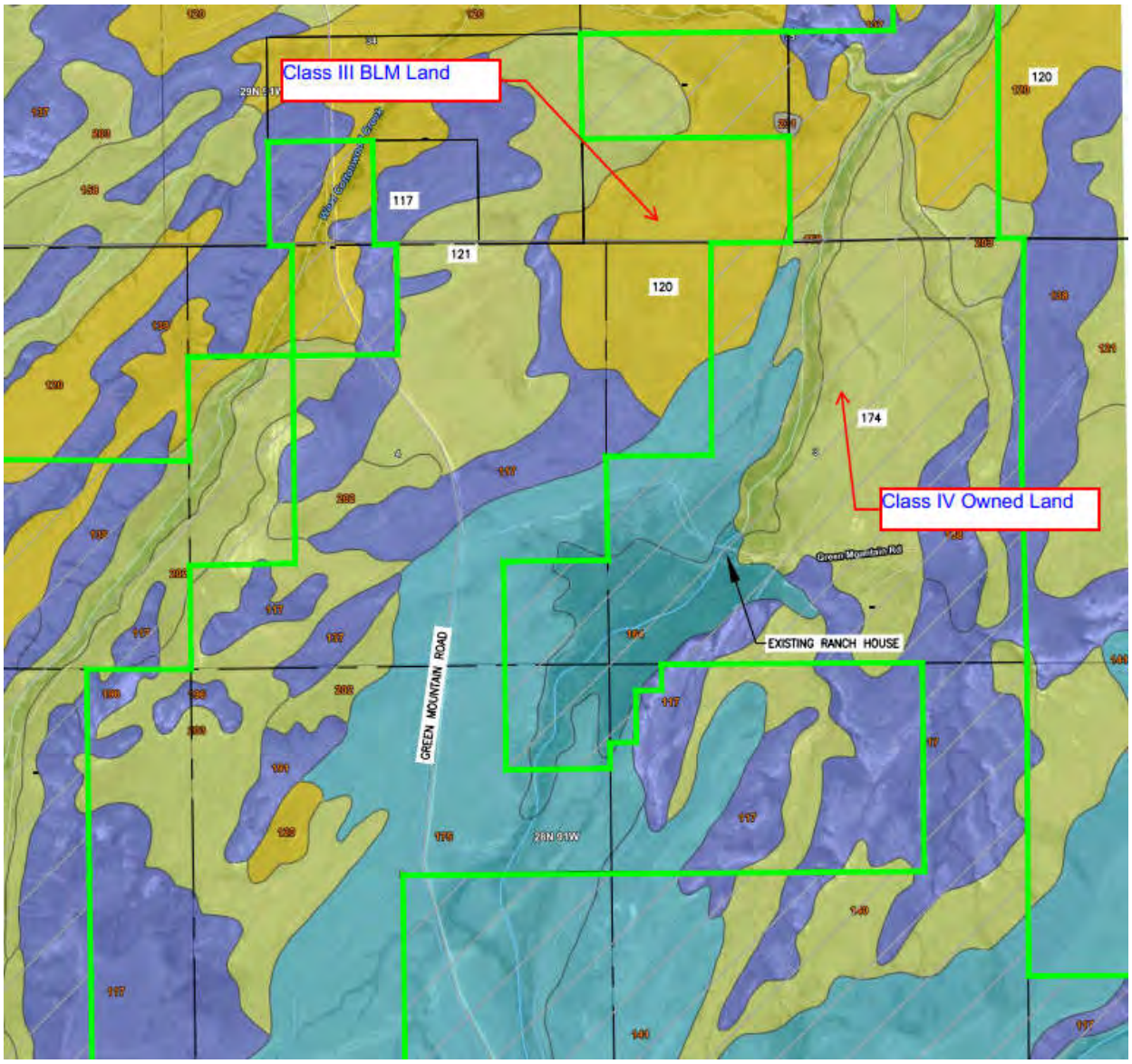


Figure 1 – Land Capability Ratings at main ranch area

The Wyoming Climate Atlas was utilized to identify the approximate rate of evaporation for Beaver Valley Ranch. The data provided by the Wyoming Climate Atlas discussing evaporation is provided by a study done by the National Climatic Data Center (NCDC), which is a subsidiary of the National Oceanic and Atmospheric Administration (NOAA). This study provides data from 11 pan evaporation weather stations across the state. The nearest and most appropriate pan evaporation station is located at Pathfinder Dam, which is roughly 45 miles from BVR and similar in elevation.

Location		JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	Annual
Pathfinder Reservoir	Mean	0.6	0.7	1.5	2.2	3.5	5.1	6.8	6.0	3.7	1.7	0.9	0.6	33.3
	SD	0.4	0.5	0.7	1.1	1.6	1.7	0.9	1.1	1.2	1.1	0.4	0.3	4.0
	High	1.0	1.7	2.6	4.5	5.9	8.3	8.4	7.8	5.3	3.1	1.9	1.1	39.9
	Low	-0.9	-0.2	-0.2	0.5	0.1	1.1	5.0	2.4	1.0	-0.8	-0.2	-0.4	19.8

Table 1 Mean, Standard Deviation, High and low net evaporation (in inches) from estimates using the Kohler-Nordenson-Fox equation with a coefficient of 0.7 for evaporation – Wyoming Climate Atlas 10.4 Evaporation Rates for Select Wyoming Stations

As would be expected, and as evidenced in Table 1, the two months exhibiting the highest evaporation rates are July and August, coinciding with the approximate timeframe during which supplemental irrigation would be necessary to maximize hay production.

VI. UPDATING EXISTING WATER RIGHTS

Nelson Engineering contacted the SEO and spoke to staff in the Surface Water Division regarding potentially modifying the existing water rights of Beaver Valley Ranch. The existing Point of Diversion, Point of Diversion and Means of Conveyance, and Place of Use can be changed through a petition filed through the SEO Board of Control (BOC).

Petitions to change the existing water rights could preserve their seniority and original filing dates, although the petition process can be lengthy and tedious, especially considering the diversity of water rights associated with BVR. Changing the Place of Use relies on utilizing the same water body or supply source. As an example, the water rights associated with the Rock Cut Ditch and Wales #1 could be petitioned to revise the diversion location to the main ranch area and modify the Place of Use to newly proposed hay field locations. This would require filing a structured petition that meets Board of Control guidelines, including a map of the existing and proposed diversion locations, and identification of the existing and proposed areas of use.

Filing for new water rights for the potential hay fields is also an option. In fact, NE's research through the SEO revealed that the existing BVR springs are not presently permitted for any use, and their beneficial use for any reason would require new SEO permits. However, since there are currently no intervening, downstream users of Cottonwood Creek between Beaver Valley Ranch and the confluence of Cottonwood Creek and the Sweetwater River, it can be safely assumed that new water rights would have sufficient seniority to be fully utilized for the intended, new uses. One potential benefit to applying for new rights, as opposed to petitioning for changes to existing rights, would be that the applicant is not required to create mapping for the existing water rights, or prepare a lengthy petition, likely resulting in cost savings.

A temporal element should also be weighed when considering petitioning the BOC vs. filing directly with the SEO for new water rights. New water rights can be filed at any time and approved on a statutory timeline, whereas the BOC specifically holds only four, quarterly meetings annually for consideration of petitions. Additionally, it is often necessary for petitions to be considered at multiple BOC meetings.

Another matter concerning the plethora of BVR water rights specifically, involves State filing fees. The SEO pointed out that filing fees for new surface rights are $50 and the cost to cancel a right is also $50. The costs to file a petition is $20 plus an additional $8 for each additional sheet. Most petition submittals are three to four sheets.

One additional water right issue discovered by NE during the course of the study, but unrelated to crop irrigation, concerns the existing domestic use at the ranch house. As mentioned previously, the BVR springs are not presently permitted for any beneficial use designation. Since the springs are actively being utilized for domestic purposes, an associated water rights application should be filed with the SEO. Assuming the desired maximum domestic flowrate will not exceed 25 gpm, a relatively simple groundwater permit can be sought. Permitting the springs for irrigation purposes at a yield exceeding 25 gpm will require more stringent surface water permitting procedures.

VII. WATER STORAGE OPTIONS

During the initial site visit there were a few locations identified as potential reservoir sites along Middle Cottonwood Creek. These locations were used as a guideline to begin evaluating and more precisely defining storage reservoir alternatives. NE evaluated the dam locations for each potential site based on topography to refine damn positioning, in an effort to optimize the amount of resultant storage against the amount of required earthwork. Based on digital topography data obtained by NE exhibiting higher accuracy than that available through the Fremont County Geographic Information System, NE relocated dams to narrower sections of creek bottoms. Water storage drawings are available for review in Appendix E.

A. Ranch House Reservoir

The first embankment location that was analyzed as a potential storage site was at the entrance road directly west of the ranch house. This site was known to have a few contributing factors that would be beneficial in storing additional water on site. This location already has a road embankment at the dam site which would potentially reduce the amount of earthwork required to build a damn embankment in this area. The footprint area of the reservoir would also be located, at least partially, on a site that currently holds water. This gives an additional level of confidence that the soils at this site are not prohibitively porous, allowing excessive leakage of stored water.

Unfortunately, the proximity to the existing house presents some problems for this storage location. By maintaining the water level of the potential reservoir low enough to avoid inundating the basement of the ranch house, the available storage volume in this location is quite limited, on the order of 3 million gallons. To put this value into perspective, utilizing a typical 5 gpm per acre irrigation demand and a 300-acre field, this small reservoir would only facilitate irrigation for 1.4 days, neglecting inherent evaporation and leakage losses. It is possible that a more detailed survey and closer study of the design could produce more storage at this location, but expanding the existing pond near the ranch house appears to provide little benefit.

B. Central Reservoir

The second reservoir location that was studied is referred to as the “central reservoir” due to its proximity to the ranch house and the potential hay fields. The site for the central reservoir was chosen by selecting a dam location where the flanks of the creek bottom rise steeply from the creek. Several embankment heights were drawn and assessed for storage capacity, but the largest embankment for this site is shown on the central storage exhibit. The storage potential for this reservoir is nearly 25 million gallons. By using

the same assumptions mentioned earlier, this reservoir could potentially be utilized for irrigation purposes for approximately 11.5 days, neglecting losses.

The location of the central reservoir is easily the best out of any of the options presented. Close proximity to the ranch house and the potential hay field locations reduces the lengths required to install new utilities to the reservoir site and waterlines from the reservoir to irrigation facilities.

C. North Reservoir

A storage reservoir at the northeast corner of the BVR Property and east of the original Henry Johnson Reservoir abandoned in 1959 has the greatest potential for storage volume among the options considered in this study. Not only does this location offer the greatest potential storage capacity, but a reservoir located downstream of the confluence of West and Middle Cottonwood Creeks would benefit from a higher inflow rate than the options situated further south. Although the flows of West Cottonwood Creek are known to be marginal, any additional flows should be considered as a benefit to the operation of the reservoir. One added benefit of constructing a reservoir at this location would be less, currently productive hay field area being inundated by the construction of the reservoir. Based on aerial imagery, there are no apparent productive hay meadows within the footprint the North Reservoir would occupy.

The location of the reservoir is the least effective/efficient in terms of necessary additional pumping head to reach future irrigation infrastructure, and in addition, the reservoir is located further away from the potential hay fields. Following suit with the other reservoirs mentioned above, the 77 million gallons of available storage would be capable of supplementing irrigation for over 35 days, neglecting losses.

D. South Reservoir

The south reservoir site was identified during the September site visit near the primary diversion structure. The dam location that maximizes storage volume would cause the water in Middle Cottonwood Creek to “back up” onto the adjacent BLM property. The storage potential for this site is small, less than 15 million gallons. The best trait for this storage location is that stored water could be conveyed to the central part of the ranch property via gravity, and potentially replenish other reservoir storage situated further downstream. The height of the reservoir is not enough to provide adequate operating pressure for irrigation facilities. However, if the reservoir were equipped with pumps, related costs would certainly be less than other options.

The footprint of the reservoir would inundate some existing hay meadows near the creek bottom, but not nearly as much as some other options. A 15-million-gallon storage reservoir would provide nearly 7 days of irrigation water for 300 acres of hay field, neglecting losses.

E. Base Inflow Stream Measurement

Following consultation with Jason King regarding the importance of an accurate spring baseflow measurement, Strike Consulting Group out of Lander was brought onto this project to more precisely quantify streamflow north of the home site where the springs concentrate in the Middle Cottonwood drainage. Strike visited the site during January in order to measure the stream flow at a time when runoff and precipitation would not contribute significantly to the baseflow. The results of this measurement may be treated as a minimum, reliable baseflow rate that can be expected year-round. The streamflow was measured and approximated to be 0.6 CFS.

If the measured, reliable baseflow rate is considered for a reservoir with a surface area of 10 acres (the central reservoir is this size when at capacity), the constant inflow of 0.6 CFS would equate to a rise of 1.43 inches per day. To put this into perspective, the net average evaporation for the Pathfinder Reservoir in August is 6.0 inches. Dividing by the number of days in August provides an evaporation loss of 0.194 inches per day. This suggests that the anticipated baseflow of Middle Cottonwood Creek would be approximately seven times greater than the evaporation rate of the central reservoir when at capacity.

F. Reservoir Seepage Loss Evaluation Discussion

The NRCS utilizes soil mapping and depth to bedrock to perform initial seepage assessments of potential reservoir sites. Per the NRCS Web Soil Survey database and consultation with the Riverton NRCS office, the site suitability for reservoirs is rated poor for all locations on the ranch using this methodology. Nearly all of the mapped soil types in this area are assigned a relatively high hydraulic conductivity and very few test holes in the area contacted bedrock. It is speculated that the original Henry Johnson Reservoir on the north end of BVR was abandoned, in part, due to poor storage retention attributable to excessive seepage.

The seepage evaluation method employed by the NRCS equates the hydraulic conductivity with seepage loss through the subsurface below the reservoir and assumes that bedrock is of low permeability. Using this method, the soil types and inflow rates from Middle Cottonwood Creek and the springs at the ranch house site would likely fail to fill or maintain reservoir pool elevations at this site. While this may be the case, to more accurately evaluate seepage at any particular reservoir site, an investigation involving subsurface exploration, laboratory testing, and flow net analysis should be conducted. The complexity of soil and bedrock profiles, the actual hydraulic conductivity of limiting layers, the potential existence of limiting preferential flow paths, and other variables need be addressed as part of reservoir feasibility studies. The results of such an investigation will then offer data on reservoir design including the use of site soils in the embankment, the need for a full or partial liner, use of site soils as a liner, the need for a cut off wall within or below the embankment, along with other useful information. Simply put, the evaluation of a reservoir site in terms of seepage is considerably more complex than employing a singular hydraulic conductivity estimate.

NE recommends that the property owner consults further with the NRCS to determine if the agency will assist in a more thorough reservoir seepage and siting evaluation. Without further study, the worst-case assumption must be employed: a liner will be required under the entire footprint and along the embankment. Common lining types include PVC, LLDPE, and HDPE membranes, geo-composite clay liners, and imported clays. Liner cushion and cover soils are required with most types.

