NATURAL RESOURCE DEVELOPMENT IMPACTS ON SURFACE WATER QUALITY ACROSS MULTI-JURISDICTIONAL WATERSHEDS WITHIN MONTANA, WYOMING AND CROW TRIBAL LANDS

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NATURAL RESOURCE DEVELOPMENT IMPACTS ON SURFACE WATER QUALITY ACROSS MULTI-JURISDICTIONAL WATERSHEDS WITHIN MONTANA, WYOMING AND CROW TRIBAL LANDS

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ABSTRACT

The first portion of my dissertation research focuses on water quality and quantity impacts from a potential coal surface mine development on Crow tribal lands in southeastern Montana. My field research analysis will focus on the surface water quality in three adjacent watersheds. The study objective was to determine baseline water quality in watersheds on the Crow Reservation prior to the development of a proposed coal mine site on tribal lands. All watersheds are located within the boundaries of the Crow Indian Reservation. The primary component of both watershed studies consists of an assessment of water quality of surface water originating on tribal lands. The objective of my field research is to determine a baseline assessment of surface water in watersheds prior to mine development, particularly on tribally owned and allotted tracts.

In addition, I will determine impacts to water quality from reclaimed coal mine spoils surface runoff and produced water discharge from coal bed methane wells within the watersheds. I will compare the water quality parameters from select undeveloped sites to developed sites within the watershed area. Several mines have been developed in areas downstream of the research site, immediately adjacent to tribal lands. Where the tributaries are still flowing, the surface water

quality will be assessed and compared to the upstream baseline data. Historical data from state agencies will also be compared to data collected within watersheds on tribal lands. Analysis has shown the increasing degradation of water quality in watersheds downstream and across the state boundary of Montana into Wyoming where historical mining has occurred.

Water quantities affected by coalbed methane development will be outlined and compared to average annual precipitation in the region. Water rights are tied to the land ownership in both states. Where coal bed methane wells were developed, the water rights of receiving waters that would be impacted by direct discharge were quantified. All surface water in Montana was owned by energy companies, in Wyoming the majority of surface water rights where CBM wells were developed was owned by energy companies with a few fee land owners with water rights feeding irrigation canals. All natural resource development was facilitated through groundwater extraction. Had the wells discharged the allowable permitted flowrate of produced water every year, the discharged water would have significantly altered the flowrate of Youngs Creek. In Wyoming the produced water was permitted as beneficial use and discharged into waterways as livestock and irrigation supplies. Montana had changed its permitting requirements and has prohibited the direct discharge of produced water into waterways. Energy companies own the majority of the water rights in the downstream reaches of the watersheds where potential coal mines would be developed. Groundwater levels in coalbed aquifers within the affected watershed have been influenced by the development of coalbed methane wells on tracts adjacent to the tribal lands. Surface water quality has also been impacted by the direct discharge of produced water from coalbed methane wells into local drainages.

Finally, I will examine how tribal land tenure policy impacts water resource management on tribal lands. The Crow Tribe was recently granted reserved water rights and will now build and enforce a water code to manage its water resources. In order to enforce regulatory programs associated with the tribal water code, the tribal government will need to have the capacity to operate effective programs. This ability of the tribe to manage its resources represents a critical step toward self-determination and ultimately toward exercising tribal sovereignty. The successful implementation of the water code will affect resulting water quality in tribal communities as well as protect individual tribal member's allottee land and water rights.

BIOGRAPHICAL SKETCH

Grace Anna Bulltail is an enrolled member of the Crow Tribe of Montana and a descendant of the Mandan, Hidatsa, and Arikara Tribes of North Dakota. Grace was raised by her paternal grandparents, Clara and Joseph Bulltail, of Pryor, Montana. Her parents are the late Alexander Bulltail Sr. and Sandra Gillette of White Shield, North Dakota. Grace was given her Crow name, "No one helps her" by her great-grandmother Winona Yellowtail and is a member of the greasy mouth clan. Grace grew up in Crow Country, in a household where the Crow language was primarily spoken and one of nine siblings, before attending boarding school at St. Paul's School in Concord, New Hampshire. Her college journey began at Cornell in 2000, as a freshman majoring in civil engineering. She completed a Bachelor of Science degree in civil engineering at Stanford University, where she was a member of the varsity crew team, competing in the 2003 women's rowing NCAA national championship, and director of the Stanford Powwow. Grace worked as an engineer in California and Montana after graduating. Grace earned master's degrees at Montana Tech in project engineering management as a Sloan Indigenous Graduate Partnership fellow and at Columbia University in earth resources engineering as a GEM Foundation fellow. Grace is a recipient of the NSF IGERT fellowship and the Cornell Colman Family fellowship in completing her doctoral degree. Grace worked as an engineering instructor at United Tribes Technical College where she served as the school's AISES, American Indian Science & Engineering Society, chapter advisor and as a faculty mentor at NASA Ames research center. Grace was elected to the AISES board of directors in 2017. Grace enjoys making traditional Crow regalia, beading, powwow dancing with friends and family, running, promoting underrepresenting students in STEM, and continuing and honoring indigenous traditions.

DEDICATION

For my *bahksee* (grandparents),

Ihke Bia (Star Woman) Clara Roberta Stewart Bulltail

Poopahte Bilaash (Fiery Owl) Joseph Moses Bulltail Sr.

ACKNOWLEDGEMENTS

Firstly, I have to acknowledge my Crow, Mandan, Hidatsa and Arikara ancestors for their persistence, bravery, and resilience. *Aho* (thanks) my family: my grandparents Clara and Joseph Bulltail, who raised me and taught me to be a proud Crow woman, my father Alex Bulltail, my hero always, my adopted parents Roberta Hunter and Glenn Cuyjet for supporting me and taking me into your family, and my sister, Cedar Rose for accompanying and assisting me on research trips and for all you do for the family. Thanks to my committee members Todd Walter, Gerald Torres, and James Bartsch. I would like to thank faculty and staff at Little Big Horn College particularly Mari Eggers and John Doyle for your support in my research in Montana. I am thankful to Sara Hernandez for her guidance, kindness, advice and diligence in her work in promoting underrepresented students at Cornell. I also thank the Diversity Programs in Engineering, the Sloan Scholars program, and the Colman Family Foundation. I thank Tiffany Simon at Columbia University for encouraging me to apply and in starting my PhD at Columbia. I thank the Sloan Indigenous Graduate Program for support in completing my first graduate degree, as well as the GEM foundation for supporting my second master's degree. I thank AISES for introducing me to engineering after the seventh grade in taking my first airplane ride to AISES summer camp in North Carolina. *Aho*: Karen Davidson-Woodruff, the Hardin school gifted and talented coordinator, for believing in the shy rez girl who liked math, Mary Jo Ondrechen for mentoring me and helping me in the most difficult phase of my PhD journey, and my nieces Kaysera and Karissandra, my powwow dance partners, for inspiring me and motivating me to do better. Thank you to my fellow lab members for assisting me and helping me through my time at Cornell.

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CHAPTER 1

IMPACTS OF COAL RESOURCES DEVELOPMENT ON SURFACE WATER QUALITY IN THE WESTERN UNITED STATES: A CASE STUDY

INTRODUCTION

This study assesses the impact of coal mining, especially coal bed methane (CBM) development, on surface water quality. This assessment builds upon a previous study conducted by a team at Little Big Horn College (LBHC) that monitored upper stream tributaries west of the Wolf Mountains in watersheds flowing into the Little Big Horn River (Sigler et al. 2012). The primary objective of this earlier study was to determine baseline water quality in watersheds on the Crow Reservation prior to the development of a proposed coal mine on tribal lands. In our study, the targeted watersheds are east of the Wolf Mountains and flow into the Tongue River (Figure 1). The headwaters of our study watersheds are located within the boundaries of the Crow Indian Reservation. The Montana Bureau of Mines and Geology (MBMG) completed a water quality study when coalmines were initially developed in the Tongue River basin during the 1970s (Hedges et al. 1998).

Part of the motivation for this study is similar to the LBHC (Sigler et al. 2012) study, that is, to provide baseline, surface water quality data in advance of potential CBM or other coal mining activities proposed for the area, specifically, on the Crow Reservation in Montana, on both tribally owned and allotted tracts. However, my extent of sampling will extend beyond the reservation to include areas with current gas extraction as well as reclaimed coalmines. The first objectives are to determine impacts to water quality, if any, associated with reclaimed mines and

produced water discharge or land application from CBM wells. Although there are potential impacts on groundwater, this study focused on surface waters due to difficulties in sampling groundwater. My study focuses largely on the Tanner Creek, Youngs Creek, Little Youngs Creek, and Ash Creek watersheds, with a few auxiliary sampling points outside of these watersheds. I used the water quality in upstream, undeveloped sub-watersheds as baseline conditions to assess any downstream conditions where there has been substantial coal-related development. The tributaries draining the developed sites flow directly into the Tongue River Reservoir.

Another motive for completing this study is that the impacts on the reservation are understudied in terms of policy and water quality impacts. The watersheds represent a unique regulatory regime as they lie within the jurisdiction of the Crow Tribe and the States of Montana and Wyoming. The policies from each jurisdiction are rarely assessed together in regard to the overall impact on the water management and resulting water quality of the watershed.

I also chose specific sampling sites that coincided with sites previously sampled by MBMG in September 1977 (Hedges et al. 1998) so I could make a longitudinal assessment and determine if water quality has changed between the mid-1970s and 2016. Analysis will include comparing the profile of these watersheds to adjacent watersheds that have experienced development.

My monitoring also includes 2 locations outside of the study watersheds near the Big Horn and West Decker mines that allowed me direct assessment of extracted water from either or both flow back or dewatering. This water, when not discharged directly into stream channels, is often

held, on site, in infiltration basins. Water in these basins that does not infiltrate, is usually channeled through culverts or other overflow structures into adjacent streams.

Site Description and Background

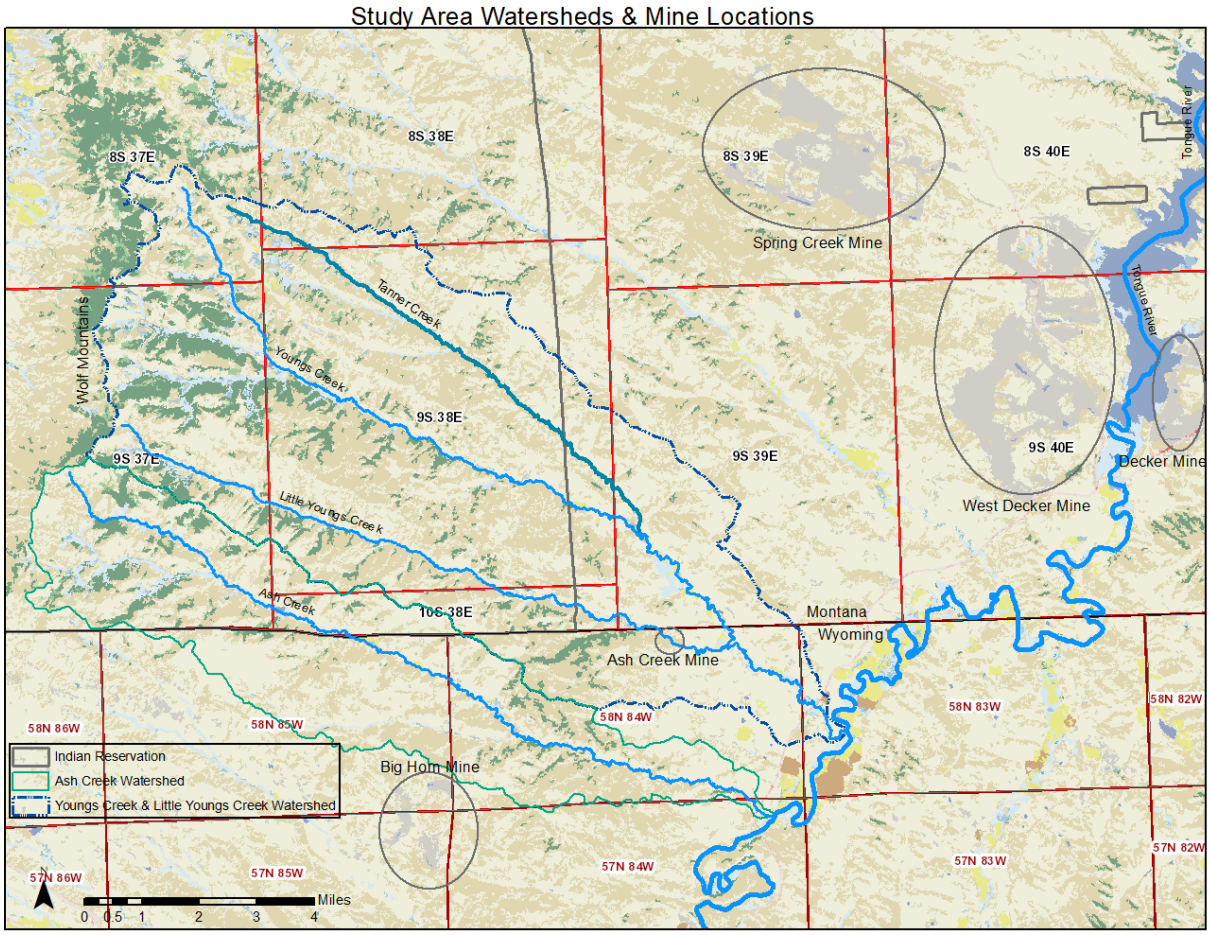

Figure 1.1. Study area watersheds & mine locations.

Rationale for Choosing Sites and Site Contexts:

Previous Studies and Data

In the mid-1970s, the MBMG completed several studies of my study area that had been identified for the development of potential coal mine sites (Hedges et al. 1974). The MBMG watershed study included Tanner Creek, Youngs Creek, Little Youngs Creek, and Squirrel Creek, all of which are partially located within the Crow Reservation boundary (Figure 1). The majority of the MBMG surface and ground water data were collected in 1974 through 1976. Therefore, I recognized that there was a potential to re-sample a sub-set of the sites from the MBMG 1977 study to assess surface water quality changes over time. Watershed characteristics of sampling locations are indicted in Table A1.

During the time of the MBMG study, several coal mines were being developed east of the reservation boundary including the Decker company mines in Montana and the Ash Creek mine to the south in Wyoming (Figure 2). At the time, the Shell Oil Company had developed mine-project plans and submitted a mine permit application (USDOI 1981). Additional data on coal aquifer locations and depths are in the final environmental impact statement of this permit application (Ibid.), however, the majority of the surface water data were cited from the MBMG 1977 study. For this study, I used the Shell Oil plans for mine development to estimate the extent of mine development in the Tanner and Youngs Creeks' watersheds.

Because the area had been previously studied by both the oil and gas industry and the MBMG, there were many, readily accessible auxiliary data. For example, well logs and coal bed methane well production data in Wyoming are available online at the Wyoming Oil and Gas Commission on the State of Wyoming website (WOGCC 2017). Additional data provided by MBMG include

coal bed methane well production and associated produced water as well as locations of coal bed methane infiltration ponds. Coal bed methane well production data are available from the Montana Oil & Gas Commission (MBOGC 2017).

Proposed Coal-Related Development and Geology

My study sites are located in the larger Powder River Basin of Wyoming and Montana, which include both active coal-related fossil fuel extraction activities and undeveloped areas for which water quality can be compared. The coal beds within the Powder River Basin have been developed in this region of Montana and Wyoming. The Powder River Basin has supplied 40 percent of the domestic coal production (USEIA 2017). The active coal developments in Montana within the Decker area are the Decker, West Decker and Spring Creek mines (Figure 2).

The Cloud Peak Energy company has identified three potential mine coal deposit tracts; Squirrel Creek, Tanner Creek, and Upper Youngs Creek project areas based on the locations within the watersheds. Each tract lies entirely within the Crow Indian Reservation (Figure 2) and has a separate option to lease. The project area is referred to as the Big Metal Mine. The Department of Interior Bureau of Indian Affairs has approved Cloud Peak's Exploration Agreement and Option to Lease Agreement with the tribe. In 2013, the tribe received $2.25 million upon signing the agreements and an additional $1.5 million upon the BIA approval of the agreements. The tribe will receive approximately $2 million per year for the 5-year option period. (CPE 2013)

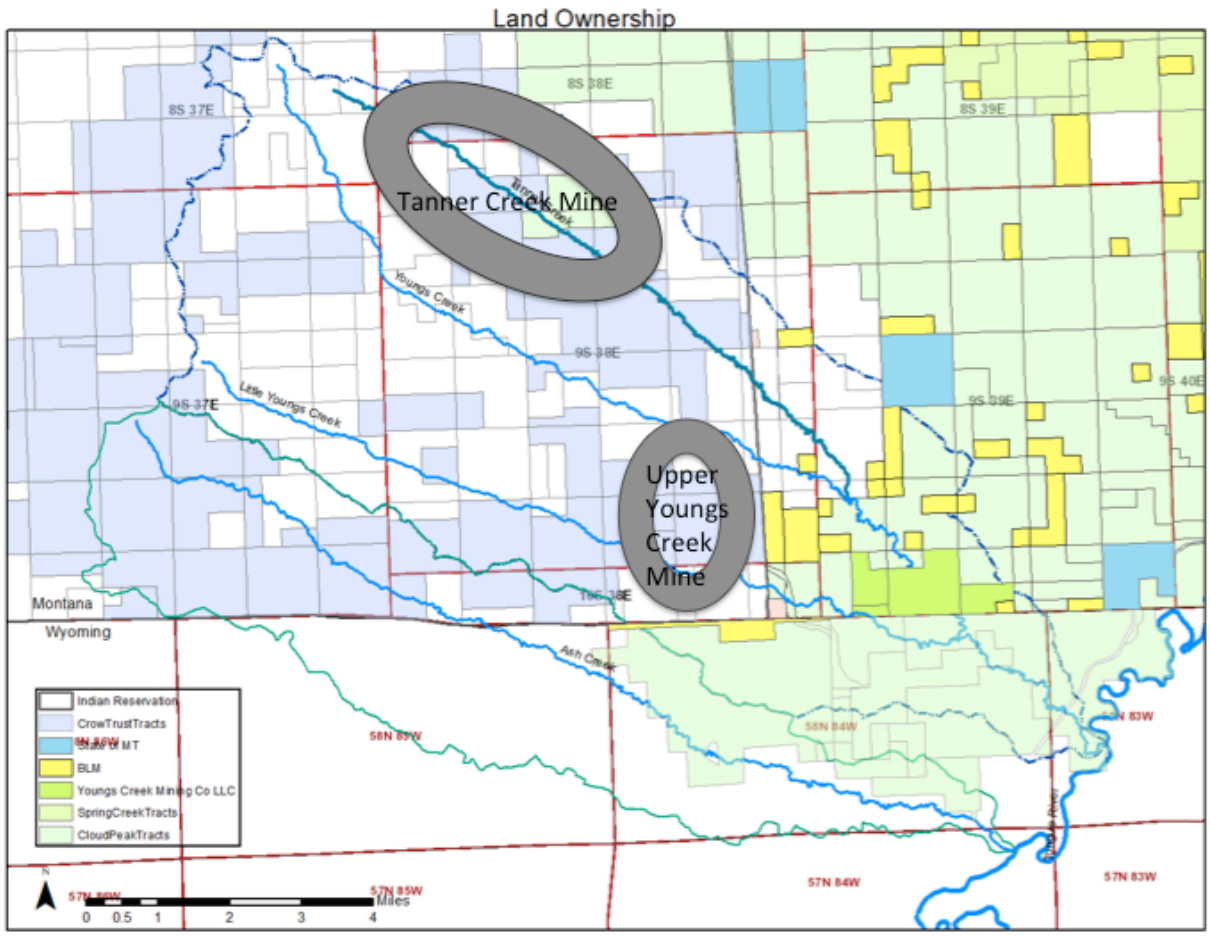

Figure 1.2. Potential coal mine sites.

