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Alluvial Valley Floor Evaluation Report
Coyote Creek Mining Company, L.L.C.
Coyote Creek Mine
Mercer County, North Dakota
March, 2013
Revised August, 2013

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Mercer County, North Dakota

February, 2013

Introduction

Scope and objectives

This report was prepared in accordance with Section 69-05.2-08-13 of the North Dakota Administrative Code. The area of this report includes Sections 3, 4, 5, 6, 7, 8, 9, 16, 17 and 18, T142N, R88W; Sections 1, 2, 3, 4, 9, 10, 11, 12, 13, 14, 15 and 16, T142N, R89W; S½ Section 3, S½ Section 4, S½ Section 5, S½ Section 6, Sections 7 and 8, portions of W½, NE¼ Section 9, NW¼ Section 10 and N½ Section 16 defined by an irregular boundary around the valley of Brush Creek as drawn by the Reclamation Division of the North Dakota Public Service Commission (PSC), portions of NW¼ Section 16, N½ Sections 17 and 18 excluding permitted areas of KRSB-8603, Sections 32, 33, 34 and 35, T143N, R88W; S½ Section 1, SE¼ Section 2, E½ Section 11, Section 12, N½ Section 13, N½, SW¼ Section 14, Section 15, E½ Section 16, Sections 20, 21, 22, 23, SW½ (diagonal) Section 24, Sections 25, 26, 27, 28, 29, 32, 33, 34, 35 and 36, T143N, R89W, Mercer County, North Dakota (Exhibit A). The report area, while contiguous, represents two tracts in terms of future development. The northeast area encompasses possible haulroad routes around existing permitted acreage of the Dakota Westmorland Corporation's Beulah Mine. Coal removal is not planned for this tract or the possible haulroad corridor. Both report segments are adjacent to areas that have received prior Alluvial Valley Floor (AVF) determinations associated with mining permit approval findings for the Beulah Mine. The present study area and previously determined areas provide continuous coverage of AVF evaluation over the area of existing mining, proposed new mining, and likely future permitting as shown in Exhibit A. These AVF study area boundaries shown in Exhibit A were reviewed on two separate occasions prior to report preparation, modified to required specifications and finally agreed to with Reclamation Division staff.

The report is based on existing information available in published work, approved mining permits, and related data in the public domain from the surface mining reclamation and regulatory process. However, observations made by environmental professionals involved in the acquisition of baseline data for future Coyote Creek Mining Company permit applications are incorporated and attributed to the individuals where appropriate. Preliminary observations from baseline data acquisition for other aspects of mine permitting are occasionally referred to and are noted as such.

The record of Alluvial Valley Floor evaluation, reporting and PSC findings at the Beulah Mine is somewhat unclear because AVF studies, permits and permit findings

documents in early work usually focused on named streams in or adjacent to proposed permit areas and often omitted comprehensive references to areas covered by the studies or determinations. Revision 22 of Dakota Westmoreland Corporation mining permit KRSB-8603 provides a review to help clarify the history of AVF studies for the Beulah Mine. Exhibit A outlines those areas covered by previous AVF studies based on information in the approved Beulah Mine permits and their findings documents. There is some overlap among these areas and the present study. The proper language concerning AVF is present in all findings documents for awarded permits for the Beulah Mine, and permitted acreage must be considered evaluated for AVF potential. Inspection of available aerial photography and other data presented here confirm that all of the previously studied and determined areas as outlined in Exhibit A are not AVF.

This study accepts existing findings in several Beulah Mine permits that the valleys of Coyote Creek, Brush Creek, short segments of the Knife River floodplain traversed by these creeks, and the Main Drainage traversing eastern portions of Beulah Mine are not AVF. This study addresses the AVF status of the Knife River drainage within the present study area. While not directly addressing the determined status of previously studied adjacent areas, this report will provide additional evaluation of existing data that supports these findings.

The OSM Guidelines state that geologic, geomorphic and water resources criteria form the regulatory definition of an AVF. An AVF must be an area with water availability sufficient for subirrigation or flood irrigation to support agricultural activities. They go on to clarify the meaning of water availability (*OSM Guidelines, p. II-9)* by stating that the water availability criteria are met if:

> (a) water is available by surface-water irrigation or subirrigation and is being or has successfully been used to enhance production of agriculturally useful vegetation; or
>
> (b) surface water is available in sufficient quantities to support agricultural activities.

Item (b) could be seen as suggesting that agricultural activities mean the entire range of rural water supply needs including household use and livestock watering. However, in spite of very broad technical summarization in many sections of *The OSM Guidelines,* nowhere is it implied or stated that uses of surface water supplies other than for enhancing crop production serve to meet the AVF criterion. Thus, this item refers to supporting plant productivity. Irrigation with ground water, even if located on a stream floodplain, does not make the stream reach an AVF.

Previous Studies and Findings

Late in 1985, Knife River Coal Mining Company submitted a study to the Reclamation Division of the Public Service Commission (PSC) demonstrating that the valley of Brush Creek was not an AVF. On November 20, 1985, the PSC issued a determination that the Brush Creek valley is not an AVF. Confusion about the AVF concept and the power of the 1985 OSMRE draft reconnaissance map, *Draft Reconnaissance Maps to Assist in Identifying Alluvial Valley Floors West-central North Dakota, OSM/TM-3/85,*

(Exhibit B) probably contributed to the status of the Knife River valley not being addressed in the earliest Knife River Coal report other than to note that it is a potential AVF.

The 1985 OSMRE reconnaissance map has been subsequently found to have numerous false positive AVF areas indicating AVF potential where it does not exist. However, the report recognized correctly the deeply incised channel and lack of AVF potential of the Knife River valley from Elm Creek to Spring Creek. Elm Creek is a southern tributary of the Knife River that enters it about 5 miles west of the study area of this report, and Spring Creek confluences with the Knife River about 1.5 miles northeast of the study area. Thus, the Elm Creek to Spring Creek reach described in the 1985 OSMRE report encompasses all of the Knife River within the present AVF study area. The OSM narrative (p. 12) observes:

> From Elm Creek to Spring Creek (pl. 2), the river is deeply incised (15 to 25 feet), and no Knife River water is used for irrigation. However, one system utilizes tributary water, and a center pivot system pumps alluvial ground water. Subirrigation is precluded by the depth of channel incision, and natural flood irrigation rarely occurs below Brush Creek.
>
> Below the confluence of the Knife River and Spring Creek, three operations use pumped sprinkler systems to irrigate alfalfa and small grains. Annual flooding does not generally reach the main valley floor, which is 20 feet or more above the channel. Subirrigation does not occur under the main valley floor (fig. 7).

Revision 22 to KRSB-8603 included an AVF study that addressed Coyote Creek. The PSC issued a determination on October 26, 2009 that the valley of Coyote Creek within that study area is not an AVF in the sense of SMCRA. The study area of that report is included within the shaded area of previously determined acreage shown in Exhibit A. An AVF study and negative determination associated with Revision 27 to KRSB-8603 covered an area between Coyote and Brush Creeks as shown on Exhibit A.

Geology and Geomorphology

The geologic and geomorphic concept of an alluvial valley floor serves to define a very large class of landscape features to which Alluvial Valley Floors, in the restricted regulatory sense of SMCRA, belong as a subset. In other words, an alluvial valley floor by a geologic and geomorphic definition includes all such features while the restricted definition of SMCRA is intended to afford protection to a subset of alluvial valley floodplains that are critical to the agricultural economy in certain areas of the arid western USA. *The OSM Guidelines, p. II-7,* cite the following to clarify the regulatory definition of AVF.

> Of special importance in the arid and semiarid coal mining areas are alluvial valley floors which are the productive lands that form the backbone of the agricultural and cattle ranching economy of these areas. For instance, in the Powder River Basin of eastern Montana and Wyoming, agricultural and ranching operations which form the basis of the existing economic system of the region could not survive without hay production from the naturally subirrigated

and flood irrigated meadows located on the alluvial valley floors. (U.S. House of Representatives, Committee on Interior and Insular Affairs, 1976).

This quote not only clarifies the restricted regulatory definition of AVF but also conveys the whole intent of the AVF concept in SMCRA.

The study area is within the Glaciated Missouri Plateau section of the Great Plains Physiographic Province. The area was glaciated, and as a result is mantled with till and outwash deposits. Reworked glacial material occurs within all drainage courses. The most notable geologic features of the area are the glacial debris-filled stream valleys which are deeply incised in bedrock. These channels were cut by glacial outwash streams or the diversion courses of proglacial streams that filled with water borne sediment. The valley of the Knife River and those of its major tributaries were established prior to or during glaciation and interglacial periods and are now filled with glacial-fluvial sediment of the Coleharbor formation which is being reworked by the present-day drainages.

The major tributary drainage areas south of the Knife River are shown in Exhibit C. The main perennial stream in the study area is the Knife River. Principal tributaries of the Knife River within the study area, from west to east, are Mud Creek, Coyote Creek and the mouth and one ephemeral tributary of Brush Creek. Several smaller and unnamed tributaries of the Knife River also drain the study area.

The principal northern tributary of the Knife River in this portion of Mercer County is Spring Creek which enters the Knife River about 1.3 miles north of the study area. Its course is generally eastward and about 7 miles from the Knife River channel at the west end of the AVF study area. Smaller, unnamed northern tributaries of the Knife River drain the narrow area between the Spring Creek drainage and the Knife River. A few of these smaller streams are in the AVF study where they enter onto and cross the Knife River floodplain. These will be discussed only where appropriate and generally in terms their presence on the Knife River floodplain. These drainages are mostly ephemeral, have no or poorly developed floodplains and are isolated from future hydrologic effect of mining in the proposed permit area. The northern tributaries of the Knife River will not be considered further in this report.

The Knife River is a meandering perennial stream deeply incised in a narrow but well-developed flood plain. Meander scars, oxbows, and bar deposits are common in the floodplain area. Terrace levels occur on the flood plain but are discontinuous, and detailed geomorphic research could reveal additional stages of terrace formation. The transition from valley floor to upland is fairly distinct on both sides of the Knife River valley. The Knife River has an average gradient of 1.9 feet/mile over the study area. Gradients of tributary stream channels are typically low. The characteristic fill deposits in the Knife River valley are silt to clayey silt with very fine- to coarse-grained sand, interbedded with clay and fine gravel. The coarse sand and gravel intervals in the valley fill reach thicknesses of up to 60 feet in drilling southwest of Beulah as reported in Croft, 1973. Plate 2 and Figure 22 (Exhibit D) from Croft (1973) show a cross section through the Knife River alluvium just below the mouth of Coyote Creek, the extent of the Knife River Aquifer in the study area, and depths of alluvium under the Knife River floodplain.

Holocene alluvium makes up a very small portion of the valley fill. These recent deposits are up to 10 feet thick but are usually less than 5 feet thick. They consist of lag gravel, silty sand and clay. Some colluvium has been deposited along the valley sides but its distribution and thickness is variable and not a factor in land use and floodplain topography. Small deposits of sandy silt may occur on the valley floors where ephemeral tributaries have emptied into the Knife River, Coyote Creek, Mud Creek and other drainages in the area.

A little less than 930 acres of the Brush Creek drainage is within the AVF Study Area in Sections 34 and 35, T143N, R88W and Section 3, T142N, R88W. Additionally, a small segment near its mouth in Section 9, T143N, R88W is located on the Knife river floodplain and is considered part of that feature. The upstream area is drained by western ephemeral tributaries of Brush Creek only one of which has its main channel within the study area. This stream channel lacks a developed floodplain and flows through rangeland. Tracts of cropland and hay land in the area occur on more gently sloping areas of uplands. This portion of the Brush Creek drainage is not a logical candidate for AVF status and will not be considered further in this report.

A little over 3 linear miles of the Coyote Creek channel and floodplain extend across the southern portion of the AVF study area in Sections 7, 8, 16 and 17, T142N, R88W. Over four linear miles of the channel and floodplain north of the study area to its mouth have been determined not to be AVF. Within the study area, Coyote Creek has a floodplain that varies in width from about 0.1 to 0.4 miles. This upstream reach of Coyote Creek appears to occupy an ancestral valley with terrace remnants formed by a larger stream. In general, the floodplain of Coyote Creek is less easily differentiated from features from ancient stream activity here than further north. Many flat-lying areas along the valley are at significantly higher elevations than water levels in the Coyote Creek channel. Investigation of the geomorphic history of the area is beyond the scope of this study. Since Coyote Creek within this AVF study area possesses a floodplain, its AVF potential will be evaluated.

Mud Creek, with a drainage area covering about 7800 acres, is the smallest drainage of the named streams in the AVF study area. It is about one third the area of the Brush Creek drainage and a little more than one ninth the area of the Coyote Creek drainage. It has a narrow floodplain ranging from about 600 to 900 feet in width extending from the center of Section 4, T142, R89W to where it empties into the Knife River about 2.5 miles to the northwest. There are no flow data for Mud Creek, but flows can be assumed to be proportionately less than those of the larger drainages. Steeper terrain and fewer significant catchments in the drainage probably mean shorter retention times for runoff from the Mud Creek drainage. The principle shallow lignite aquifers in the area evidently crop out upstream of Section 4, T142, R89W, so intermittent flow may occur within the two and one half miles from Section 4 to its mouth. As with most small streams in the region, the transition from ephemeral to intermittent flow probably shifts up and down the stream yearly depending upon the influence of precipitation on groundwater and surface inflow.

There are areas within the AVF Study Area that are drained by small streams that flow directly into the Knife River. These occur in areas between Gold and Mud Creeks,

between Mud and Coyote Creeks, and between Coyote and Brush Creeks. These areas are labeled "Knife River Small Drainages" in Exhibit C. These drainages are ephemeral and small, generally extending over 1.5 miles or less before dropping onto the Knife River floodplain. None of them have developed floodplains and they are not candidates for AVF status. Their downstream portions crossing the Knife River floodplain are considered as part of that floodplain in this report. These streams and their contributing drainages are not considered further in this report.

In general, drainageways are well defined and form pronounced valleys or draws on the upland. Relief and depth of stream down-cutting is more pronounced in the western one-half of the area. Remnants of surficial glacial deposits are widespread outside the study area to the east of Brush Creek, are generally confined to the upland areas between Brush Creek and Coyote Creek, and are even more restricted to smaller upland areas west of Coyote Creek. Areas with slopes conducive to cultivated crops and hay production are mostly found in the eastern one-third of the study area. Within the rolling terrain of the western portions of the area, suitable slopes for hay production are more commonly found on upland interfluvial locations. The steeper slopes of drainage networks are used primarily for livestock grazing. There is a general correspondence between the gentler slopes of glaciated upland areas and sites suitable for crop cultivation or hay production.