VIII. IRRIGATION IMPROVEMENTS

A strategy to irrigate the available potential crop lands on the property begins with a useable storage reservoir. As mentioned above, excessive seepage may present a significant challenge in developing adequate water storage on site. Assuming a viable storage component exists, a system of pumps and pipelines to supply water to irrigation systems will be necessary. An exhibit depicting potential irrigation improvements is provided in Appendix F.

A. Center Pivot Sprinkler Systems

It would be difficult to suggest any type of irrigation device other than a center pivot for this property. Center pivot sprinklers are widely used and there are many dealers for different brands of pivots across the state, including a Reinke dealer in Lander, WY. Center pivots are reliable, efficient, and typically require little maintenance and manpower.

Due to the volume of water typically applied by center pivot sprinklers, a significant source of power is often required. Most often, a three-phase power supply is utilized to feed the pumps that supply water to the pivots, but in some cases, a single-phase power service is sufficient. During preliminary discussions with Jason King, it was indicated that the nearest location for three-phase power service is approximately 4 miles from the ranch. Therefore, utilization of three-phase power for any future irrigation project at BVR is unlikely. Most irrigation suppliers also offer gas or diesel-powered options for remote sites like this one. A quality irrigation dealer should be able to discuss the more cost-effective route for supplying power to irrigation pumps.

B. Water Transmission

In order to convey water from an on-site storage reservoir to a remote pivot wetwell, or other receiving structure, a transmission system will need to be designed and constructed. A pump station at the reservoir and buried waterlines to serve each irrigation device would likely be required to facilitate conveyance. A pump station would face the same power challenges as the center pivots mentioned above. Depending on the cost implications of extending three-phase power to the reservoir site, a gas or diesel-powered pump may be an adequate solution in this case, as well. HDPE water lines could likely be installed to any location on the ranch site without issue.

There is also the possibility that a single, central pump station could be integrated to both convey irrigation water through the transmission system, and deliver water through each pivot structure, employing a variable frequency drive. While this configuration would undoubtedly be more costly than a system dedicated solely to transmission, it may prove more economical than individual wetwells and pumps at each pivot location. However, until the viability of siting a storage reservoir on the ranch is confirmed, pump and delivery system designs and cost comparisons are unwarranted.

C. Construction Considerations

Beaver Valley Ranch is approximately 50 miles from Lander, WY and 100 miles from Casper, WY, potentially introducing increased construction costs and times inherent to a remote site. Parts to repair broken equipment are often days away and can cause delays to any project in a rural location.

Construction cost implications related to environmental sensitivity can also affect many projects in Wyoming. During the investigation phase of this project, Nelson Engineering contacted the Wyoming Game and Fish Department (WGFD) to discuss critical wildlife habitats that could potentially be affected by construction activities. No critical habitat for big game species was identified, although the WGFD did indicate that no construction is allowed within a 2-mile radius from active sage grouse leks. NE was able to obtain the sage grouse habitat data set from WGFD, and analyze the data in comparison to the Beaver Valley Ranch Site. Fortunately, for the irrigation improvements under consideration at the ranch site, the nearest lek is approximately 3 miles away.

IX. CONCLUSION AND RECOMMENDATIONS

A. Contact the NRCS for reservoir planning

The first recommendation NE suggests, to continue evaluating the hay crop production viability at Beaver Valley Ranch, is to contact the Riverton NRCS office. The NRCS has programs in place for technical assistance to aid agricultural property owners in understanding the practicality and expectation of success concerning potential or proposed irrigation improvements. Based on conversations that NE has had with the NRCS office in Riverton, this ranch may be eligible for technical assistance.

It would be contrary to NE's recommendation to proceed with further irrigation planning without understanding the viability of the potential reservoir sites. If the NRCS is unable to provide technical assistance in a timely manner, or if the owner deems it more effective, NE recommends that a reputable geotechnical engineer be retained to perform a site investigation and soil analyses in order to calculate the seepage rate anticipated for higher value, larger reservoir sites. This would include drilling boreholes, digging test pits, and sampling many locations at varying soil horizons within the footprint of a prospective reservoir site. Soil samples would be analyzed for grain size distribution and cohesion, and potentially sent to an independent lab capable of more sophisticated testing. A geotechnical study of this size and capacity would likely cost $20,000, or more, considering the equipment required and the extent of laboratory testing.

B. Explore Irrigation Options

If it is determined that a reservoir could be successfully constructed at the Beaver Valley Ranch, with the base inflows for the reservoir(s) expected to "keep up" with the rate of seepage and evaporation anticipated for each site, the next step would be to understand the types and brands of irrigation devices that are available and suitable for use at Beaver Valley Ranch. An irrigation supplier should be consulted to discuss the types of pumps and sprinklers that are available, and which ones can operate by utilizing single phase power or a fuel supply.

A site visit from an irrigation specialist and/or supplier would be greatly beneficial to understand the site-specific constraints associated with implementing a center pivot sprinkler system in various locations on the property.

C. Understand the potential for land swap with BLM

Portions of the public lands surrounding the main ranch area (predominantly owned by the BLM) have been identified as potentially productive cropland, some with better Land Capability values than fee simple BVR property. Considering the minimum, acceptable crop yields stipulated by Jason King, there is likely insufficient, viable, fee simple property available without obtaining additional cropland near preferred reservoir sites.

During NE's discussions with the NRCS field office in Riverton, NRCS staff indicated that the conditions of a land swap with adjacent BLM properties would likely be evaluated based on "Land Capability". This is the same rating system that NE utilized in evaluating the candidacy of the ranch property to serve as productive hay fields. If the BLM land considered in a land swap to ultimately increase the overall hay production at BVR possesses a Land Capability rating of "3" , the reciprocal BVR trade property will likewise need to be rated "3" or lower.

D. Apply for new water rights

Based on NE's conversations with SEO staff, it appears the simplest option to appropriate water for future irrigation systems or improvements, will be to file for new water rights. Changes to the Place of Use will require maps to be created for the existing and proposed uses, while a new water right only requires a map to be created for the proposed use location. A new water right to cover the areas planned to be irrigated by new infrastructure could be created by a single filing. Since there are no existing downstream rights to Cottonwood Creek, the value of maintaining the senior rights from the early 1900s is greatly diminished. Succinctly, NE's recommendation is to retain applicable, useable, existing water rights and apply for a new water right when the irrigation evaluation at BVR culminates.

E. Pray for Rain

Ranching continues to be a challenging enterprise. The margins in the beef market seem to narrow every year. It is NE's opinion that the success of a self-sustaining ranch in this area relies greatly on the function of a viable water storage facility to facilitate late season irrigation. If a refined site study suggests that a reservoir at the ranch may be viable, Beaver Valley Ranch certainly has a fighting chance to succeed as an operational cattle ranch, capable of producing its own winter feed supply.

Appendix A
Water Rights Maps

LEGEND

- WATER RIGHTS LAND AREA
- WATER RIGHTS LAND AREA OFF PROPERTY
- RANCH PROPERTY LINE
- WATER BODY (NOT COMPREHENSIVE)
- MANMADE DITCH (NOT COMPREHENSIVE)

JOHNSON DITCH (13 ACRES)

HENRY JOHNSON RESERVOIR AND DITCH (CANCELED 1959)

181-AC LAND PERMITTED FOR IRRIGATION UNDER EXISTING WATER RIGHTS

EAST COTTONWOOD (25 ACRES)

67-AC LAND PERMITTED FOR IRRIGATION UNDER EXISTING WATER RIGHTS

JOHNSON #5 (15 ACRES)

WASH #3 (31 ACRES)

GREEN MOUNTAIN SPRING (OFF PROPERTY)

WASH #2 (10 ACRES)

JOHNSON #2 (48 ACRES)

JOHNSON #4 (22 ACRES)

WASH DITCH (26 ACRES)

JOHNSON #3 (28 ACRES)

WEST COTTONWOOD CREEK

JOHNSON #1 (30 ACRES)

2 MILE BUFFER SPRING CREEK LEK

82-AC LAND PERMITTED FOR IRRIGATION UNDER EXISTING WATER RIGHTS

130-AC LAND PERMITTED FOR IRRIGATION UNDER EXISTING WATER RIGHTS

OLE DITCH #1 (45 ACRES)

EAST COTTONWOOD CREEK

WALES #2 (10 ACRES)

OLE DITCH #2 (37 ACRES)

ROCK CUT DITCH (30 ACRES)

MIDDLE COTTONWOOD CREEK

ENLARGED WALES #1 (100 ACRES)

N E

0 1000 2000

REV.	DATE	
	9/4/2020	SURVEYED
	FC-GIS	ENGINEERED
	TSR	DRAWN
	AL	CHECKED
		APPROVED

NELSON ENGINEERING
P.O. BOX 1599, JACKSON WYOMING (307) 733-2087

DRAWING TITLE
WATER RIGHTS MAP
MAIN RANCH AREA

JOB TITLE
JASON KING - BEAVER VALLEY RANCH
IRRIGATION SYSTEM EVALUATION
FREMONT COUNTY, WY

DRAWING NO
A1

JOB NO
19-294-01

Appendix B
Existing Well Permit

Form U.W. 7

IF WELL IS TO BE ABANDONED, SEE ITEM 20

NOTE: Do not fold this form. Use typewriter or print neatly with black ink.

STATE OF WYOMING

OFFICE OF THE STATE ENGINEER

STATEMENT OF COMPLETION AND DESCRIPTION OF WELL

for Domestic or Stock Watering Use Only

A preferred water right is given to such use when the yield or flow does not exceed .056 cubic feet per second or 25 gallons per minute. Domestic use refers to household use and the watering of lawns and gardens for family use, not to exceed one acre.

Permit No. U.W. 11152 Temporary Filing No. 5-9-314

Water Division No. 1 (10)

U.W. District Fremont Co.

**Completed Prior to May 24, 1969 [X]

NAME OF WELL Victory Well #0120

1. Owner United States Government
2. Address P. O. Box 1828, Cheyenne, Wyoming 82001
3. Agent to receive correspondence District Manager, Bureau of Land Management, Lander, Wyoming 82520
4. Name & address of driller Wm. Titus, Address unknown
5. Well is constructed on lands owned by United States Government
   (Obtaining of easement or right of way is the responsibility of the applicant's. Include copy if land is privately owned and owner is not a co-applicant.)
6. Type of construction: Dug ☐ Drilled ☒ Unknown (Type of Rig)
   Driven ☐ Jet ☐ Other
7. Use of Water—Domestic ☐ Stock ☒
8. Means of conveyance, distance and direction to point of use
   Unknown
9. Date started June 19, 19 42.
10. Date completed January 30, 19 43. (including pump)
11. Date after completion when water was used Summer, 19 43.
12. WELL DESCRIPTION
    Total Depth 322' Depth to Water Level 170 ft.
13. TEST DATA
    Yield 5 gpm How Tested Bailing
    Drawdown 20 ft. Length of Test
14. PUMP DATA
    Type Windmill (Turbine, Centrifugal, etc.) Power Source Windmill (Elec., Gas, etc.)
    Horsepower Amount of Water Being Used 5 gpm (Gallons per Minute)
15. CASING RECORD

Plain Casing

Size	8"	Kind	Steel	from	0 ft.	to	221 ft.
Size	6"	Kind	Steel	from	221 ft.	to	290 ft.
Size		Kind		from	ft.	to	ft.

Perforated Casing

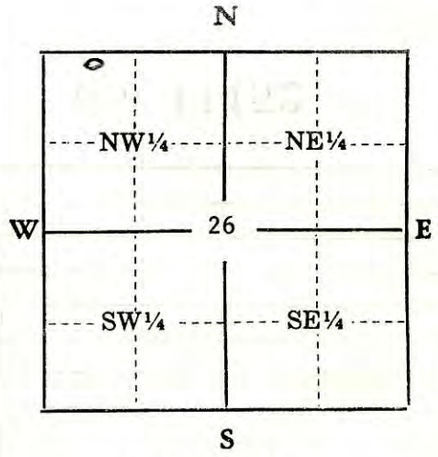
Size		Kind		from	ft.	to	ft.
Size		Kind		from	ft.	to	ft.

WELL LOCATION

Fremont County

NW ¼ of NW ¼ of Sec. 26

T. 29 N., R. 91 W.



Scale: 2" = 1 mile

Above diagram represents one full section. Locate well accurately in small square representing 40 ac.
or
fill in the following:

Lot ____ & Block ____ or Tract ____

of the ____ (Subdivision or Addition)

of ____ (City, Town or County)

Section ____, T. ____ N., R. ____ W.

**For wells constructed after May 24, 1969, Application Form U.W. 5 must be submitted prior to construction.

Permit No. U.W. 11152 Book No. 60 Page No. 195

THE MILLS COMPANY, SHERIDAN

Unknown

16. Was surface seal provided? Yes ☐ No ☐ To What Depth_____ Material used: _____
Was well gravel packed? Yes ☐ No ☐

17. FLOWING WELL (Owner is responsible for installing control device on flowing well.)
Does well flow? Yes ☐ No ☒
Flow controlled by: Valve ☐ Cap ☐ Plug ☐ Does well leak around casing? Yes ☐ No ☐

18. LOG OF WELL—Clearly indicate first water bearing material and principal water bearing material.

From Feet	To Feet	Material Type, Texture, Color	REMARKS (Cementing, Shutoff, Packing, etc.)	Indicate Water Bearing Formation	Indicate Perforated Casing Location
0	230	Loose Sand			
230	289	Loose Sand			
289	322	Soft Sandstone			

19. QUALITY OF WATER INFORMATION

V.W. 11152

Was a chemical analysis made? Yes ☐ No ☒
If so, please include a copy of the analysis with this form.
If not, do you consider the water as: Good ☐ Acceptable ☒ Poor ☐ Unusable ☐
Was a bacteriological analysis made? Yes ☐ No ☒
If a domestic well, was the well disinfected by the driller? Yes ☐ No ☐

20. IF WELL IS TO BE ABANDONED, complete only Items 1 through 6, Item 10 and Item 18 (Log of Well) and state reason for abandonment below.
It is the responsibility of the owner to properly plug or fill in the well in order to prevent contamination of ground water and to cover or cap the well at ground level.

REMARKS: Address any inquiries to the attention of Mr. Boyce Coffey, Area Manager, Bureau of Land Management, P. O. Box 589, Lander, Wyoming 82520.

Under penalties of perjury, I declare that I have examined this form and to the best of my knowledge and belief it is true, correct and complete.