The coal layers within the basin located in the Tongue River Member lie shallow enough to the surface for coal strip mining development (Wheaton et al. 2004). All of the coalmines in the Powder River Basin are developed as surface strip mines. The coal beds targeted by Cloud Peak, i.e., those on the Crow Reservation, lie at higher elevations than the other regional mines. These coal beds outcrop throughout the target and study area among the foothills and alluvial valleys of the study watersheds.

Powder River Basin CBM Reserves

A vast amount of CBM reserves are stored in coal seams throughout the Powder River Basin. Due to the geological setting, fewer reserves are located in Montana coal seams than in Wyoming. The Montana portion with the basin contains an estimated 0.86 trillion cubic feet (TCF) of CBM gas, while the Wyoming had produced 4.18 TCF through 2010 within the Powder River Basin (Ibid).

In Montana, CBM development is limited to 19.3 kilometers (12 miles) north of the state line and between the Wolf Mountains to the west and the Powder River to the east. This area would include the first two townships within the Crow Reservation west to the Wolf Mountains. This limitation coincides with the area targeted for coal surface mine development. "Of the numerous coal beds in the Powder River Basin, the primary targets for CBM development in Montana have been the Anderson, Dietz, Canyon, and Carney coal beds within the Tongue River Member of the Fort Union Formation." (Wheaton et al. 2004) Active CBM development is located east of the Tongue River Reservoir as of 2017 (MBOGC 2017).

Land Use

Lands located on the Crow reservation within the study area are largely uninhabited and primarily used for pasture and grazing lands. There are a few residences on fee lands located along Youngs Creek based on land records (State of MT 2017) and site visits and personal observation. The land topology is varied with foothills and creek drainages with increasing altitudes upstream to the northwest toward the Wolf Mountains.

East of the reservation, the land topology consists of rolling hills and wider valleys along the Youngs Creek drainage. "Most of the land is utilized for cattle ranching, dryland farming, or coal mining with flood-irrigated farmlands along stream valley floors. Water for irrigation comes from several surface-water sources, especially from the Tongue River" (Wheaton 2002). The primary land use is pasture and grazing as well as varied agricultural use along the alluvial valley.

Climate

The study region is considered semi-arid and receives relatively low levels of precipitation, ranging from 30 to 38 cm (12 to 15 inches).

Table 1.1. Drainage area and annual precipitation and annual discharge of creeks within the study area.

Tanner Creek at Reservation Boundary (Hedges et al. 1998)	
Drainage Area	31.9 km^2 (7882.5 acres)
Average Annual Discharge	39.93 l/s (1.41 cfs)
Average Annual Runoff	3.81 cm (1.5 in)

Youngs Creek at Reservation Boundary (Hedges et al. 1998)	
Drainage Area	56.2 km^2 (13887 acres)
Average Annual Discharge	150.08 l/s (5.3 cfs)
Average Annual Runoff	8.13 cm (3.2 in.)
Annual Precipitation	36.83 cm (14.5 in)

Youngs Creek at Mouth/Confluence with Tongue River (Hedges et al. 1974)	
Drainage Area	166 km^2 (41020 acres)
Average Annual Discharge	0.26 cms (9.16 cfs)
Average Annual Runoff	49.1 mm (1.93 in.)
Annual Precipitation	349 mm (13.74 in.)

Little Youngs Creek at Mouth (Hedges et al. 1974)	
Drainage Area	44.1 km^2 (10897 acres)
Average Annual Discharge	0.05 cms (1.77 cfs)
Average Annual Runoff	34.3 mm (1.35 in.)

Annual Precipitation 356 mm (14.02 in.)

Surface Water & Groundwater Quality

Surface waters in the watersheds are classified as calcium-magnesium bicarbonate type water (Hedges et al. 1998). This is consistent with streams that are surface water fed. Tanner Creek has more highly mineralized waters than Youngs and Little Youngs Creeks (Hedges et al. 1998). The overall Total Dissolved Solids (TDS) of all streams increases downstream. "In all of the streams, progressive downstream increases in dissolved sodium and sulfate occur, reflecting ground water contributions from deeper parts of the system." (Hedges et al. 1998).

Initially, headwaters of a stream would have lower SAR levels, as the dominant cations in surface fed waters are calcium and magnesium (Davis 1984). SAR levels would increase with distance downstream as ground waters contribute increasingly to the stream flow. Groundwater contributing sodium dominated water would increase SAR in stream flows. In general, SAR levels are expected to stabilize after a certain point with overall larger stream flows

Groundwater quality of the alluvium in Youngs Creek and Tanner Creek at the mouth of each stream is primarily sulfate (SO_4) anion and relatively high TDS of 1500 mg/L (Hedges et al. 1998). By comparison, Little Youngs Creek alluvium contained less than 1000 mg/L TDS.

Total Dissolved Solids, TDS

Youngs Creek and Little Young Creek have TDS concentrations ranging between 200 and 400 mg/L (Hedges et al. 1998). The largest TDS concentration level at the mouth of Youngs Creek during the low flow measurement was 750 mg/L. Tanner Creek has TDS concentrations ranging between 400 and 1200 mg/L. The Tongue River has and average TDS concentration of 440 mg/L (Hedges et al. 1998).

TDS values in surface water will be lower than groundwater concentrations. Where surface flow dominates in the headwaters TDS concentrations will be lower. Groundwater will contribute to stream flow further downstream thereby increasing TDS concentration. "In all of the streams, progressive downstream increases in dissolved sodium and sulfate occur, reflecting ground water contributions from deeper parts of the system." (Ibid.) The concentration will also be lower in streams during high flow rates.

The spoils aquifers of reclaimed mines will have higher TDS than adjacent coal aquifers. The spoils aquifers will exhibit higher concentrations of sodium, sulfate, and bicarbonate than the coal aquifers. These elevated concentrations are due to the dissolution of minerals and clays in the spoils aquifers. The ion exchange of the calcium and magnesium ions in favor of the sodium ion within the spoils aquifer also increases the TDS. In the spoils aquifer, the predominant anion will be sulfate. Increases in chloride concentrations may occur. Bicarbonate may increase but will be limited to levels of less than 1,000 mg/L in groundwater. TDS levels in spoils aquifers

may reach 5,000 mg/L as demonstrated in mined areas in southeastern Montana (Davis et al. 1986).

Background and Relevant BioGeochemical Processes:

Coal Seam Aquifer Water Quality

Sodium will be the dominant cation in coal bed waters associated with coal bed methane production. The Sodium Adsorption Ratio (SAR, described later) values of coproduced waters in Montana will be greater than 30. Bicarbonate will be the dominant anion with typical Total Dissolved Solids (TDS) levels ranging from 1000 to 2500 mg/L. Depending on the flow influences present in the coal seam aquifer, levels of TDS will be highly variable. The dominance of sodium-bicarbonate waters associated with coal bed methane coproduced waters is of particular concern in monitoring water quality in the study area.

Chemical Composition of Coal Bed Methane Waters

The coal bed waters will favor the dominance of the sodium ion based on the flow path processes of the recharge waters. Waters flowing through clay will be dominated by sodium where calcium and magnesium have been adsorbed to the soils in place of sodium.

In the study area, several processes occur in the coal seam creating conditions for the generation of methane. These include the reduction of sulfate, removal of calcium and magnesium, and the increase in bicarbonate as the dominant anion (Lee 1981). These conditions allow for the

biogenic production of methane in coal seams in this portion of the Powder River Basin (Van Voast 2003).

Biogeochemical Processes:

Sulfate Reduction

Sulfate reduction will occur in oxygen depleted conditions in the coal aquifer (Rice and Claypool 1981). With the reduction of sulfate, bicarbonate will increase. The high bicarbonate concentration in coal bed waters is primarily the result of sulfate reduction (Freeze and Cherry 1979). Sulfate reduction is linked to the production of biogenic methane (Rice and Claypool 1981).

Removal of Divalent Cations

The increased concentration of bicarbonate will lead to the process of precipitation of calcium and magnesium (Decker et al. 1987), depleting both divalent cations. The further reduction of calcium and magnesium is driven by the precipitation of calcite, $CaCO_3$, and dolomite, $CaMg(CO_3)_2$, in the presence of elevated levels of bicarbonate (Freeze and Cherry 1979). With the increase in bicarbonate, the resulting pH of formation waters will increase.

Methane Formation

The methane produced will be largely from biogenic origin (Law et al. 1993). Methane production from CO_2 reduction will be the dominant biogenesis process. Carbon dioxide reduction does not increase bicarbonate levels. CO_2 reduction is described by:

$$CO_2 + 4H_2 \rightarrow CH_4 + 2H_2O$$

CBM formed in the Powder River basin is primarily the result of methane biogenesis (Rice and Claypool, 1981). Methane generation may occur during the sulfate-reduction process, as a concurrent reaction possibly as a catalyst type of reaction. This reaction will depend on the type of methanogenic bacteria present. There is a distinct geochemical signature of coal bed aquifers that will produce methane (Ibid). The signature will include specific constituents that vary slightly according to marine or freshwater deposition (Van Voast 2003).

Absence of Coal Bed Methane Gas in Coal Aquifers

Certain coal beds in the Tongue River formation do not produce coal bed methane (Van Voast 2003). The Robinson and Rosebud Coal formations in the northernmost portion of the Powder River Basin in Montana are found to have sodium sulfate/bicarbonate rich coal bed waters (Van Voast and Hedges 1980). This geochemical signature of the coproduced water is indicative of coal beds that will not produce methane (Van Voast 2003). The high concentrations of sulfate would prevent the conditions necessary for biogenic production of methane in the coal bed aquifer.

CBM Regulation

Prior to 2010, operators were allowed to discharge produced water from coalbed methane wells directly into stream drainages in Montana and Wyoming (MCA 82-11-175). Wyoming has separate produced water standards and permitted direct discharge into stream drainages for beneficial use (USBLM 2003). The US Environmental Protection Agency (EPA) delisted coal bed methane produced water from the agency regulation in 2014 (USEPA 2014). EPA produced an environmental impact report on coal bed methane produced waters (USEPA 2010). The states of Montana and Wyoming regulatory policies on CBM development are detailed in Chapter 2.

Bureau of Land Management, BLM, considers aquifer waters with levels of total dissolved solids less than 10,000 ppm to 'useable water' within federal and tribal land (43 C.F.R. pt. 3160). The EPA considers waters with the same TDS levels to be classified as USDW sources (40 CFR § 144.3). All of the waters in the coal bed aquifers within the study watersheds would be considered USDW sources and usable sources. This classification as a useable water source may influence the BLM and state agencies regulation of coal bed methane produced waters as beneficial use.

Tribal Regulations

All federal statutes placed by the EPA such as the Clean Water Act will apply to tribal lands (USEPA 1984). The state of Montana does not have environmental jurisdiction over tribal lands or over water quality on tribal lands (MCA 85-20-901). The exception to the EPA enforcing regulations on tribal lands applies when the tribe has been granted Treatment As State (TAS)

from the EPA (40 CFR 131.8). To attain the TAS status, the tribe has to demonstrate the capacity to run environmental programs (USEPA 2008). The environmental standards must be equivalent to EPA standards. Tribes can also require that environmental standards of surface water quality, for example, exceed standards set by the EPA. The Crow Tribe does not have TAS status and would then have to comply with current EPA water quality standards.

Tribal Water Sources

Several water bodies, primarily rivers, on the Crow reservation are listed as impaired. The contaminant levels in municipal drinking water sources such as the Little Bighorn River often contain elevated levels of bacterial and pathogens of concern. In addition, municipal water treatment plants have been found to be incapable of properly treating drinking water and resulting standards have often violated drinking water standards.

Municipal, Rural, and Industrial (MR&I) Water Supply

Recently, the Crow Tribe has received funding to build a municipal, rural, and industrial water supply system (P.L. 111-291). One water source, the Bighorn River, has been determined to provide adequate amounts and quality for the water system (USBR 2016). The water system will serve all communities within the tribe's 8903 square kilometers (2.2 million acre) land base. The system will connect rural consumers to an adequate domestic water supply where those households rely on low quality groundwater wells. The tribe included initial plans to supply industrial demands to the proposed Big Metal mine development (Bartlett & West 2014). This

extension of the water supply line will traverse one of the greatest distances from the source water and gain the most elevation increase in the delivery area.

The tribe has also expressed interest in building and operating coal to liquid coal gasification plants (AAEC 2008). This operation would require vast amounts of water. The tribe has entertained this industrial demand in discussions for sizing the water system.

Volumes of Wastewater & Aquifer Drawdown

Produced water volumes generated in the study area watersheds will be detailed in Chapter 2. Coal mining in the area has also influenced groundwater levels in the coal bed aquifers. The Decker and the West Decker mines have been shown to influence hydrostatic pressures in coal bed aquifers (Wheaton et al. 2004). Coal mining has resulted in a drawdown of 3 meters at a distance of 3.2 km from the mine. The drawdown of 20 feet would correspond to 6.1 m at a distance of 1.6-3.2 km from coal bed methane development.

METHODS

Determining Sampling Points

Like previous studies, sampling points have been based at locations that were generally accessible from nearby roadways such as outlets of roadway culverts, stream crossings, and clearings in brush and tree covering. Sampling points were also located at the confluence of tributary streams, and at the mouth of each stream. Sampling points were generally located within roadway right of way areas. Our study was limited to surface water because groundwater was generally not as accessible. Sampling sites were chosen near MBMG 1977 samples sites. Some MBMG sites on Youngs Creek were not sampled due to time constraints and lack of site information at the time of sampling. Water samples from Tanner Creek were primarily taken in June when the creek was flowing throughout the entire length.

Several sampling locations were selected based on proximity to prior resource development. Locations nearest the Tongue River Reservoir, immediately outside of the eastern edge of the Decker Mine were selected to target surface waters running off the mine site. One location near the reservoir displayed a State of Montana Department of Environmental Quality discharge permit number posted at the site of a discharge point. This point discharged directly into the Tongue River Reservoir through a culvert under Highway 314. The source of the water appeared to come from a pond on the mine site that may be used to retain groundwater pumped from the active mine and associated coal aquifers. The groundwater levels in the mine site are influenced by the water table of the reservoir located immediately adjacent to the mine east of Highway 314.

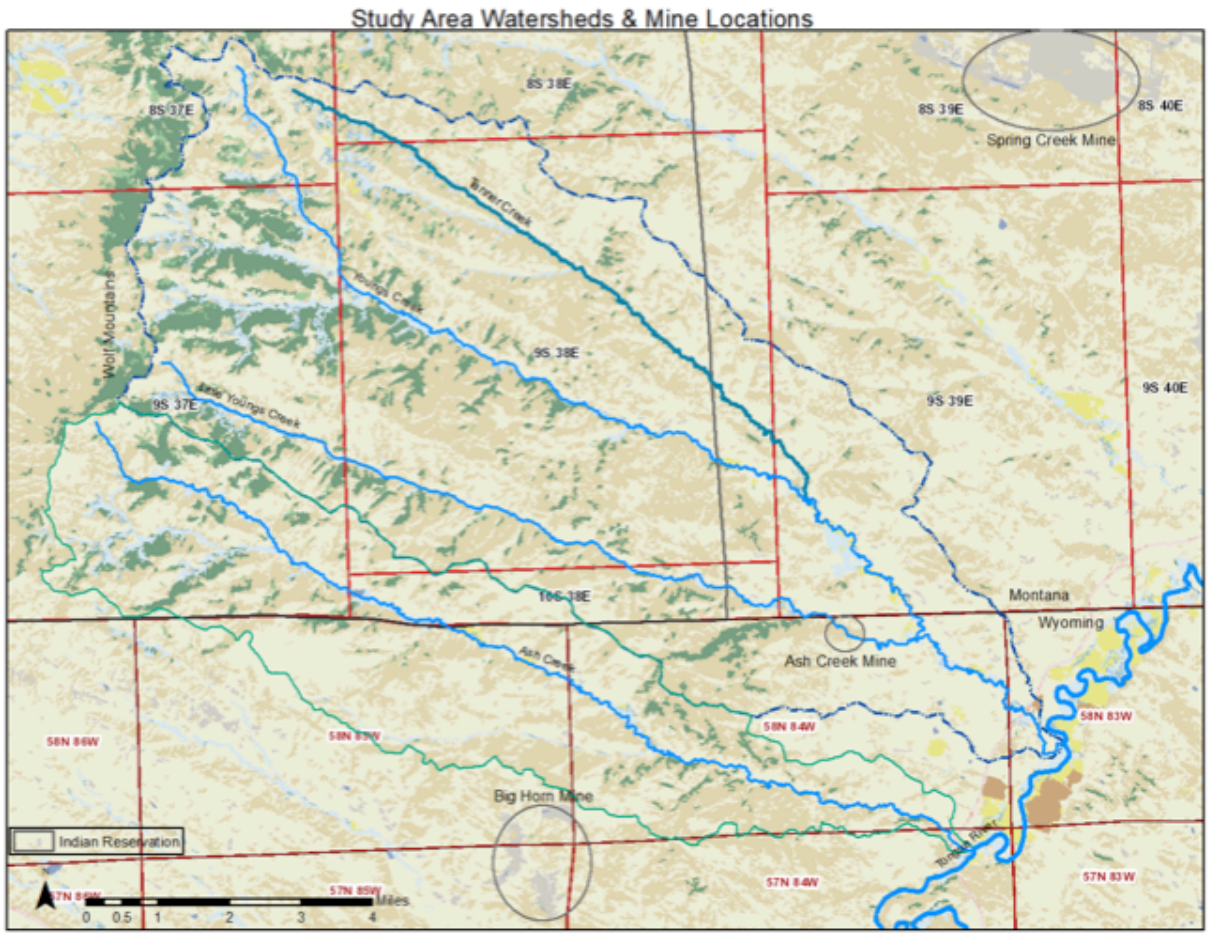

Figure 1.3. Study area watersheds & historical mine locations (indicated with ovals).