Natural water catchments are limited to reaches of drainageway channels and the area is generally well-drained. Effective drainage and limited surface water retention on the landscape is likely a factor in limiting local ground water recharge. Consequently, relatively low hydraulic heads in shallow bedrock aquifers do not produce exceptional groundwater discharge to seeps or alluvial aquifers and do not provide areas of enhanced crop production on floodplains or upland seep areas.

Stratigraphy

From oldest to youngest strata, the study area consists of the Bullion Creek Formation, Sentinel Butte Formation, Golden Valley Formation, Coleharbor Formation, and the Oahe Formation. The Sentinel Butte Formation, of Paleocene Age, forms the upland areas and it and the Bullion Creek Formation comprise the shallow bedrock of the study area and contain the lignite sequences of interest. The Eocene Golden Valley Formation occurs on drainage divides between Mud and Elm Creeks and Coyote and Brush Creeks on the southern edge of the study area. These formations are of non-marine fluvial origin. Significant lignite beds in the study area are the Schoolhouse, Upper Beulah, Lower Beulah, Jim Creek and Antelope Creek seams. The Upper Beulah Lignite is the main lignite to be mined. Glacial drift deposits of the Coleharbor Formation of Pleistocene Age mantle the bedrock in places and fill older valleys and glacial trenches. Alluvial deposits of the Oahe Formation of Holocene Age are the near-surface deposits in the creek drainages. Colluvial deposits of the Oahe Formation, consisting of reworked glacial, bedrock and topsoil material, may occur locally. The Pleistocene Coleharbor Formation and the Holocene Oahe Formation are commonly undifferentiated in mapping of the channel fill deposits and can be collectively referred to as Quaternary Alluvium (Qal).

Climate and Hydrology

Because of its location in the center of North America, Mercer County, North Dakota experiences temperature extremes characteristic of a continental climate, with cold winters and mild to hot summers. One feature of a continental climate is that short-term weather, on a scale important in human affairs, can be variable and only reliably predictable on a scale of hours. Long-term patterns, on annual to decadal scale, can be more predictable. Temperature and precipitation can vary widely. Hot weather, though usually confined to June, July, and August, can sometimes begin as early as April or May, and may continue through September. The 181 F (83 C) variation between North Dakota's highest and lowest temperature is the 3rd largest variation of any U.S. state, and the largest of any non-mountainous state. In the Beulah area, the lowest temperatures occur in December through February with the highest in June through August. Months of highest precipitation are May, June and July. Table 1 summarizes local long-term climate averages.

Table 1
Climatic summary, Beulah, ND

Beulah, North Dakota - Monthly Averages & Records - F°					
Month	Average Low	Average High	Record Low	Record High	Average Precip.
January	0°	22°	-42° (1968)	59° (1981)	0.31"
February	9°	30°	-42° (1994)	68° (2002)	0.42"
March	19°	41°	-32° (1998)	81° (2007)	0.73"
April	30°	58°	-11° (1975)	97° (1980)	1.71"
May	41°	71°	11° (2005)	99° (1980)	2.21"
June	50°	79°	27° (1998)	105° (2002)	3.3"
July	55°	85°	30° (1957)	109° (2002)	2.35"
August	54°	85°	30° (1982)	106° (2003)	1.53"
September	43°	73°	13° (1974)	108° (1978)	1.6"
October	32°	60°	-12° (1991)	96° (1997)	1.35"
November	18°	39°	-25° (1985)	82° (1999)	0.7"
December	5°	26°	-46° (1983)	65° (1979)	0.38"

Source: www.intellicast.com/Local/History

Winter through spring precipitation is significant in the hydrologic regime. Late winter and spring runoff from snowmelt generally produce the highest stream flows of the year. Most recharge to the ground water saturated zone occurs in this period of time. Once vegetation is growing, water retention on the landscape and plant uptake of water

increase, and relatively intense precipitation events are needed to produce significant runoff or infiltration. West–central North Dakota is considered semi-arid but long-term climatic records show the region has had significantly more years dominated by wet conditions than have states to the west and south.

Most of the study area is an upland consisting of bedrock unconformably overlain by a mantle of glacial deposits. The surface drainage is well integrated, and water from snowmelt or heavy rainfall events is concentrated into established ephemeral stream channels. Surface water from snowfall entrapment and melting recharges wetland catchments in these channels and provides infiltration to the saturated zone. Groundwater seep discharge from perched saturated zones augments surface water supplies in wetlands and pools of ephemeral and a few intermittent streams. These smaller drainageways have not formed significant floodplains or terraces. In general, favorable slope development and the presence of surface water catchments are more prevalent in the eastern one-third of the study area and annual fluxes of groundwater recharge from local surface infiltration are assumed to be greater there.

Streams in the AVF Study area can be classified as perennial, intermittent or ephemeral based their regime's permanence of flow. The boundaries between perennial, intermittent or ephemeral tend to be indistinct. NDAC 69-05.2-01-02 defines ephemeral stream as a stream which flows only in direct response to precipitation in the immediate watershed or in response to the melting of a cover of snow and ice, and which has a channel bottom that is always above the local water table. An intermittent stream is a stream or part of a stream that flows continuously for at least one month of the calendar year as a result of ground water discharge or surface runoff. A perennial stream means a stream or part of a stream that flows continuously during all of the calendar year as a result of ground water discharge or surface runoff. Ambiguities inherent in these definitions are overcome with logical application of regional climate and hydrology.

The main stem Knife River throughout the AVF Study Area is a perennial stream. The main stems of Brush Creek and Coyote Creek have been classified in various Dakota Westmoreland Corporation (DWC) and prior Knife River Corporation AVF studies and permits for Beulah Mine as perennial streams. The segment of Coyote Creek's main channel within the AVF Study Area is presumed to be perennial based on DWC investigations to the north and periodic observations by Kelly Krabbenhoft in the course of 2012 field work. Reaches of the channel near the south end of the study area probably have intermittent flow, but detailed investigation is beyond the scope of this report.

Flow characteristics of Mud Creek are uncertain. It is considered an intermittent stream in this report with the possibility that some or all of its lower reach may have perennial flow. Reliable determination of a stream's flow as perennial or intermittent is dependent upon field data acquisition periodically over a typical water year, and field investigation of this nature was beyond the requirements of this study. Use of commonly available topographic, soils and geologic information alone to infer stream flow has been attempted mostly in areas of high precipitation the eastern US and with uncertain success. Mud Creek, from about the center of Section 4, T142, R89W to its mouth, is underlain by Channeled Straw Loam soils which typify hydric conditions. In the eastern US, a stream with a contributing drainage of 12.2 square miles could be assumed

perennial. Semiarid conditions and the limited groundwater resources that evidently crop out in its drainage suggest that Mud Creek does not maintain perennial flow.

In terms of AVF potential, the remaining streams of the AVF Study Area lack developed floodplains and are typically ephemeral or nominally intermittent. They are not potential candidates for AVF status.

USGS summaries of monthly flow records for the Knife River at stations along its main stem demonstrate the streams' characteristics. Summaries of available data at these sites are shown in Tables 2 and 3 below, and the original USGS data are in Exhibit E. The average monthly mean discharge at USGS Station 06340010 near Beulah, ND has been about 340 cfs; however, the median of these monthly discharge rates is 96 cfs. High discharges during a few infrequent runoff events produce the high average. The median and percentiles are less affected by anomalous values and are more characteristic of stream flow when a few extreme values are present. These data are biased because the station is only operated spring through late summer and maximum annual runoff events from snow melt are missed. USGS Station 06340500 at Hazen, ND is further from the study area and also contains recording gaps, but it has a longer run of data that include fall and winter low flow periods and late winter runoff events. It has a long-term mean value of 167 cfs and a median of monthly means of 33 cfs. The maximum and minimum flow values for the Hazen station range from 0 to 24,000 cfs. These data better represent the variance in Knife River flows than do data from the site near Beulah.

Ranges in gage heights at the Beulah and Hazen stations and their quartile values reflect the variance in water levels and the magnitude of normal and extreme events in the Knife River. Of course, gage height does not proportionately increase with discharge since once flows exceed bank-full stage, large volumes of discharge can be accommodated by the larger cross-sectional area of the river floodplain. The data confirm that flow tends to be confined to the deep channel and general flooding of the Knife River floodplain is a rare occurrence.

Base flow conditions refer to those extended dry periods between significant rainfall runoff events when stream flow is maintained largely by contributions from groundwater and other long-term storage in the contributing drainage. The inter-quartile ranges of flows in the Knife River are greatest from March through July, and inspection of the data shows the infrequent and variable occurrence of months with high mean discharges. Inspection of the data from USGS Station 06340500 at Hazen, ND suggest that the 10 percentile value, 10 cfs, is a reasonable estimate of its base flow value. Comparison of a base flow of 10 cfs to a median monthly flow rate of 33 cfs suggests that groundwater contributions from bedrock and alluvial aquifers are a significant part of the characteristic flow of Knife River. They also show that the quantity of surface water available for withdrawal for major water uses such as irrigation at points along the stream may be limited.

Table 2

USGS 06340010 Surface Water Station - Knife River near Beulah, ND

	Gage height (ft)	Mean Discharge (cfs)
Period of Record 3/14/2010 to 10/3/2012 (not operational October-February)		
Number of Records	563	593
Maximum	67.8	5290
Minimum	53.3	17
Range	14.6	5273
Mean	55.5	340
Median	54.5	96
75th %tile	55.9	273
25th %tile	54.1	50
Lowest 10%	53.5	28
USGS 06340010 KNIFE RIVER NEAR BEULAH, ND Latitude 47°15'14", Longitude 101°47'08" NAD83 Mercer County, ND, Hydrologic Unit 10130201 Drainage area: 1,880 square miles Datum of gage: 1,700 feet above NGVD29		

The OSM Guidelines, P.II-9 clarifies the concept of subirrigation as:

> The term "subirrigation" is understood to mean the supply of water to plant roots from an underlying alluvial ground-water system such that the vegetation is more productive than in other areas and that the vegetation continues to grow during the moisture-stress portion of the growing season. **Some low-lying areas have greater vegetation productivity than adjacent uplands merely because of better soils, snow drift accumulation, or occasional flood overflow. These areas are not considered to be subirrigated,** and one of the tasks of identification studies is to distinguish those valley areas whose productivity is a result of subirrigation, and not a result of water from some other source. **The water availability criterion excludes areas that could be developed for subirrigation; e.g., by establishing deep rooting alfalfa to tap ground water not presently used by native vegetation.** [emphasis added]

Table 3
USGS 06340500 Surface Water Station – Knife River at Hazan, ND

	Temperture (°C)	Daily Mean Discharge (cfs)	Mean Suspended Sediment (t/d)	Mean Suspended Sediment (mg/l)	Gage height (ft)
Period of record: 4/1/1929 to 10/8/2012					
Number of Records	2482	29045	297	292	4623
Maximum	32	24000	29400	6900	26.5
Minimum	0	0	2	29	0.5
Range	32	24000	29399	6871	26.1
Mean	10	167	631	441	2.0
Median	9	33	17	116	1.6
75th %tile	19	78	102	300	2.1
25th %tile	0	18	6	75	1.2
Lowest 10%	0	10	4	55	0.9
USGS 06340500 KNIFE RIVER AT HAZEN, ND Latitude 47°17'07", Longitude 101°37'18" NAD27 Mercer County, ND, Hydrologic Unit 10130201 Drainage area: 2,240 square miles Datum of gage: 1,712.35 feet above NGVD29.					

The emphasized sentences above are important because they provide a reasonable limit to the regulatory definition of subirrigation. *Appendix C Subirrigation* of the guidelines also emphasizes that the saturated zone must be in reach of the normal rooting depths of shallow rooting hayland and cropland plants under common cultivation in the area rather than only exceptionally deep rooted species such as alfalfa.

The presence of subirrigation, or the occurrence of the saturated zone at depths in the soil that are reached by the normal rooting depths of natural vegetation, is generally non-existent on the floodplain of Knife River in the study area. Croft (1973, Figure 25) shows an unconfined alluvial aquifer on the Knife River floodplain near Hazen, ND in Section 18, T144N, R86W downstream of the study area with water levels ranging from about 16.5 to 21.5 feet below ground surface. Two monitoring wells, CM12-22B and C completed to date in the Knife River alluvium for the proposed permit, had water levels about 29 feet below ground surface on September 13, 2012. These wells in the NW1/4NW1/4 Section 23, T143N, R89W are about 104 feet from water's edge of the Knife River.

State Water Commission records have a water level reading on December 5, 2001 of 29 feet below the surface from a domestic well in the Knife River aquifer in Section 21, T143N, R89W. Without more exact location, the well is likely associated with the farmstead in the NE1/4 of Section 21 about 1.3 miles west of the monitoring wells, CM12-22B and C. Aerial photography suggests that the well is probably within 100 to 300 feet of water's edge of the Knife River. An irrigation well in the NW¼SW¼

Section 7, T143N, R88W and about 250 feet from the Knife River had a water level of 19.5 feet below the surface on September 10, 1980. Again, no exact location is given in the State Water Commission permit, but the well was located during a field review on April 30, 2013 with Reclamation Division staff. The well supplies alluvial ground water to center pivot irrigators located in Sections 7 and 18.

The water table aquifers in the Knife River alluvium are typically at their lowest hydraulic head in fall and winter in response to limited recharge. They can be expected to recharge and gain head during spring from infiltration of winter snow melt. Significant water level increases will occur in response to significant spring snowmelt or spring precipitation. These water level increases will still be below normal rooting depths of crop and rangeland plants common to the Knife River floodplain. In the study area, the saturated zone in the Knife River alluvium occurs at depths of 20 to 30 feet below the surface and may rise to depths of 10 to 20 feet during significant recharge fluxes. These depths indicate that hydraulic head in the unconfined system is controlled, as expected, by the elevation of surface water in the deeply incised river channel and is well below the normal rooting depths of commonly cultivated crops and hay land plants. Any subirrigated areas that may be present along the Knife River in the study area are small, on the scale of a few acres or fractions thereof, and are not significant to agriculture.