Alan D. Evans Acting District Mgr
Signature of Owner or Authorized Agent

Oct 27, 19 71
Date

Date of Receipt: Nov. 16, 19 71

Date of Priority: January 30, 19 43

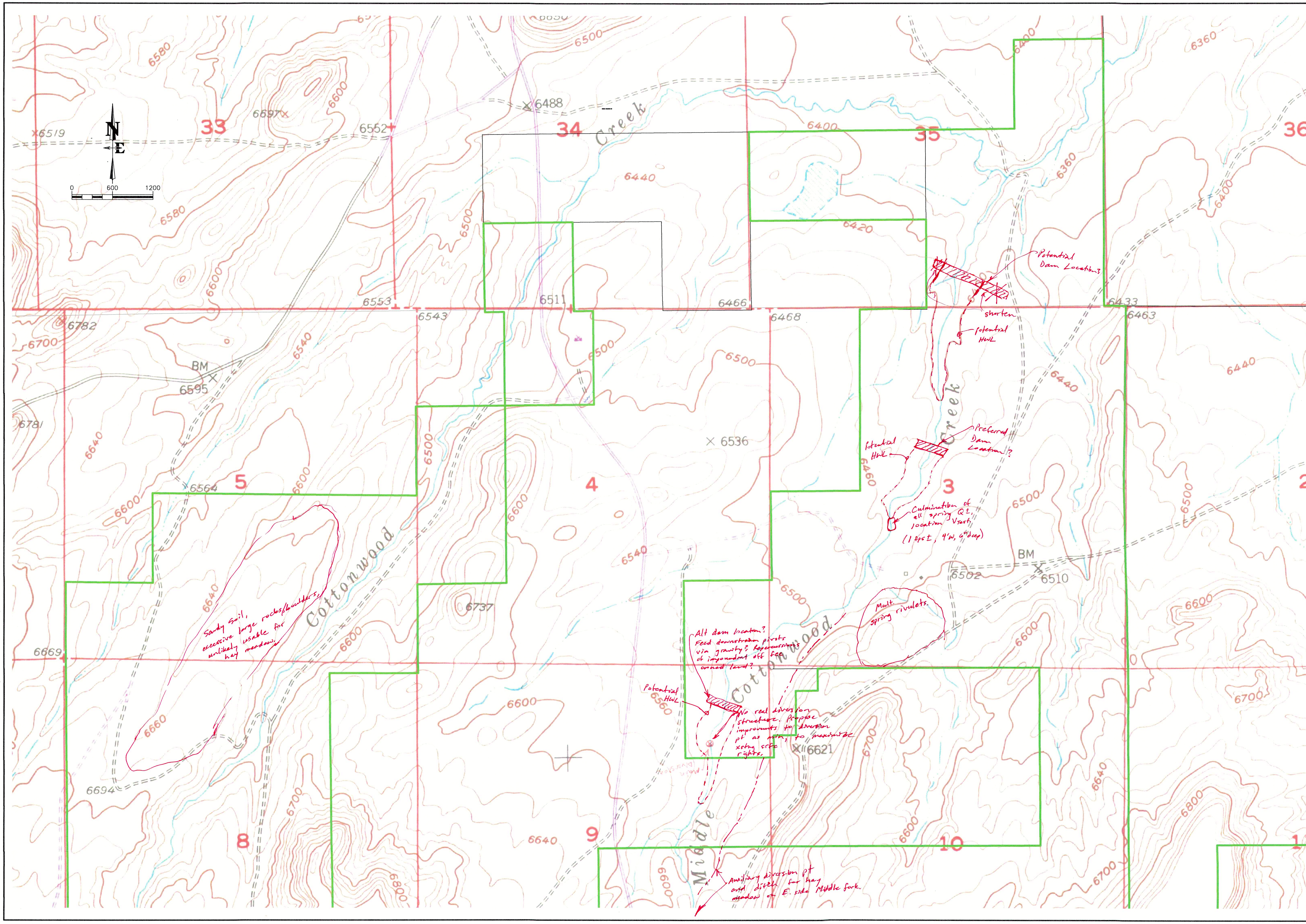
Richard G. Stucksdale

Date of Approval: Nov. 23, 19 71

Richard G. Stucksdale
for State Engineer

Appendix C

Site Visits and Flow Measurement



Notes from 9/16/19 site visit

Beaver Valley Ranch

REV.	DATE	SURVEYED	ENGINEERED	DRAWN	CHECKED	APPROVED

NELSON ENGINEERING
P.O. BOX 1599, JACKSON WYOMING (307) 733-2087

DRAWING TITLE ####

JOB TITLE

DRAWING NO

JOB NO 19-294-01

Appendix D
NRCS Soil Survey Reports

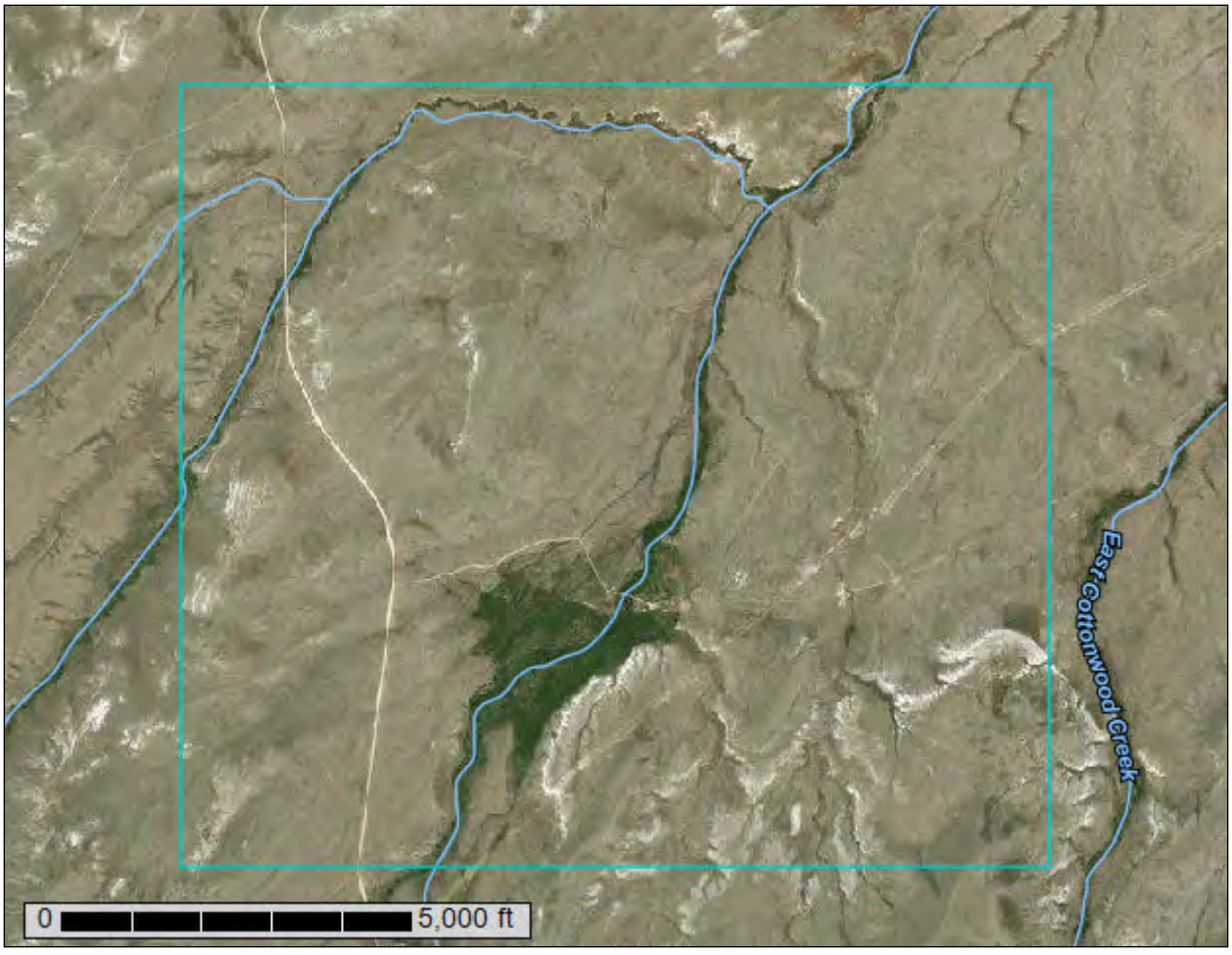
United States Department of Agriculture

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 Fremont County, Wyoming, East Part and Dubois Area



October 28, 2019

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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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.

Map Scale: 1:8,440 if printed on D landscape (34" x 22") sheet.
Meters: 0 100 200 400 600
Feet: 0 400 800 1600 2400
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

Political Features
- PLSS Township and Range
- PLSS Section

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: Fremont County, Wyoming, East Part and Dubois Area
Survey Area Data: Version 16, Sep 17, 2019

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

Date(s) aerial images were photographed: Sep 4, 2011—Sep 15, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Map Unit Legend

Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
117	Blackhall-Carmody association, hilly	509.2	16.0%
120	Bosler-Rock River sandy loams, 1 to 8 percent slopes	635.0	19.9%
121	Bosler-Ryan Park fine sandy loams, 1 to 8 percent slopes	398.1	12.5%
137	Cragosen-Rock outcrop-Carmody complex, hilly	77.1	2.4%
138	Cragosen-Bosler-Cushool association, rolling	210.7	6.6%
140	Cushool-Rock River association, 2 to 8 percent slopes	209.9	6.6%
141	Dahlquist-Rock River complex, 1 to 12 percent slopes	113.4	3.6%
158	Havre-Forelle-Glendive complex, 0 to 3 percent slopes	93.9	2.9%
164	Iceslew-Countryman complex, 0 to 3 percent slopes	106.0	3.3%
174	Milren-Bosler-Rock River sandy loams, 1 to 12 percent slopes	210.7	6.6%
175	Milvar-Milren complex, 1 to 6 percent slopes	371.3	11.6%
191	Rentsac-Carmody complex, hilly	23.3	0.7%
196	Rock outcrop-Blackhall complex, hilly	2.6	0.1%
202	Ryan Park loamy fine sand, undulating	80.5	2.5%
203	Ryan Park-Carmody association, 1 to 15 percent slopes	147.0	4.6%
231	Water	1.8	0.1%
Totals for Area of Interest		**3,190.5**	**100.0%**

Map Unit Descriptions

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.

Fremont County, Wyoming, East Part and Dubois Area

117—Blackhall-Carmody association, hilly

Map Unit Setting

National map unit symbol: jwd7
Elevation: 5,400 to 7,500 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 50 degrees F
Frost-free period: 80 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Blackhall and similar soils: 45 percent
Carmody and similar soils: 35 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Blackhall

Setting

Landform: Ridges, hills
Landform position (three-dimensional): Nose slope
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Colluvium derived from sandstone and/or alluvium derived from sandstone and/or residuum weathered from sandstone

Typical profile

A - 0 to 2 inches: fine sandy loam
Bk - 2 to 17 inches: sandy loam
Cr - 17 to 59 inches: bedrock

Properties and qualities

Slope: 5 to 45 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 13.0
Available water storage in profile: Very low (about 2.4 inches)

Interpretive groups

Land capability classification (irrigated): 7e
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: SHALLOW SANDY (10-14SE) (R034XY366WY)
Hydric soil rating: No

Description of Carmody

Setting

Landform: Plateaus, hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Alluvium derived from sandstone and siltstone

Typical profile

A - 0 to 4 inches: fine sandy loam
C - 4 to 24 inches: very fine sandy loam
Cr - 24 to 59 inches: bedrock

Properties and qualities

Slope: 5 to 25 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Medium
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 6 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 3.6 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Rock outcrop

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

Poposhia

Percent of map unit: 4 percent
Landform: Terraces, hillslopes, fan aprons, hills, fans
Landform position (two-dimensional): Footslope
Landform position (three-dimensional): Base slope, tread
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

Luhon

Percent of map unit: 4 percent
Landform: Hillslopes, alluvial fans
Landform position (two-dimensional): Backslope
Landform position (three-dimensional): Side slope

Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SHALLOW LOAMY (10-14 SE) (R034XY362WY)
Hydric soil rating: No

Blazon

Percent of map unit: 4 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SHALLOW CLAYEY (10-14SE) (R034XY358WY)
Hydric soil rating: No

Diamondville

Percent of map unit: 4 percent
Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

120—Bosler-Rock River sandy loams, 1 to 8 percent slopes

Map Unit Setting

National map unit symbol: jwdb
Elevation: 5,400 to 7,500 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 80 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

Bosler and similar soils: 45 percent
Rock river and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bosler

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 3 inches: sandy loam
Bt - 3 to 31 inches: sandy clay loam
Btk - 31 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: 25 to 33 inches to abrupt textural change
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 12.0
Available water storage in profile: Low (about 4.6 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Description of Rock River

Setting

Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from sandstone

Typical profile

A - 0 to 3 inches: sandy loam
Bt - 3 to 13 inches: sandy clay loam
C - 13 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 14 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 3.0
Available water storage in profile: Moderate (about 8.1 inches)

Interpretive groups

Land capability classification (irrigated): 3e
Land capability classification (nonirrigated): 4e

Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Cragosen
Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (three-dimensional): Head slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SHALLOW LOAMY (10-14 SE) (R034XY362WY)
Hydric soil rating: No

Cushool
Percent of map unit: 5 percent
Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Forelle
Percent of map unit: 5 percent
Landform: Alluvial fans
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: Loamy (Ly) 10-14" East Precipitation Zone (R032XY322WY)
Hydric soil rating: No

121—Bosler-Ryan Park fine sandy loams, 1 to 8 percent slopes

Map Unit Setting
National map unit symbol: jwdc
Elevation: 5,400 to 7,500 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 80 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition
Bosler and similar soils: 45 percent
Ryan park and similar soils: 30 percent
Minor components: 25 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Bosler

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 6 inches: fine sandy loam
Bt - 6 to 13 inches: sandy clay loam
Btk - 13 to 20 inches: gravelly sandy clay loam
2Bk - 20 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 35 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 12.0
Available water storage in profile: Low (about 4.3 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Description of Ryan Park

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone

Typical profile

A - 0 to 3 inches: fine sandy loam
Bt - 3 to 12 inches: sandy loam
Bk - 12 to 60 inches: loamy fine sand

Properties and qualities

Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches

Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 12.0
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Carmody

Percent of map unit: 7 percent
Landform: Hillslopes
Landform position (three-dimensional): Base slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Cushool

Percent of map unit: 6 percent
Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Milren

Percent of map unit: 6 percent
Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

Rock river

Percent of map unit: 6 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

137—Cragosen-Rock outcrop-Carmody complex, hilly

Map Unit Setting

National map unit symbol: jwdw
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 85 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Cragosen and similar soils: 45 percent
Rock outcrop: 25 percent
Carmody and similar soils: 15 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cragosen

Setting

Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from sandstone

Typical profile

A - 0 to 4 inches: gravelly loam
Bk - 4 to 19 inches: very gravelly sandy loam
Cr - 19 to 29 inches: unweathered bedrock

Properties and qualities

Slope: 5 to 60 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: Very low (about 1.6 inches)

Interpretive groups

Land capability classification (irrigated): 7s
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D