Another sampling location was selected at the site of a reclaimed coal mine south of the Ash Creek watershed in the reclaimed Big Horn Mine in Figure 2. The location is referred to as Big Horn Mine at Hidden Water Creek as it is in the drainage area that flows into the Tongue River south of Ash Creek. The site was developed with several coal mine pits across the drainage. There is a pond located in one of the reclaimed pit areas. The standing water was sampled during a period of low flow in September. The pond did not appear to flow into a connecting drainage at the time of low flow.

These sampling locations were accessible in open, unfenced areas where signage is posted regarding the permit designation and reclamation status. The permit and reclamation status can be researched and tied to documentation of land use and water quality data. The samples taken in each watershed are indicated in Figure 6.

Parameters of water quality that will be measured include; cations, anions, total suspended solids, and metals. Cation and anion measurements will detail the geochemical signature of the stream waters. Metals may be used to detail signature of streams prior to development of the watersheds. Total suspended solids will indicate the turbidity of the stream.

Chemical Analysis

Water samples were collected, filtered preserved, and analyzed at Cornell University. Anions were analyzed by ion chromatograph. Dissolved metals were analyzed by ICP inductively coupled plasma mass spectrometry. 23 samples collected in September were sent to a commercial laboratory in Montana to measure total suspended solids and total dissolved solids.

This time period would also coincide with larger surface water runoff in headwaters. During low flow periods, groundwater flow into streams will have a larger impact on the stream flow.

Sodium Adsorption Ratio, SAR

Coal bed methane produced waters are monitored by SAR as the primary indicator for water quality. SAR is described by (Wheaton et al. 2004):

$$\mathrm{SAR} = \frac{\mathrm{Na}}{\sqrt{\frac{(\mathrm{Ca} + \mathrm{Mg})}{2}}}$$

Where Sodium (Na), Calcium (Ca), and Magnesium (Mg) are measured in concentrations of milliequivalents per liter.

Historical SAR levels measured in the Tanner Creek watershed are 0.4 - 0.5 and Youngs Creek 0.1 - 1 during low flow periods (Hedges et al. 1998). Coal bed methane produced water discharges to surface waters are monitored to limit the resultant SAR level of the Tongue River (ARM 17.30.670). SAR limits for the Tongue River are 3 for irrigation season and 5 during the rest of the year (Ibid.). Waters with high SAR levels are limited from land application as salinity may damage soil and crops (Hanson et al 1999). Analysis will focus on the SAR levels of samples as this served as the primary monitoring criteria and limiting factor for produced water discharge in all watersheds.

Density of Wells

The concentration of CBM wells per section or square mile in Montana in the Township 9 South and Range 39 East is outlined in the appendices, which includes the watersheds of Youngs Creek and Little Youngs Creek east of the reservation boundary. There are 3 sections in Montana

within the Youngs Creek drainage where CBM wells had been drilled (Figure 4). The concentration ranges from 1 well per 2.59 km^2 (1 mi^2) to 19 wells per 2.59 km^2 (1 mi^2). There are 25 total wells within the Youngs Creek watershed and one well within the Little Youngs Creek watershed in Montana. There are no coal bed methane wells located within the reservation boundary.

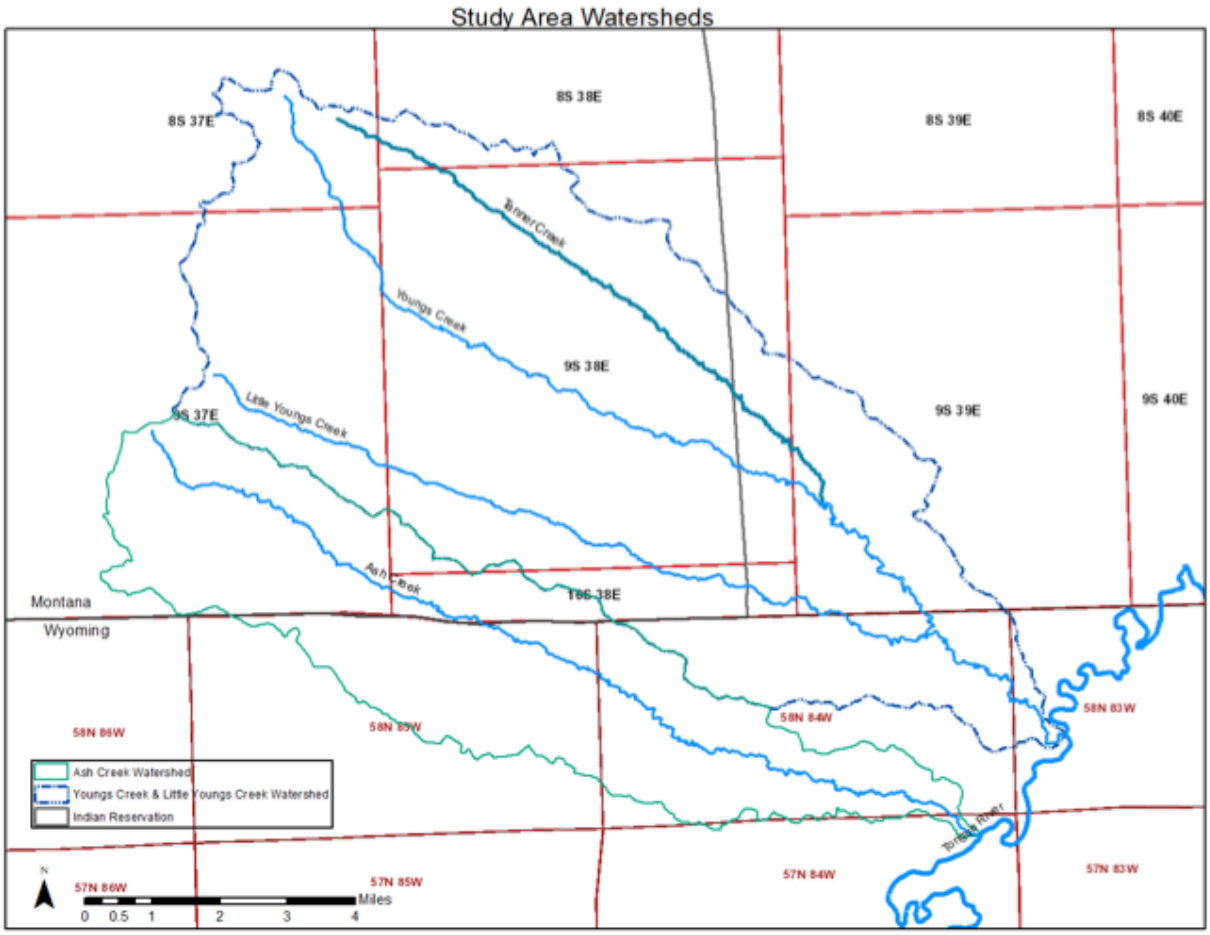

Figure 1.4. Study area watershed townships. Watershed area for the Youngs Creek and tributaries are outlined in townships within Montana and Wyoming.

Coal bed methane well concentration in Wyoming in the Township 58 North and Range 84 West is higher than the sections in Montana (Figure 3). The largest concentration is 24 wells per 2.59 km^2 (1 mi^2) in section 24, which is located in the Youngs Creek drainage (Figure 4). The wells in sections 22, 23, 24, 25, 26, and 27 flow into the Little Youngs Creek and Youngs Creek drainages (Figure 4). Coal bed methane wells are also located in Township 58 North and Range 83 West sections 19 and 30 flow into the downstream end of Youngs Creek drainage (Figure 4). Each section has one well that flows into the Youngs Creek drainage.

There are several CBM wells in sections within the Ash Creek drainage. Sections 35 and 28 have 5 and 2 CBM wells, respectively, that flow into the Ash Creek drainage. Several oil wells are also located along the Ash Creek drainage. The Dry Creek watershed located south of Youngs Creek watershed and north of the downstream end of Ash Creek watershed also has significant coalbed methane well development but does not appear to interact with drainages in either watershed.

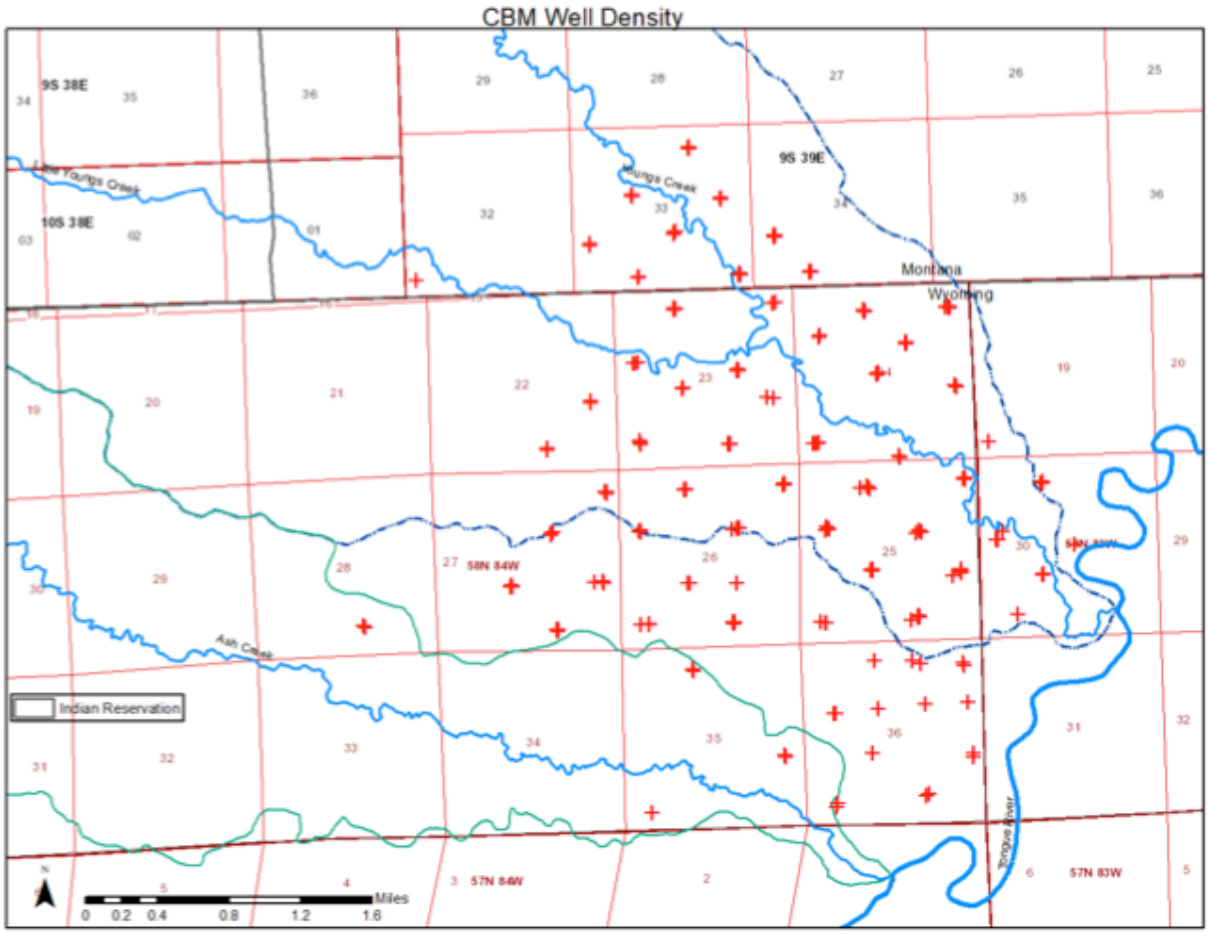

Figure 1.5. CBM well locations. Well (+) density located in each section is presented within Little Youngs Creek, Youngs Creek, and Ash Creek watersheds.

CBM Development

The CBM wells in Montana and Wyoming are developed in clusters, each well targeting different coal bed formations. Wells will be co-located drilled primarily in the Dietz 1-3, Carney, Monarch formations and occasionally King and Roberts formations. Each well developed in separate formation produces varying levels of gas and water. Some formations in co-located wells may not produce gas or water. There are also several dry wells listed in the CBM fields that are not included in this analysis.

The majority of the wells in this area are listed as capped or inactive. Active coal bed methane wells in Wyoming were likely to have discharged produced waters directly into surface water drainages.

Table 1.2. Distance of sampling points to wells.

Sampling Site	Distance to CBM wells
In Montana	
Youngs Creek	2 sample points > 1.6 km from CBM wells
Little Youngs Creek	Sampling points were upstream from CBM well development
In Wyoming	
Youngs Creek	
YC-6	354 m & 370 m from CBM wells
YC-7	209 m, 209 m, 225 m from CBM wells
YC-8	145 m, 158 m, 160 m from CBM wells
Little Youngs Creek	
LYC106	515 m, 515 m from CBM wells
Ash Creek	
AC3	692 m, 692 m from CBM wells
AC107	547 m from CBM well
AC86	434 m., 482 m from CBM wells

Table 1.3. Distance to mine development.

Sampling Site	Distance to Mine
In Montana	
MPDES Outfall	Immediately adjacent to West Decker Mine
In Wyoming	
LYC Culvert	152 m from Ash Creek mine
YC-7	563 m from Ash Creek mine
Hidden Water Pond	Located within the reclaimed Big Horn mine site

RESULTS

The results section will focus on the cation and SAR data, as the criteria were indicators for permitted coal bed methane produced water discharged to stream drainages (ARM 17.30.670). Cation and SAR Values for each watershed are included in the appendices.

Cation Levels

The spring on Tanner Creek had the lowest total measured concentrations of all water samples. It also exhibited the lowest levels of calcium, magnesium, and sodium. The spring had a slight level of sulfate >5 mg/L which can be an indication of being a ground water fed spring. It does have a higher concentration of potassium as compared to other samples (Figure 6). The stock pond did not have sulfate present within the detection limit, which can indicate that it is a surface water fed pond (Hedges et al. 1998). The stock pond also had higher levels of calcium, magnesium and slightly more sodium than the spring above the Tanner Creek watershed.

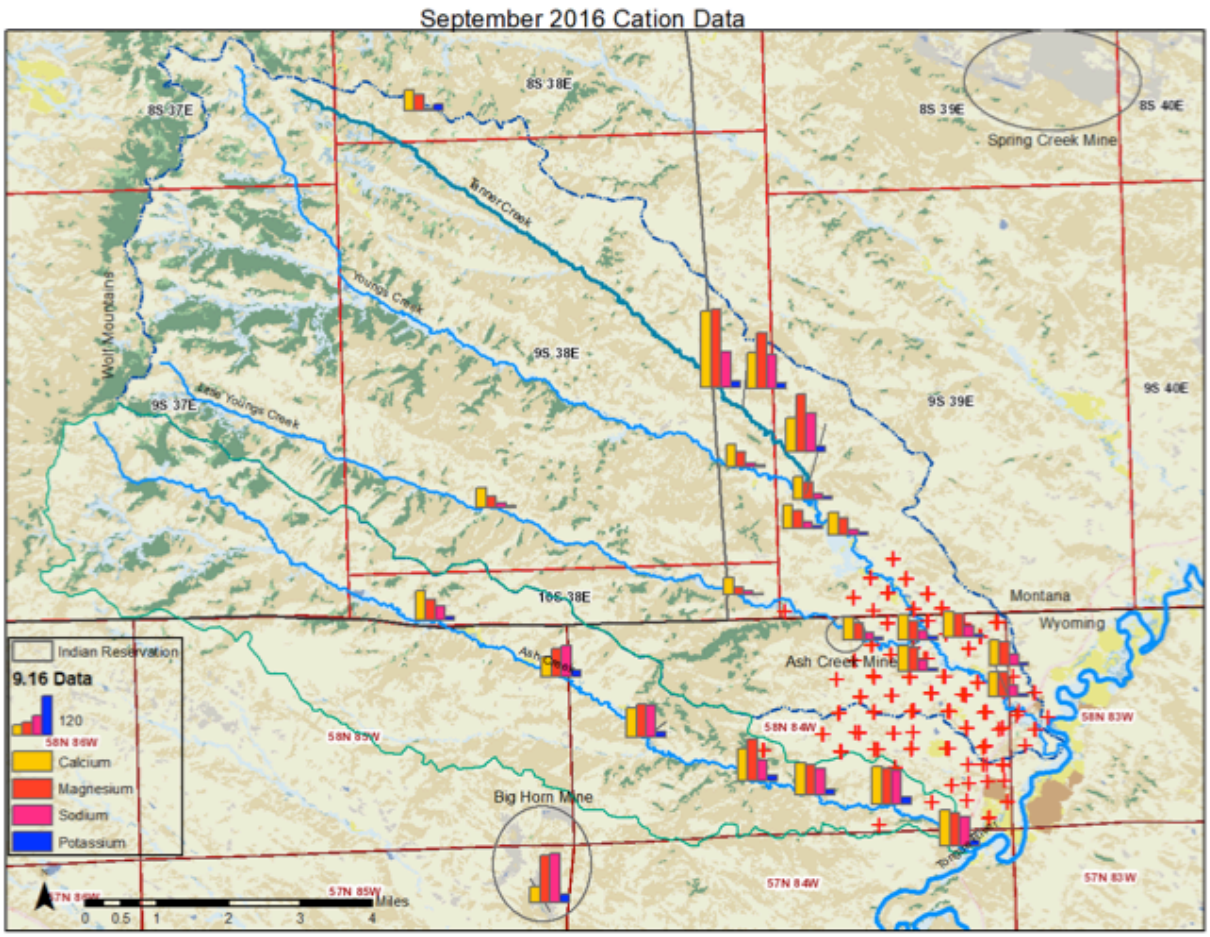

Figure 1.6. September 2016 cation data with CBM wells & mines. Map of watershed study area comparing cations: calcium, magnesium, sodium, & potassium to each cation concentration level in parts per million (ppm).