Flow data for Coyote Creek are limited. USGS Surface Water Site 06339550 was operated near its mouth in the SW¼ of Section 13, T143N, R89W from October 1, 1977 to December 21, 1983. Daily mean discharges for this site are summarized in Table 4. Flows are typical of larger tributary streams in the region. Daily flows range from an extreme high of 1600 cfs to no flow. The mean shows the influence of extreme events. The median of daily averages is less than 1 cfs and 75% of the daily records are 2.4 cfs or less. Except for snowmelt and extreme precipitation events that generally occur before the plant growing season, flow and surface water availability in the channel is very limited. The base flow contribution is probably in the range of 0.2 to 0.5 cfs and responsible for most of the characteristic flow.

In the course of baseline data acquisition, the low hydraulic heads observed in bedrock aquifers in the general permit area in 2012 suggest that groundwater discharge has potential for maintaining only low volumes of base flow in area streams. This inference is supported by the historic flow characteristics of area streams. Groundwater discharge seepage above stream water elevations tends to be utilized by vegetation during the growing season and retained in a variety of ways in the vadose and surface environments during cold months. Highest groundwater discharge contributions to stream flow likely coincide with and follow spring runoff. The degree of below-grade interchange between the shallow alluvium in the channels of larger tributary streams and bedrock aquifers is beyond the scope of this study. But, it is likely that a significant component of the limited base flow in some reaches of these streams comes through groundwater discharge into their underlying alluvium. The perennial classification of Coyote Creek, Brush Creek, and possibly downstream reaches of Mud Creek are best viewed as nominal. Usable surface water resources of these streams are limited and not significantly different from those of intermittent streams in the region.

Surface water quality is not a central issue in AVF determination but is important in assessing water suitability for irrigation. Water quality information is available from USGS Station 06340500 on the Knife River at Hazen and for DWC monitoring sites on Coyote Creek in the SW¼ Section 13, T143N, R89W near its mouth and in SE¼ Section 31, T143N, R88W about 0.5 miles north of the southern portion of the AVF study area. A DWC monitoring site on Brush Creek in the SE¼ Section 25, T143N, R88W less than a mile east of the AVF study area, while beyond the AVF study area, provides information on the upper reaches of that stream. The Coyote Creek and Brush Creek monitoring sites are within stream reaches that have previously been determined to not be AVF. Summary statistics and locations for these sites are given in Table 5 and the complete data are available in Exhibit E. The data show reasonable similarity between the sites, and greater variance in many parameters in the tributary streams than in the main stem which is typical of stream chemistry.

Median SAR values of all three streams range from 5.49 to 7.63 with a lowest 25th percentile value of 5.09 occurring in the Knife River data. Median specific conductivity values range from 1500 to 2457 mMOHS/cm with a lowest 25th percentile value of 1190 mMOHS/cm. Irrigation suitability of the surface waters in Knife River proper and its tributaries, Coyote and Brush Creeks, are similar with all having low sodium hazard but high to very high salinity potential. The Knife River surface water samples at Hazen represent water integrated over the upper area of the Knife River drainage and more variable surface water quantity and quality can be expected over the tributary drainages of the basin as evidenced by the Coyote Creek and Brush Creek data. The somewhat lower SC and SAR values in the Knife River compared with its tributaries may reflect local infiltration, storage and subsequent base flow contribution of less mineralized waters from floodplain infiltration and the alluvial aquifer of the main stem channel. Surface water in any portion of the Knife River or its tributaries would be marginally suitable for limited irrigation.

Table 4

USGS 06339550 Surface Water Station – Coyote Creek Near Zap, ND

USGS 06339550 COYOTE CREEK NR ZAP, ND Period of Record 10/1977 to 12/1983	
	Monthly Mean Discharge (cfs)
Number of Records	75
Maximum	185.20
Minimum	0.00
Range	185.20
Mean	11.70
Median	1.18
75th %tile	6.05
25th %tile	0.36
Lowest 10%	0.13
Mercer County, North Dakota Hydrologic Unit Code 10130201 Latitude 47°11'57", Longitude 101°54'42" NAD27 Drainage area 65.2 square miles Gage datum 1,809.75 feet above NGVD29	

Table 5
Coyote Creek, Brush Creek and Knife River surface water quality

	Fld-pH	SC	SAR	TDS	Ca	Mg	Na	K	Cl	SO4	Total Fe
13CCC-W/ST Coyote Creek - SW1/4 Sec. 13, T143N, R89W, about 1 linear mile of its its mouth											
Maximum	8.7	3,681	10.10	2,910	208.0	589.0	530	14.0	18.0	1,620	0.80
75th %tile	8.6	2,479	8.38	2,140	131.5	123.0	436	13.5	14.4	1,100	0.49
Median	**8.4**	**2,425**	**7.63**	**1,930**	**97.9**	**77.5**	**412**	**11.8**	**12.5**	**951**	**0.41**
25th %tile	8.1	2,285	6.31	1,905	75.3	54.1	374	10.3	10.5	783	0.27
Minimum	7.8	1,316	4.03	954	61.6	43.7	172	8.9	7.6	520	0.18
31DBD-W/ST Coyote Creek - SE1/4 Sec. 31, T143N, R88W,about 0.25 miles north of AVF study area											
Maximum	8.6	3,707	12.00	2,920	212.0	153.0	546	14.5	17.7	1,600	1.34
75th %tile	8.5	2,554	8.89	2,185	123.8	94.7	457	12.4	11.6	1,116	0.57
Median	**8.4**	**2,457**	**6.98**	**1,960**	**84.5**	**61.8**	**438**	**10.7**	**9.6**	**887**	**0.40**
25th %tile	8.1	2,175	6.44	1,850	74.5	51.5	344	9.9	9.3	842	0.36
Minimum	7.7	1,400	3.92	871	52.8	44.5	171	8.6	7.6	554	0.18
25DCC-E/ST Brush Creek - SE1/4 Sec. 25, T143N, R88W, ca. 0.75 miles E. of tributary in AVF study area											
Maximum	9.0	6,610	20.00	7,120	239.0	298.0	1,850	47.7	67.9	4,000	0.98
75th %tile	8.3	2,719	6.40	2,225	147.5	130.0	406	16.5	24.0	1,125	0.71
Median	**8.1**	**2,318**	**5.49**	**1,830**	**94.1**	**96.7**	**338**	**15.0**	**16.4**	**925**	**0.33**
25th %tile	7.8	1,991	4.94	1,550	87.7	86.5	277	11.7	12.7	755	0.23
Minimum	6.5	442	1.56	357	23.8	15.1	40	11.1	4.0	113	0.13
USGS Surface Water Station 06340500 Knife River at Hazen, ND											
Maximum	9.2	3,100	9.8	1,890	130.0	70.2	410	15	21.5	860	7.00
75th %tile	8.4	1,835	6.7	1,290	77.5	47.0	300	9.6	7.9	520	0.95
Median	**8.2**	**1,500**	**5.89**	**1,035**	**63.0**	**39.0**	**240**	**8.8**	**6.3**	**423**	**0.44**
25th %tile	7.9	1,190	5.09	883	51.0	30.0	195	7.8	4.3	320	0.16
Minimum	7	170	1.27	128	14.0	2.2	17	0.3	0.5	26	0.00

Data on Coyote Creek floodplain alluvium are limited. Two monitoring wells drilled in the summer of 2012 by Coyote Creek Mining Company characterize the alluvium. CM12-08B in the NE¼, Section 31, T143N, R88W, 45 feet from the Coyote Creek channel and screened in the base of the alluvium at a depth of 20 feet, had a static water level of 9.3 feet below ground surface on September 14, 2012. About ¾ miles south and downstream, CM12-20C in the SE¼ Section 31, T143N, R88W, about 70 feet from the Coyote Creek channel and screened at the base of the alluvium at a depth of 15 feet, had a static water level of 8.5 feet below ground surface on September 14, 2012. Four older groundwater monitoring wells to the south and close to the Coyote Creek channel are apparently screened in lignite based on their depths and lower static water levels. The alluvium under Coyote Creek is shallow and has static water levels below the rooting depths of common range vegetation and cultivated crops in the area. The saturated zone is characterized by low hydraulic head that has very limited potential as a ground water supply for significant irrigation.

Soils

The project area is in the Missouri Plateau section of the Northwestern Great Plains ecoregion (Bryce et. al., 1996). They describe the region as:

> *".....a semiarid rolling plain of shale, siltstone, and sandstone punctuated by occasional buttes and badlands. Native grasslands persist in areas of steep or broken topography, but they have been largely replaced by spring wheat and alfalfa over most of the ecoregion. Agriculture is limited by erratic precipitation patterns and limited opportunities for irrigation. On the Missouri Plateau, west of the Missouri River, the topography is largely unaffected by glaciation and retains its original soils and complex stream drainage pattern. A mosaic of spring wheat, alfalfa, and grazing land covers the shortgrass prairie ....."*

Most of the soils in the area are classified as Mollisols (Haplustolls, Calciustolls, Argiustolls, and Natrustolls), and Entisols (Ustorthents). The temperature regime is Frigid and the moisture regime is Typic Ustic. Soils on summit or convex landscape positions lack or have thinner mollic epipedons, while backslopes through toeslopes have thicker mollic epipedons. Glacial erratics, consisting of large stones, commonly occur. An Order Two soil survey has been completed by the USDA-SCS (Weiser, 1975). Exhibit F shows the NRCS soils map within the study area and Exhibit G shows a map legend for soils occurring within the AVF study area. Mean annual precipitation is 15 to 17 inches and frost-free days are 95-130.

Most of the study area is glacially modified bedrock controlled upland. It drains into the Knife River, a tributary of the Missouri River. The upland primarily consists of Tertiary-aged deposits. A thin mantle of Quaternary-aged glacial till is found on stable interfluves. In most areas the surface drainage is well integrated, and excess precipitation is concentrated into established ephemeral stream channels. Excess surface water also recharges wetland catchments in these channels and provides infiltration to the saturated zone. Groundwater seep discharge from perched saturated zones augments surface water supplies in wetlands and pools of ephemeral streams. These drainageways have not formed significant floodplains or terraces. Many of the soils occurring in the alluvium filled valleys and tributary drainageways tend to be saline.

The Soil Survey of Mercer County, North Dakota was used to evaluate the soils in the study area (Exhibits F and G). The most commonly occurring soils within the study area based on acreages of mapped units in Exhibit F are Cabba Loams with 15-35% slopes (6143 acres) occurring generally over the area but with greater coverage in the southern one-third of the area. Rhoads-Daglum soils (2992 acres) are found mostly west of Coyote Creek and in the southern and western portions of the study area. Flaxton fine sandy loam (2088 acres) occurs primarily in the northern two-thirds of the area. Straw loam (1605 acres) is the primary soil on floodplains of the Knife River and Coyote Creek, and its distribution is a good indicator of floodplain areas. Channeled Straw loam (877 acres) is characteristic of headwaters reaches with narrow and less developed

floodplains such as Coyote Creek and Mud Creek near the west margin of the study area. Noonan-Flaxton, Cabba loams with 9-15% slopes, and Flaxton-Williams complex soils (1460, 1336 and 1107 acres, respectively) are other soils covering more than 1000 acres. They are found largely in the southern and eastern portions of the study area

Mr. Mike Ulmer and Mr. C. J. Heidt, Soil Scientists and Soil Classifiers, are mapping soils within the area for an upcoming permit application. They prepared a report on their observations along the Knife River over its extent in the AVF study area from the western border of Sec. 29, T143N, R89W to the eastern border of Sec. 3, T143N, R88W including the previously determined segment in Section 14, T143N, R89W (Appendix A) They concluded that the soil resources and imagery in this area did not reveal any conclusive areas of subirrigation. Two small areas were identified with potential subirrigated landscape characteristics, but both areas are very small, covering 14 and 15 acres, are not managed uniquely, and do not significantly influence crop or range production in the area. No artificial flooding or water spreading areas were identified.

There is no soil evidence of any subirrigation of consequence occurring along the Knife River, Coyote Creek, Mud Creek or other smaller tributaries of Coyote Creek, Mud Creek or the Knife River within the study area. As with most drainageways in West-central North Dakota, there are probably scattered low areas of shoreline or low meander terraces of a few acres or less in size where the saturated zone may be available to the rooting depths of normal vegetation during the growing season. The deeply incised channels of the Knife River and other streams in the study area suggest that shoreline fringes with patches of subirrigated plants are less common here than along many other streams in the region. Cut banks are common features of streams with developed floodplains in the area. Productive soils do occur on floodplain areas but their productivity is due to slope and soil genesis and not to subirrigation.

Land Use and Vegetation

The OSM Guidelines, p.II-12, emphasize that the key criterion of an AVF is having an important, if not critical, economic role in the success of local agricultural cropping practices by noting,

> ... it is important to understand the style of agricultural land use in an area, and the way, if there is one, that stream valleys are important to agriculture. As previously noted, if certain stream valleys do not serve a special role in agricultural land use in a particular coal region, or if their special role is not a function of water availability, then these streams are not alluvial valley floors in that region. [underlining is in the original text]

Scale, significance and negligible impact are issues addressed in the *The OSM Guidelines, Chapter III* under permit data needed when an AVF is present and may be affected by mining. However, the physical scale and geometry of potential AVF areas and their significance in the economics of individual agricultural operations are issues that must be addressed in an analysis leading to an AVF determination.

There are significant differences in land use over the AVF study area. Cattle raising is the dominant land use but crop production is more common in the eastern east one-third of the area with Coyote Creek being a convenient dividing line.

The Knife River floodplain provides an extensive area of relatively flat agricultural land that is from 0.75 to 1.5 miles wide but commonly broken into smaller land use tracts by the sharply meandering river channel.

Floodplain development on Coyote Creek is most pronounced from its mouth through Section 31, T143N, R88W in areas already determined not to be AVF. It continues southward into Section 6, T142N, R88W in the study area where it is still about 0.4 mile wide. It is used as rangeland as is the rest of Section 6. Section 5 to the east has significant tracts of crop land and hay land on suitable upland slopes. In section 7, 8, 16 and 17 to the south the Coyote Creek floodplain narrows to about 0.25 mile. Over the area, cropland and hay fields on the creek floodplain tend to extend from near the channel onto adjacent upslope areas. Clearly, favorable slope generally unrelated to floodplain development controls the occurrence of crop and hay production in this area.

Beaver Creek enters Coyote Creek in Section 17, T142N, R88W. Its floodplain set in a broader valley suggests that the Beaver Creek valley may have been formed by an earlier drainage pattern. The geomorphic history of this area is beyond the scope of this study. However, field patterns near the stream have taken advantage of the broad valley and the gentle slopes on surrounding uplands. Cropland and hay land tracts show the strong control of slope on their location and shape. There is no evidence of water availability controlling the location of cropland or hay land tracts in this area.