Ecological site: SHALLOW LOAMY (10-14 SE) (R034XY362WY)
Hydric soil rating: No

Description of Rock Outcrop

Setting

Landform: Hillslopes

Interpretive groups

Land capability classification (irrigated): 8
Land capability classification (nonirrigated): 8
Hydric soil rating: No

Description of Carmody

Setting

Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from sandstone and/or slope alluvium derived from sandstone

Typical profile

A - 0 to 1 inches: sandy loam
C - 1 to 35 inches: very fine sandy loam
Cr - 35 to 45 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 40 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 6 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Cushool, sl, 2-25% slopes

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

Blackhall, fsl, 5-40% slopes

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

Blazon, cl, 3-40% slopes
Percent of map unit: 4 percent
Hydric soil rating: No

Coalmont, fsl, 2-20% slopes
Percent of map unit: 3 percent
Hydric soil rating: No

138—Cragosen-Bosler-Cushool association, rolling

Map Unit Setting
National map unit symbol: jwdx
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 85 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition
Cragosen and similar soils: 35 percent
Bosler and similar soils: 30 percent
Cushool and similar soils: 20 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cragosen

Setting
Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from sandstone

Typical profile
A - 0 to 6 inches: gravelly loam
Bk - 6 to 11 inches: very gravelly loam
Cr - 11 to 20 inches: unweathered bedrock

Properties and qualities
Slope: 6 to 30 percent
Depth to restrictive feature: 10 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 4 percent

Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 10.0
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): 7s
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: SHALLOW LOAMY (10-14 SE) (R034XY362WY)
Hydric soil rating: No

Description of Bosler

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 2 inches: sandy loam
Bt - 2 to 20 inches: sandy clay loam
2Bk1 - 20 to 24 inches: loamy sand
2Bk2 - 24 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Description of Cushool

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Slope alluvium derived from sandstone

Typical profile

A - 0 to 3 inches: sandy loam
Bt - 3 to 16 inches: sandy clay loam

Bk - 16 to 36 inches: fine sandy loam
Cr - 36 to 46 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 25 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Low (about 5.3 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Blazon, cl, 5-30% slopes

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

Blackhall, fsl, 5-30% slopes

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

Carmody, fsl, 3-30% slopes

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

Rock river, fsl, 2-8% slopes

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

140—Cushool-Rock River association, 2 to 8 percent slopes

Map Unit Setting

National map unit symbol: jwdz
Elevation: 5,400 to 7,500 feet
Mean annual precipitation: 10 to 14 inches

Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 80 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

Cushool and similar soils: 55 percent
Rock river and similar soils: 35 percent
Minor components: 10 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Cushool

Setting

Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Residuum weathered from sandstone and/or slope alluvium derived from sandstone

Typical profile

A - 0 to 3 inches: sandy loam
Bt - 3 to 17 inches: sandy clay loam
Bk - 17 to 35 inches: fine sandy loam
Cr - 35 to 59 inches: bedrock

Properties and qualities

Slope: 3 to 8 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high (0.20 to 0.60 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Low (about 5.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: C
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Description of Rock River

Setting

Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 3 inches: fine sandy loam
Btk - 3 to 18 inches: sandy clay loam
Bk - 18 to 34 inches: sandy clay loam
C - 34 to 60 inches: sandy clay loam

Properties and qualities

Slope: 2 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 14 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 3.0
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Diamondville

Percent of map unit: 2 percent
Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

Cragosen

Percent of map unit: 2 percent
Landform: Hillslopes
Landform position (three-dimensional): Head slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SHALLOW LOAMY (10-14 SE) (R034XY362WY)
Hydric soil rating: No

Bosler

Percent of map unit: 2 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Forelle

Percent of map unit: 2 percent
Landform: Alluvial fans
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: Loamy (Ly) 10-14" East Precipitation Zone (R032XY322WY)
Hydric soil rating: No

Almy

Percent of map unit: 2 percent
Landform: Basin floors
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

141—Dahlquist-Rock River complex, 1 to 12 percent slopes

Map Unit Setting

National map unit symbol: jwf0
Elevation: 5,400 to 7,500 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 80 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Dahlquist and similar soils: 55 percent
Rock river and similar soils: 25 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Dahlquist

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 3 inches: very cobbly loam
Btk - 3 to 14 inches: very gravelly sandy clay loam
Bk - 14 to 60 inches: extremely cobbly sandy loam

Properties and qualities

Slope: 2 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Very low (about 1.8 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: B
Ecological site: COARSE UPLAND (10-14SE) (R034XY308WY)
Hydric soil rating: No

Description of Rock River

Setting

Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 4 inches: sandy loam
Btk - 4 to 21 inches: sandy clay loam
C - 21 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 14 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 3.0
Available water storage in profile: Moderate (about 8.3 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Cushool

Percent of map unit: 6 percent

Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Carmody

Percent of map unit: 6 percent
Landform: Plateaus, hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Rock outcrop

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

Bosler

Percent of map unit: 4 percent
Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

158—Havre-Forelle-Glendive complex, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: jwfk
Elevation: 5,400 to 7,500 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 80 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Havre and similar soils: 45 percent
Forelle and similar soils: 20 percent
Cowestglen and similar soils: 15 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Havre

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 4 inches: loam
C - 4 to 60 inches: stratified fine sandy loam to clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: High (about 10.2 inches)

Interpretive groups

Land capability classification (irrigated): 4c
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B
Ecological site: LOAMY OVERFLOW (10-14SE) (R034XY326WY)
Hydric soil rating: No

Description of Forelle

Setting

Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 5 inches: loam
Bt - 5 to 19 inches: clay loam
C - 19 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 6 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 8.5 inches)

Interpretive groups

Land capability classification (irrigated): 4c
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: B

Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

Description of Cowestglen

Setting

Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Concave
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 4 inches: sandy loam
C - 4 to 60 inches: stratified loamy sand to sandy clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: Rare
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): 4c
Land capability classification (nonirrigated): 4c
Hydrologic Soil Group: A
Ecological site: LOAMY OVERFLOW (10-14SE) (R034XY326WY)
Hydric soil rating: No

Minor Components

Bosler

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Rock river

Percent of map unit: 10 percent
Landform: Terraces
Landform position (three-dimensional): Tread
Down-slope shape: Linear
Across-slope shape: Linear
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

164—Iceslew-Countryman complex, 0 to 3 percent slopes

Map Unit Setting

National map unit symbol: jwfr
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 85 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Iceslew and similar soils: 55 percent
Countryman and similar soils: 30 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Iceslew

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from sandstone and/or alluvium derived from siltstone

Typical profile

A - 0 to 2 inches: very fine sandy loam
C - 2 to 12 inches: loam
Cg1 - 12 to 32 inches: loam
Cg2 - 32 to 60 inches: stratified sandy loam to silty clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Poorly drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: About 0 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Very slightly saline to moderately saline (2.0 to 8.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: High (about 9.9 inches)

Interpretive groups

Land capability classification (irrigated): 6w
Land capability classification (nonirrigated): 6w
Hydrologic Soil Group: B/D
Ecological site: SALINE SUBIRRIGATED (10-14SE) (R034XY342WY)
Hydric soil rating: Yes

Description of Countryman

Setting

Landform: Flood plains
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 2 inches: loam
C1 - 2 to 15 inches: very fine sandy loam
C2 - 15 to 21 inches: sandy loam
Cg - 21 to 60 inches: stratified loamy sand to clay loam

Properties and qualities

Slope: 0 to 3 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Somewhat poorly drained
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: About 18 to 42 inches
Frequency of flooding: Occasional
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Gypsum, maximum in profile: 3 percent
Salinity, maximum in profile: Slightly saline to moderately saline (4.0 to 8.0 mmhos/cm)
Available water storage in profile: Moderate (about 8.2 inches)

Interpretive groups

Land capability classification (irrigated): 3w
Land capability classification (nonirrigated): 4w
Hydrologic Soil Group: B
Ecological site: SALINE SUBIRRIGATED (10-14SE) (R034XY342WY)
Hydric soil rating: No

Minor Components

Absher, l, 1-8% slopes

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

Ryan park, lfs, 1-10% slopes

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

Bosler, fsl, 1-8% slopes

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

Forelle, l, 1-8% slopes
Percent of map unit: 3 percent
Hydric soil rating: No

Iceslew, vfsl, 3-6% slopes
Percent of map unit: 3 percent
Landform: Flood plains
Hydric soil rating: Yes

174—Milren-Bosler-Rock River sandy loams, 1 to 12 percent slopes

Map Unit Setting
National map unit symbol: jwg2
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 85 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition
Milren and similar soils: 45 percent
Bosler and similar soils: 20 percent
Rock river and similar soils: 15 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Milren

Setting
Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile
A - 0 to 3 inches: sandy loam
Bt - 3 to 11 inches: sandy clay
Btk - 11 to 16 inches: sandy clay loam
Bk - 16 to 23 inches: loam
C1 - 23 to 56 inches: fine sandy loam
C2 - 56 to 60 inches: loamy fine sand

Properties and qualities
Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 in profile: 14 percent
Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 8.6 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

Description of Bosler

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 2 inches: sandy loam
Bt - 2 to 20 inches: sandy clay loam
Bk - 20 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 20 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Description of Rock River

Setting

Landform: Alluvial fans
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 3 inches: sandy loam

Bt - 3 to 15 inches: sandy clay loam
Bk - 15 to 34 inches: sandy clay loam
C - 34 to 60 inches: sandy clay loam

Properties and qualities

Slope: 1 to 12 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.60 to 2.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 14 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 3.0
Available water storage in profile: Moderate (about 8.7 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Blackhall, fsl, 5-30% slopes

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

Cragosen, gr-l, 5-45% slopes

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

Diamondville, scl, 1-15% slopes

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

Milvar, st-l, 1-6% slopes

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

175—Milvar-Milren complex, 1 to 6 percent slopes

Map Unit Setting

National map unit symbol: jwg3
Mean annual precipitation: 10 to 14 inches

Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 85 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

Milvar and similar soils: 45 percent
Milren and similar soils: 40 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Milvar

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 3 inches: stony loam
Bt - 3 to 16 inches: gravelly clay loam
Bk1 - 16 to 26 inches: very gravelly loam
2Bk2 - 26 to 60 inches: very gravelly loamy sand

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 in profile: 30 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Low (about 4.1 inches)

Interpretive groups

Land capability classification (irrigated): 6s
Land capability classification (nonirrigated): 6s
Hydrologic Soil Group: C
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

Description of Milren

Setting

Landform: Terraces
Down-slope shape: Linear
Across-slope shape: Linear
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 2 inches: fine sandy loam
Bt - 2 to 16 inches: sandy clay

Bk - 16 to 27 inches: loam
C - 27 to 60 inches: fine sandy loam

Properties and qualities

Slope: 1 to 6 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
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 in profile: 14 percent
Salinity, maximum in profile: Very slightly saline to slightly saline (2.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Moderate (about 9.0 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 4e
Hydrologic Soil Group: C
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

Minor Components

Rock river, sl, 1-6% slopes

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

Dahlquist, cbv-l, 2-10% slopes

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

Cragosen, gr-l, 2-30% slopes

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

Brownsto, l, 1-6% slopes

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

Bosler, sl, 1-6% slopes

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

191—Rentsac-Carmody complex, hilly

Map Unit Setting

National map unit symbol: jwgm

Elevation: 5,400 to 7,500 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 80 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition

Rentsac and similar soils: 50 percent
Carmody and similar soils: 30 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rentsac

Setting

Landform: Mountains, hills, plains, escarpments
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Slope alluvium derived from limestone and sandstone and/or colluvium derived from limestone and sandstone over residuum weathered from limestone and sandstone

Typical profile

A - 0 to 5 inches: very gravelly loam
C - 5 to 15 inches: very gravelly loam
R - 15 to 25 inches: bedrock

Properties and qualities

Slope: 6 to 40 percent
Percent of area covered with surface fragments: 2.0 percent
Depth to restrictive feature: 10 to 20 inches to lithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 15 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to slightly saline (0.0 to 4.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 5.0
Available water storage in profile: Very low (about 1.2 inches)

Interpretive groups

Land capability classification (irrigated): 7s
Land capability classification (nonirrigated): 7s
Hydrologic Soil Group: D
Ecological site: SHALLOW LOAMY (10-14 SE) (R034XY362WY)
Hydric soil rating: No

Description of Carmody

Setting

Landform: Intermontane basins
Down-slope shape: Linear
Across-slope shape: Convex

Parent material: Slope alluvium derived from sandstone and siltstone

Typical profile

A - 0 to 4 inches: fine sandy loam
C - 4 to 30 inches: fine sandy loam
Cr - 30 to 59 inches: bedrock

Properties and qualities

Slope: 2 to 40 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 6 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 4.5 inches)

Interpretive groups

Land capability classification (irrigated): 6e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Diamondville

Percent of map unit: 4 percent
Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: LOAMY (10-14SE) (R034XY322WY)
Hydric soil rating: No

Forelle

Percent of map unit: 4 percent
Landform: Alluvial fans
Down-slope shape: Convex
Across-slope shape: Convex
Ecological site: Loamy (Ly) 10-14" East Precipitation Zone (R032XY322WY)
Hydric soil rating: No

Pensore

Percent of map unit: 4 percent
Landform: Hills
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: Shallow Loamy (SwLy) 10-14" East Precipitation Zone (R032XY362WY)
Hydric soil rating: No

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

Blackhall
Percent of map unit: 4 percent
Landform: Ridges, hills
Landform position (three-dimensional): Nose slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SHALLOW SANDY (10-14SE) (R034XY366WY)
Hydric soil rating: No

196—Rock outcrop-Blackhall complex, hilly

Map Unit Setting
National map unit symbol: jwgs
Elevation: 5,400 to 7,500 feet
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 39 to 45 degrees F
Frost-free period: 80 to 120 days
Farmland classification: Not prime farmland

Map Unit Composition
Rock outcrop: 40 percent
Blackhall and similar soils: 40 percent
Minor components: 20 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Rock Outcrop

Interpretive groups
Land capability classification (irrigated): 8
Land capability classification (nonirrigated): 8
Hydrologic Soil Group: D
Hydric soil rating: No

Description of Blackhall

Setting
Landform: Hills, ridges
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Residuum weathered from calcareous sandstone and/or slope alluvium derived from calcareous sandstone

Typical profile
A - 0 to 2 inches: sandy loam
Bw - 2 to 18 inches: sandy loam

Cr - 18 to 59 inches: bedrock

Properties and qualities

Slope: 5 to 45 percent
Depth to restrictive feature: 6 to 20 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: High
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 5 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Sodium adsorption ratio, maximum in profile: 13.0
Available water storage in profile: Very low (about 2.5 inches)

Interpretive groups

Land capability classification (irrigated): 7e
Land capability classification (nonirrigated): 7e
Hydrologic Soil Group: D
Ecological site: SHALLOW SANDY (10-14SE) (R034XY366WY)
Hydric soil rating: No

Minor Components

Rentsac

Percent of map unit: 5 percent
Landform: Hills, plains, escarpments, mountains
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SHALLOW LOAMY (10-14 SE) (R034XY362WY)
Hydric soil rating: No