SAR

The reclamation pond on Hidden Water Creek has elevated levels of sodium, magnesium moderate levels of calcium. Sulfate was not detected in the sample, which would indicate that ground water is not influencing the pond. This sample had the highest SAR level that is consistent with the presence of sodium, calcium, and magnesium. SAR measured concentration levels are indicated in Figure 9.

DISCUSSION

Indications of CBM and Mining Impacts on Water Quality

CBM impacts would have elevated levels of sodium and SAR. Additional contaminants may include potassium, sulfate, bicarbonate, fluoride, ammonia, barium, iron, arsenic, and radionuclides according to the EPA (USEPA 2010). Water quality impacts from CBM development may be transient. As Youngs Creek experienced the most development with the highest concentration of well density and closest distance to wells, the flow rate of the stream is high enough to resist impacts of produced water. The impacts of CBM produced water may have been exhibited at the time of well production but the stream water quality is similar to values recorded in 1977 prior to well pre-development.

Infiltration ponds for CBM wells were shown to impact ground water quality (Healy et al. 2008). Depending on the well sites, infiltration of the produced water may have affected the water table directly below the pond site. The produced water would have elevated SAR levels and would raise the SAR levels in the groundwater.

Ash Creek did not experience the same amount of CBM development, however, the watershed has a higher concentration of oil and gas development. The concentration of oil wells along Ash Creek range from 1 to 7 wells per section (WOGCC 2017). The oil and gas wells are located in formations at greater depths than the coal bed seams. Samples from Ash Creek typically contained elevated chloride levels.

Comparison to MBMG Data:

Changes in Land Use and Water Quality Since 1970s Data Collected

As the sampling points were generally accessible by roadway or more accessible due to natural features of the stream, these locations were also readily accessible to livestock grazing in adjacent pasturelands. In the summer months, livestock, mainly cattle, were found watering at most sampling locations throughout Tanner and Youngs Creeks.

Contaminant levels of Youngs Creek did not appear to differ in Table 4 on from initial levels taken in 1976. The land use activities may have changed the Youngs Creek channel in some downstream areas where irrigation canals run throughout the alluvial valley fed by the creek. These areas appear to be downstream of the confluence of Little Youngs Creek and Youngs Creek and upstream of the mouth of Youngs Creek.

There were 4 sampling sites on Youngs Creek that corresponded with the MBMG 1977 sites. On Little Youngs Creek 3 sampling sites corresponded with the 1977 sites. A paired t-test of sample data indicates a slight decrease in SAR levels particularly in the Youngs Creek sites at p-value of 0.06.

Table 1.4. Paired t-test for 1977 and 2016 data. The mean of difference reported represents 2016 data minus 1977 data values. The data for Ca, Mg, Na, & K are in units of ppm. Abbreviations: standard error (SE), degrees of freedom (df).

	Difference Mean	SE	Df	t-value	p-value
Ca					
Youngs Creek	9.8	2.75	3	3.56	0.0189
Little Youngs Creek	18.9	4.63	2	4.07	0.0277
Mg					
Youngs Creek	-2.3	4.93	3	-0.46	0.3384
Little Youngs Creek	0	7.56	2	0	0.5
Na					
Youngs Creek	-9.1	5.78	3	-1.57	0.1072
Little Youngs Creek	-23.3	23.09	2	-1.01	0.2094
K					
Youngs Creek	-0.2	0.72	3	-0.23	0.4164
Little Youngs Creek	0.2	1.42	2	0.16	0.4438
SAR					
Youngs Creek	-0.2	0.08	3	-2.12	0.0609
Little Youngs Creek	-0.5	0.51	2	-1.04	0.2038

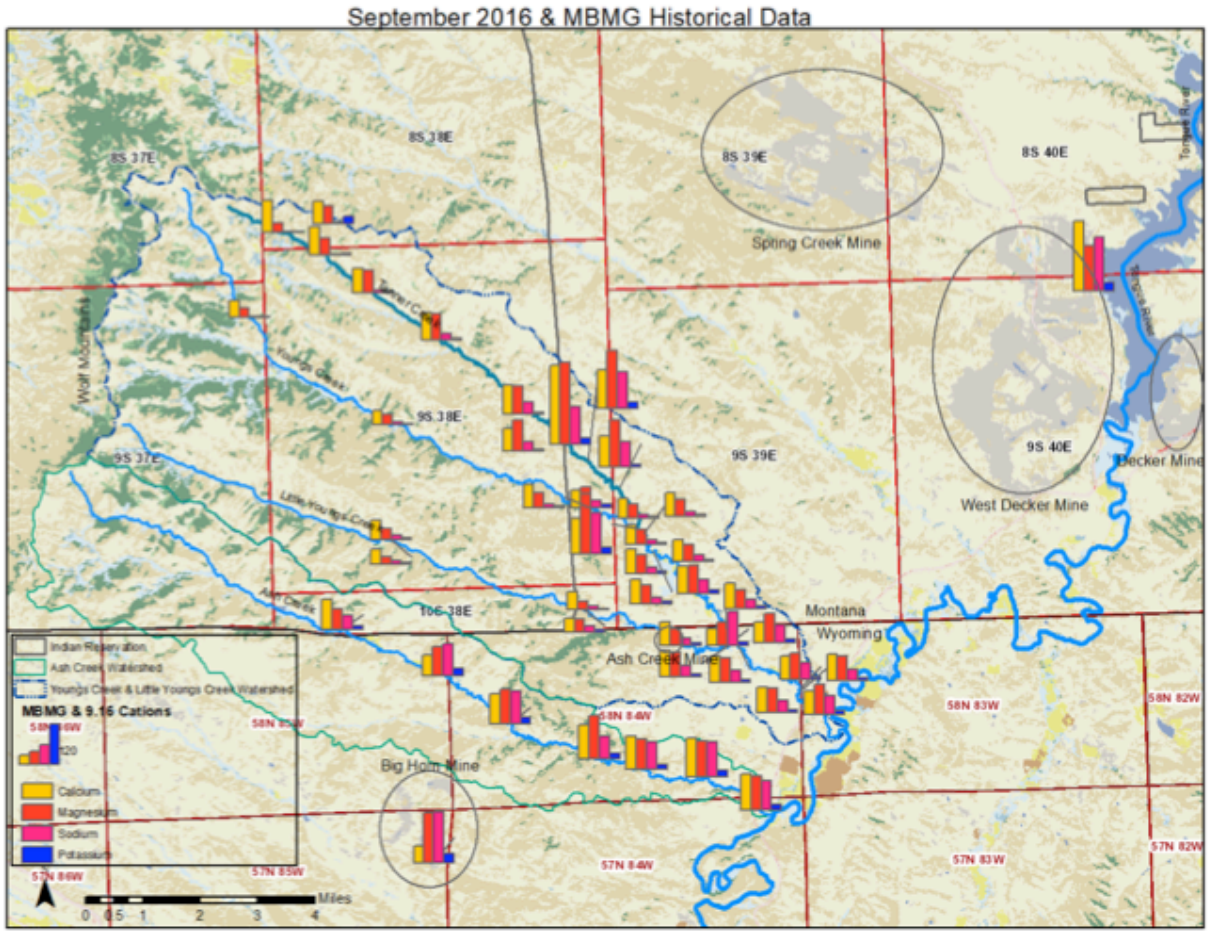

Figure 1.7. September 2016 & MBMG Historical Data. Cation data is shown for all samples and historical data in the watersheds and near mining sites. The legend indicates the symbology of the historical and 2016 data.

The Ash Creek Mine was developed and mined through 1978 within a portion of Little Youngs Creek watershed in Wyoming (Figure 8). The mine was inactive after 1978 and the developed portion of 140 acres was later reclaimed in 1996. The Ash Creek Mine project area was amended to include a larger portion in Wyoming extending south and east to the Ash Creek watershed. The amended project was renamed Youngs Creek Mine and was approved in 2010 by Wyoming agencies including the state of Wyoming Department of Environmental Quality.

The Ash Creek mine site was dewatered beginning in 1976 then was reclaimed and dewatering ceased in 1995 (Meredith et al. 2011). The water produced during the dewatering process was likely discharged to infiltration ponds or to nearby streams which would include Little Youngs Creek. A sample was taken downstream from the mine site on Little Youngs Creek. This sample collected by MBMG exhibited elevated levels of sodium at 103 mg/L and a SAR level of 2.2.

Contaminant and indicator levels appear to be elevated within the Ash Creek drainage downstream of the Montana border into Wyoming. The Montana border is also the boundary of the Crow Reservation in the Ash Creek watershed. The majority of the Ash Creek watershed sampled is within the state of Wyoming. There are operating oil wells along the creek in addition to several now abandoned CBM wells (WOGCC 2017). Background and historical data is limited for the Ash Creek watershed due to the location in Wyoming and lying outside of the study area of Montana agencies and databases. A few USGS data sets from the 1970s may capture effects of the drilling of the oil wells in the watershed. Comparatively, the Ash Creek watershed indicates higher levels of chloride, sodium, and SAR indicators than the Youngs Creek watershed.

Mining Impacts

Water quality impacts from mining development may be more pronounced than that of CBM because mining development requires significant coal seam dewatering. The reclaimed mine spoils will change the character of the saturated groundwater and surface runoff. As seen with the sample from a pond in the reclaimed area of the former Big Horn Mine, the spoils will have

increased SAR. The pond was not connected to a flowing stream, at least not in an obvious way, which would also contribute to the increased level of contaminants found in standing water, i.e., concentration via evaporation. The mine site would be less hydrologically connected to natural groundwater flow paths, therefore, the standing pond water would likely originate from the surface runoff within the site.

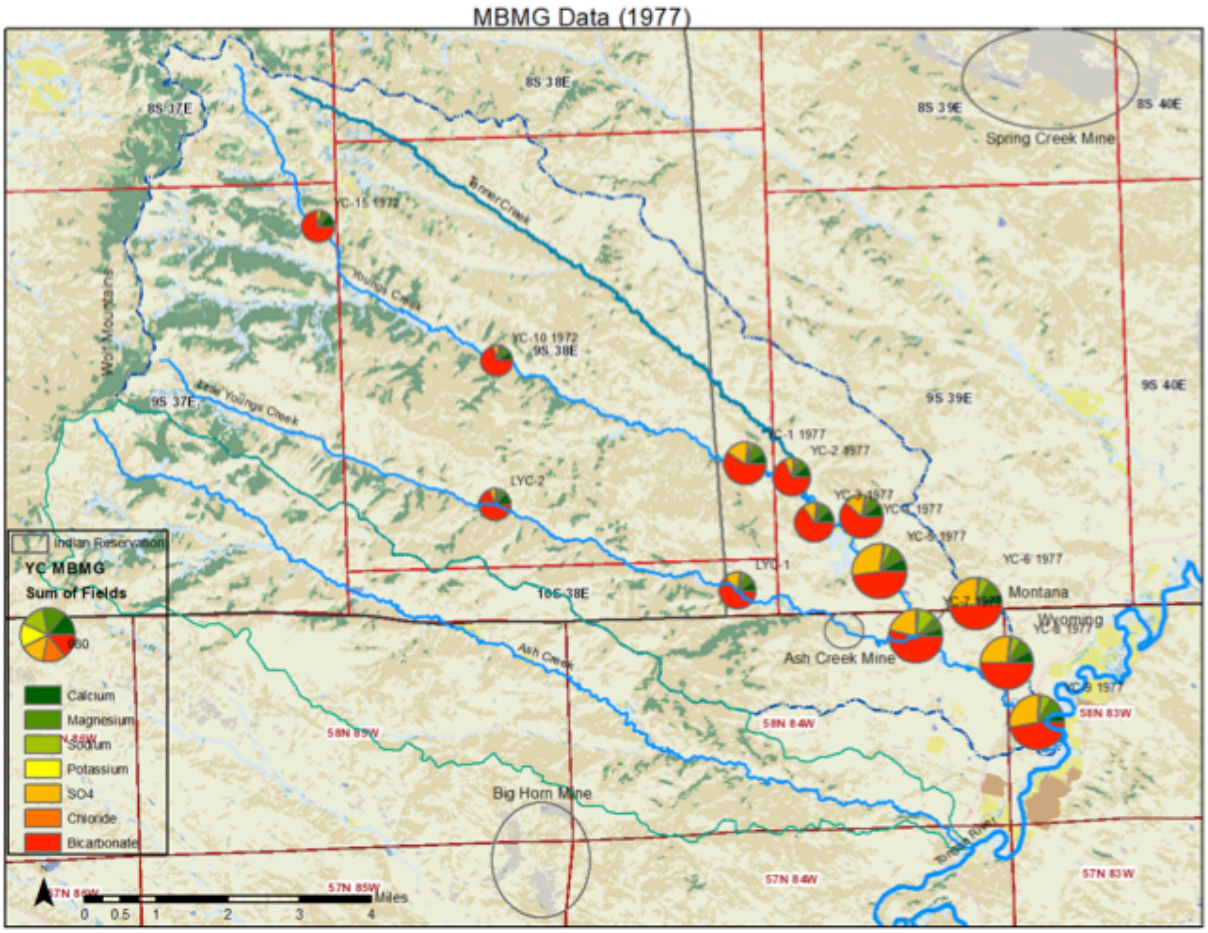

Figure 1.8. MBMG Data & historical mine locations.

The Ash Creek mine site appears to impact the nearby surface water quality on Little Youngs Creek. A MBMG sample from 1977 shows high levels of sodium, sulfate, chloride (Figure 8)

and high SAR value (Figure 9). This sample would have been taken during the operational period of the Ash Creek mine. Samples taken downstream of the reclaimed mine site also show elevated sodium and SAR relative to upstream samples. The mine site has been demonstrated to influence Little Youngs Creek as in stream flow is lost within the reclaimed mine site (Hedges et al. 1998). Coal bed methane wells were not developed in the Ash Creek mine site and few wells in the Little Youngs Creek watershed were located upstream of the sampling point at Little Youngs Creek culvert.

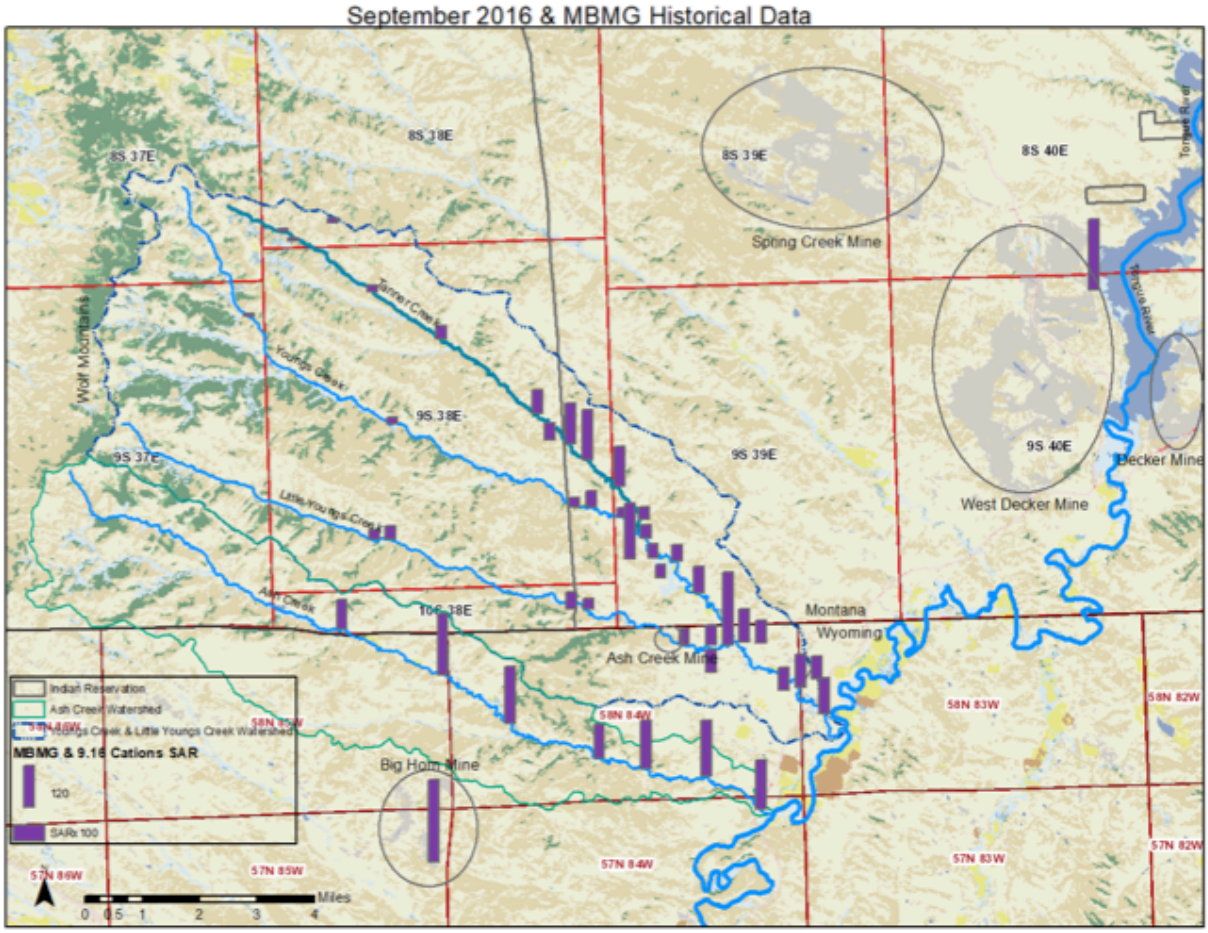

Figure 1.9. September 2016 & MBMBG historical data SAR levels. Maps with labeled collection sites are included in the appendices.