Two unnamed tributaries of Coyote Creek enter it near the west quarter corner of Section 8, T142N, R88W. These tributaries have poorly developed floodplains and are not candidate AVF areas. Mud Creek which flows into the Knife River in Section 29, T143N, R89W has a poorly developed floodplain. These drainagways are within rangeland tracts and are used as rangeland. Hay and other crop production along these drainages tends to be on flatter areas that tend to occur on uplands rather than on valley floors. These are not candidate AVF areas.

Within the study area shown in Exhibit A, land uses of tracts interpreted from NAIP color photography and within sections were grouped as cropland, hay land, rangeland, farmstead and industrial to evaluate the relationships between land use on the Knife River floodplain and uplands in the area (Exhibit H). No attempt was made to generate detailed categorization of land use or the boundary precision characteristic of pre-mining land use studies for permitting actions. However, that portion of the map area within the proposed permit boundary is based on land use categories generated by KDK Consulting for baseline analysis in an upcoming application by Coyote Creek Mining Company.

Land use tracts shown in Exhibit H and occurring within or extending onto the Knife River floodplain were grouped and then compared with all other tracts in the study area. Tracts extending between floodplain and upland areas are counted in both groups rather than partitioning them since the comparison is intended as an approximation. When the overlap was small, generally about 5 percent or less of the tract, the tract was placed in only one group as a matter of judgment. Results are shown in Table 5.

Table 5
Land Use Comparison between Knife River Floodplain and Other Portions of AVF Study Area

Land Use	Knife River Floodplain (percentage)	Other Areas (percentage)
Cropland	11.8%	8.4%
Farmstead	1.1%	0.7%
Hay Land	12.9%	9.1%
Rangeland	74.2%	81.8%
	100.0%	100.0%

The higher percentage of cropland and hay land on the floodplain reflects the flat terrain and favorable soils rather than natural irrigation. The slightly higher incidence of farmsteads probably relates to the historic importance of surface water, wood supplies, access to transportation and aesthetic values of the valley. Land use on the Knife River floodplain is integrated into land uses of larger agricultural units. Agricultural practices on the floodplain are not distinct from those on upland areas, and the area does not have a special role in local agriculture. There is not pronounced differences in land use between the Knife River floodplain and adjacent uplands that would be expected with a true AVF area. In comparison with other North Dakota areas that have been evaluated for possible occurrence of AVF, the predominant rolling terrain and steeper slopes of the western half of the study area have weighted the percentages for upland areas in Table 5 toward rangeland usage far more so than would be expected in central North Dakota.

The uses and irregular shape of cropland and hay land tracts that occur along drainageways and around steeper slopes in the study area evidently evolved in the first half of the 20th Century or earlier to accommodate topographic limitations to agriculture. In terms of floodplain usage, with one exception, there is no evidence in the study area of remnants of water spreading, irrigation dikes or dams, or other cultural features suggesting that floodplain irrigation has ever been a part of farming practice in the area or influenced tract boundaries. The single instance is discussed below and is a system of water spreading dikes originally intended to enhance alfalfa production by spreading runoff from two ephemeral drainages on about 43 acres of Knife River floodplain. In general, the shape of cropland and hay land tracts that occur along drainage floodplains in the study area are commonly influenced by land slope more than by soil type and water availability. The limited water resources, including groundwater which is not an AVF value, of major stream valleys in the study area give those areas little if any added value over the whole area for crop and hay production. Favorable growing conditions provided over the entire area by regional climate and soils place a premium on gentle slopes that support modern cropping and haying practices.

Mr. Kelly Krabbenhoft made the following observations on haying within the study area during his baseline field work in 2012 that show floodplain areas are not regarded as

special resources for hay production but are integrated into haying practices applied by operators to the whole area.

> Haying initiated in early to mid-June as vegetation was ahead of normal with the warm dry growing conditions encountered in 2012. This haying activity was not only seen within the permit and surrounding lands, but in numerous western counties. Activity increased during late June and early July as most hayland vegetation began to regress through senescence with moisture stress. Activity continued into late July and early August. By that time, most of the prime haylands had been cut and activity turned to road ditches and ancillary areas as dry conditions persisted. Ranchers attempted to make up for shortages in their primary fields by cutting all prospective areas. Most of which likely had not been cut during the previous 3 seasons which were cool and had above average moisture. The only observation of a second cutting, to date, came from the SE4 Section 31, 143-88 near the Casey Voigt ranch. It did not appear there was a difference in timing of cutting between areas adjacent to creeks and rivers versus upland sites.

Key indicator grass species of Subirrigated ecological sites are Big Bluestem, Switchgrass, Indiangrass, Prairie Cordgrass, and Little Bluestem. Mr. Krabbenhoft has also observed that, within the proposed permit area, there appears to be no significant difference in the abundance of these species between the Knife River and Coyote Creek floodplains and the surrounding uplands. No Similarity Indices were assessed within the current study specific to the potential AVF areas. However, similar low percentages relative to the Historic Climax Plant Community and decreased yields due to management were observed within the native ecological sites.

Irrigation History and Potential

Topographic conditions make unfeasible the diversion of the Knife River or its major tributaries including Coyote Creek, Brush Creek and Mud Creek onto their floodplains to develop gravity-feed water spreading systems. The meandering channel and steep cut banks prevent the feasible development of upstream diversions to irrigate downstream areas.The channels of these streams are deeply incised in the valley floor and meander from side to side in their valleys, creating steep cut banks; however, the floodplain appears to be less terraced by meander scarring than other larger streams in the region and generally more accessible with farm machinery. The deep channel and low flow regime limit natural flooding to rare events. Natural flooding of lowlands over the region tends to occur during brief and exceptionally high runoff events in late winter and spring before the growing season giving no opportunity for irrigation by water spreading.

State Water Commission water permit records were searched for past and current water use permits in T142N, R88W; T142N, R89W, T143N, R88W and T143N, R89W. Two permits were located. Archie Wanner holds a permit to 225 acre-feet of water from the Knife River aquifer in Section 29, T143N, R89W with a priority date of 3/18/2008. There has been no reported water use of record and the site was not investigated further. Ronald Gunsch holds a permit with three locations for water withdrawal from the Knife

River groundwater aquifer with a priority date of 8/1/1974. Only the site in the SE¼, Section 7, T143N, R88W has reported use that ranges from 1981 to the present. The majority of the acreage under irrigation with this water is in the NW¼ of Section 18 south of the floodplain and the withdrawal site.

An area of surface water spreading covering about 43 acres north of the Knife River in the NW¼ Section 14, T143N, R89W diverts and spreads water during high water stages of spring run-off on two unnamed tributary streams. These streams converge to within about 0.1 to 0.25 of one another on the Knife River floodplain before discharging into the Knife River. The area does not utilize Knife River water. This site was not considered further because of its small size, unusual geomorphic setting that allows for limited water spreading, and its location north of the Knife River opposite and hydrologically isolated any foreseen mining or associated disturbance at Coyote Creek Mine.

However, the Reclamation Division of the Public Service Commission requested more information on this unusual site, and Mr. Tom Buechler whose family owns the land was contacted for that information. He said the spreading system was built by his father in 1965 or 1966 for the purpose of enhancing alfalfa hay production. It may have been funded in part by an NRCS program then in place. He noted that it was effective at providing early cuttings of alfalfa hay only during years of sufficient spring runoff. He had no thoughts on whether or not it provided any benefit to the tract's current use for more shallow rooted crops since the land has been leased to operators for many years. The tract has been used for corn production the past one or two years. He commented that it has been several years since there has been sufficient spring runoff to operate the system, and he noted that 60-70% of the water comes from the west drainageway.

Utilization of flow from small tributary streams for pre- or early growing season enhancement of soil moisture on floodplains or suitably flat uplands has apparently not been practiced elsewhere in this portion of the Knife River basin and is questionably feasible and effective. It did not become an irrigation practice for the area even with government support that may have been available. The OSMRE (1985, p. 25) report made the following observations about the small spreader dike systems in North Dakota that succinctly summarize their economic status.

> There are several reasons why these small spreader dike systems are not considered a regional practice. First, there are so few of them used that most farmers and ranchers obviously do not consider them a viable development strategy. Second, the small drainages where spreader dikes would be built are not as crucial to operations as perhaps similar drainages would be in more arid coal regions. Uplands in west-central North Dakota have good soils. Rainfall averages about 16 inches annually, falls mainly during the growing season, and is adequate for dry land crops. Thus, the uplands are chosen for additional cropland over the small valley bottoms.

Coyote Creek and Mud Creek main channels within the AVF study area show no evidence of surface water spreading, flood irrigation, catchments for irrigation or other mechanisms to enhance hay or crop production on their floodplains. Floodplain areas are mostly used for rangeland. Crop and hay production occurring on the Coyote Creek floodplain is controlled by slope rather than water availability. Crop and hay land tracts

on the floodplain extend onto areas above the floodplain and upland fields continue onto floodplain areas for maximum field size to the degree allowed by terrain and ownership.

Agricultural interests in an area are always striving to innovate and optimize agricultural production. Over 100 years of striving for optimum agricultural production in the Knife River drainage basin has not produced any significant amount of past or current irrigated cropland or hay land on the river floodplain or on the floodplains of its major tributaries.

Wording in the OSM AVF guidelines serves to limit speculation about the future potential for irrigation to past or present uses common in the area. The guidelines state that an AVF must be an area with water availability sufficient for subirrigation or flood irrigation to support agricultural activities and that "water is available by surface-water irrigation or subirrigation and is being or has successfully been used to enhance production of agriculturally useful vegetation."*(OSM Guidelines, p II-9)*

The base flow in the Knife River interpreted from flows recorded from 2010 to 2012 at USGS gauging station 06340010 near Beulah, ND in the late summer and late winter months of minimum precipitation suggest ground water contributes generally about 30 cfs to the stream. The station was not operated October through February over the period of record, and base flow had to be assumed from the lowest 10% of monthly discharges. Its median monthly flow is 96 cfs. Gaged height has a range of 14.5 feet. The base flow of the Knife River is probably closer to 10 cfs based on records at USGS Station 06340500 located at Hazen, ND. Although more removed from the study area, the Station at Hazen has a longer record and provides more records over fall and winter periods when most if not all flow is from groundwater contributions. These data suggest that 10 to 30 cfs of Knife River flow is from ground water sources, or approximately 30% of the median of monthly discharges.

Table 6
Irrigation requirements of typical North Dakota crops.

System Capacity in gallons per minute per acre (gpm/acre) for different soil textures needed to supply sufficient water for each crop in 9 out of 10 years. An application efficiency of 80% and a 50% depletion of available soil water were used for the calculations.

Crop	Root Zone Depth (ft)	Coarse Sand and Gravel	Sand	Loamy Sand	Sandy Loam	Fine Sandy Loam	Loam and Silt Loam
POTATOES**	2	8.2	7.5	7	6.4	6.1	5.7
DRY BEANS	2	7.9	7.1	6.4	6.1	5.7	5.4
SOYBEANS	2	7.9	7.1	6.4	6.1	5.7	5.4
CORN	3	7.3	6.6	5.9	5.5	5.3	4.9
SUGARBEETS	3	7.3	6.6	5.9	5.5	5.3	4.9
SMALL GRAINS	3	7.3	6.6	5.9	5.5	5.3	4.9
ALFALFA	4	6.8	5.9	5.6	5.1	5	4.5

** Adjusted for 40% depletion of available water

Source: http://www.ag.ndsu.edu/pubs/ageng/irrigate/ae91w.htm

Table 6, specific to North Dakota irrigated crop conditions, suggests that Knife River flows would be capable of providing surface water needed to irrigate a modest acreage of cropland. Given the seasonal irregularity in quantity of runoff from these streams, irrigation potential based on surface water availability is far less than the maximum suggested by USGS average flows.

Assume a reliable flow rate in the range of 10-30 cfs (4,440 to 13,460 gpm) for the Knife River in the months of June, July and August. Assume 5 gpm per acre is needed for sufficient irrigation of corn, small grains and alfalfa. The Knife River surface flow could provide water for 889 to 2693 irrigated acres, with total permitted withdrawals likely to total less than one-half this maximum volume and acreage. Withdrawals of this magnitude during the irrigating season could significantly impact livestock watering capacity and stress aquatic communities along the river. Livestock watering along the river remains a significant value to local agriculture.

Significant flood irrigation potential does not exist along the Knife River without resorting to pump lifting. Small tract size, irregularity of the topography and meandered channel course combine to make water spreading and flood irrigation systems unfeasible. Tillable acreage is limited in size and scattered among areas only suitable as grazing land that offer minimum potential for expanding tillable field size to accommodate even large-scale groundwater use with center pivot irrigation. State Water Commission records show no interest in surface water irrigation. This lack of interest on the part of operators confirms a very low potential for irrigation along this reach of the Knife River and its tributaries including Coyote Creek, Brush Creek and Mud Creek. While irrigation with pumped surface water from the Knife River is feasible, the one instance of center pivot irrigation in proximity to the Knife River aquifer uses that more economical and reliable ground water resource rather than surface water from the Knife River channel.