Cragosen

Percent of map unit: 5 percent
Landform: Hillslopes
Landform position (three-dimensional): Head slope
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SHALLOW LOAMY (10-14 SE) (R034XY362WY)
Hydric soil rating: No

Blazon

Percent of map unit: 5 percent
Landform: Hillslopes
Down-slope shape: Linear
Across-slope shape: Convex
Ecological site: SHALLOW CLAYEY (10-14SE) (R034XY358WY)
Hydric soil rating: No

Carmody

Percent of map unit: 5 percent
Landform: Plateaus, hillslopes
Down-slope shape: Linear
Across-slope shape: Convex

Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

202—Ryan Park loamy fine sand, undulating

Map Unit Setting

National map unit symbol: jwh2
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 85 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition

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

Description of Ryan Park

Setting

Landform: Fan aprons
Down-slope shape: Convex
Across-slope shape: Convex
Parent material: Alluvium derived from mixed

Typical profile

A - 0 to 3 inches: loamy fine sand
Btk - 3 to 17 inches: fine sandy loam
C - 17 to 60 inches: sandy loam

Properties and qualities

Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained
Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.1 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: SANDY (10-14SE) (R034XY350WY)

Hydric soil rating: No

Minor Components

Rock river, fsl, 1-8% slopes
Percent of map unit: 4 percent
Hydric soil rating: No

Bosler, fsl, 1-8% slopes
Percent of map unit: 4 percent
Hydric soil rating: No

Cushool, sl, 2-25% slopes
Percent of map unit: 4 percent
Hydric soil rating: No

Zeomont, ls, 2-15% slopes
Percent of map unit: 3 percent
Hydric soil rating: No

203—Ryan Park-Carmody association, 1 to 15 percent slopes

Map Unit Setting
National map unit symbol: jwh4
Mean annual precipitation: 10 to 14 inches
Mean annual air temperature: 41 to 45 degrees F
Frost-free period: 85 to 110 days
Farmland classification: Not prime farmland

Map Unit Composition
Ryan park and similar soils: 50 percent
Carmody and similar soils: 35 percent
Minor components: 15 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Description of Ryan Park

Setting
Landform: Fan aprons
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Alluvium derived from mixed

Typical profile
A - 0 to 5 inches: sandy loam
Btk - 5 to 15 inches: sandy loam
C - 15 to 60 inches: sandy loam

Properties and qualities
Slope: 1 to 8 percent
Depth to restrictive feature: More than 80 inches
Natural drainage class: Well drained

Runoff class: Very low
Capacity of the most limiting layer to transmit water (Ksat): High (2.00 to 6.00 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 10 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Moderate (about 7.2 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: A
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Description of Carmody

Setting

Landform: Ridges
Down-slope shape: Linear
Across-slope shape: Convex
Parent material: Slope alluvium derived from sandstone

Typical profile

A - 0 to 5 inches: sandy loam
C - 5 to 38 inches: fine sandy loam
Cr - 38 to 48 inches: unweathered bedrock

Properties and qualities

Slope: 3 to 15 percent
Depth to restrictive feature: 20 to 40 inches to paralithic bedrock
Natural drainage class: Well drained
Runoff class: Low
Capacity of the most limiting layer to transmit water (Ksat): Very low to moderately high (0.00 to 0.20 in/hr)
Depth to water table: More than 80 inches
Frequency of flooding: None
Frequency of ponding: None
Calcium carbonate, maximum in profile: 6 percent
Gypsum, maximum in profile: 4 percent
Salinity, maximum in profile: Nonsaline to very slightly saline (0.0 to 2.0 mmhos/cm)
Available water storage in profile: Low (about 5.7 inches)

Interpretive groups

Land capability classification (irrigated): 4e
Land capability classification (nonirrigated): 6e
Hydrologic Soil Group: B
Ecological site: SANDY (10-14SE) (R034XY350WY)
Hydric soil rating: No

Minor Components

Carmody, sl, 15-25% slopes
Percent of map unit: 3 percent
Hydric soil rating: No

Bosler, fsl, 1-8% slopes
Percent of map unit: 3 percent
Hydric soil rating: No

Rock river, fsl, 1-8% slopes
Percent of map unit: 3 percent
Hydric soil rating: No

Cushool, sl, 2-25% slopes
Percent of map unit: 3 percent
Hydric soil rating: No

Blackhall, fsl, 5-30% slopes
Percent of map unit: 3 percent
Hydric soil rating: No

231—Water

Map Unit Composition
Water: 100 percent
Estimates are based on observations, descriptions, and transects of the mapunit.

Soil Information for All Uses

Suitabilities and Limitations for Use

The Suitabilities and Limitations for Use section includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

Vegetative Productivity

Vegetative productivity includes estimates of potential vegetative production for a variety of land uses, including cropland, forestland, hayland, pastureland, horticulture and rangeland. In the underlying database, some states maintain crop yield data by individual map unit component. Other states maintain the data at the map unit level. Attributes are included for both, although only one or the other is likely to contain data for any given geographic area. For other land uses, productivity data is shown only at the map unit component level. Examples include potential crop yields under irrigated and nonirrigated conditions, forest productivity, forest site index, and total rangeland production under of normal, favorable and unfavorable conditions.

Yields of Irrigated Crops (Component): Grass hay (Tons)

These are the estimated average yields per acre that can be expected of selected irrigated crops under a high level of management. In any given year, yields may be higher or lower than those indicated because of variations in rainfall and other climatic factors. It is assumed that the irrigation system is adapted to the soils and to the crops grown, that good-quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

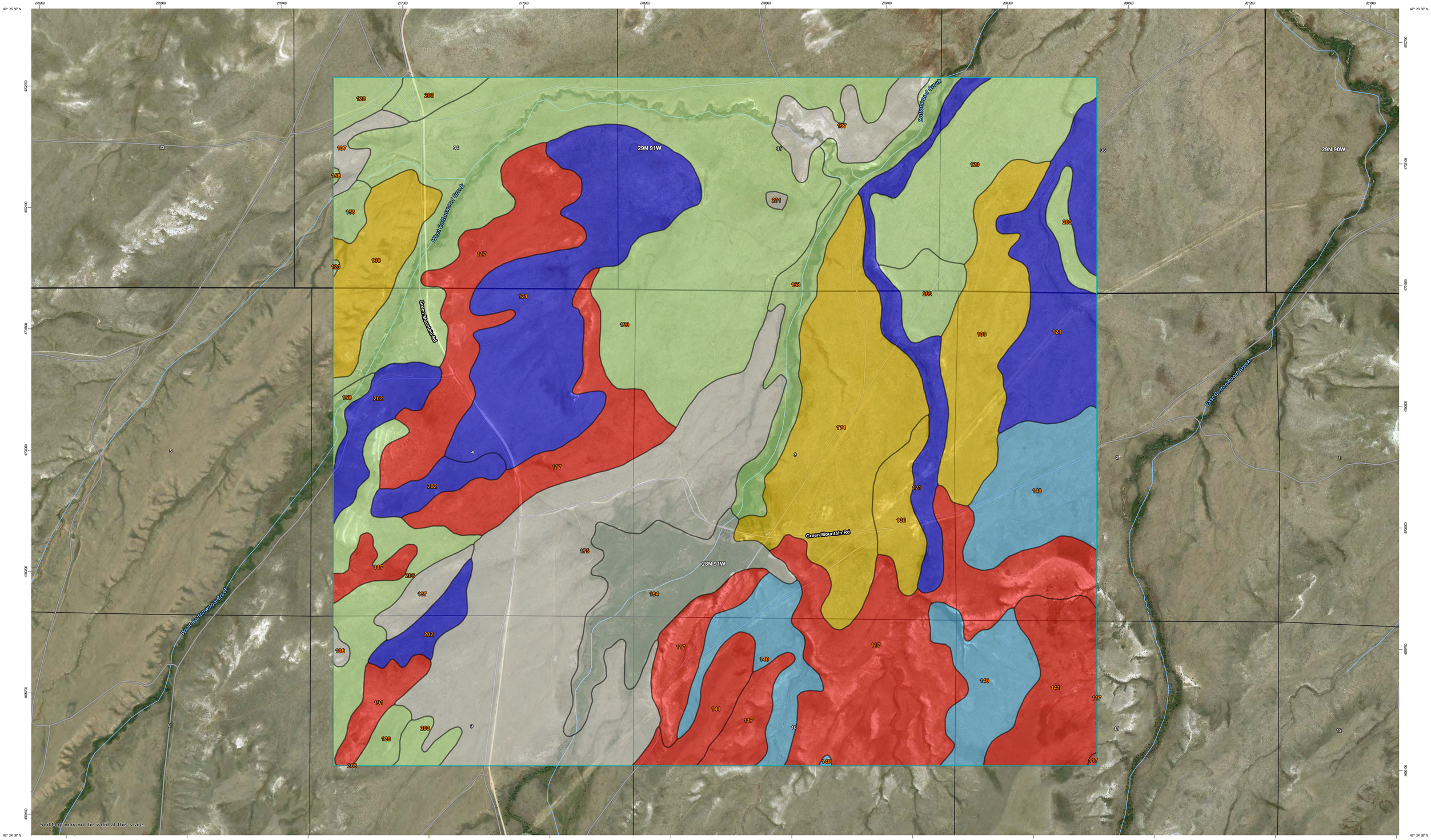
In the database, some states maintain crop yield data by individual map unit component and others maintain the data at the map unit level. Attributes are included in this application for both, although only one or the other is likely to have data for any given geographic area. This attribute uses data maintained at the map unit component level.

The yields are actually recorded as three separate values in the database. A low value and a high value indicate the range for the soil component. A "representative" value indicates the expected value for the component. For these yields, only the representative value is used.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby areas and results of field trials and demonstrations also are considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for the selected crop. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.



Map Scale: 1:8,440 if printed on D landscape (34" x 22") sheet.
Meters: 0 100 200 400 600
Feet: 0 400 800 1600 2400
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 Rating Polygons
- <= 0.28
- > 0.28 and <= 0.75
- > 0.75 and <= 1.60
- > 1.60 and <= 1.87
- > 1.87 and <= 2.55
- Not rated or not available

Soil Rating Lines
- <= 0.28
- > 0.28 and <= 0.75
- > 0.75 and <= 1.60
- > 1.60 and <= 1.87
- > 1.87 and <= 2.55
- Not rated or not available

Soil Rating Points
- <= 0.28
- > 0.28 and <= 0.75
- > 0.75 and <= 1.60
- > 1.60 and <= 1.87
- > 1.87 and <= 2.55
- Not rated or not available

Political Features
- PLSS Township and Range
- PLSS Section

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.

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Survey Area Data: Version 16, Sep 17, 2019

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

Date(s) aerial images were photographed: Sep 4, 2011—Sep 15, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND

MAP INFORMATION

imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Yields of Irrigated Crops (Component): Grass hay (Tons)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
117	Blackhall-Carmody association, hilly	0.10	509.2	16.0%
120	Bosler-Rock River sandy loams, 1 to 8 percent slopes	1.40	635.0	19.9%
121	Bosler-Ryan Park fine sandy loams, 1 to 8 percent slopes	2.21	398.1	12.5%
137	Cragosen-Rock outcrop-Carmody complex, hilly		77.1	2.4%
138	Cragosen-Bosler-Cushool association, rolling	0.75	210.7	6.6%
140	Cushool-Rock River association, 2 to 8 percent slopes	1.87	209.9	6.6%
141	Dahlquist-Rock River complex, 1 to 12 percent slopes	0.28	113.4	3.6%
158	Havre-Forelle-Glendive complex, 0 to 3 percent slopes	1.60	93.9	2.9%
164	Iceslew-Countryman complex, 0 to 3 percent slopes		106.0	3.3%
174	Milren-Bosler-Rock River sandy loams, 1 to 12 percent slopes	0.50	210.7	6.6%
175	Milvar-Milren complex, 1 to 6 percent slopes		371.3	11.6%
191	Rentsac-Carmody complex, hilly	0.20	23.3	0.7%
196	Rock outcrop-Blackhall complex, hilly		2.6	0.1%
202	Ryan Park loamy fine sand, undulating	2.55	80.5	2.5%
203	Ryan Park-Carmody association, 1 to 15 percent slopes	1.50	147.0	4.6%
231	Water		1.8	0.1%
Totals for Area of Interest			**3,190.5**	**100.0%**

Rating Options—Yields of Irrigated Crops (Component): Grass hay (Tons)

Crop: Grass hay

Yield Units: Tons

Aggregation Method: Weighted Average

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

Interpret Nulls as Zero: Yes

Yields of Irrigated Crops (Map Unit): Grass hay (Tons)

These are the estimated average yields per acre that can be expected of selected irrigated crops under a high level of management. In any given year, yields may be higher or lower than those indicated because of variations in rainfall and other climatic factors. It is assumed that the irrigation system is adapted to the soils and to the crops grown, that good-quality irrigation water is uniformly applied as needed, and that tillage is kept to a minimum.

In the database, some states maintain crop yield data by individual map unit component and others maintain the data at the map unit level. Attributes are included in this application for both, although only one or the other is likely to contain data for any given geographic area. This attribute uses data maintained at the map unit level.