The sample originating from the Decker Mine site also demonstrated an elevated SAR level, the water was likely sourced from dewatering of the coal seam aquifer in an attempt to drawdown the groundwater table. The mine site in the area had not yet been reclaimed and would require continuous dewatering as the nearby Tongue River reservoir would elevate the groundwater table. The outfall fed directly into the Tongue River reservoir. Although the water had elevated SAR levels of 2.1 discharged to the reservoir was within SAR permit levels and below the CBM contaminant limit for SAR levels permitted by the Montana Department of Environmental Quality.

Factors Contributing to Elevated Indicator/Contaminant Levels

Variation in Climate/Precipitation

Water samples were collected in April, June, and September. The September sample collection was scheduled to coincide with the 1977 MBMG study during the watershed low flow period. The majority of the upper Tanner Creek watershed was found to be dry during this sample time with stream flow found at the lowest reach of the creek. There were a few bends in the creek with standing water in the lower most 3.2 km (2 mi) of the creek above the confluence with Youngs Creek. Youngs Creek was flowing through the entire stream length. Little Youngs Creek and Ash Creek were also flowing in the most upstream sampling sites to the downstream confluence sites. The water was sampled during a low flow period in September when runoff would be at minimal levels. The low flow rate would lead to higher expected overall total dissolved solids with less flow contribution from surface water that exhibits lower total dissolved solids.

Drawdown of Groundwater Aquifers

Several coal mines in the region have been shown to draw down water levels in coal seam aquifers (Van Voast et al. 1988). Coal bed methane development significantly decreased water levels in coal seam aquifers that were dewatered for methane production. The amounts of produced water drawn from coal seam aquifers in the study area will be detailed in Chapter 2.

Land Area Impacted by Mine

The total acreage of each watershed that would be impacted by mine development will be detailed. The entire Tanner Creek watershed would be impacted upstream of the reservation boundary. The Youngs Creek watershed would be altered within the Upper Youngs Creek boundary, a few miles upstream of the reservation boundary as detailed in Figure 2. Depending on the extent of the disturbance on the ridge between Tanner Creek and Youngs Creek, the watershed along Youngs Creek will be impacted up past the headwater boundary of Tanner Creek. The greatest disturbance to actual surface land will be most apparent in the Tanner Creek watershed.

The drainage from backfilled mine spoils in the headwater areas would alter the stream flow from current dominance of typical surface fed flows of calcium-bicarbonate to elevated TDS levels with increases in sodium, bicarbonate, and sulfate (Davis et al. 1986). This change would be exhibited in surface water runoff. Groundwater changes in the alluvium would also be

affected by the higher TDS and increased cation concentration. The alluvium in Tanner Creek would be completely altered throughout nearly the entire stream length upstream from the reservation border. The permeability of the alluvium would also be affected and would take the characteristics of the spoils aquifer. The runoff volume from surface water would be expected to increase due to less vegetation and decreased infiltration or percolation of the saturated spoils soil. The topology would also have more uniform slopes with decreased impediments to flow than the natural rugged landscape. This would lead to increased volumes of surface water runoff from the reclaimed watersheds in Tanner Creek and Youngs Creek. As mine spoil samples were limited, surface water in reclaimed sites should be further studied to determine resulting water quality.

CONCLUSIONS

Reclaimed mining sites may have lasting impacts on the nearby surface water quality in the study area. Historical and current samples have demonstrated elevated contaminant levels downstream of the Ash Creek Mine in the Little Youngs Creek watershed. A sample from a pond in the former Big Horn Mine reclaimed site contained the most elevated SAR levels of all surface water samples. Coal bed methane development impacts may have been transient in the Youngs Creek surface water based on sample results. Historical oil and gas development appears to be impacting surface water quality within the Ash Creek watershed.

APPENDIX

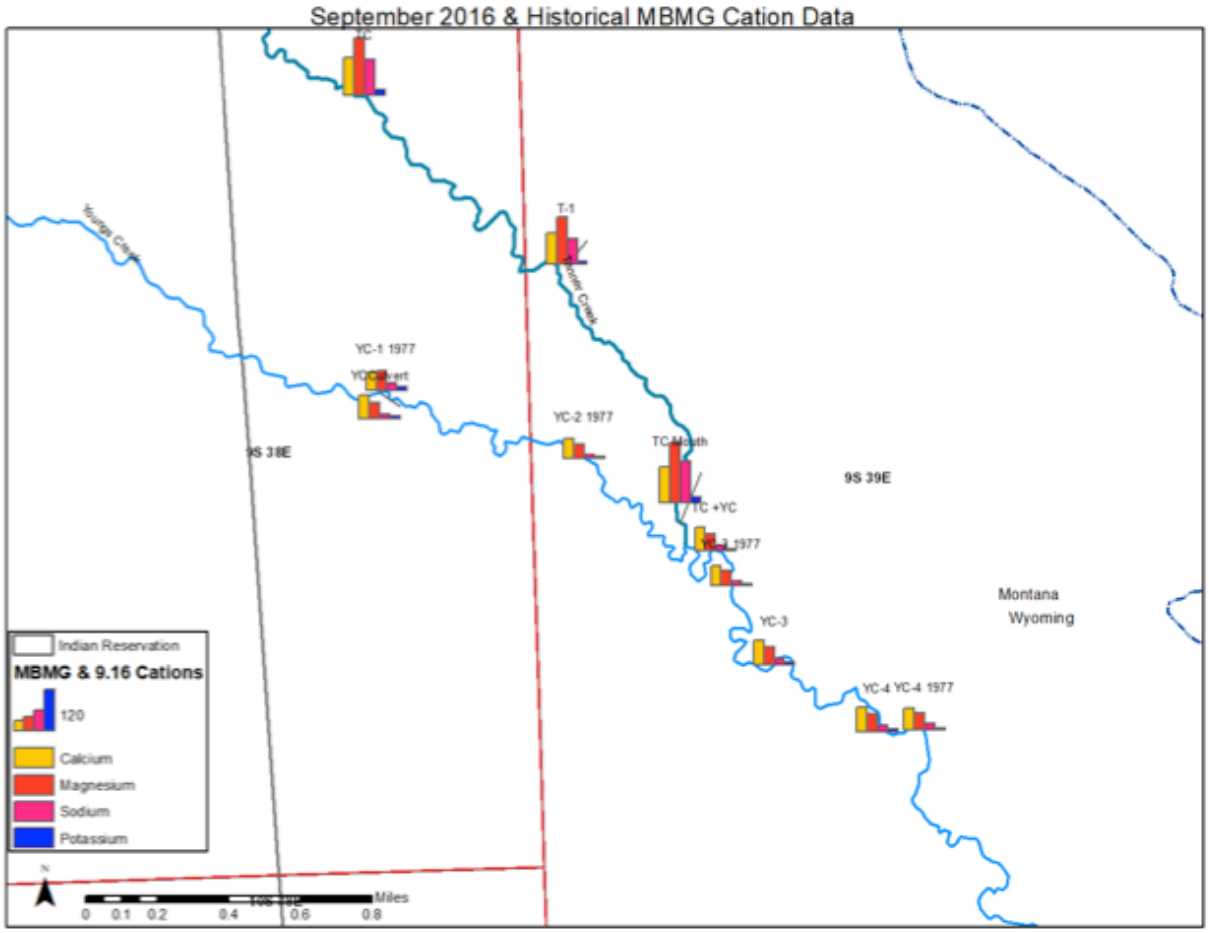

Figure 1.10. Cation data from September 2016 compared to historical data in Youngs Creek & Tanner Creek.

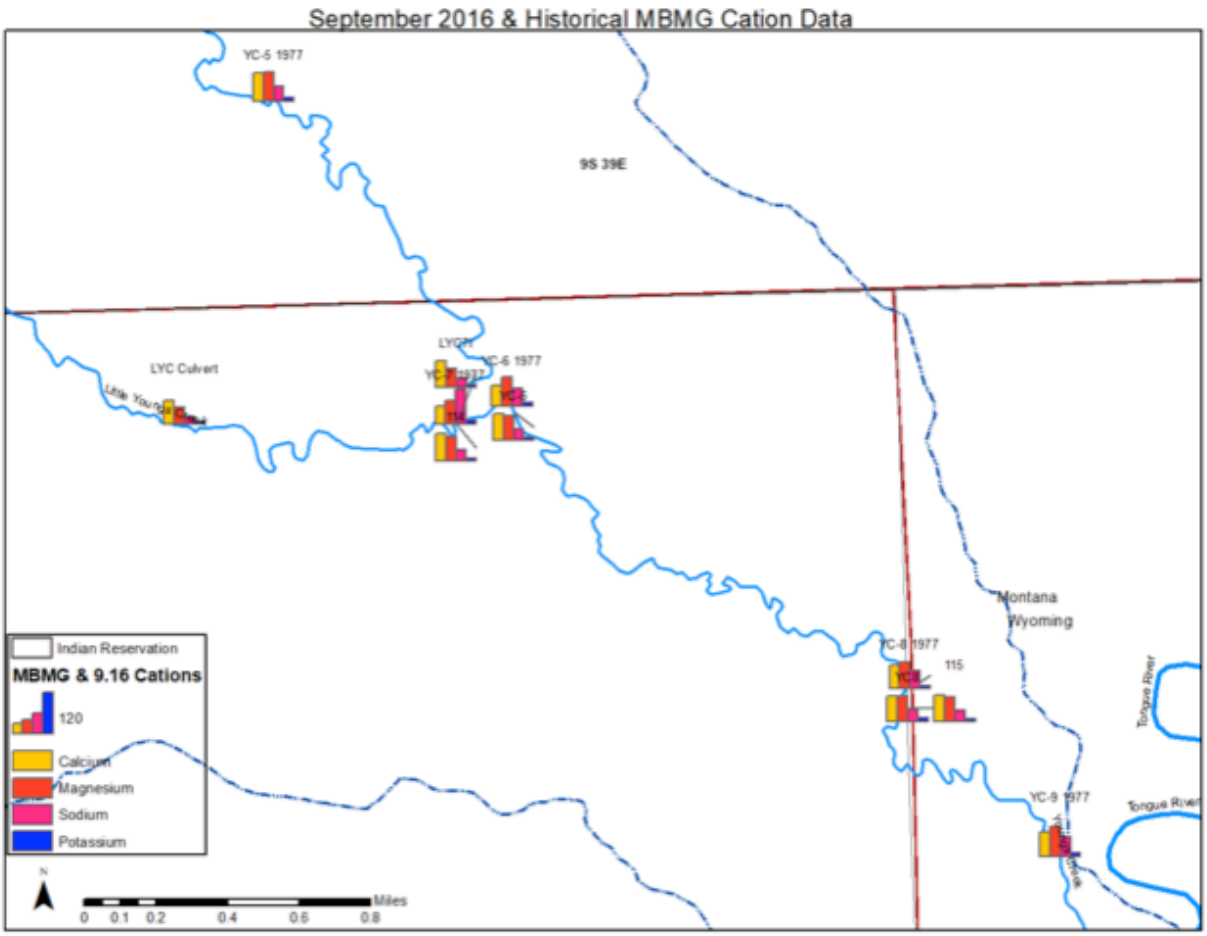

Figure 1.11. Cation data from September 2016 compared to historical data in Youngs Creek & Little Youngs Creek.

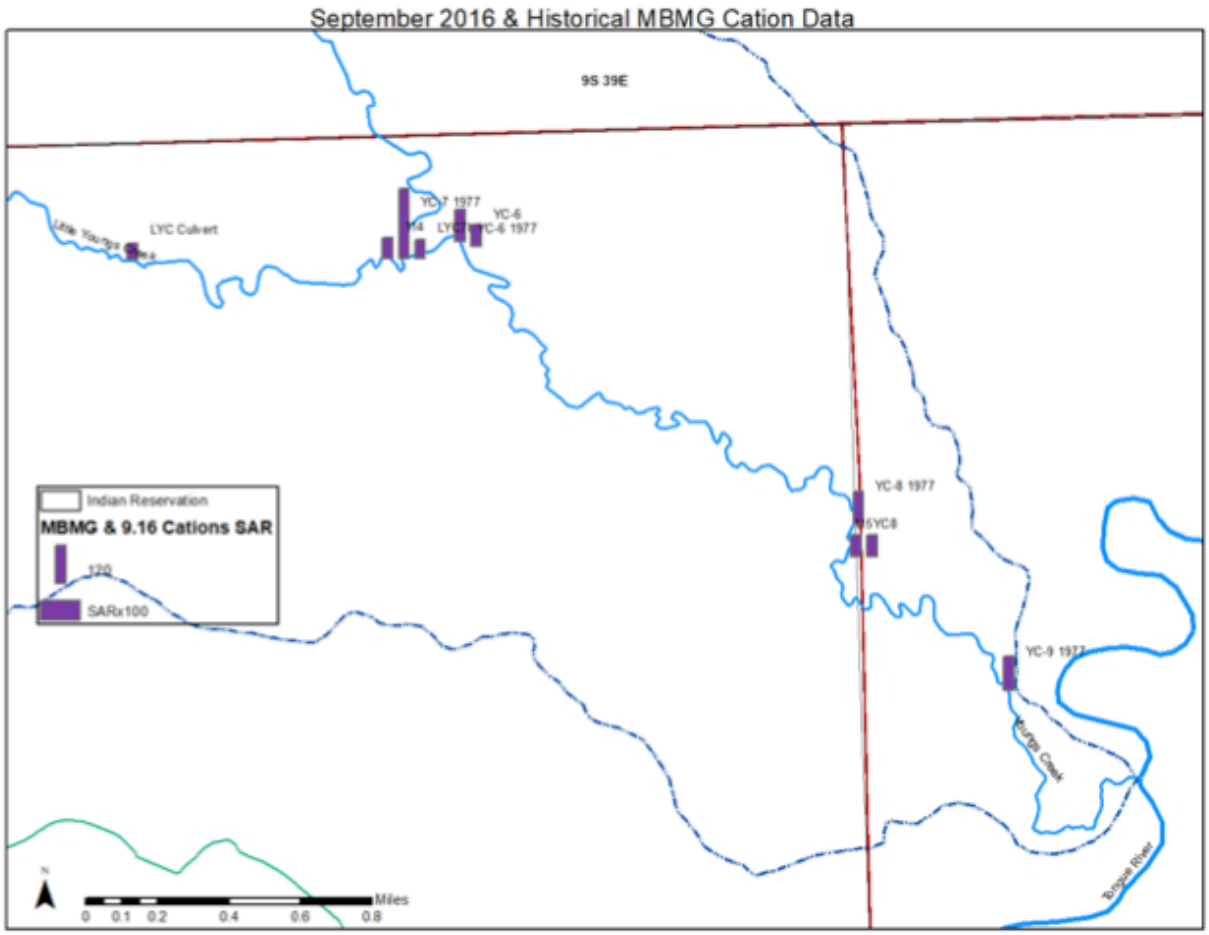

Figure 1.12. SAR levels from September 2016 compared to historical data in Youngs Creek & Little Youngs Creek.

Table 1.5. Characterization of sampling points.

Watershed Area
Elevation
State: MT/WY
Density of Wells in Watershed
Ownership
Tribal, Fee, State, Federal
(Land Use)

Watershed Area

Youngs Creek represents the largest watershed area, with points downstream of Little Youngs Creek having the largest tributary areas. Tanner Creek would represent the smallest tributary area.

The watershed is disconnected from the Wolf Mountains and is surrounded by Upper Youngs Creek and Squirrel Creek. As a result, the watershed has the lowest precipitation and runoff of all the creeks in the study area.

Little Youngs Creek and Ash Creek both have headwaters located in the Wolf Mountains and slightly higher annual precipitation and runoff. Watersheds with headwaters originating in the mountains generally have larger annual precipitation.

Table 1.6. Elevation range of watersheds.

Watershed	Elevation
Tanner Creek	4864 – 3743 ft
Youngs Creek	4349 – 3559 ft
Little Youngs Creek	4171 – 3624 ft
Ash Creek	4143 – 3548 ft

Montana

Sampling points upstream of the reservation boundary are not located near energy development. A few sampling points on Youngs Creek north of the state border are near coal bed methane wells, however, all points are upstream of wells.

Wyoming

All of the sampling points in Wyoming are located downstream of some form of energy development. The Little Youngs Creek watershed, there is past coal mine development and coal

bed methane wells. Youngs Creek sampling points are downstream of prior coal bed methane well development. Ash Creek watershed sampling points are downstream of oil and gas and coal bed methane well development.

Ownership (West of Reservation Boundary)

Tanner Creek has the largest tribal ownership with approximately 70 percent tribal land interests in the potential mine area (Figure 5).