Summary and Recommendations

The environmental and agricultural properties of the Knife River floodplain, the Coyote Creek drainage (upstream from previously determined areas) and all other portions of the study area were investigated relative to their status as Alluvial Valley Floors. Findings are summarized as follows:

1. In the study area of this report, two streams have developed floodplains sufficient in size to warrant evaluation of their AVF potential. The Knife River has a well-developed floodplain and is a perennial stream over its length in Mercer County. Coyote Creek is a perennial to intermittent stream with a narrower floodplain that still merits evaluation.
2. All downstream portions of Coyote Creek floodplain, within T143N, R88W and T143N, R89W, have been determined to not be AVF in prior permit findings associated with Beulah Mine permit KRSB-8603. The floodplain narrows in its upstream reaches evaluated in this report, and these reaches are found to not be AVF.
3. Mud Creek, a smaller drainage in the western portion of the study area, has a very narrow floodplain in its downstream reach of about 2 miles in length. It is predominately range land, and hay production in the contributing drainage comes mostly from gently sloping upland areas. Mud Creek has no AVF values or potential.
4. The main channel of Brush Creek is outside this AVF study area and those main stem reaches of the stream in close proximity to this study area have been determined to not be AVF in prior determinations related to mine permitting at Beulah Mine. An ephemeral or nominally intermittent tributary drainage of Brush Creek occurs within the AVF study area in Sections 34 and 35, T143N, R88W. This drainage lacks a floodplain and the shallow valley is rangeland. It is not an AVF.
5. The Knife River has not been evaluated for AVF status except for a short segment in Section 14, T143N, R89W that was evidently considered along with the mouth of Coyote Creek in determinations made relative to Beulah Mine permitting.
6. The OSMRE publication, *Draft Reconnaissance Maps to Assist in Identifying Alluvial Valley Floors, West-Central North Dakota, OSM/TM-3/85, 1985* correctly identified the key features that remove the Knife River floodplain in this area from AVF status, primarily its deeply incised channel with the floodplain being 15 to 20 feet above water level and the lack of historic or current irrigation that meets the criteria for AVF irrigation. The report observes the similarity in crop production between the floodplain, higher terraces and uplands along the river that is made possible by favorable climate, soils and slope. It also concludes that the very limited number of irrigated lands along the river is influenced by the marginal economic advantage of irrigation to dry-land farming and ranching in the area.
7. In the study area, only the valley fill of the Knife River is recognized as a significant aquifer in the Mercer-Oliver County Ground Water Study. Alluvial deposits in the valleys of Coyote Creek and other tributary streams in the area are too shallow and narrow to be significant water resources. Saturated zones of about 5 to 10 feet thick are probably characteristic of Coyote Creek alluvium.
8. The Knife River and Coyote Creek floodplains in the study area are not subirrigated. The water table on the floodplains range from 8 to 30 feet below the

ground surface. The normal rooting depth of natural vegetation and typical North crops is generally less than 3 feet.

9. Soils on floodplains in the study area are dominated by Straw loam. Soil series associated with subirrigation are not present, and the stream floodplains are not subirrigated in the opinions of C.J. Heidt and Mike Ulmer, both Professional Soil Classifiers.
10. Rangeland is the largest land use by acreage on both the Knife River floodplain and all other parts of the study area. Cropland tracts tend to overlap floodplain and upland areas with slope being the primary control of their location. Crop selection and farming practices on the floodplains are comparable to those on adjacent upland areas and are dictated by slope and topography rather than water availability. Based on land use and productivity, crop production on floodplains does not receive special management practices or priority that would indicate it is a critical aspect of area agriculture. Mike Ulmer, C.J. Heidt and Kelly Krabbenhoft in their observations felt that the Knife River floodplain shows no evidence of agricultural management significantly different from upland areas.
11. Kelly Krabbenhoft found no subirrigated sites or plant communities indicative of subirrigation in the study area during field inventories of ecological sites in 2012. Also he concluded that floodplain rangeland sites were not significantly more productive than rangeland on the surrounding uplands.
12. State Water Commission historic records show no past, present or planned agricultural irrigation on the Knife River or Coyote Creek floodplains utilizing surface water. One small area of center pivot irrigation is located both on the Knife River floodplain and its side slopes, and it utilizes groundwater from the Knife River aquifer. A small 43 acre area of water spreading uses high stage flows from two small unnamed northern tributaries of the Knife River to enhance soil moisture on Knife River floodplain sediments.
13. The Knife River typically has its highest flows in late winter and early spring before the plant growing season. It tends to be near base flow conditions during the growing season. Base flow median discharge of about 10-30 cfs is also a likely characteristic range for reliable flows during the growing season months of May, June and July. This base flow indicates the maximum volume of water available for withdrawal during the growing season. This supply could irrigate a. maximum of 889 to 2693 acres based on typical needs of North Dakota crops, but maximum withdrawals could impact usage for livestock watering. Coyote, Brush and Mud Creeks lack the surface water quantities needed to support any significant irrigation.
14. Surface water quality in the Knife River, Coyote Creek and Brush Creek poses high to very high salinity hazard that limits the potential for using these resources for significant irrigation.
15. The limited resource of growing season flows in the Knife River, the relatively small and irregular areas of adjacent cropland and the necessity of pump lifting make future irrigation with Knife River water unlikely. Like the one small 180-acre example of sprinkler irrigation in the study area, any future irrigation attempts will rely on groundwater from the Knife River aquifer.
16. Mining and reclamation at Dakota Westmorland's Beulah Mine has taken place in close proximity to the Knife River, Coyote Creek and Brush Creek for over 35 years and has not harmed the environmental or agricultural values of these streams. Future permit applications will provide the necessary mining and

reclamation plans to assure that the environmental or agricultural values of the Knife River, Coyote Creek and other streams in the AVF study area will be maintained and no material damage will occur to these drainages.

This study finds that the contribution of floodplains in the Knife River drainage of Mercer County to crop and hay production is not a factor in local agriculture. There is no evidence that the Knife River and Coyote Creek or other drainages within or adjacent to the AVF study area meet any of the criteria essential for determining them to be AVF. Their agricultural usage is not different from adjacent upland areas, nor are they critical to crop or livestock feed production as are the true AVF areas in the arid west. They have no history of surface water irrigation or economically feasible irrigation potential for enhancing current or foreseeable agriculture in the area. They are not subirrigated. Water, soil and wildlife resources of these floodplain areas are more directly, stringently and effectively protected by the surface and groundwater protection requirements of SMCRA and North Dakota regulations than by inappropriate designation of the valleys as Alluvial Valley Floors.

It is recommended that a determination be made that no Alluvial Valley Floors occur within the study area of this report as delineated in Exhibit A. It is also recommended that, for clarification, the findings specifically reaffirm or find that the Knife River floodplain segment previously determined in Section 14, T143N, R89W is not an AVF. Land use, geologic, hydrologic and related data are presented here to reaffirm prior findings that this small stream segment is not an AVF. It is similarly recommended that the determination reaffirm that all of Coyote Creek, from its mouth to the southern boundary of this AVF study area, including reaches evaluated in previous AVF determinations, is not an Alluvial Valley Floor. Since a non-candidate tributary of Brush Creek is within this study area, it is recommended that it be reaffirmed that Brush Creek is not an AVF. It is also recommended that the determination state that Mud Creek is not an AVF.

References

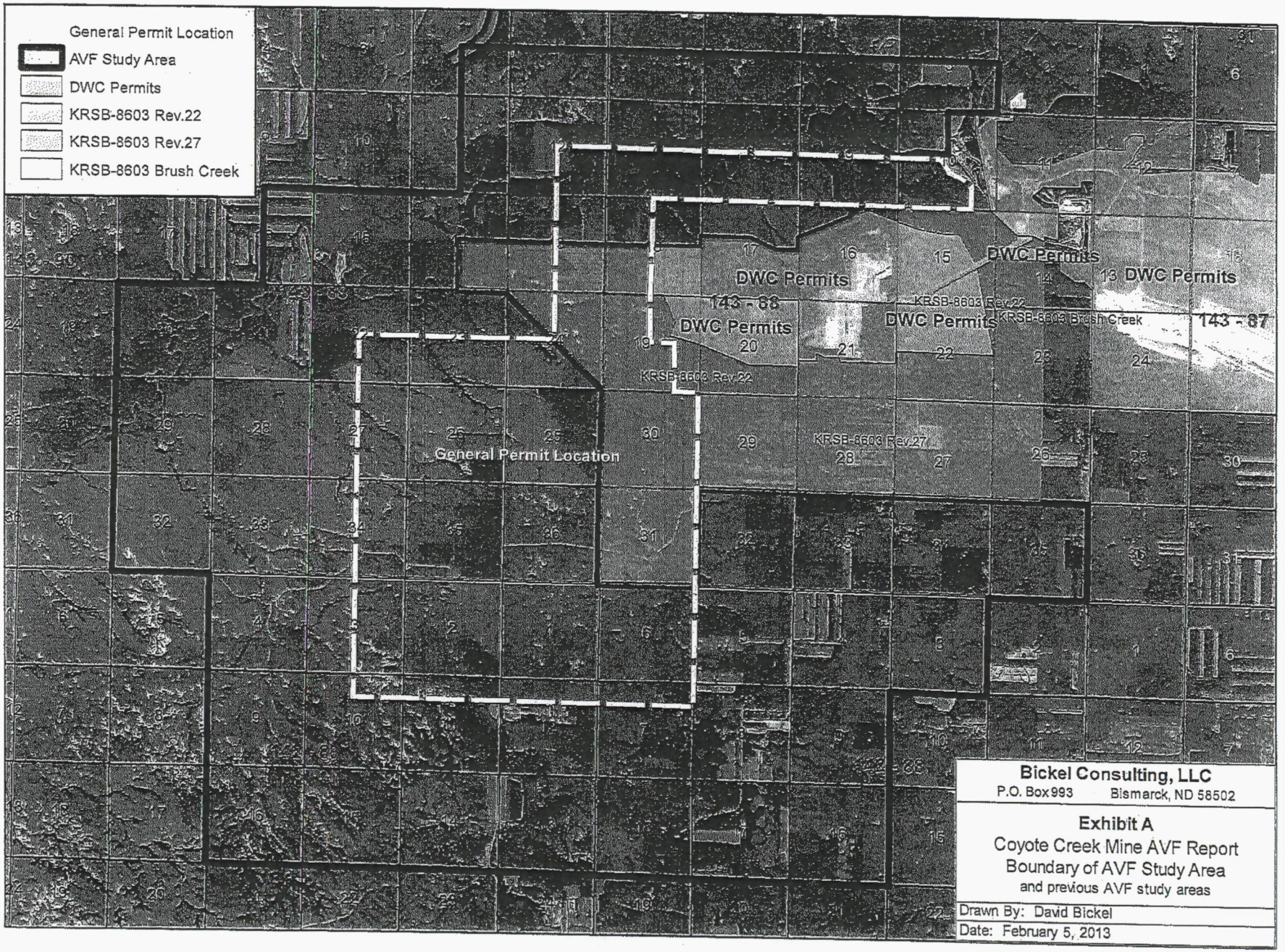
Bryce, S.A., Omernik, J.M., Pater, D.A., Ulmer, M., Schaar, J., Freeouf, J., Johnson, R., Kuck, P., and Azevedo, S.H., 1996, Ecoregions of North Dakota and South Dakota, (color poster with map, descriptive text, summary tables, and photographs): Reston, Virginia, U.S. Geological Survey (map scale 1:1,500,000).

Carlson, C. G. 1973. Geology of Mercer and Oliver Counties, North Dakota. Bull. N.D. Geol. Surv. 56, Pt. 1; N.D. State Water Comm. Co. Groundwater Studies 15, Pt. 1.

Croft, M. G. 1973. Ground-water Resources Mercer and Oliver Counties, North Dakota. Bull. N.D. Geol. Surv. 56, Pt. 3; N.D. State Water Comm. Co. Groundwater Studies 15, Pt. 3

OSMRE. 1983. Alluvial Valley Floor Identification and Study Guidelines, Draft of August, 1983.