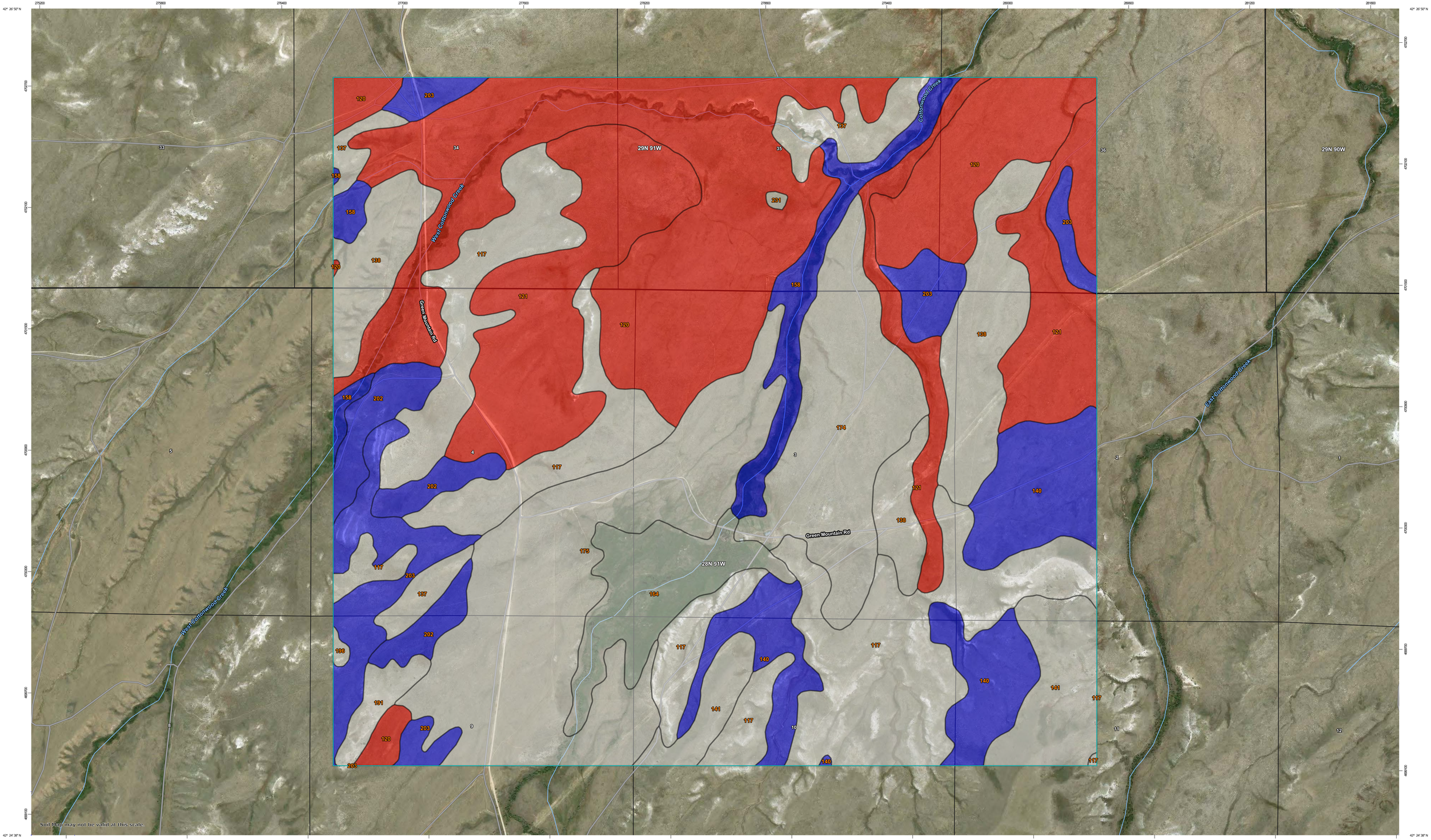
The yields are actually recorded as three separate values in the database. A low value and a high value indicate the range for the soil component. A "representative" value indicates the expected value for the component. For these yields, only the representative value is used.

The yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Available yield data from nearby areas and results of field trials and demonstrations also are considered.

The management needed to obtain the indicated yields of the various crops depends on the kind of soil and the crop. Management can include drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate and timely tillage; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residue, barnyard manure, and green manure crops; and harvesting that ensures the smallest possible loss.

The estimated yields reflect the productive capacity of each soil for the selected crop. Yields are likely to increase as new production technology is developed. The

productivity of a given soil compared with that of other soils, however, is not likely to change.


275200
275800
276400
277000
277600
278200
278800
279400
280000
280600
281200
281800
42° 26' 50" N
42° 24' 38" N
105° 44' 2" W
105° 39' 5" W
4702700
4702100
4701500
4700900
4700300
4699700
4699100
4698500
33
34
35
36
4
3
2
1
5
8
9
10
11
12
29N 91W
29N 90W
28N 91W
West Cottonwood Creek
Cottonwood Creek
East Cottonwood Creek
Green Mountain Rd
120
203
137
158
231
138
117
121
202
174
140
141
164
175
191
Soil Map may not be valid at this scale.
Map Scale: 1:8,440 if printed on D landscape (34" x 22") sheet.
Meters
0 100 200 400 600
Feet
0 400 800 1600 2400
N
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 Rating Polygons

- <= 2.50
- > 2.50 and <= 3.00
- Not rated or not available

Soil Rating Lines

- <= 2.50
- > 2.50 and <= 3.00
- Not rated or not available

Soil Rating Points

- <= 2.50
- > 2.50 and <= 3.00
- Not rated or not available

Political Features

- PLSS Township and Range
- PLSS Section

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.

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

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Survey Area Data: Version 16, Sep 17, 2019

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

Date(s) aerial images were photographed: Sep 4, 2011—Sep 15, 2016

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background

MAP LEGEND	MAP INFORMATION
	imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

Table—Yields of Irrigated Crops (Map Unit): Grass hay (Tons)

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
117	Blackhall-Carmody association, hilly		509.2	16.0%
120	Bosler-Rock River sandy loams, 1 to 8 percent slopes	2.50	635.0	19.9%
121	Bosler-Ryan Park fine sandy loams, 1 to 8 percent slopes	2.50	398.1	12.5%
137	Cragosen-Rock outcrop-Carmody complex, hilly		77.1	2.4%
138	Cragosen-Bosler-Cushool association, rolling		210.7	6.6%
140	Cushool-Rock River association, 2 to 8 percent slopes	3.00	209.9	6.6%
141	Dahlquist-Rock River complex, 1 to 12 percent slopes		113.4	3.6%
158	Havre-Forelle-Glendive complex, 0 to 3 percent slopes	3.00	93.9	2.9%
164	Iceslew-Countryman complex, 0 to 3 percent slopes		106.0	3.3%
174	Milren-Bosler-Rock River sandy loams, 1 to 12 percent slopes		210.7	6.6%
175	Milvar-Milren complex, 1 to 6 percent slopes		371.3	11.6%
191	Rentsac-Carmody complex, hilly		23.3	0.7%
196	Rock outcrop-Blackhall complex, hilly		2.6	0.1%
202	Ryan Park loamy fine sand, undulating	3.00	80.5	2.5%
203	Ryan Park-Carmody association, 1 to 15 percent slopes	3.00	147.0	4.6%
231	Water		1.8	0.1%
Totals for Area of Interest			**3,190.5**	**100.0%**

Rating Options—Yields of Irrigated Crops (Map Unit): Grass hay (Tons)

Crop: Grass hay

Yield Units: Tons

Aggregation Method: No Aggregation Necessary

Tie-break Rule: Higher

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United States Department of Agriculture

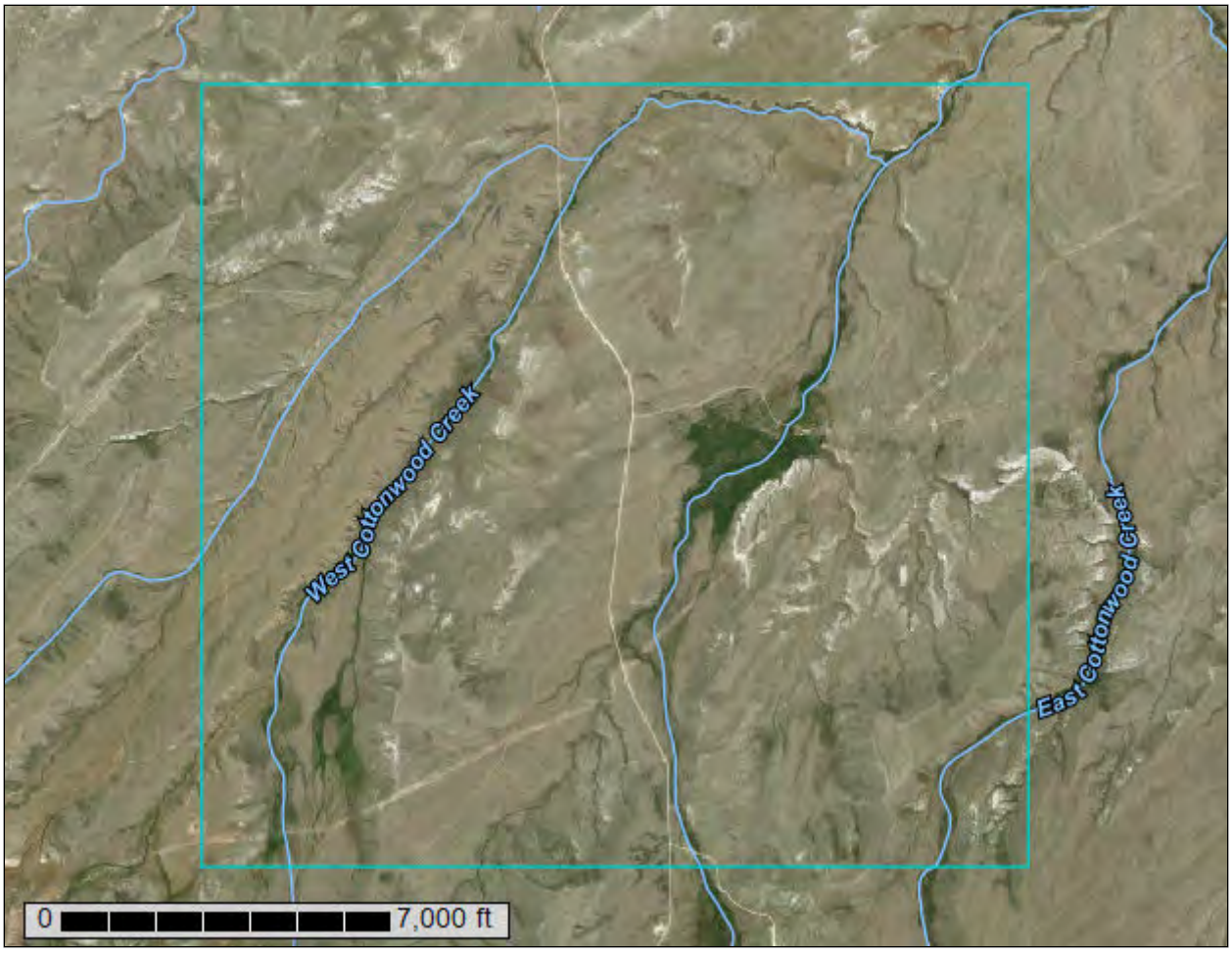
NRCS

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 Fremont County, Wyoming, East Part and Dubois Area

Irrigated Capability



November 20, 2019

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.

The U.S. Department of Agriculture (USDA) prohibits discrimination in all its programs and activities on the basis of race, color, national origin, age, disability, and where applicable, sex, marital status, familial status, parental status, religion, sexual orientation, genetic information, political beliefs, reprisal, or because all or a part of an individual's income is derived from any public assistance program. (Not all prohibited bases apply to all programs.) Persons with disabilities who require

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Contents

Soil Information for All Uses

Suitabilities and Limitations for Use

The Suitabilities and Limitations for Use section includes various soil interpretations displayed as thematic maps with a summary table for the soil map units in the selected area of interest. A single value or rating for each map unit is generated by aggregating the interpretive ratings of individual map unit components. This aggregation process is defined for each interpretation.

Land Classifications

Land Classifications are specified land use and management groupings that are assigned to soil areas because combinations of soil have similar behavior for specified practices. Most are based on soil properties and other factors that directly influence the specific use of the soil. Example classifications include ecological site classification, farmland classification, irrigated and nonirrigated land capability classification, and hydric rating.

Irrigated Capability Class

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations that show suitability and limitations of groups of soils for rangeland, for woodland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels-capability class, subclass, and unit. Only class and subclass are included in this data set.

Capability classes, the broadest groups, are designated by the numbers 1 through 8. The numbers indicate progressively greater limitations and narrower choices for practical use. The classes are defined as follows:

Class 1 soils have few limitations that restrict their use.

Class 2 soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.

Class 3 soils have severe limitations that reduce the choice of plants or that require special conservation practices, or both.

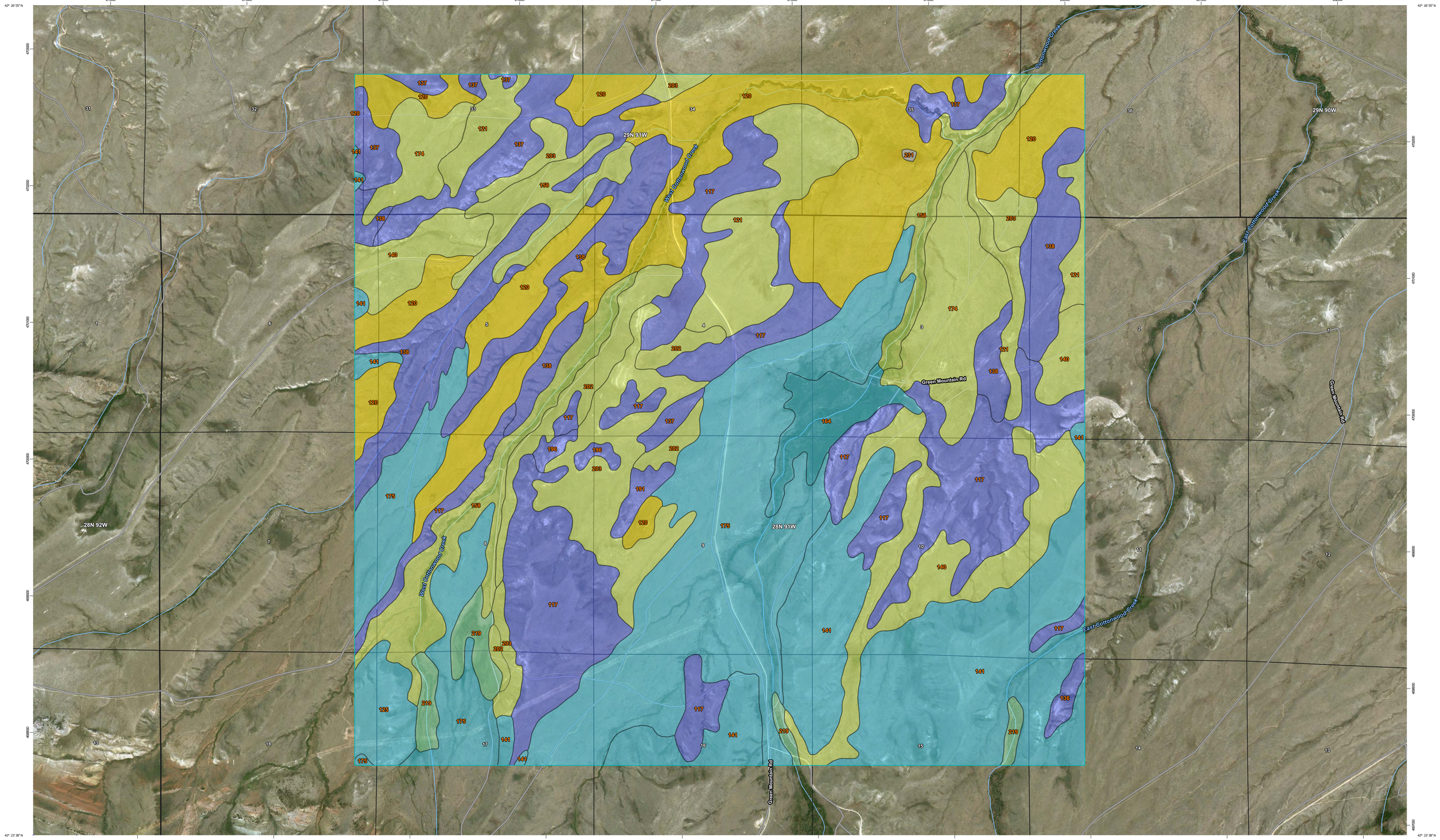
Class 4 soils have very severe limitations that reduce the choice of plants or that require very careful management, or both.