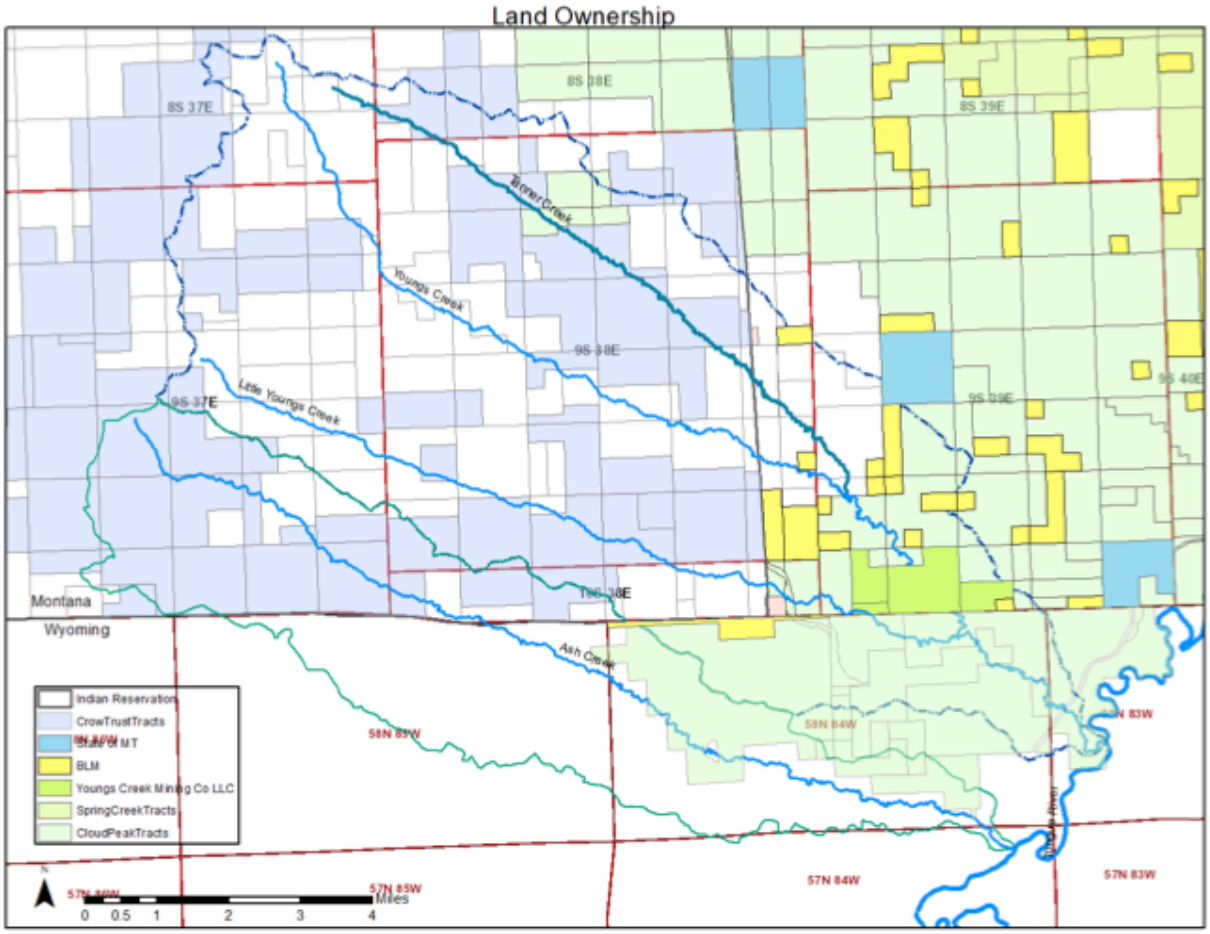

Figure 1.13. Land ownership in study area watersheds. The land tracts represent tax parcels and allotments.

Youngs Creek is primarily fee land ownership throughout the watershed. The ownership of tribal lands within the watershed is approximately 40% (Figure A4).

The Little Youngs Creek watershed is approximately 60 percent fee land ownership and 40 percent tribal ownership. The Youngs Creek Mine project area contains the majority of the Little Youngs Creek watershed in Wyoming. Within the project area, Chevron has leased or sold its

surface land title to Cloud Peak. Fee lands held by private owners comprise the remaining land ownership of the watershed.

The Ash Creek watershed north of the Montana state line is primarily under tribal ownership. The Ash Creek watershed in Wyoming is entirely fee land. Land ownership throughout the entire watersheds east and south of the reservation is detailed in Chapter 2.

Table 1.7. Youngs Creek and Little Youngs Creek water quality results.

	Youngs Creek No. Samples 7	Little Youngs Creek No. Samples 5
Sodium	12 - 36 mg/L	12 - 34 mg/L
Chloride	2 - 3 mg/L	2 - 3 mg/L
SAR	0.28 - 0.69	0.34 - 0.66
Magnesium	47 - 74 mg/L	25 - 73 mg/L
Potassium	6 - 9 mg/L	5 - 9 mg/L
Calcium	70 - 80 mg/L	54 - 80 mg/L
Arsenic	0.006 - 0.011 ppm	0.003 - 0.012 ppm
Barium	0.088 - 0.116 ppm	0.068 - 0.112 ppm
Boron	0.075 - 0.156 ppm	0.053 - 0.163 ppm
Iron	0.002 - 0.029 ppm	0 - 0.018 ppm
Date Sampled	9/2016	9/2016

Table 1.8. Tanner Creek and Ash Creek water quality results.

	Tanner Creek No. Samples 3	Ash Creek No. Samples 8
Sodium	109 - 123 mg/L	45 - 105 mg/L
Chloride	7 - 13 mg/L	3 - 45 mg/L
SAR	1.21 - 1.68	0.49 - 1.84
Magnesium	175 - 245 mg/L	52 - 129 mg/L
Potassium	18 - 21 mg/L	8 - 21 mg/L
Calcium	109 - 238 mg/L	62 - 117 mg/L
Arsenic	0.007 - 0.01 ppm	0.002 - 0.011 ppm
Barium	0.028 -0.142 ppm	0.014 - 0.15 ppm
Boron	0.234 - 0.382 ppm	0.136 - 0.429 ppm
Iron	0.034 - 0.255 ppm	0 - 0.016 ppm
Date Sampled	9/2016	9/2016

Table 1.9. Reclaimed and developed sites water quality results.

Developed Sites	Hidden Water Creek Big Horn Mine – Reclaimed	MPDES Outfall West Decker Mine
Sodium	154 mg/L	159 mg/L
Chloride	21 mg/L	20 mg/L
SAR	2.47	2.1
Magnesium	149 mg/L	136 mg/L
Potassium	29 mg/L	24 mg/L
Calcium	52 mg/L	209 mg/L
Arsenic	0.16 ppm	0.005 ppm
Barium	0.039 ppm	0.048 ppm
Boron	0.227 ppm	0.466 ppm
Iron	0.009 ppm	0
Date Sampled	9/2016	4/2016

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CHAPTER 2

WATER RIGHTS AND COAL BED METHANE PRODUCED WATER MANAGEMENT IN THE YOUNGS CREEK WATERSHED

ABSTRACT

This chapter will examine the water rights policy in the State of Montana and State of Wyoming under natural resource extraction in the Youngs Creek watershed. The states operate under differing water right and environmental policy regimes. The study area is located in the Youngs Creek watershed that is located in both states. The study area is the same location as outlined in Chapter 1 but will not include the Ash Creek watershed.

The water right and environmental policy analysis will focus on Youngs Creek, a tributary stream of the Tongue River. The mouth of Youngs Creek on the Tongue River is located in Wyoming that then flows into Montana. The two states have been battling over water flow allocation and water quality on this river. Downstream users in Montana had expressed concern about the water quality from streams flowing into Montana from the Powder River Basin in Wyoming, including the Tongue River. The Powder River Basin located in both states had seen rapid coal bed methane production in the first decade of 2000. Other downstream users on the Tongue River include the Northern Cheyenne Tribe, irrigation water users associations, and private landholders with water rights that have contested Wyoming environmental policies.

Policies governing the management of produced water in Wyoming and Montana will be outlined. Land and mineral rights owners in each state will be compared. Finally, water rights holders in impacted areas and potential mineral development areas will be discussed. The watershed has experienced coal bed methane and coalmine development. Several permitted and proposed mine developments within the Youngs Creek watershed may cumulatively impact the hydrologic balance of the watershed.

The amounts of produced water from coal bed methane wells in the Youngs Creek watershed will be detailed. This amount of water will be compared to the allocation of water rights holders in both states. Additionally, the amount of produced water will be compared to historical flows of Youngs Creek.

Due to the surface water scarcity and prior appropriation regimes, all natural resource activity will depend on the use or extraction of groundwater. Groundwater permitting or use is granted for the time period the water will be in use for mining or oil and gas activity. Impacts to downstream water users may prove to be cumulative in terms of reduced water quality and quantity.

INTRODUCTION

Water Rights in Montana

The State of Montana observes the prior appropriation of water rights within state waterways. The prior appropriation doctrine applies to both state surface and groundwater sources (Irwin v. Phillips; Coffin v. Left Hand). The State of Montana grants water rights on fee lands within the state and will also grant water rights on fee lands within the reservation.

Surface water rights along Youngs Creek consist primarily of irrigation and stock water. Irrigation allocations depend on the stated irrigation method and historical irrigated acreage associated with the allocation. Surface water may be cited as a source for stock ponds throughout the watershed.

Within the Youngs Creek and Tanner Creek watershed, water rights are based on the point of diversion, or source, and the place of use. Several surface water rights have differing sources and places of use locations. The differing locations are both generally within an adjoining stretch of the Youngs Creek watershed. The oldest surface water rights within the Youngs Creek basin outside the Crow Indian reservation were issued in October 12, 1894 and the newest are dated July 31, 1944 (MTDNRC 2017).

A stock surface water right consists of livestock drinking directly from the surface water source in a specified location. The guideline allowance is 30 gallons per day per animal unit. An animal unit is generally defined as a cow and calf pair. The number of animals using the water rights

should be within a reasonable carrying capacity for the land and within historical use of the water right. Livestock water rights are also granted from groundwater sources with the allowance of 30 gallons per day per animal unit based on reasonable carrying capacity and historical use. Stock water rights appropriation dates range from 1894 to 1915 from surface water.

Groundwater rights consist of stock and domestic use rights. Stock water rights vary from 10 gallons per minute, gpm, to 35 gpm flow rates from groundwater sources throughout the Youngs Creek basin in Montana. Water rights for domestic well water supplies consist of sources from groundwater aquifers and naturally occurring springs. Groundwater rights throughout the basin generally have more recent appropriation dates than surface water rights. Domestic water rights were appropriated in 1930. Stock water rights from groundwater range from 1930 to 1973.

State Permitted Users

Several water rights located on the reservation in the Youngs Creek claim Walton rights with the priority date of 1868. Walton rights owners gain reserved tribal water rights in purchasing allotted tribal lands. Walton rights will be further detailed in Chapter 3. The water right also states the water right is not included in the reserved right of the Crow compact. Priority dates for these water rights are often at the earliest dates listed in the watershed, in this case May 7, 1868. This is effectively the date of the Crow Tribe's signing of the 1868 treaty at Fort Laramie (15 Stats., 649., 1868). Several fee landowners within the reservation boundary have surface water rights along Youngs Creek in the reservation boundary. Fee landowners have claimed many

springs on the reservation within the Youngs Creek and Tanner Creek watersheds for domestic and stock water rights.

After the Water Compact between the Crow Tribe and the State of Montana, all watershed basins on tribal lands were designated as closed (MCA 85-20-901). The closing of basins in Montana has occurred throughout many watersheds in the region that prevents additional water rights claims issued from the State of Montana.

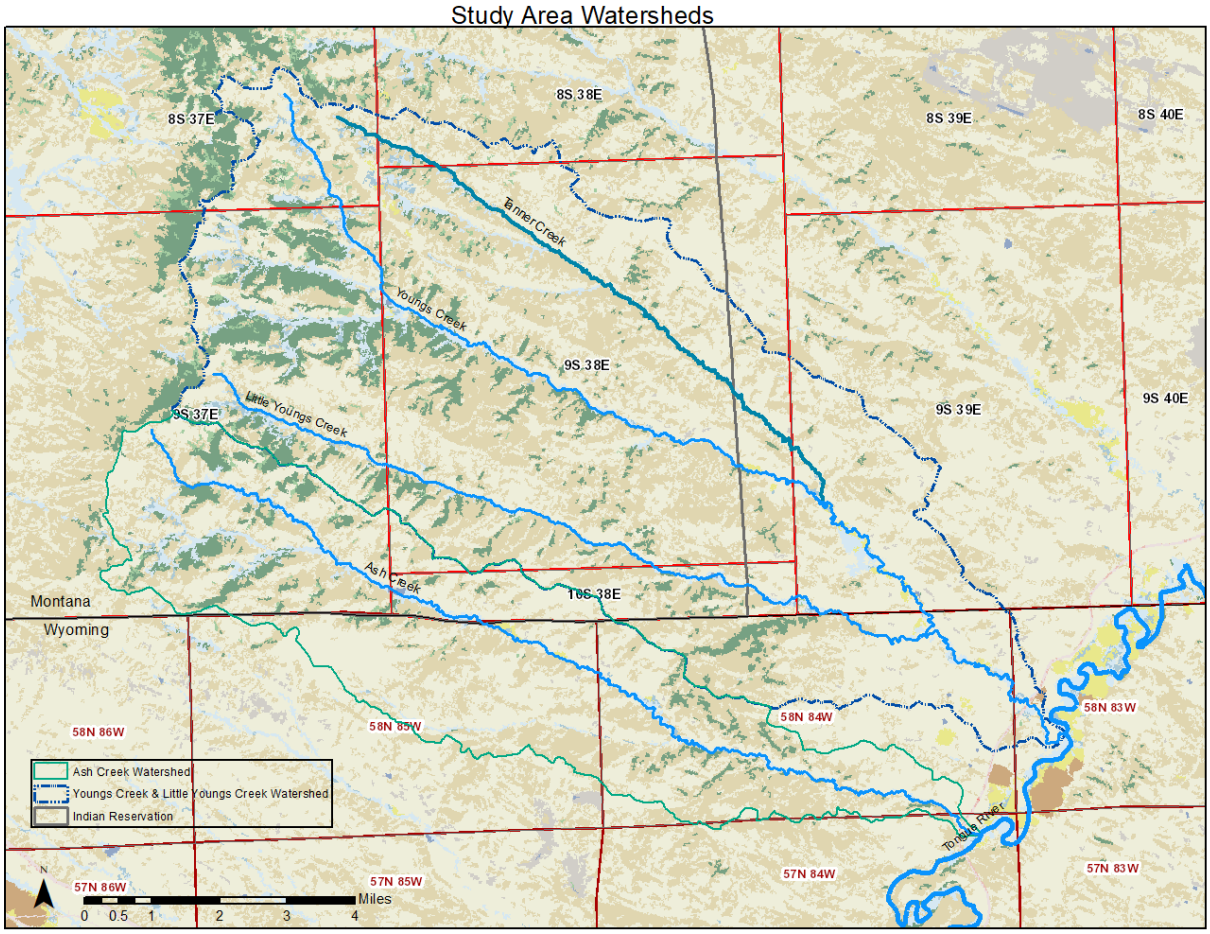

Figure 2.1. Study area watersheds in Montana and Wyoming.

Water Rights in Wyoming

The State of Wyoming also observes the prior appropriation doctrine of water rights in state waterways. Fee land owners maintain all water rights in the watersheds located in Wyoming within the study area. Surface water rights within the Youngs Creek watershed within Wyoming have been allocated primarily from irrigation ditches. Youngs Creek surface water rights priority dates range from 1884 to 1917 (WYSEO 2017). On Little Youngs Creek, water rights priority dates range from 1898 to 1915. Surface water may be cited as a source for stock ponds throughout the watershed. Groundwater rights in Wyoming are primarily tied to domestic water supplies. Stock water or active irrigation water rights sourced from groundwater were not listed in the Youngs Creek watershed study area within Wyoming.

Surface water rights conveyed through irrigation ditch systems are sourced from the Little Youngs Creek and Youngs Creek in Wyoming in Township 58 North 84 West Sections 22, 23, 24, and 25. The surface water rights holders in these sections are primarily private landowners. The Chevron company owns a few surface water rights in sections 24 and 25 in the Glade Water and Peoples ditches, with priority dates of 1909 and 1917, respectively.

Yellowstone River Compact

The States of Montana and Wyoming, along with North Dakota, entered into the Yellowstone River Compact of 1950 (MRC 89-903) to govern the water allocations from rivers flowing into the Yellowstone River watershed in Montana originating in Wyoming. This compact agreement

includes the watersheds of the Tongue, Powder, Clarks Fork and Big Horn Rivers from their headwaters in Wyoming to their confluence with the Yellowstone River. The watershed area includes the entire land bases of the Crow and Northern Cheyenne reservations. The States of Montana and Wyoming must jointly administer water allocations for all the watersheds according to compact terms.

The two states have been contesting water allocations for each state within the Tongue and Powder River watersheds. Coal bed methane activity in Wyoming resulted in the depletion of watershed flows in the Tongue and Powder River basins where the highest concentration of well development has occurred. Under the compact, Montana is to receive the majority of the flow, over 58 percent, of the Powder and Tongue rivers. In 2007, the State of Montana sued the State of Wyoming, Montana v. Wyoming, on the basis that Wyoming was extracting more than its allocation of water and depleting the flows of the Tongue and Powder Rivers entering Montana. A Supreme Court appointed special master determined that Wyoming was in violation of the compact in pumping excessive groundwater to the detriment of surface flows entering into Montana rivers. The ruling held although groundwater was not addressed in the original compact.