OSMRE. 1985. Draft Reconnaissance Maps to Assist in Identifying Alluvial Valley Floors, West-Central North Dakota, OSM/TM-3/85.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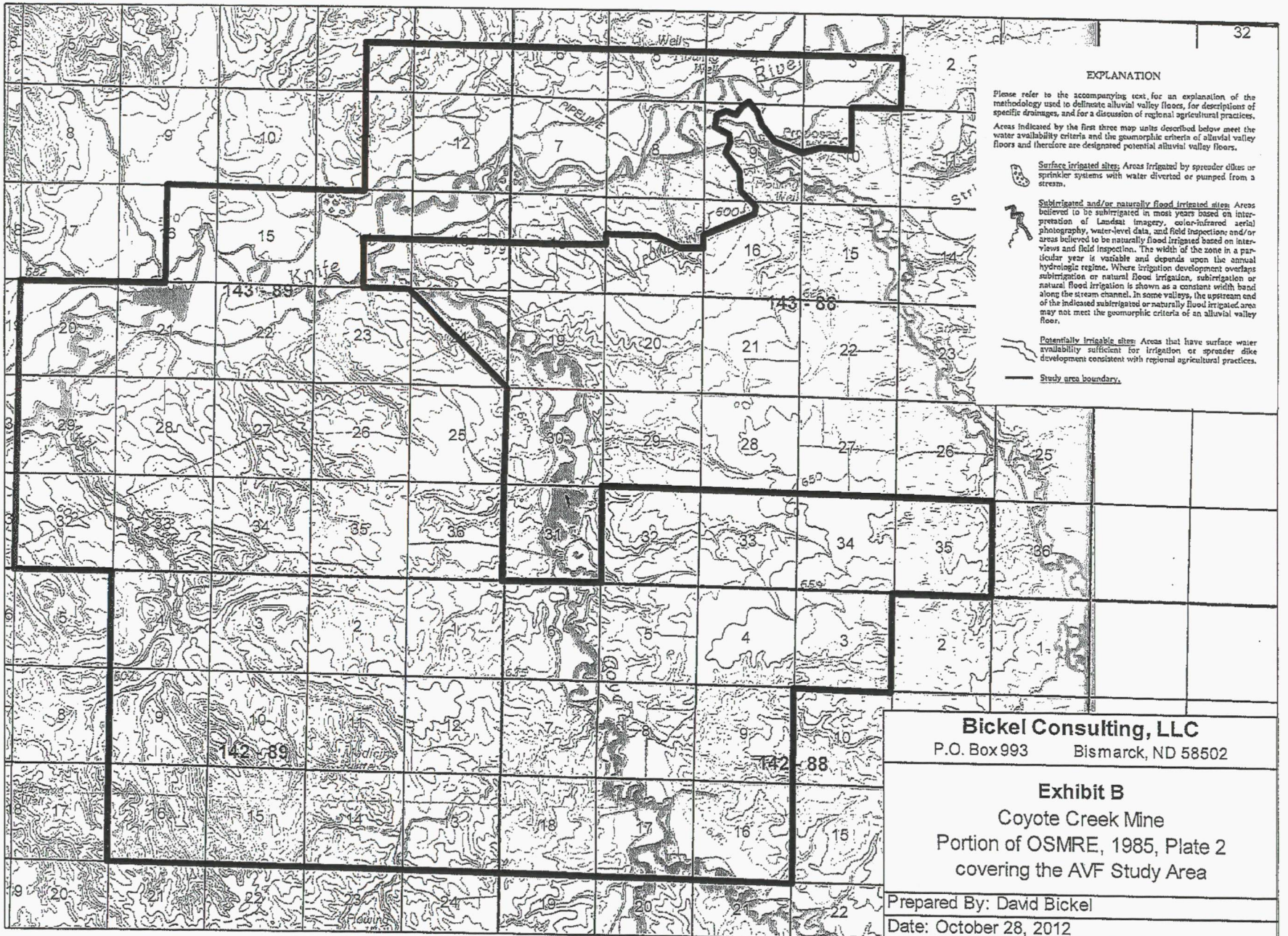
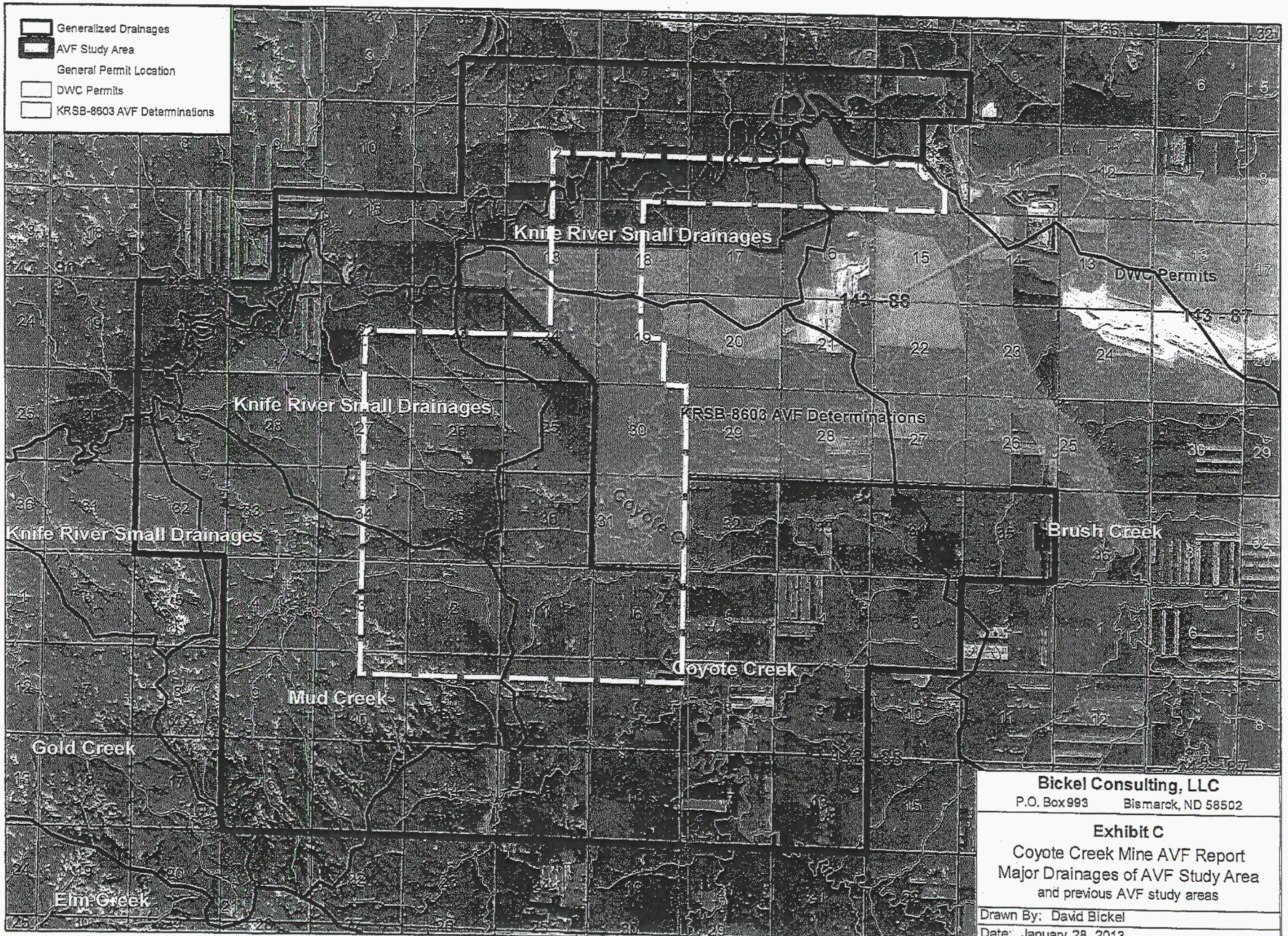
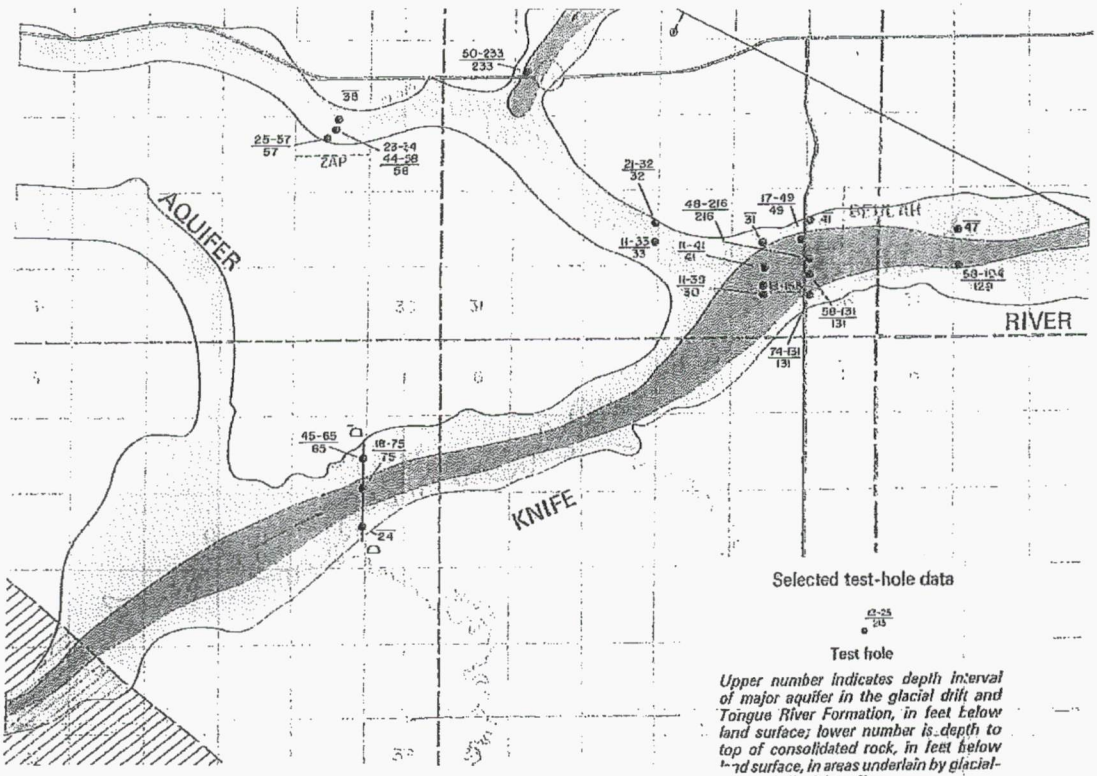
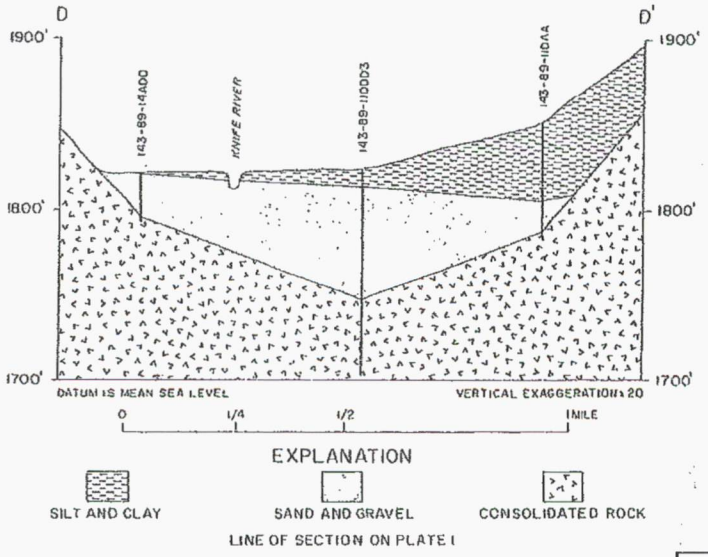
AVF Study Area
DWC Permits
KRSB-8603 Rev.22
KRSB-8603 Rev.27
KRSB-8603 Brush Creek
DWC Permits
143 - 88
DWC Permits
DWC Permits
DWC Permits
KRSB-8603 Rev.22
KRSB-8603 Brush Creek
143 - 87
KRSB-8603 Rev.22
KRSB-8603 Rev.27
General Permit Location
Bickel Consulting, LLC
P.O. Box 993 Bismarck, ND 58502
Exhibit A
Coyote Creek Mine AVF Report
Boundary of AVF Study Area
and previous AVF study areas
Drawn By: David Bickel
Date: February 5, 2013



what is redocks?


Generalized Drainages
AVF Study Area
General Permit Location
DWC Permits
KRSB-8603 AVF Determinations
Knife River Small Drainages
Knife River Small Drainages
KRSB-8603 AVF Determinations
Knife River Small Drainages
Brush Creek
Coyote Creek
Coyote Creek
Mud Creek
Gold Creek
Elm Creek
DWC Permits
Bickel Consulting, LLC
P.O. Box 993 Bismarck, ND 58502
Exhibit C
Coyote Creek Mine AVF Report
Major Drainages of AVF Study Area
and previous AVF study areas
Drawn By: David Bickel
Date: January 28, 2013





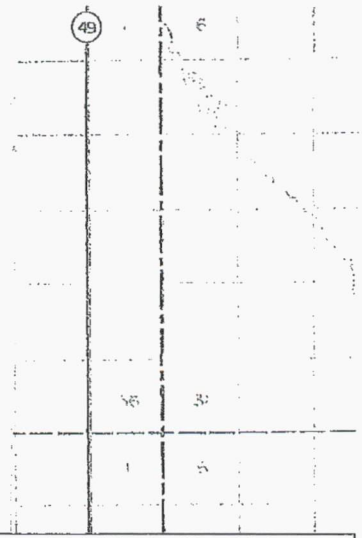


FIGURE 22.--Geologic section D-D' through the Knife River aquifer, Mercer County.

Bickel Consulting, LLC P.O. Box 993 Bismarck, ND 58502
Exhibit D Coyote Creek Mine AVF Report Knife River Aquifer and Cross-section (Croft, 1973)
Prepared By: David Bickel
Date: October 28, 2012