Class 5 soils are subject to little or no erosion but have other limitations, impractical to remove, that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.

Class 6 soils have severe limitations that make them generally unsuitable for cultivation and that restrict their use mainly to pasture, rangeland, forestland, or wildlife habitat.

Class 7 soils have very severe limitations that make them unsuitable for cultivation and that restrict their use mainly to grazing, forestland, or wildlife habitat.

Class 8 soils and miscellaneous areas have limitations that preclude commercial plant production and that restrict their use to recreational purposes, wildlife habitat, watershed, or esthetic purposes.



Map Scale: 1:12,500 if printed on D landscape (34" x 22") sheet.
Meters: 0 150 300 600 900
Feet: 0 500 1000 2000 3000
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 Rating Polygons

- Capability Class - I
- Capability Class - II
- Capability Class - III
- Capability Class - IV
- Capability Class - V
- Capability Class - VI
- Capability Class - VII
- Capability Class - VIII
- Not rated or not available

Soil Rating Lines

- Capability Class - I
- Capability Class - II
- Capability Class - III
- Capability Class - IV
- Capability Class - V
- Capability Class - VI
- Capability Class - VII
- Capability Class - VIII
- Not rated or not available

Soil Rating Points

- Capability Class - I
- Capability Class - II
- Capability Class - III
- Capability Class - IV
- Capability Class - V
- Capability Class - VI
- Capability Class - VII
- Capability Class - VIII
- Not rated or not available

Political Features

- PLSS Township and Range
- PLSS Section

Water Features

- Streams and Canals

Transportation

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

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- Aerial Photography

MAP INFORMATION

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Table—Irrigated Capability Class

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
117	Blackhall-Carmody association, hilly	7	908.5	13.5%
120	Bosler-Rock River sandy loams, 1 to 8 percent slopes	3	949.7	14.2%
121	Bosler-Ryan Park fine sandy loams, 1 to 8 percent slopes	4	363.0	5.4%
125	Brownsto very bouldery-Decross variant-Brownsto complex, hilly	6	81.6	1.2%
136	Cragosen-Carmody-Blazon complex, hilly	7	17.7	0.3%
137	Cragosen-Rock outcrop-Carmody complex, hilly	7	257.8	3.8%
138	Cragosen-Bosler-Cushool association, rolling	7	482.6	7.2%
140	Cushool-Rock River association, 2 to 8 percent slopes	4	405.0	6.0%
141	Dahlquist-Rock River complex, 1 to 12 percent slopes	6	822.3	12.3%
158	Havre-Forelle-Glendive complex, 0 to 3 percent slopes	4	364.5	5.4%
164	Iceslew-Countryman complex, 0 to 3 percent slopes	6	106.0	1.6%
174	Milren-Bosler-Rock River sandy loams, 1 to 12 percent slopes	4	289.5	4.3%
175	Milvar-Milren complex, 1 to 6 percent slopes	6	1,080.6	16.1%
191	Rentsac-Carmody complex, hilly	7	23.4	0.3%
196	Rock outcrop-Blackhall complex, hilly	7	20.9	0.3%
202	Ryan Park loamy fine sand, undulating	4	140.6	2.1%
203	Ryan Park-Carmody association, 1 to 15 percent slopes	4	303.3	4.5%
219	Venapass-Silas loams, 0 to 6 percent slopes	5	86.0	1.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
231	Water		1.8	0.0%
Totals for Area of Interest			**6,704.7**	**100.0%**

Rating Options—Irrigated Capability Class

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Higher

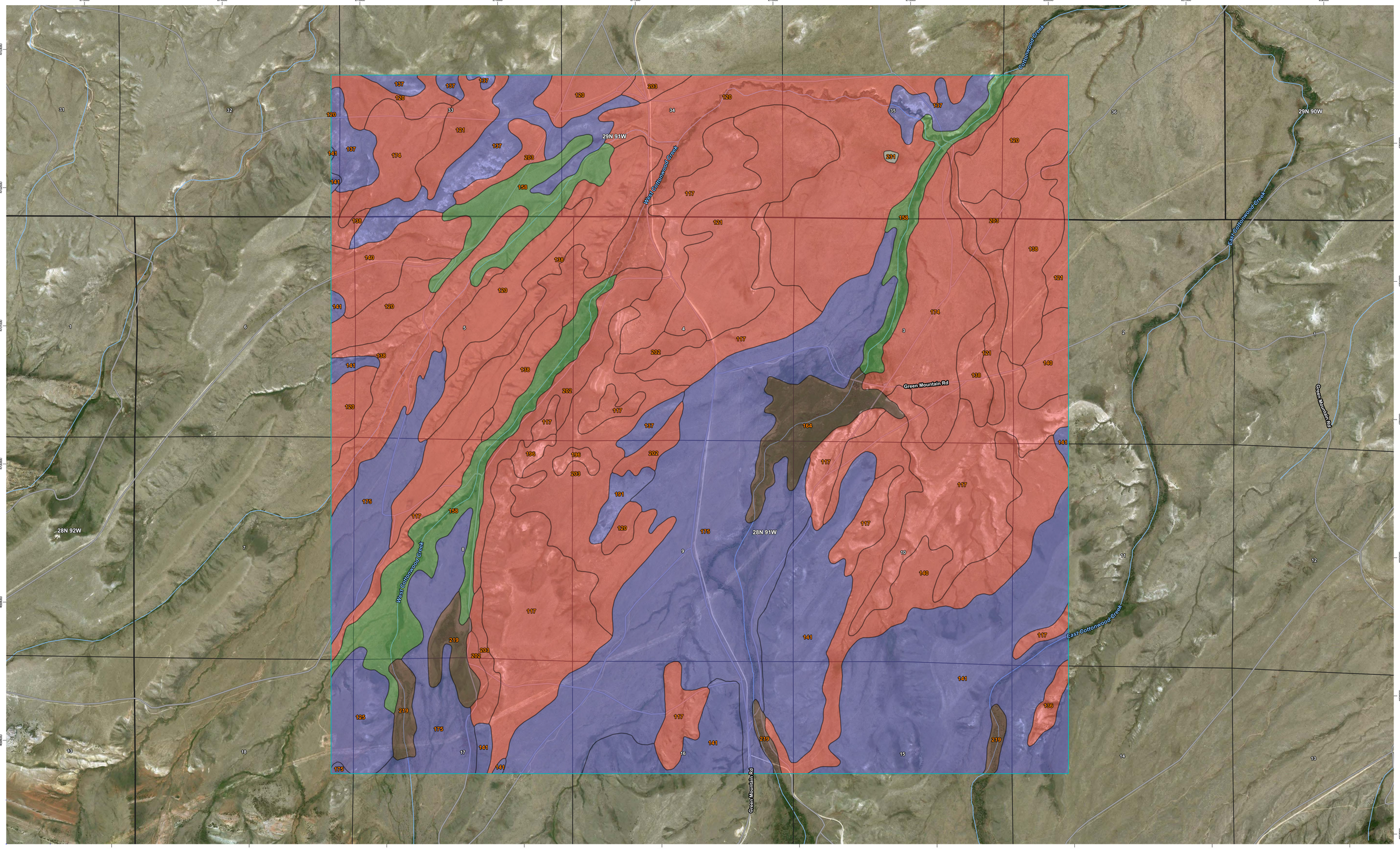
Irrigated Capability Subclass

Land capability classification shows, in a general way, the suitability of soils for most kinds of field crops. Crops that require special management are excluded. The soils are grouped according to their limitations for field crops, the risk of damage if they are used for crops, and the way they respond to management. The criteria used in grouping the soils do not include major and generally expensive landforming that would change slope, depth, or other characteristics of the soils, nor do they include possible but unlikely major reclamation projects. Capability classification is not a substitute for interpretations that show suitability and limitations of groups of soils for rangeland, for woodland, or for engineering purposes.

In the capability system, soils are generally grouped at three levels-capability class, subclass, and unit. Only class and subclass are included in this data set.

Capability subclasses are soil groups within one capability class. They are designated by adding a small letter, "e," "w," "s," or "c," to the class numeral, for example, 2e. The letter "e" shows that the main hazard is the risk of erosion unless close-growing plant cover is maintained; "w" shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage); "s" shows that the soil is limited mainly because it is shallow, droughty, or stony; and "c," used in only some parts of the United States, shows that the chief limitation is climate that is very cold or very dry.

In class 1 there are no subclasses because the soils of this class have few limitations. Class 5 contains only the subclasses indicated by "w," "s," or "c" because the soils in class 5 are subject to little or no erosion. They have other limitations that restrict their use to pasture, rangeland, forestland, or wildlife habitat.



Map Scale: 1:12,500 if printed on D landscape (34" x 22") sheet.

Meters: 0 150 300 600 900

Feet: 0 500 1000 2000 3000

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 Rating Polygons

- Erosion
- Soil limitation within the rooting zone
- Excess water
- Climate condition
- Not rated or not available

Soil Rating Lines

- Erosion
- Soil limitation within the rooting zone
- Excess water
- Climate condition
- Not rated or not available

Soil Rating Points

- Erosion
- Soil limitation within the rooting zone
- Excess water
- Climate condition
- Not rated or not available

Political Features

- PLSS Township and Range
- PLSS Section

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.

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: Fremont County, Wyoming, East Part and Dubois Area
Survey Area Data: Version 16, Sep 17, 2019

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

Date(s) aerial images were photographed: Sep 4, 2011—Sep 15, 2016

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.

Table—Irrigated Capability Subclass

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
117	Blackhall-Carmody association, hilly	e	908.5	13.5%
120	Bosler-Rock River sandy loams, 1 to 8 percent slopes	e	949.7	14.2%
121	Bosler-Ryan Park fine sandy loams, 1 to 8 percent slopes	e	363.0	5.4%
125	Brownsto very bouldery-Decross variant-Brownsto complex, hilly	s	81.6	1.2%
136	Cragosen-Carmody-Blazon complex, hilly	e	17.7	0.3%
137	Cragosen-Rock outcrop-Carmody complex, hilly	s	257.8	3.8%
138	Cragosen-Bosler-Cushool association, rolling	e	482.6	7.2%
140	Cushool-Rock River association, 2 to 8 percent slopes	e	405.0	6.0%
141	Dahlquist-Rock River complex, 1 to 12 percent slopes	s	822.3	12.3%
158	Havre-Forelle-Glendive complex, 0 to 3 percent slopes	c	364.5	5.4%
164	Iceslew-Countryman complex, 0 to 3 percent slopes	w	106.0	1.6%
174	Milren-Bosler-Rock River sandy loams, 1 to 12 percent slopes	e	289.5	4.3%
175	Milvar-Milren complex, 1 to 6 percent slopes	s	1,080.6	16.1%
191	Rentsac-Carmody complex, hilly	s	23.4	0.3%
196	Rock outcrop-Blackhall complex, hilly	e	20.9	0.3%
202	Ryan Park loamy fine sand, undulating	e	140.6	2.1%
203	Ryan Park-Carmody association, 1 to 15 percent slopes	e	303.3	4.5%
219	Venapass-Silas loams, 0 to 6 percent slopes	w	86.0	1.3%

Map unit symbol	Map unit name	Rating	Acres in AOI	Percent of AOI
231	Water		1.8	0.0%
Totals for Area of Interest			**6,704.7**	**100.0%**

Rating Options—Irrigated Capability Subclass

Aggregation Method: Dominant Condition

Component Percent Cutoff: None Specified

Tie-break Rule: Lower

Appendix E
Storage Option Drawings

SOIL TYPE 158
HARVE–FORELLE–GLENDIVE COMPLEX
PROFILE:
0"–4": LOAM
4"–60": STRATIFIED FINE SANDY LOAM TO CLAY LOAM
NATURAL DRAINAGE CLASS: WELL DRAINED
TRANSITIVITY: MOD–HIGH TO HIGH (0.60 TO 2.0 IN/HR)

SOIL TYPE 137
CRAGOSEN–ROCK OUTCROP–CARMODY COMPLEX
PROFILE:
0"–4": GRAVELLY LOAM
4"–19": VERY GRAVELLY SANDY LOAM
19"–29": UNWEATHERED BEDROCK
NATURAL DRAINAGE CLASS: WELL DRAINED
TRANSITIVITY: VERY LOW TO MOD–HIGH (0.0 TO 0.20 IN/HR)

SOIL TYPE 121
BOSLER–RYAN PARK FINE SANDY LOAMS
PROFILE:
0"–6": FINE SANDY LOAM
6"–13": SANDY CLAY LOAM
13"–20": GRAVELLY SANDY CLAY LOAM
20"–60": VERY GRAVELLY LOAMY SAND
NATURAL DRAINAGE CLASS: WELL DRAINED
TRANSITIVITY: MOD–HIGH TO HIGH (0.60 TO 2.0 IN/HR)

SOIL TYPE 120
BOSLER–ROCK RIVER SANDY LOAMS
PROFILE:
0"–3": SANDY LOAM
3"–31": SANDY CLAY LOAM
31"–60": VERY GRAVELLY LOAMY SAND
NATURAL DRAINAGE CLASS: WELL DRAINED
TRANSITIVITY: MOD–HIGH TO HIGH (0.60 TO 2.0 IN/HR)

BOUNDARY OF NRCS AREA OF INTEREST

SECTION LINES FROM NRCS REPORT (NOT CONSISTENT WITH GIS PARCEL DATA)

"NORTH RESERVOIR"
29,034 CYDS EMBANKMENT
76.96 MG STORAGE

PROPERTY LINE

30 AC SURFACE AREA

29N 91W

35

137

231

120

121

158

120

Cottonwood Creek

N

E

0 200 400

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REV.	DATE	
	9/4/2020	
	SURVEYED	FC-GIS
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	DRAWN	AL
	CHECKED	
	APPROVED	

NELSON ENGINEERING
P.O. BOX 1599, JACKSON WYOMING (307) 733-2087

DRAWING TITLE
STORAGE OPTIONS
NORTH

JOB TITLE
JASON KING - BEAVER VALLEY RANCH
IRRIGATION SYSTEM EVALUATION
FREMONT COUNTY, WY

DRAWING NO
E1

JOB NO
19-294-01

SOIL TYPE 158
HARVE–FORELLE–GLENDIVE COMPLEX
PROFILE:
0"–4": LOAM
4"–60": STRATIFIED FINE SANDY LOAM TO CLAY LOAM
NATURAL DRAINAGE CLASS: WELL DRAINED
TRANSITIVITY: MOD–HIGH TO HIGH (0.60 TO 2.0 IN/HR)

SOIL TYPE 164
ICESLEW–COUNTRYMAN COMPLEX
PROFILE:
0"–2": VERY FINE SANDY LOAM
2"–12": LOAM
12"–32": LOAM
32"–60": STRATIFIED SANDY LOAM TO SILTY CLAY LOAM
NATURAL DRAINAGE CLASS: SOMEWHAT POORLY DRAINED
TRANSITIVITY: HIGH (2.0 TO 6.0 IN/HR)