Montana CBM Regulation

The federal government owns significant mineral rights within the Powder River Basin that have been developed for coal bed methane recovery. The Bureau of Land Management Application for Permit to Drill in Montana requires a drilling plan, surface use plan, bond and surety information, certification of lease and a cultural report (USBLM 2003b). A water management

plan for produced water during the testing and production of the well is required as part of the surface use plan. Water mitigation agreements must be made with groundwater users that may be potentially affected by coal bed methane development. A cultural resources plan must be developed in compliance with the National Historic Preservation Act on federal coal bed methane projects. A cultural resource inventory must be conducted for the proposed project area when federal and tribal mineral resources will be developed.

Montana Code Annotated CBM

The coal bed methane well developer must receive a permit to discharge water according to the Montana Code Annotated (MCA) Title 75, chapter 5. The Montana Department of Environmental Quality will issue the permits. Since 2010, the State of Montana has not allowed the direct discharge of produced water into drainages. The produced water discharged to waterways must be treated to reduce sodium adsorption ratio, SAR, levels.

Contaminant levels are primarily monitored based on the measurable SAR levels of the Tongue River. As the Tongue River flows from Wyoming into Montana, the water quality levels are monitored at the state boundary. Well operators in both states are responsible for maintaining water quality levels in the Tongue River.

A typical coal bed methane lease would be for a group of collocated wells placed according to spacing permits. Well production levels must be reported to the Montana Oil and Gas Commission and well logs submitted to the Montana Bureau of Mines and Geology.

Spacing Units

Well development projects would be permitted according to well spacing requirements. In Montana and Wyoming, wells are spaced on 80-acre units. (USBLM 2003b.) Wells would be developed in collocated units. The collocated wells typically target separate coal bed aquifers from the same well pad. The spacing unit placement facilitates coal bed dewatering and depressurizes the aquifer hydraulic head thereby increasing the release of methane gas from the seam. The spacing of wells was implemented to limit extent of land surface damage from high-density well developments.

Water users are protected based on the proximity of their water diversion or points of usage to well development. Damages to appropriation rights holders from coal bed methane development are available only in the case where the water diversion is located within a mile of the wells. The diversion point is described as the point where the water is used or put into production. If a region has been shown to be impacted within half a mile of a specific coal bed methane well, the radius for assessing damages will be extended to one mile (MCA 82-11-175).

Beneficial Use

Beneficial use is defined as surface or groundwater used for agricultural, industrial, irrigation, mining, municipal, power, stock, or domestic, fish and wildlife, and recreational uses (MCA 85-2-102).

A beneficial use permit is not required for a coal bed methane well due to the regulation exemption of the produced water generated, as it is not a desired product. However, a permit is required to put the produced water to a beneficial use. The beneficial uses cited for the coal bed methane produced water in the Youngs Creek basin were for livestock watering and irrigation.

Montana Coal Bed Methane Produced Water General Permit

In order for an applicant to receive produced waters, the landowner must state in a beneficial use letter that the produced water will be used for wildlife or livestock watering. The applicant must submit a water management plan and water quality data for the produced water. The water quality data will be from a representative sample taken from a similar well within a 20-mile radius at the same formation and relative depth. The water quality of the sample must not exceed effluent limits set by the Montana Department of Environmental Quality, MT DEQ. These limits include total dissolved solids, TDS, level of 2500 parts per million and sodium level of 800 milligrams per liter (MCA 75-5).

Well operators in Montana had received permits for the discharge of produced water to surface drainages. The MT DEQ issued the permits as Montana Pollutant Discharge Elimination system,

MPDES, permits. All wells within a lease were included in the same MPDES permit. State law requires that all discharges from an outfall must be authorized under a MPDES permit.

Impoundments

According to MT DEQ MPDES general permit (ARM 17.30.670) terms, produced water is to be held in impoundment ponds for "prescribed beneficial use" and discharge will only be allowed by a letter of authorization. Permits were granted for a period of five years. The permit established self-monitoring effluent limits for total dissolved solids, TDS, selenium, pH, and oil and grease. The monitoring activities were to occur semiannually. The discharging source and the impoundments would both be subject to the monitoring requirements. Additional monitoring requirements for impoundment ponds include bicarbonate, calcium, magnesium, potassium, chloride, nitrate, sodium, sulfate, radium 226, 228, radon 222, arsenic, barium, iron, lead, beryllium, and SAR.

The impoundment pond must be able to contain precipitation from a 25-year, 24-hour rainfall event. Discharges from the impoundment pond will only be allowed, should precipitation exceed this rainfall event causing the pond to overflow. The impoundments must be located at a site where the depth of the groundwater table from the surface is over 50 feet. Impoundments on BLM surface lands are to be located at least 0.25 mile from riparian and wetlands. (USBLM 2003a.)

Powder River Basin Controlled Groundwater Area

All of the watersheds in the study area are located in the Powder River Basin Controlled Groundwater Area. This area includes portions of the Crow and Northern Cheyenne reservations that lie within the Powder River Basin. The controlled area applies to all geologic formations that lie above the Lebo formation. The protections of the groundwater include:

"Applies only to wells designed and installed for the extraction of coalbed methane (CBM).

- CBM development must follow the standards for drilling, completing, testing, and production of CBM wells as adopted by the Board of Oil and Gas Conservation.
- CBM operators must offer water mitigation agreements to owners of water wells or natural springs within one-half mile of a CBM operation or within the area that the operator reasonably believes may be impacted by the CBM operation, whichever is greater. This area will automatically be extended one-half mile beyond any well adversely affected.
- DNRC will designate a Technical Advisory Committee to oversee groundwater characteristics and monitoring, and reporting requirements." (MCA 85-2-506)

The establishment of the controlled groundwater area will allow for the depletion of targeted aquifers for extended periods of time in a region of scarce water resources. The controlled groundwater area also includes several active coal mines in the region. These sites include the Absaloke coalmine site located on tribal lands and the Decker and Spring Creek mines. The

controlled groundwater area extends over the entire Powder River Basin geological formation in Montana.

Wyoming CBM Regulation

Regulations set by the State of Wyoming are directed to protect the water quality of downstream water rights holders. The regulations would preserve the water quality of irrigation water sources downstream of the coal bed methane well development. The stated preferred water management method by the regulators is impoundment in ponds preventing discharge to surface waters.

The State of Wyoming does not require produced water be treated prior to discharge into state waterways. Wyoming discharge limitations are based on the classification of the receiving body of water. Discharges to the Tongue River were limited to two options where impoundment ponds would be the primary method of water management. Both permits will contain effluent limits that are "protective of livestock and wildlife uses."(WYDEQ 2001a.) In the event that there were downstream water right holders and users within the closed basin, sodium adsorption ratios and electrical conductivity effluent limits would be in effect. The closed basin is defined as not having connectivity to state surface waters.

Surface Water Classification of Waterways

The Tongue River is classified as a 2AB waterway in the State of Wyoming. Class 2A waterways are preserved for drinking water uses and may be perennial, intermittent or ephemeral.

Class 2AB waterways are known to support fish populations and are an attainable source of drinking water. Additionally, "Class 2AB waters include all Class 2AB waters are also protected for nongame fisheries, fish consumption, aquatic life other than fish, recreation, wildlife, industry, agriculture and scenic value uses." (WYDEQ 2001b.)

The Youngs Creek, Little Youngs Creek, and Ash Creek waterways are classified as 3B by the state of Wyoming. Restrictions of concentration levels of certain contaminants in 3B waterways are set by state. The classification is based on the intermittent or ephemeral flow of the tributaries that do not support fish populations but may support aquatic life such as amphibians and invertebrates. The waterway of this classification is not a drinking water source.

The Tongue River is classified as having a more protected water class than the smaller creeks. The Tongue River is included in the Yellowstone River Compact and is closely monitored for water quantity and water quality flowing downstream into Montana. Permits allowed within the Tongue River are more limited than in other watersheds citing the lack of an agreement on effluent limits between downstream Montana tribes and the states (USBLM 2003a).

Beneficial Use

Coal bed methane well operators can apply for permits to put produced water to beneficial use. The beneficial use permit is appropriated as a groundwater right for the stated purpose of livestock watering. The produced water is listed as being discharged to Youngs Creek and Little

Youngs Creek in Wyoming. Livestock beneficial use permits were for flow rates of 25 gpm with a maximum annual volume of 40.3 acre-feet. Operators can also apply for beneficial use permits for irrigation with the same flow rate and annual volume maximum amounts as livestock beneficial use.

Operators

In the Montana portion of the Youngs Creek watershed, Fidelity Exploration & Production Company was the sole operator of the coal bed methane wells developed. Fidelity operated a majority of the coal bed methane wells in the Wyoming portion of the Youngs Creek, Little Youngs Creek and Ash Creek watershed. There were a few other companies operating in the Wyoming portion of the watersheds. These operators include Huber J M Corporation and Storm Cat Energy USA Operating Corporation. Within Wyoming, Fidelity operated the majority of the producing coal bed methane wells. Storm Cat Energy operated producing wells in Township 58 North 84 West section 35.Both Huber and Storm Cat Energy drilled several dry or non-producing wells in Township 58 North 84 West sections 20, 28, 34, and 35.

Fidelity Lawsuit

The Northern Cheyenne Tribe contested the discharge of produced water into the Tongue River. The Tongue River runs adjacent to the eastern boundary of the Northern Cheyenne reservation. The tribe had brought several lawsuits against the Montana Department of Environmental Quality for permitting the discharge of untreated produced water to the Tongue River. Several landowner groups also filed lawsuits against MT DEQ including the Tongue Rivers' Water

Association and the Northern Plains Resource Council, Inc. These organizations also served as co-plaintiffs in the lawsuits brought by the tribe (Northern Cheyenne Tribe v. MT DEQ 2010).

The MT DEQ permitted leases of Fidelity Corporation in 1999 and renewal permits in 2006. Fidelity represented the largest developer of coal bed methane wells in the Tongue River drainage and within Montana. At the time of the Montana Supreme Court ruling, Fidelity had developed 900 wells in the Tongue River basin within Montana. After a ruling by the Montana Supreme Court upholding the Northern Cheyenne and co-plaintiffs' argument that the produced water should not be directly discharged into waterways without treatment, the terms of Fidelity's permit were declared void. The Court found that the company violated the Clean Water Act in discharging untreated produced water from coal bed methane wells. Shortly after the ruling, the state of Montana required the treatment of all produced water entering into state waterways.

Although, the ruling and subsequent MT DEQ permits required all operators within Montana to treat produced water, operators in Wyoming were not required to do so. Wyoming regulatory agencies have not required the treatment of produced water. Within the Tongue River basin, the State of Wyoming allows only discharge to impoundment ponds. In other basins such as the Powder River and Hanging Woman Creek, permits to discharge to state waters are still in effect.

Proponents of protecting water quality downstream of coal bed methane well fields have called on the State of Wyoming to implement regulations to stop the discharge of untreated produced waters. The proponents argue that Wyoming is in violation of the Yellowstone River compact

that governs policy from waterways flowing from Wyoming into Montana. The State of Montana can only require that the water quality to maintain certain concentration levels upon reaching Montana. The State of Montana cannot control activities and policies taking place in Wyoming.

The Northern Cheyenne Tribe proposed and adopted its own water quality standards for the Tongue River in 2003. The tribe uses the water for irrigation, livestock watering, recreation, and cultural purposes. The MT DEQ and other state regulatory agencies would not recognize the standards unless the EPA approved them. The Northern Cheyenne Tribe has been granted Treatment as State status by the EPA since 2006 (USEPA 2006). The tribe also has reserved water rights within the boundaries of its tribal land base and to the Tongue River.

EPA Delists CBM

In 2014, the EPA did not require agency effluent standards for the regulation of coal bed methane wells. The EPA states, "Discharges from coalbed methane (CBM) extraction from onshore oil and gas facilities are not subject to effluent limitations guidelines or standards under the Oil and Gas Extraction Category, 40 CFR Part 435. EPA did not consider such discharges in developing the requirements in Part 435."(USEPA 2014) The EPA conducted a study of coal bed methane extraction in 2010 (USEPA 2010). The study included environmental impacts within the Powder River basin.

State & Federally Controlled Resources

The federal government would lease mineral tracts within the watersheds in Montana as well as in Wyoming upon mineral and mine development. The CX Ranch lands purchased by Cloud Peak Energy were previously shown to be located above federal mineral rights in Montana (CPE 2012). The Shell Oil Company had also owned land tracts in Montana Township 9 South 39 East Section 33 and had proposed a coal strip mining development of the land in 1980 (USDOI 1981).

The surface landowners above the developed mineral resources in Montana are primarily energy companies. Cloud Peak Energy and subsidiary companies have purchased fee surface lands between the Decker Mines to the east and the reservation boundary to the west. Ranchers hold less surface land within the region. There are a few small parcels of federal and state surface lands within the watersheds in this study. Energy companies developed several coal bed methane wells on these lands during the boom period in the first decade of 2000. In Wyoming, surface landowners include the Chevron and Cenex companies.

Mineral Ownership

Coal bed methane wells were developed in private fee and federal coal mineral resources throughout the watershed study area. Chevron and Shell companies also own mineral resources where coal bed methane wells were developed in the Youngs Creek watershed in Wyoming.

All of the producing wells within the Youngs Creek and Little Youngs Creek watersheds in Montana are listed as located in federal mineral rights. The majority of the producing wells in Wyoming in the Youngs Creek watershed in both Townships 58 North 83 West and 58 North 84 West were developed in fee mineral rights.

Within the study area, a total of six producing wells located in federal mineral rights were located in Wyoming Township 58 North 83 West Sections 19 & 30 and Township 58 North 84 West sections 26, and 35. Of the wells developed in federal mineral rights, Fidelity operated five and Storm Cat Energy operated one.

MT Production Levels

25 coal bed methane wells in the Youngs Creek watershed produced a total of 427.09 acre-feet produced water (MBOGC 2017). This number includes the omission of the dry well in Montana Township 9 South 39 East section 32 in the Little Youngs Creek watershed. Several wells in Township 9 South 39 East section 33 produced only water.

WY Production Levels

90 coal bed methane wells in the watershed of Little Youngs Creek and Youngs Creek produced a total of 1210.58 acre-feet of produced water (WOGCC 2017). This number includes wells listed that may have not produced any gas or produced water. There were several wells within the watersheds that produced only water.

Five coal bed methane wells in the Ash Creek watershed yielded 62.35 acre-feet produced water. This number includes 2 dry wells in Wyoming Township 58 North 84 West section 28 that did not produce gas or water (Ibid).

Well Density

In the Montana portion of the Youngs Creek watershed, there was no well development on the reservation. The density of well development was less than 19 wells per section or per square mile in two sections within the Youngs Creek watershed. In total, well records were found for 26 coal bed methane wells listed as producing wells within the Youngs Creek and Little Youngs Creek watersheds in Montana (MBOGC 2017). A total of 26 producing coal bed methane wells would have discharged produced water to streams or infiltration ponds in the Youngs Creek and Little Youngs Creek watersheds in Montana.

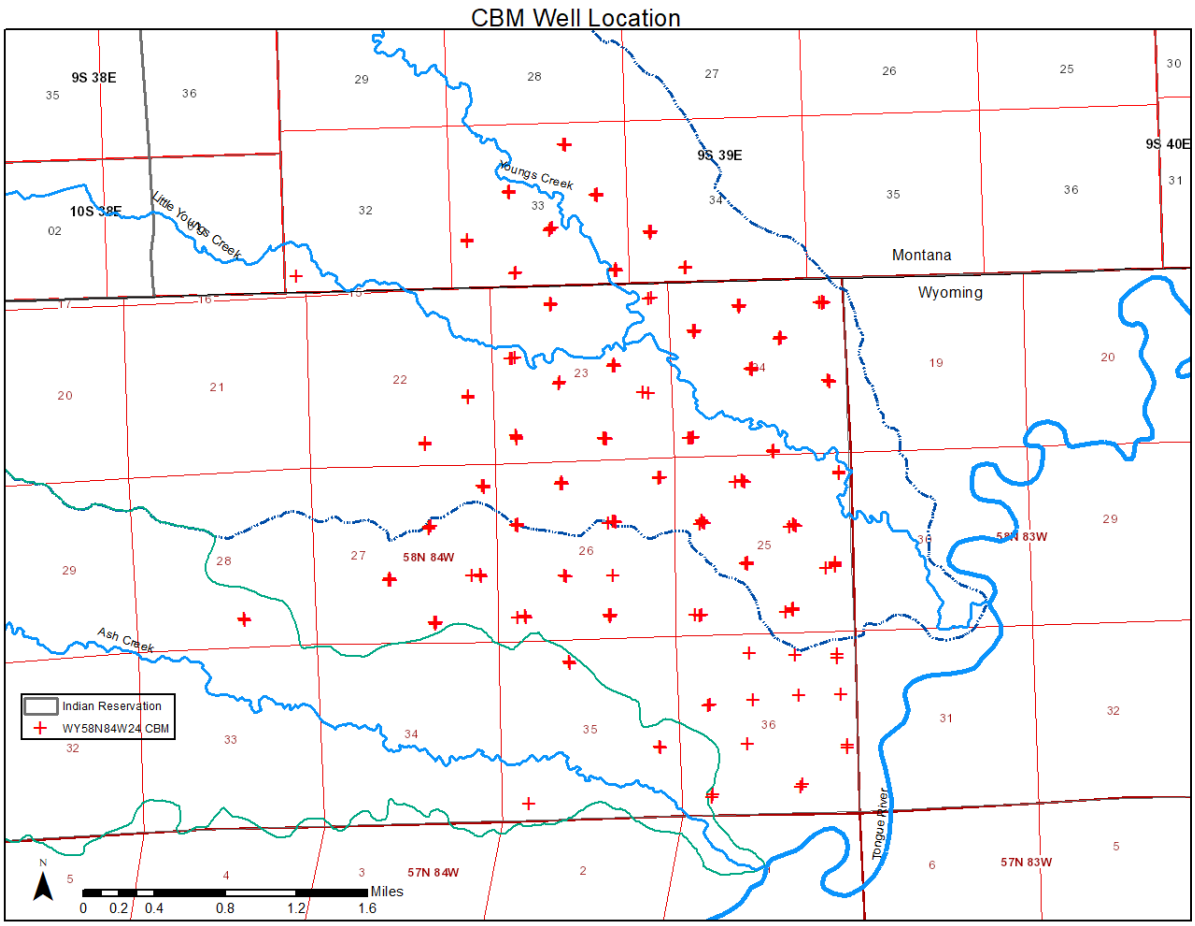

Figure 2.2. CBM well locations near watershed study areas. Red (+) indicate CBM wells.