Exhibit E - 305 Pages
Included 5 pages of 305


```
#
#
# US Geological Survey, Water Resources Data
# retrieved: 2012-06-21 01:33:43 EDT       (vaww01)
#
# This file contains USGS Surface-Water Monthly Statistics
#
# Note:The statistics generated from  this site are based on approved
daily-mean data and may not match those published by the USGS in official
publications.
# The user is responsible for assessment and use of statistics from this
site.
# For more details on why the statistics may not match, visit
http://waterdata.usgs.gov/nwis/?dv_statistics_disclaimer.
#
# ** No Incomplete data have been used for statistical calculation
#
# This file includes the following columns:
#
#
# agency_cd     agency code
# site_no USGS site number
# parameter_cd
# dd_nu
# year_nu Calendar year for value
# month_nu      Month for value
# mean_va monthly-mean value.
#          if there is not complete record
#          for a month this field is blank
#
#
# Sites in this file include:
# USGS 06340500 KNIFE RIVER AT HAZEN, ND
#
# Explanation of Parameter Code and dd_nu used in the Statistics Data
# parameter_cd    Parameter Name                                  dd_nu Location
Name
# 00060           Discharge, cubic feet per second        2
# 80155           Suspended sediment discharge, tons per day          5

# 80154           Suspended sediment concentration, milligrams per liter
            7
# 00065           Gage height, feet       8
#
#
agency_cd   site_no     parameter_cd      dd_nu year_nu     month_nu
      mean_va
5s     15s    5s     3n     4s     2s     12n
USGS   06340500     00060 2      1929   4      125.9
USGS   06340500     00060 2      1929   6      191.7
USGS   06340500     00060 2      1929   7      25.9
USGS   06340500     00060 2      1929   8      8.42
USGS   06340500     00060 2      1929   9      6.47
USGS   06340500     00060 2      1929   10     10.0
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# ---------------------------------- WARNING ----------------------------
------------
# The data you have obtained from this automated U.S. Geological Survey
database
# have not received Director's approval and as such are provisional and
subject to
# revision.  The data are released on the condition that neither the USGS
nor the
# United States Government may be held liable for any damages resulting
from its use.
# Additional info: http://nwis.waterdata.usgs.gov/nwis/help/?provisional
#
# File-format description:
http://nwis.waterdata.usgs.gov/nwis/?tab_delimited_format_info
# Automated-retrieval info:
http://nwis.waterdata.usgs.gov/nwis/?automated_retrieval_info
#
# Contact:   gs-w_support_nwisweb@usgs.gov
# retrieved: 2012-10-09 15:07:32 EDT       (nadww01)
#
# Data for the following 1 site(s) are contained in this file
#    USGS 06340010 KNIFE RIVER NEAR BEULAH, ND
# ---------------------------------------------------------------------
-------------
#
# Data provided for site 06340010
#    DD parameter statistic   Description
#    02   00065     00003     Gage height, feet (Mean)
#    04   00060     00003     Discharge, cubic feet per second (Mean)
#
# Data-value qualification codes included in this output:
#     A  Approved for publication -- Processing and review completed.
#     P  Provisional data subject to revision.
#     e  Value has been estimated.
#
agency_cd   site_no     datetime    02_00065_00003   02_00065_00003_cd
     04_00060_00003   04_00060_00003_cd
5s    15s   20d   14n   10s   14n   10s
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USGS  06340010    2010-03-29  60.34 A     1510  A
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Exhibit E - Basic Data: USGS 06339550, 06340010, 06340500 flow & quality; DWC Beulah Mine Coyote & Brush Creeks quality

---------- WARNING ----------
The data you have obtained from this automated U.S. Geological Survey database
have not received Director's approval and as such are provisional and subject to
revision. The data are released on the condition that neither the USGS nor the
United States Government may be held liable for any damages resulting from its use.
Additional info: http://waterdata.usgs.gov/nwis/help/?provisional
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File-format description: http://waterdata.usgs.gov/nwis/?tab_delimited_format_info
Automated-retrieval info: http://waterdata.usgs.gov/nwis/?automated_retrieval_info
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Contact: gs-w_support_nwisweb@usgs.gov
retrieved: 2013-01-14 01:16:56 EST (sdww02)
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Data provided for site 06339550
DD parameter statistic Description
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#
Data-value qualification codes included in this output:
A Approved for publication -- Processing and review completed.
#

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10/5/1977	0.88
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10/8/1977	2.2
10/9/1977	7.1
10/10/1977	10
10/11/1977	6.2
10/12/1977	4.3
10/13/1977	3.6
10/14/1977	3
10/15/1977	2.1
10/16/1977	1.8
10/17/1977	1.4
10/18/1977	1.2
10/19/1977	1.1
10/20/1977	0.9

Exhibit E - Basic Data: USGS 06339550, 06340010, 06340500 flow & quality; DWC Beulah Mine Coyote & Brush Creeks quality

USGS Surface Water Station 06340500 Knife River at Hazen, ND - Selected Parameters

Date Time	Water Temp degC	Air Temp degC	Discharge cfs	Instant. Discharge cfs	Turbidity JTU	Turbidity NTU	SC uS/cm
105 parameters					Unfiltered	Unfiltered	Unfiltered
USGS Parameter Code:	-10	-20	-60	-61	-70	-76	-95
10/20/1949				37			1280
3/24/1950				1550			277
3/26/1950				2570			224
4/15/1950				4720			234
4/19/1950				10500			226
4/22/1950				1730			415
5/18/1950				357			899
6/15/1950				117			1230
8/8/1950				50			1390
8/14/1950				72			1350
9/5/1950				44			1290
10/2/1950				47			1370
10/31/1950				44			1420
1/15/1951				29			1700
2/6/1951				25			1620
3/31/1951				7600			170
4/6/1951				7350			213
4/9/1951				1860			341
6/8/1951				575			669
9/6/1951				105			934
9/29/1969 16:15			31				1290
10/14/1969 16:00	6.0		35				1340
11/12/1969 13:30	2.0		38				1420
12/9/1969 14:45	1.0		34				1700
1/7/1970 15:30	1.0		25				1810
2/5/1970 14:50	1.0		23				1850
3/4/1970 15:05	1.0		25				1790
4/17/1970 11:35	7.0		214				974
5/12/1970 15:25	8.0		5930				529
6/11/1970 11:45			146				1690
7/6/1970 13:40			106				1360
8/3/1970 14:30			199				1230
10/20/1970 14:45	7.0		51				1590
11/16/1970 15:00	1.0		50				1730
12/15/1970 15:00	0.0		35				2110
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2/11/1971 14:45	1.0		13				1900
3/19/1971 15:05	2.0		2790				324
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6/3/1971 13:10	20.0		70				1630
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8/4/1971 16:10	24.0		36				1410
9/8/1971 15:00	17.0		59				1460
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3/22/1972 13:40	5.0		1380				400
4/21/1972 16:35	10.0		191				1160

Exhibit E - Basic Data: USGS 06339550, 06340010, 06340500 flow & quality; DWC Beulah Mine Coyote & Brush Creeks quality

USGS Surface Water Station 063

Date Time 105 parameters USGS Parameter Code:	Dissolved O2 mg/l Unfiltered -300	Dissolved O2 %sat Unfiltered -301	BOD 5-day mg/l Unfiltered -310	COD mg/l Unfiltered -340	Field pH Unfiltered -400	Lab pH Unfiltered -403	CO2 mg/l Unfiltered -405
10/20/1949					8.1		5.9
3/24/1950					7.3		8.2
3/26/1950					7.3		6.2
4/15/1950					7.2		11
4/19/1950					7		16
4/22/1950					7.2		17
5/18/1950					8.2		3
6/15/1950					8		8.3
8/8/1950					8		9
8/14/1950					7.9		11
9/5/1950					7.9		11
10/2/1950					7.9		11
10/31/1950					8.1		7.4
1/15/1951					7.8		18
2/6/1951					7.8		17
3/31/1951					7.2		6.7
4/6/1951					7.3		7.5
4/9/1951					7.4		8.4
6/8/1951					7.4		15
9/6/1951					7.5		16
9/29/1969 16:15					8.3		3.6
10/14/1969 16:00					8		8.2
11/12/1969 13:30					8.1		6.6
12/9/1969 14:45					8		9.6
1/7/1970 15:30					8		11
2/5/1970 14:50					8		11
3/4/1970 15:05					8		11
4/17/1970 11:35					7.6		11
5/12/1970 15:25					7.5		7.5
6/11/1970 11:45					7.9		11
7/6/1970 13:40					7.9		9.8
8/3/1970 14:30					7.8		10
10/20/1970 14:45					8.1		7.2
11/16/1970 15:00					8		9.5
12/15/1970 15:00					7.9		15
1/12/1971 15:05					8		12
2/11/1971 14:45					8		10
3/19/1971 15:05					7		17
4/13/1971 17:15					7.6		11
5/4/1971 11:15					8		6.1
6/3/1971 13:10					7.9		10
7/7/1971 18:30					7.9		8.8
8/4/1971 16:10					7.8		13
9/8/1971 15:00					8.1		6.2
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3/22/1972 13:40							
4/21/1972 16:35							

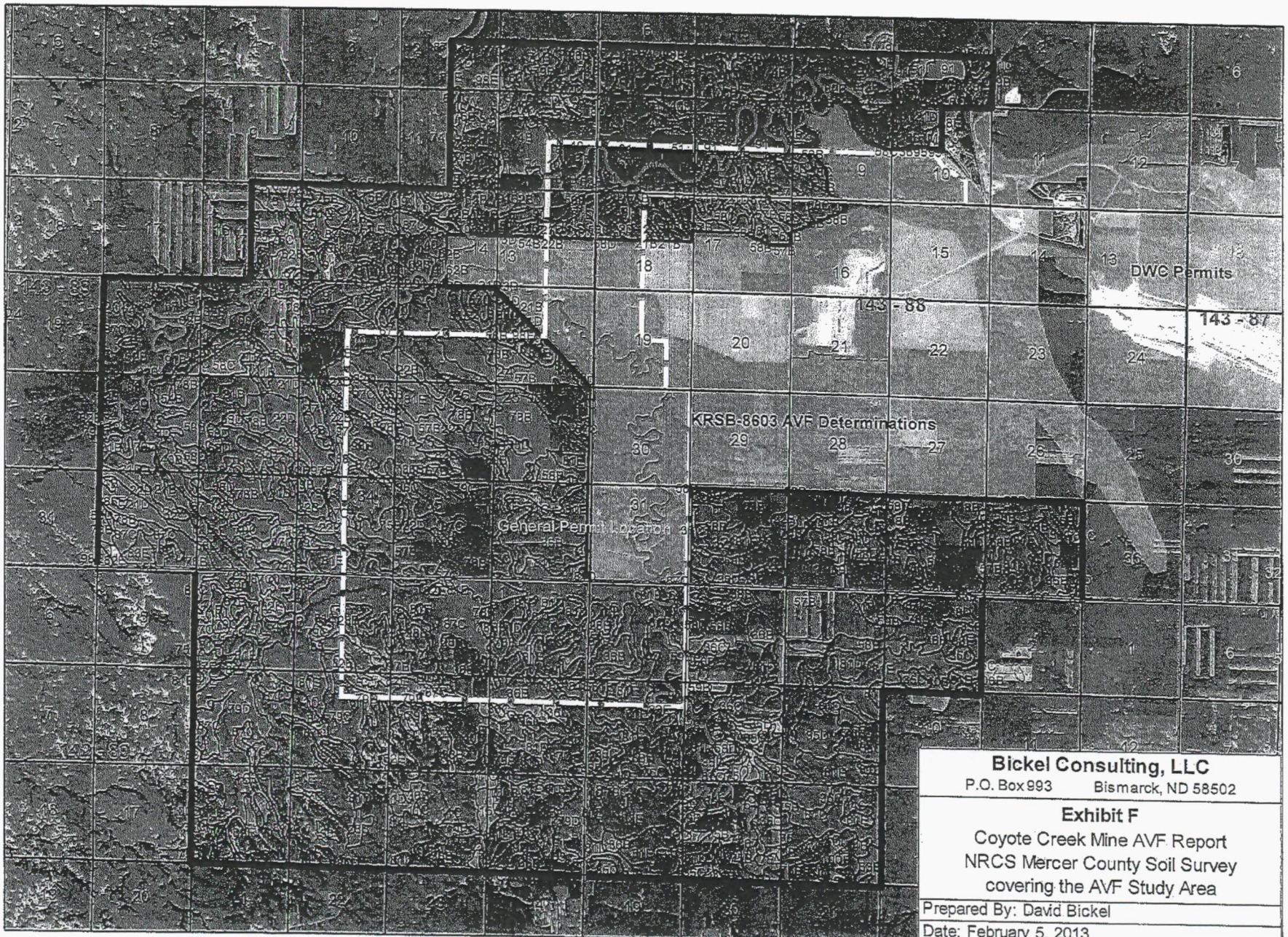

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Exhibit F
Coyote Creek Mine AVF Report
NRCS Mercer County Soil Survey
covering the AVF Study Area

Prepared By: David Bickel
Date: February 5, 2013

Exhibit G. Map legend and acreages for Mercer County Soils map within the AVF study area

Map Symbol	Soil	Acres
2	Tonka silt loam, 0 to 1 percent slopes	6.6
5	Dimmick silty clay, 0 to 1 percent slopes	48.0
7	Straw silty clay loam	42.6
8	Grail silty clay loam, 0 to 2 percent slopes	9.7
10	Savage silty clay loam	157.0
15	Lawther silty clay	106.6
17	Heil silty clay loam	32.5
36	Willaims loam 0-3 % slopes	36.0
40	Shambo loam 0-2 % slopes	325.0
43	Colvin silt loam	2.0
44	Arnegard loam 0-2 % slopes	67.0
47	Halveron loam	11.1
51	Straw silt loam 0-2 % slopes	315.8
67	Straw loam channeled	877.3
73	Belfield silt loam	275.0
75	Belfield-Daglum silt loams 0-2 % slopes	585.4
85	Harriet varient silt loam	63.9
88	Harriet clay	30.2
91	Straw loam 0-2 % slopes	1605.0
95	Flaxton-Williams loams	106.8