SOIL TYPE 174
MILREN–BOSLER–ROCK RIVER SANDY LOAMS
PROFILE:
0"–3": SANDY LOAM
3"–11": SANDY CLAY
11"–16": SANDY CLAY LOAM
16"–23": LOAM
23"–56": FINE SANDY LOAM
56"–60": LOAMY FINE SAND
NATURAL DRAINAGE CLASS: WELL DRAINED
TRANSITIVITY: MOD–LOW TO MOD–HIGH (0.06 TO 0.20 IN/HR)

SOIL TYPE 175
MILVAR–MILREN COMPLEX
PROFILE:
0"–3": STONY LOAM
3"–16": GRAVELLY CLAY LOAM
16"–26": VERY GRAVELLY LOAM
26"–60": VERY GRAVELLY LOAMY SAND
NATURAL DRAINAGE CLASS: WELL DRAINED
TRANSITIVITY: MOD–LOW TO MOD–HIGH (0.06 TO 0.20 IN/HR)

PROPERTY LINE

175 158 174

"CENTRAL RESERVOIR"
18,925 CYDS EMBANKMENT
24.89 MG STORAGE

3

10 AC SURFACE AREA

174

121

175

28N 91W

138

"HOUSE POND"
2500 CYDS EMBANKMENT
3.03 MG STORAGE

164

2.5 AC SURFACE AREA

SECTION LINES FROM NRCS REPORT (NOT CONSISTENT WITH GIS PARCEL DATA)

164

N E

0 200 400

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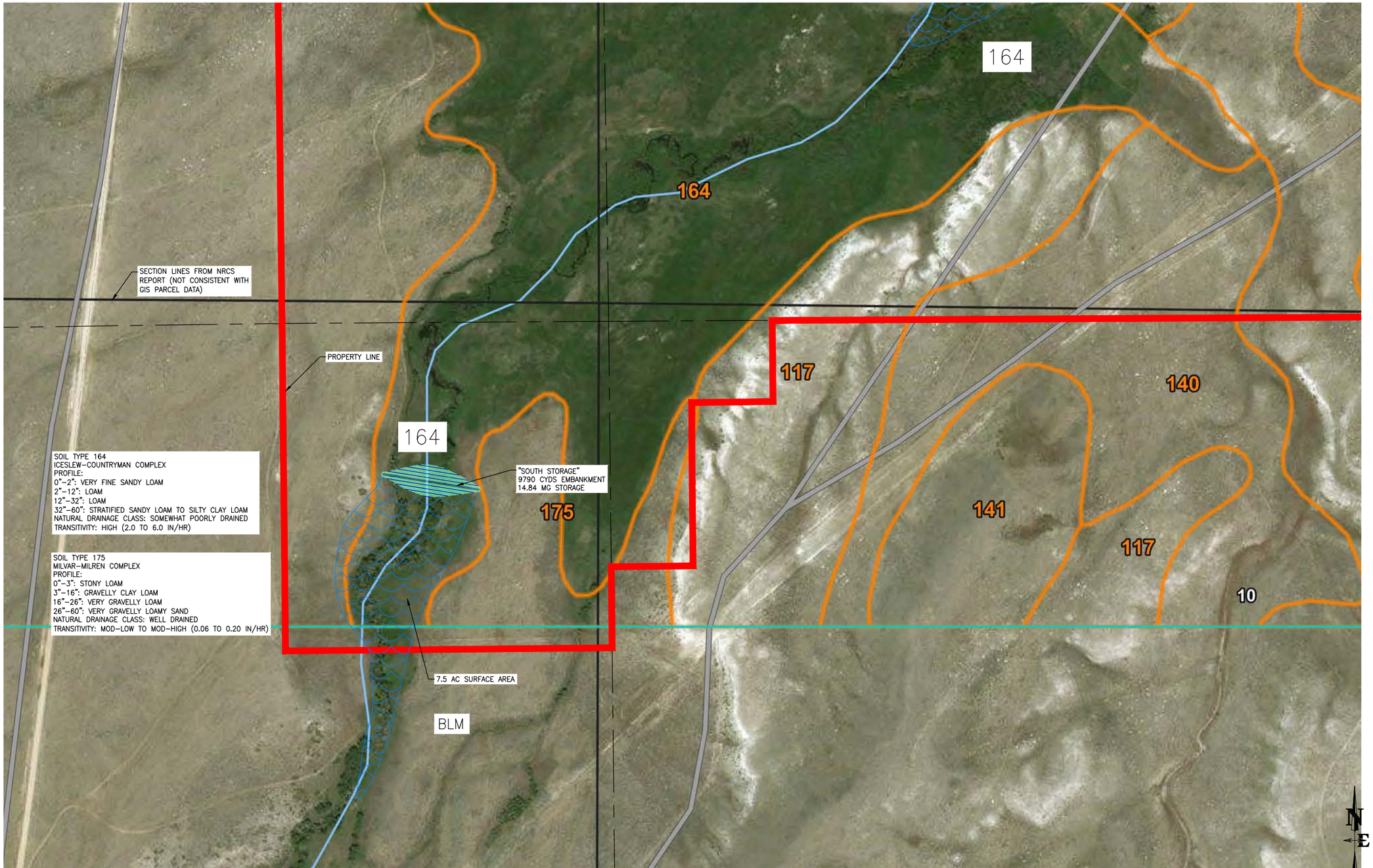
DRAWING TITLE
STORAGE OPTIONS
CENTRAL

JOB TITLE
JASON KING - BEAVER VALLEY RANCH
IRRIGATION SYSTEM EVALUATION
FREMONT COUNTY, WY

DRAWING NO
E2

JOB NO
19-294-01



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DRAWING TITLE: STORAGE OPTIONS SOUTH

JOB TITLE: JASON KING – BEAVER VALLEY RANCH
IRRIGATION SYSTEM EVALUATION
FREMONT COUNTY, WY

DRAWING NO: E3

JOB NO: 19–294–01

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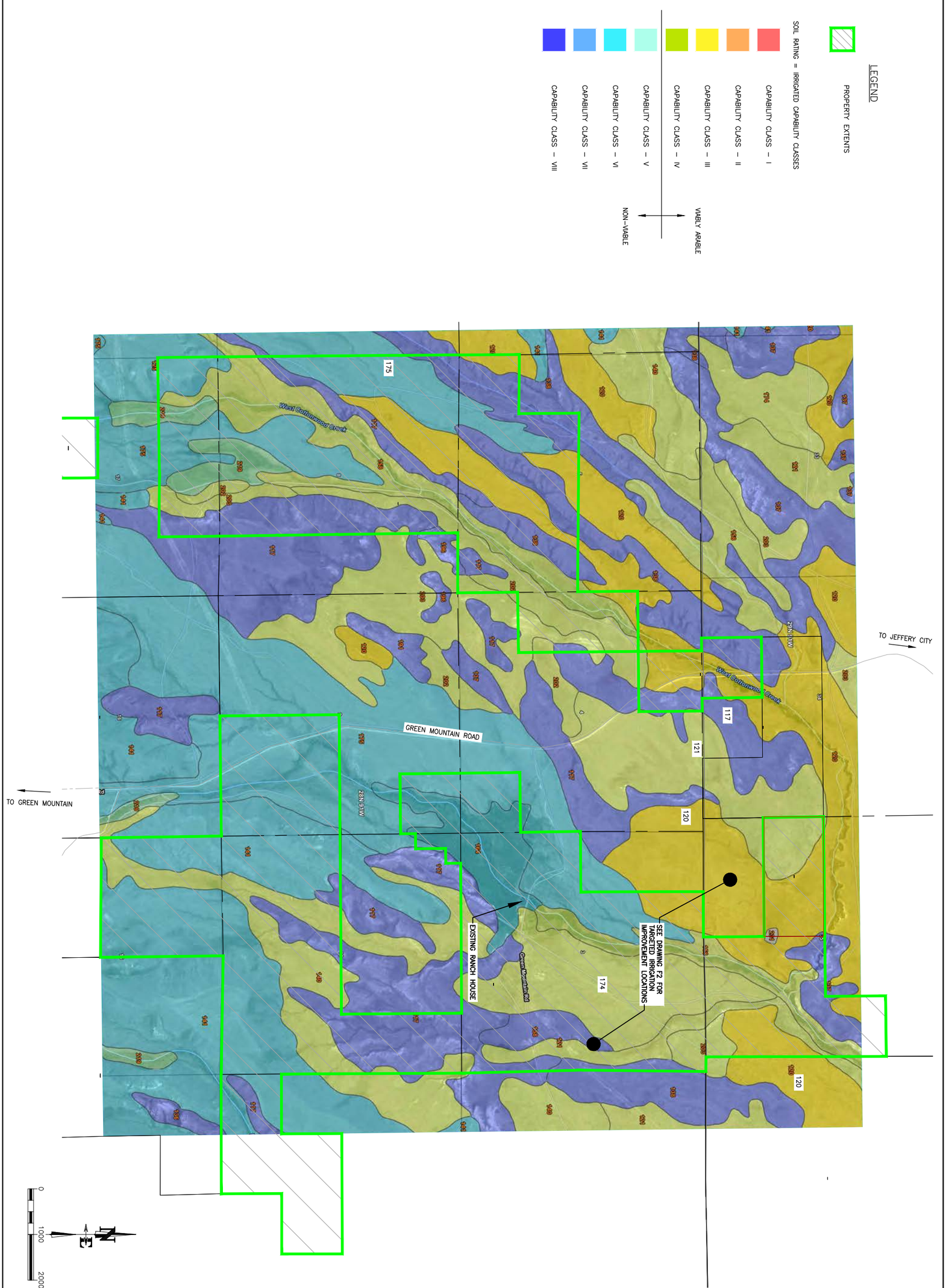
Appendix F
Irrigation Exhibits



DRAWING NO: F1	JOB TITLE: JASON KING – BEAVER VALLEY RANCH IRRIGATION SYSTEM EVALUATION FREMONT COUNTY, WY	DRAWING TITLE: NRCS SOILS MAPPING EXHIBIT OVERVIEW IRRIGATED CAPABILITY CLASS	NELSON ENGINEERING P.O. BOX 1599, JACKSON WYOMING (307) 733-2087	DATE: 9/4/2020 SURVEYED: FC-GIS ENGINEERED: TSR DRAWN: AL CHECKED: APPROVED:	REV.
JOB NO: 19-294-01					

LEGEND

PROPERTY EXTENTS

SOIL RATING = IRRIGATED CAPABILITY CLASSES

CAPABILITY CLASS – I

CAPABILITY CLASS – II

CAPABILITY CLASS – III

VIABLY ARABLE

CAPABILITY CLASS – IV

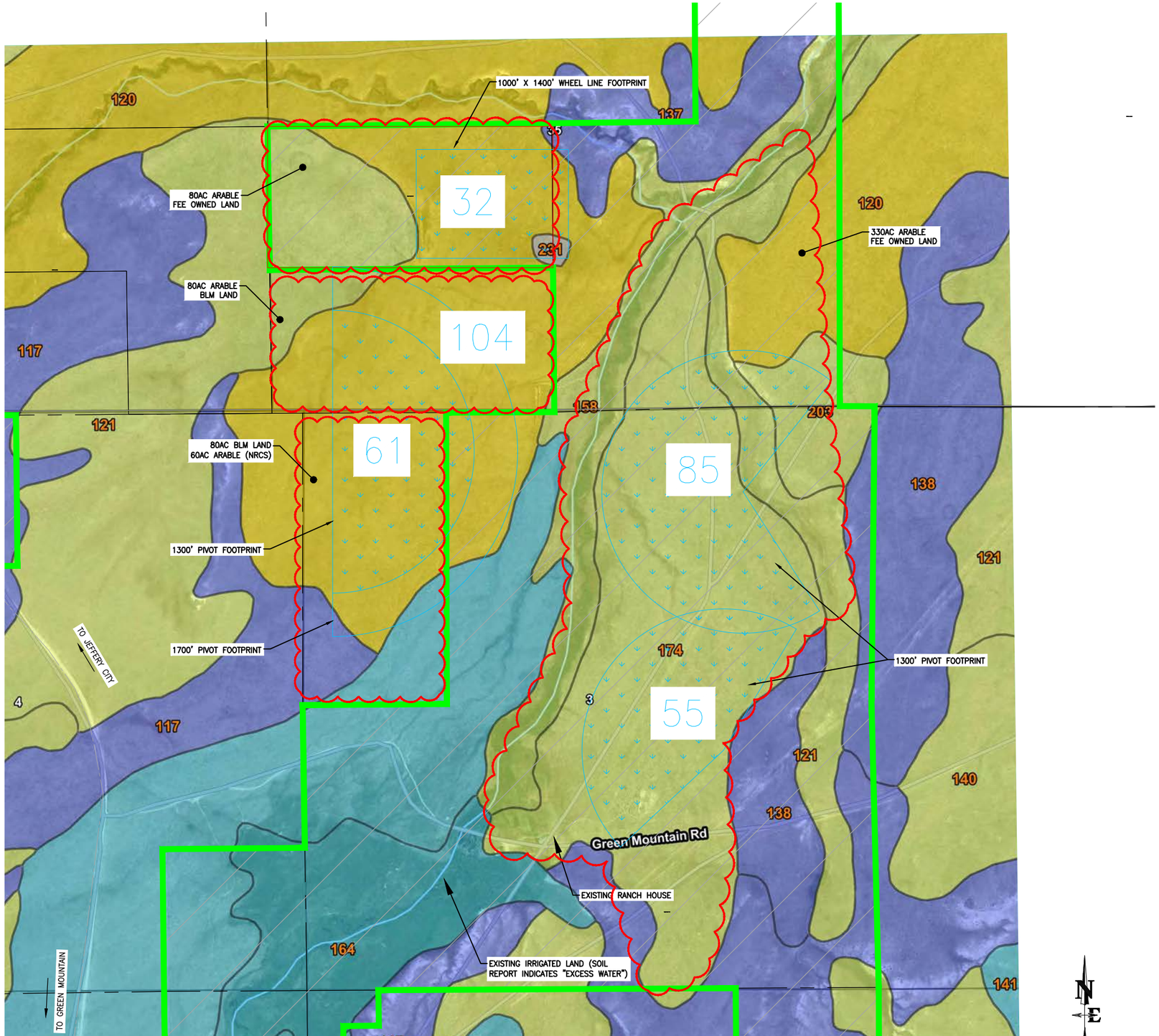
CAPABILITY CLASS – V

NON–VIABLE

CAPABILITY CLASS – VI

CAPABILITY CLASS – VII

CAPABILITY CLASS – VIII



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	APPROVED	

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DRAWING TITLE
IRRIGATED CAPABILITY CLASS
TARGETED IRRIGATION
IMPROVEMENT LOCATIONS

JOB TITLE
JASON KING – BEAVER VALLEY RANCH
IRRIGATION SYSTEM EVALUATION
FREMONT COUNTY, WY

DRAWING NO
F2

JOB NO
19-294-01