104	Magnus silty clay loam	81.5
108	Belfield-Straw silt loams	242.0
100B	Amor loam	147.3
110B	Belfield silt loam	6.5
11C	Cherry silty clay loam	221.0
21B	Lihen loamy fine sand	379.3
21D	Telfer loamy fine sand	600.7
22B	Krem loamy fine sand 0-6 % slopes	309.5
22D	Krem loamy fine sand 6-15 % slopes	406.8
28B	Temvik-Williams silt loams	170.8
35C	Amor-Werner loams 6-9 % slopes	417.1
35D	Amor-Werner loams 9-15 % slopes	260.3
36B	Williams loam 3-6 % slopes	992.1
36C	Williams loam 6-9 % slopes	363.1
38C	Williams-Zahl loams	10.2
38D	Zahl-Williams loams	253.3
38E	Zahl loam	65.4
3D	Seroco-Telfer loamy fine sands	149.7
40B	Shambo loam 2-6 % slopes	111.4
41B	Parshall loam	37.1
44B	Arnegard loam 2-6 % slopes	20.9
44C	Arnegard loam 6-9 % slopes	14.2
54B	Lihen fine sandy loam	83.3
55B	Vibar fine sandy loam	2.4
56B	Lefor fine sandy loam	12.1

Exhibit G. Map legend and acreages for Mercer County Soils map within the AVF study area

57B	Flaxton fine sandy loam 0-6 % slopes	2088.5
57C	Flaxton fine sandy loam 6-9 % slopes	90.9
58B	Flaxton-Williams complex 3-6 % slopes	1107.2
58C	Flaxton-Williams complex 6-9 % slopes	688.1
58D	Flaxton-Williams complex 9-15 % slopes	232.2
59B	Parshall fine silty loam	384.6
62B	Velva fine silty loam	982.5
71B	Searing loam	33.1
71C	Searing-Ringling loams, 6-9 % slopes	3.1
74B	Regent-Dogtooth complex 0-6 % slopes	652.2
74C	Regent-Dogtooth complex 6-9 % slopes	79.7
75B	Belfield-Daglum silt loams 2-6 % slopes	525.8
75C	Belfield-Daglum silt loams 6-9 % slopes	51.8
76B	Sen-Dogtooth complex, 3-6% slopes	52.9
76C	Sen-Dogtooth complex, 6-9% slopes	11.0
78B	Noonan-Flaxton fine sandy loams	1460.0
79B	Moreau silty clay 3-6 % slopes	135.2
79C	Moreau silty clay 6-9 % slopes	585.7
79D	Wayden-Moreau silty clays	874.1
81D	Cabba loam 9-15 % slopes	1336.4
81E	Cabba loam 15-35 % slopes	6143.4
82E	Cabba-Badland complex 15-50 % slopes	646.2
83C	Vebar-Cohagen fine sandy loams	12.0
83E	Cohagen-Vebar fine sandy loams	401.4
86E	Wabek soils	15.7
87C	Rhodes-Daglum complex	2991.8
8B	Grail silty clay loam, 2-6% slopes	10.6
91B	Straw loam 2-6 % slopes	117.7
92B	Noonan-Willaims loams	15.9
97B	Sen silt loam 3-6 % slopes	103.4
97C	Sen silt loam 6-9 % slopes	52.0
98E	Ringling-Cabba complex	562.2
Mx	Mined Land complex	17.3
W	Water	129.1

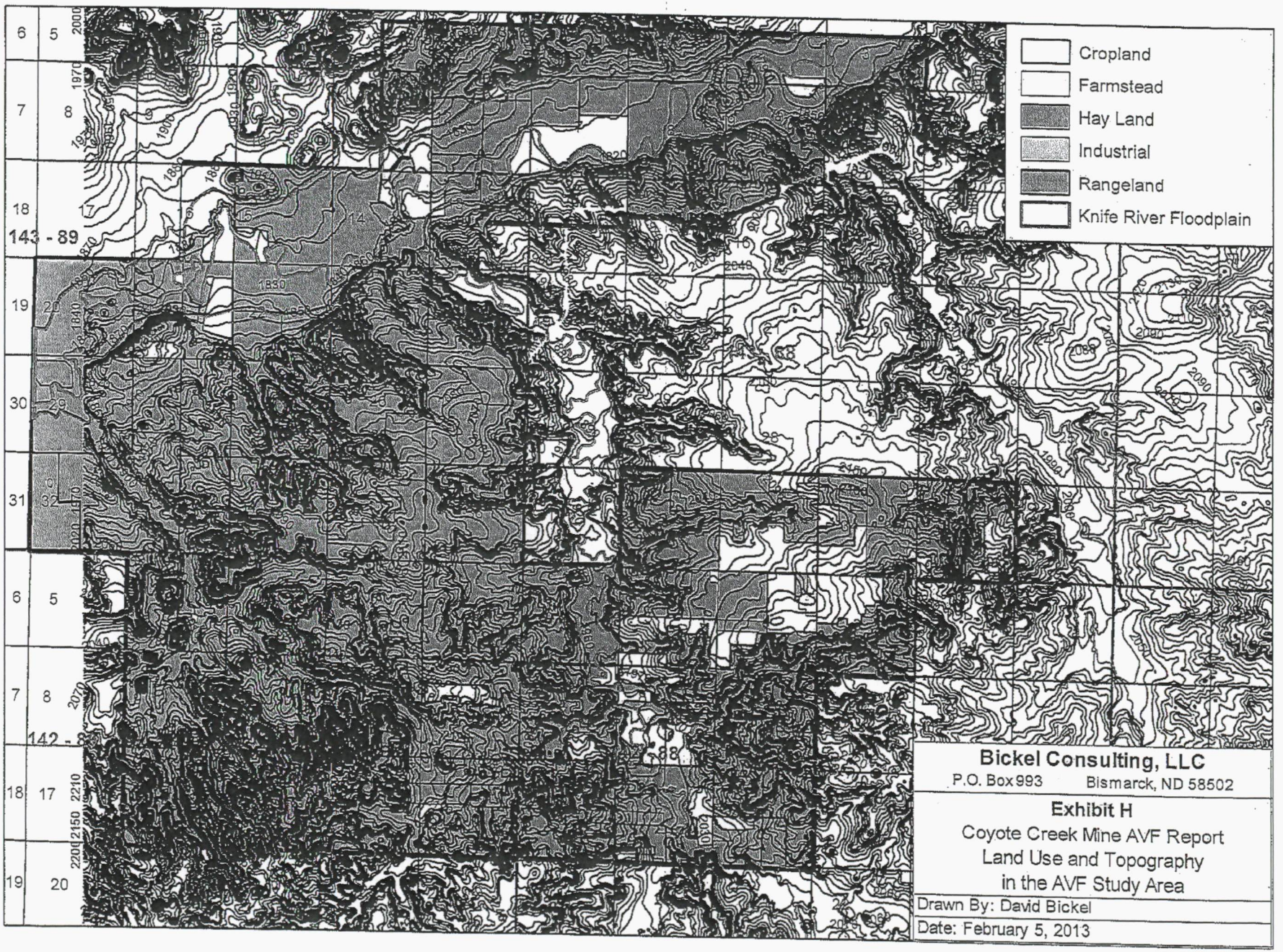
Cropland
Farmstead
Hay Land
Industrial
Rangeland
Knife River Floodplain
143 - 89
142 - 8
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Exhibit H
Coyote Creek Mine AVF Report
Land Use and Topography
in the AVF Study Area
Drawn By: David Bickel
Date: February 5, 2013

Evaluation of the Soil Resources as related to Alluvial Valley Floors along a Portion of the Knife River in Mercer County, North Dakota

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CJ Heidt
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9/19/2012

Introduction

The Federal Office of Surface Mining (OSM) 1977 Surface Mining Control and Reclamation Act (SMCRA) regulations define Alluvial Valley Floors (AVFs) as unconsolidated stream-laid deposits where water availability is sufficient for subirrigation or flood irrigation agricultural activities (Public Law 95-87). The determination of AVFs requires detailed studies of soils, geomorphology, hydrology, vegetation, and land use. This report presents a preliminary evaluation of the soil resources in the study area and identification of any evidence of past artificial flood irrigation or water spreading and the potential of any natural subirrigated areas.

Study Area

The area evaluated occurred along a short stretch of the Knife River and adjacent tributaries in Mercer County, North Dakota. It followed the floodplain of the Knife River from the western border of Sec. 29, T143N, R89W to the eastern border of Sec. 3, T143N, R88W (see Figure 1). This area encompassed portions of 16 sections and all which is included in Hydrologic Unit 10130201. The floodplain of the Knife River and its tributaries in this area are well defined with steeper escarpments delineating the floodplain boundary. Landuse in the area is either cropland or native rangeland.

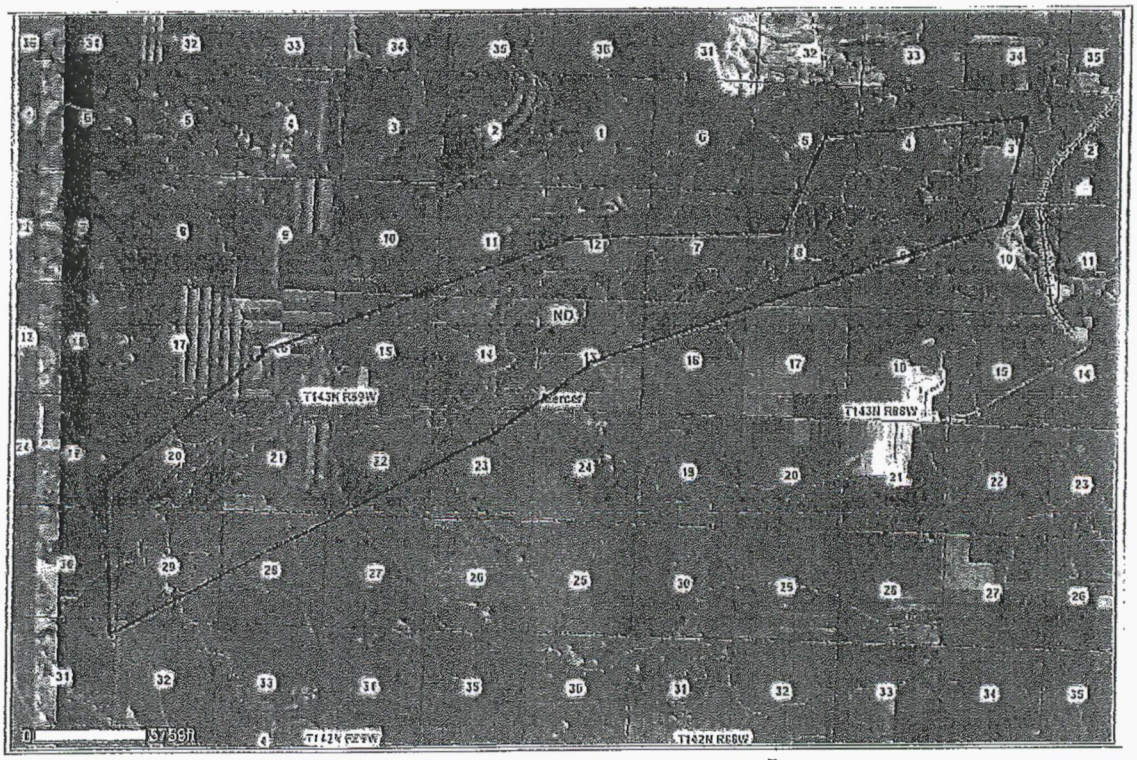

Figure 1. AVF – soil evaluation study area.

Methods

The soils in the area were evaluated by viewing the USDA-Natural Resources Conservation Service's Web Soil Survey (Soil Survey Staff, 2012). This is an Order Two Soil Survey that was developed at a scale of 1:20,000 and published in 1978. This soil survey had a very well designed mapping legend and had a minimum delineation size of approximately three acres. The soil survey and accompanying images were viewed at a scale of approximately 1:3600. In addition to the Web Soil Survey, additional images were evaluated from Google Earth at a similar scale. Both sources provided high quality, recent, color images at a scale suitable for identifying potential subirrigated areas or water spreading.

In addition to the soils and map units identified with the Web Soil Survey, the images were evaluated for potential inclusions of subirrigated soils in map units, land use or vegetation changes indicating potential subirrigation or flood irrigation, and cultural evidence of water spreading, flood irrigation, or subirrigated areas.

The development of a recent high intensity soil survey on similar landscapes close to the study area gave the authors knowledge of the landscapes, soil-landform-vegetation relationships, and the ability to correlate photograph signatures to soil properties.

Results

Soil Resources

The Knife River floodplain was well defined in the area. The river and its tributaries are well entrenched and many feet below the existing floodplain. This entrenchment helps explain the well-drained nature of most of the soils in the area.

Most of the soils on the floodplain in the study area classify as Cumulic Haplustolls (Straw series), Vertic (Cumulic) Haplustolls (Magnus Series), Fluventic Haplustolls (Velva Series) and Glossic Natrustolls (Belfield Series). These soils are generally Land Capability Class 2 or 3. These soils have moderately high to high water-holding capacity. They are very productive soils and most are considered Prime Farmland or Prime Farmland if Irrigated. These soils are moderately well to well drained. At the time of the Order 2 Soil Survey, they were all considered well drained with water tables below one meter most of the year. They all have rare to common flooding potential.

In addition to the dominant soils mentioned above, several poorly drained soils are found in oxbows on the floodplain. These oxbows occur several feet below the level of the surrounding floodplain. The soils classify as Typic Natraquerts (Heil) and Vertic (Cumulic) Epiaquolls (Dimmick). These soils typically have water tables near the surface in the spring and generally pond water after snowmelt and heavy rains. They are not considered suitable as cropland and have capability classes of 5 or 6 in undrained conditions.

No subirrigated soils or somewhat-poorly drained soils were mapped in the Order Two Soil Survey. There were no obvious inclusions of subirrigated areas on the images as indicated by cultural practices or vegetation. However, there were two small areas that could potentially have subirrigated hydrology. One area occurred in Sec. 14, T143N, R89W (see Figure 2). This area was mapped as MU-7, Straw, silty clay loam. It is surrounded by a poorly drained oxbow, which was retaining water at the time of the photograph. This area consisted of approximately 14 acres. Landuse was similar to the surrounding areas. The eastern portion was part of a larger cropland field and the western portion was range. No special or unique management practices were discerned.

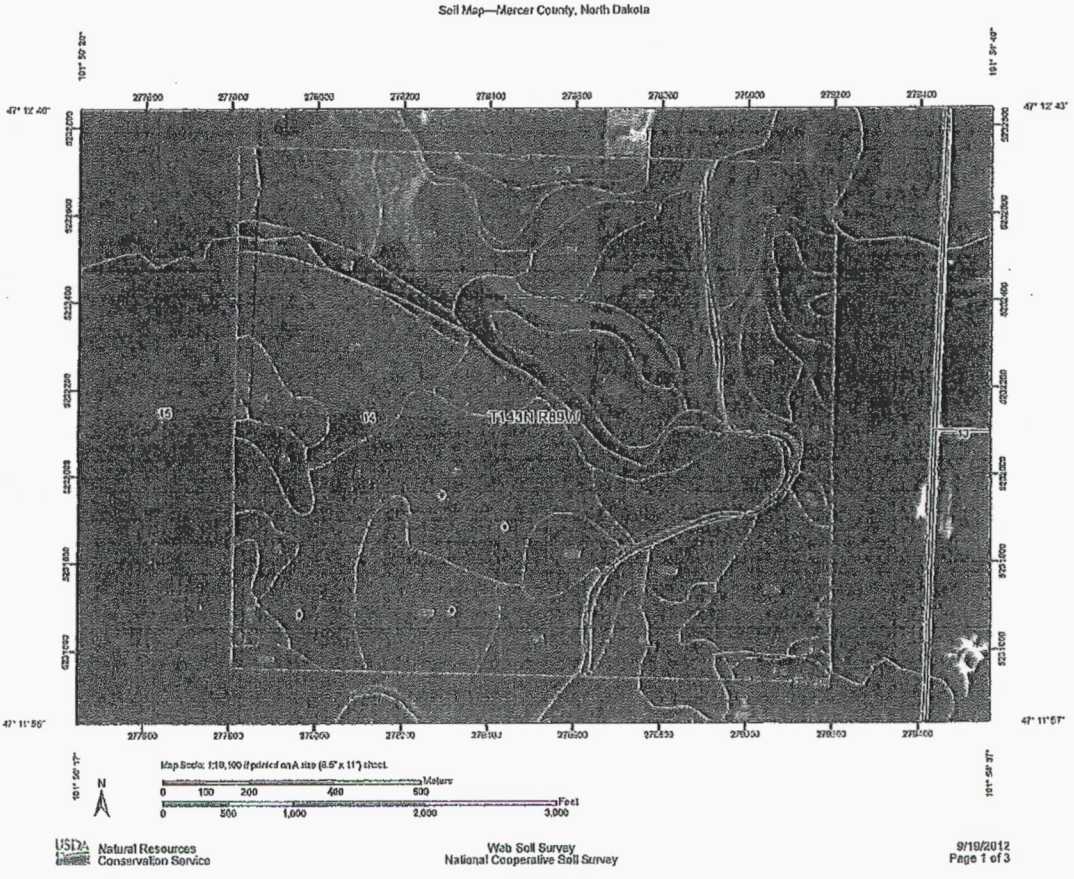

Figure 2. Area of potential subirrigated soils in Section 14. Note Map Unit 7 in center of image.

The second area occurred in Sec. 21, T143N, R89W (see Figure 3). It consisted of the interior of two oxbows at the confluence of the Knife River and several tributaries. The area encompassed approximately 15 acres and was mapped MU-67, Straw channeled and MU-62B, Velva fine sandy loam. Landuse in the area was range. No unique management practices were being utilized.

Figure 3. Area of potential subirrigated soils in Section 21. Note Map Units 67 and 62B in left center of image. Also note some converging tributaries.

Both of these areas have landscape characteristics that could potentially support subirrigated hydrology. Only on-site evaluation could confirm the presence of subirrigation; however, both areas are of small areal extent, are not managed uniquely, and do not significantly impact crop or range production in the area.

Artificial Flooding

No evidence was seen on the images of artificial flooding or water spreading. Although this practice is used by producers in western North Dakota, its use is not widespread and usually is associated with more sloping alluvial fan landscapes.

Conclusions

A review of the soil resources and imagery in the study area did not reveal any conclusive areas of subirrigation. Two small areas were identified with potential subirrigated landscape characteristics. No artificial flooding or water spreading areas were identified.

Citations

Soil Survey Staff, Natural Resources Conservation Service, United States Department of Agriculture. Web Soil Survey. Available online at http://websoilsurvey.nrcs.usda.gov/. Accessed August 2012.

Wilhelm, Francis. 1978. Soil survey of Mercer County, North Dakota. Soil Conservation Service. USDA.