Wyoming portions of the Youngs Creek and Ash Creek watersheds experienced significantly higher rates of well development than the Montana portions. The well density was between 1 and 24 wells per section and a total of 90 wells were developed in the watersheds. The wells were typically collocated with 2 to 3 wells at each well site targeting different coal bed formations (WOGCC 2017).

Geology

The majority of coal seams targeted for coal bed methane well production lie within 700 feet of the ground surface (Hedges et al. 1998). In the Youngs Creek and Little Youngs Creek watersheds, the targeted formations are the Roland, Smith, Anderson-Deitz, Canyon, Carney, Wall, and Roberts coal seams. These coal seams lie above the Lebo shale formation.

Fault Lines

Fault lines in coal seams can interrupt the hydrologic flow of the effective coal aquifer. There are several fault lines located throughout the Tanner and Youngs Creek watersheds. The fault lines are shown to disconnect the transmissivity of the coal aquifer in the region (Hedges et al. 1980; Van Voast and Hedges 1975). Therefore, stresses in the disconnected aquifer regions will not propagate through a complete fault.

The direction of the fault lines in targeted coal seams are described as down slope and uplifted. Faults within the Tanner Creek and Youngs Creek watersheds are generally uplifted to the northwest. At points near the alluvial bed, fault lines in the Anderson and Dietz coal seams can interact with and influence the alluvial groundwater flow. In certain reaches of the streams, the loss or gain of surface water in the stream can be attributed to the influence of the coal bed aquifer fault line (Hedges et al. 1998).

Aquifer Transmissivity & Conductivity

Aquifer transmissivity of the coal seams are significantly higher than adjacent formation layers.

Transmissivity levels range from (3.2 to 180 ft^3/day). Coal aquifer conductivities range from (0.1 – 3.6 ft/day). By comparison, the Youngs Creek alluvium has a conductivity of 265 – 400 ft/day (Hedges et al. 1998).

The coal seams will also have varying hydraulic head levels. The declining hydraulic head levels can be transmitted throughout the coal aquifer. As coal bed methane wells resulted in significant amounts of produced water depressurizing the coal seam, the hydraulic head levels decreased significantly near the wells. Declining head levels extended for several miles from the well site **(**Wheaton and Metesh 2002**)**. The impacted coal seam aquifers required several years to return to initial pressure head levels when dewatering ceased (Meredith et al. 2011).

Aquifers impacted by the coal bed methane wells would not be confined to sections where wells have been drilled. The aquifer drawdown has been shown to extend at least 2 miles from coal bed methane well projects (Meredith and Kuzara 2015). Potential impacts to the coal seam aquifers surrounding mine sites will depend on the connectivity of the aquifer. Fault lines will act as a barrier to declining head levels where the coal layer is disconnected due to significant displacement of the fault (Hedges et al. 1980; Van Voast and Hedges 1975).

Data Analysis

All coal bed methane well data in Montana was sourced from the Montana Board of Oil & Gas Conservation. All coal bed methane well data in Wyoming was sourced from the Wyoming Oil & Gas Conservation Commission. Well data included location, coal bed formation, amount of gas produced and amount of water produced. Well data collected also included name of well operator and the status of land and mineral ownership. Wells that were not listed in each state oil and gas conservation databases as being assigned a production profile were not included as developed wells. Wells that had been designated dry wells in both databases were not included in the well count.

Water rights information for all lands located in Montana was collected from the Montana Department of Natural Resources and Conservation Water Rights Query system. Water rights information for all lands located in Wyoming was sourced from the Wyoming State Engineer's Office water rights database. The Wyoming database also contained the water rights permits for all coal bed methane wells for the beneficial use of produced water. Water rights that were fully adjudicated were included in the list of water users and water rights holders.

WATER RIGHTS IN CBM IMPACTED AREAS

Water Rights Source & Place of Use

There are some variances with the water right place of use and the source or diversion point of the water. The analysis will focus on the source of the surface water rights along Youngs Creek rather than the places of use. Discharged produced water in the stream drainages was more likely

to impact the creeks as sources of water allocation. The volumes of produced water would then flow from points of discharge to the downstream water users.

Similarly, groundwater rights may have differing locations of sources and places of use. A livestock groundwater right in Montana Township 9 South 39 East Section 29 has listed places of use in five sections outside of the source. The period of use for this water right is May 15 to November 15 with a 35 gpm flow rate and a maximum allowed volume of 6 acre-feet. A means of conveyance is not stated as to how the groundwater source would be transported for a use outside of the well or point of diversion.

Water Rights Holders Fee & Energy Companies

Surface water rights in areas with developed coal bed methane wells are primarily assigned for irrigation usage. The means of conveying the surface water rights are from irrigation ditch systems. Water rights holders are assigned a flow rate or water volume based on the historically irrigated acreage.

The Cloud Peak company and affiliates control a large amount of water rights within the Youngs Creek basin. The company purchased 38,800 acres of fee tracts known as the CX Ranch in 2012 (CPE 2012). This purchased area includes tracts within the Youngs Creek basin. With the surface title, the company also gained water rights title associated with these tracts. The companies are listed as Youngs Creek Mining Co. LLC and Arrowhead I LLC. Youngs Creek Mining Co. and

Arrowhead I LLC own all the water rights within Montana Township 9 South Range 39 East Sections 32, 33, and 34. These sections represent all of the coal bed methane development in the Montana portion of the Youngs Creek watershed.

The amount of surface water rights the companies controls within the Youngs Creek and Little Youngs Creek basin amount to a maximum of 629 cfs for irrigation, and 12 surface water rights at an undefined quantity for stock. The water rights dates associated with the points of diversion range from 1894 to 1944. Groundwater rights owned by the companies range from 15 and 20 gpm for domestic supplies, and 35 gpm for stock.

In the Wyoming portion of the Youngs Creek watershed, the Chevron Company owns water rights in the Verley Extension of the Peoples Ditch and in the enlargement extension of the Glade Water Ditch. There are 10 listed users with prior appropriated surface water rights of 8.849 cfs total flow rate within the Peoples and Glade Water irrigation ditches with sources in the Wyoming Township 58 North 84 West Sections 24 and 25. Chevron controls rights to a total flow rate of 2.38 cfs in both ditches sourced from Youngs Creek in these sections. The priority dates of the water rights range from 1884 to 1909 within the irrigation allocations.

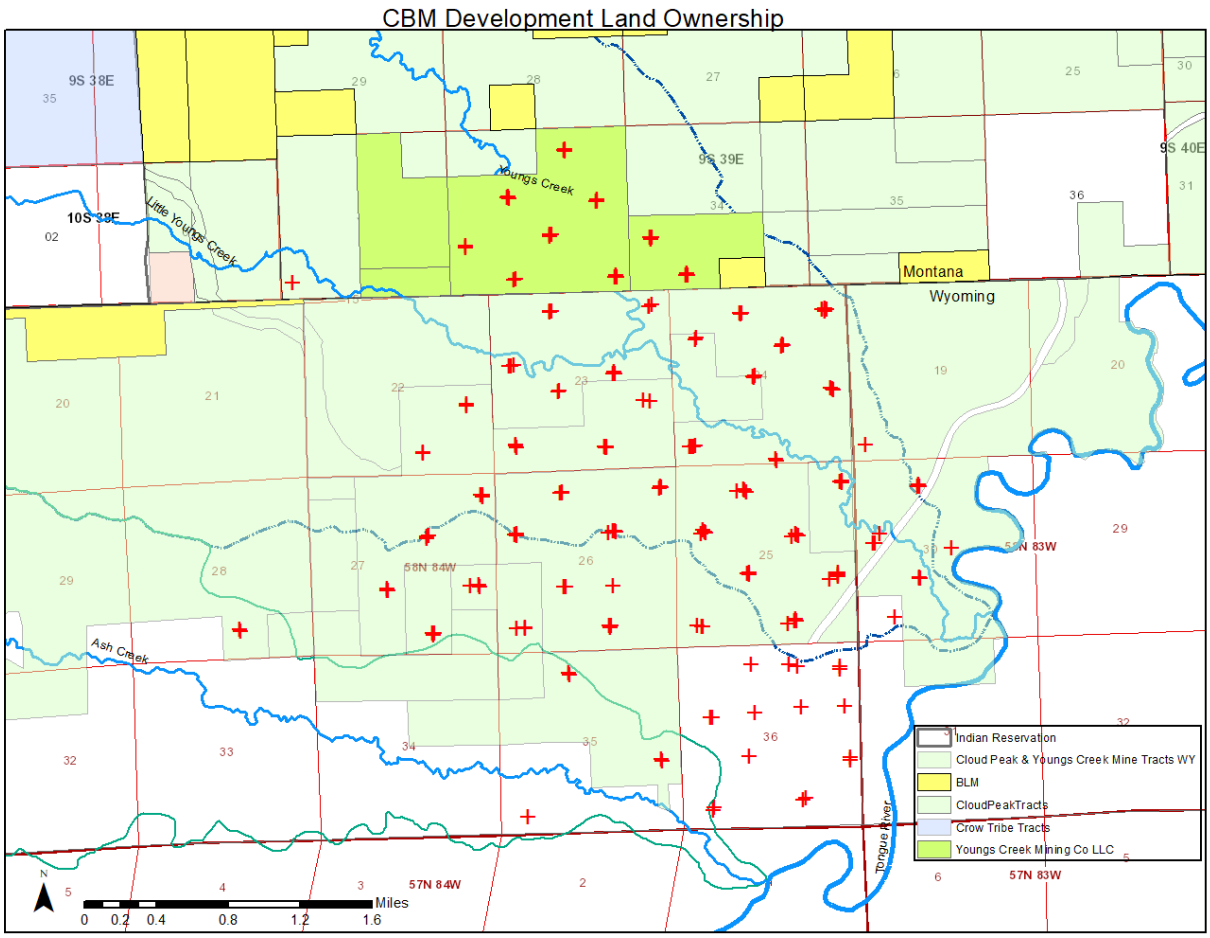

Figure 2.3. Surface land ownership with CBM development. Red (+) indicate CBM wells.

Land Ownership MT & Wyoming

As in Montana, Wyoming surface land is primarily owned by the Cloud Peak Energy Company and affiliated companies within the watershed impacted by coal bed methane development.

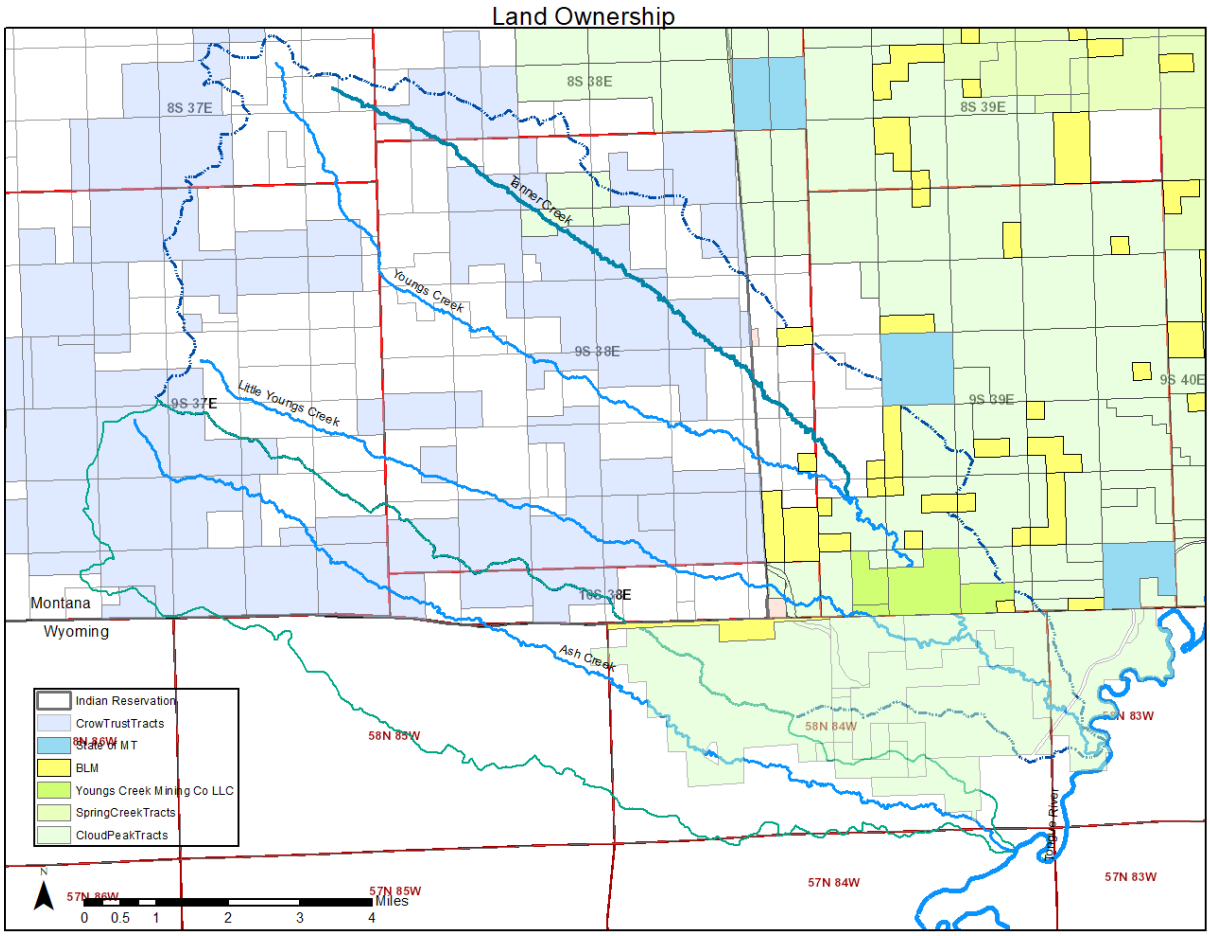

Figure 2.4. Surface land ownership in Youngs Creek and Little Youngs Creek watersheds. Tracts represent tax parcels or allotments.

In the Wyoming portion of the Youngs Creek and Little Youngs Creek watersheds, although energy companies own all the land, other fee owners control the majority of the surface water rights in the area impacted by coal bed methane development. These owners have appropriated rights sourced from Youngs Creek in the Glade Water and Peoples and Lord ditches. The fee landowners control all the water rights sourced from the Little Youngs Creek in the Oberreich and Eisle ditches as well as the Welch ditch sourced from a tributary of Little Youngs Creek.

Irrigation Water Allocation from Surface vs. Groundwater

General surface water allocations for irrigated acreage in the Youngs Creek basin within Montana are listed in Table 2.1.

Table 2.1. Surface water allocation by irrigation method.

Irrigation Method	Allocation
Flood	17 gpm per acre
Spreader	2 acre-feet per acre
Natural Overflow	Historical use (not measured)

Water rates for irrigation have been adjusted or reduced to 17 gpm for each acre irrigated. This is for the method of flood irrigation. The flow rate will not exceed 17 gpm unless the claim has been substantiated to require an excess flow rate for historical agricultural use. In general, water rights in the Youngs Creek watershed have been readjusted and/or reduced to 2 acre-feet of water allocation for one acre irrigated by method of water spreading. Natural overflow rights are not assigned a volume or flow rate but the right is limited to historical use. The surface water rights may be assigned a period of use based on documented use (MTWC 2008).

There are two irrigation surface water rights holders in Montana with total flow rates of 629 gpm with a maximum irrigated area of 37 acres. The allocated flow rates implement the flood irrigation method assigned 17 gpm per acre.

Table 2.2. Stock water allocation in Montana.

Method	Allocation
Volume	30 gallons/day/animal unit
Flowrate	35 gpm

If the flow rate is to exceed 35 gpm, the claim must be substantiated with documentation of historical use exceeding 35 gpm. In Montana, stock water rights are sourced from in stream surface water flow and groundwater.

Table 2.3. Total water demand allocation from all rights in the impacted sections in Montana.

Surface	Flowrate	Method
Irrigation	629 gpm	Flood
Stock	undefined	In Stream

Groundwater	Flowrate	Max Volume
Stock	10 gpm	Undefined
Domestic	35 gpm	3 acre -feet

Within the impacted sections, there are 12 Stock surface water rights owners, 1 stock groundwater rights owner with 10 gpm flow rate, and two domestic water rights owners with 15 and 20 gpm flow rates.

Irrigation Users in Youngs Creek Watershed on the Reservation

Historically, irrigation rates were limited to one miner's inch per acre. One miner's inch is equal to 0.025 cfs (1/40th of cfs) in Montana. This is also equivalent to 11.25 gpm or 1.5 cfm. A court ruling, Anderson v. Spear Morgan Livestock Co., in 1936 allocated the flow rate to all fee

landowners outside the reservation within the Youngs Creek and Tanner Creek watershed. Within the reservation, surface water rights allocations of later priority dates with methods of flood irrigation follow state allocations for the Youngs Creek watershed of 17 gpm per acre.

On the Crow Reservation surface water rights have also been allocated based on natural overflow. There is no flow rate allocation associated with natural overflow method on this water right. The period of use and diversion is stated as March 1 through November 1. The total volume is not to exceed the historical and beneficial use of water associated with this right. The priority date is 1927. Another Walton water right holder with a flood irrigation method has a maximum flow rate of 3 cfs to a diversion dam for the irrigation of 44.1 acres.

In Wyoming, surface water allocations are based on flow rates from irrigation ditches.

These ditches include the Peoples and Lord, also cited as Peoples, and Glade Water ditches and enlargements. The source of these ditches is Youngs Creek within sections Township 58 North 84 West 24 and 25. The surface water rights for the affected sections are a total flow rate of 8.849 cfs in Youngs Creek through the ditches.

Table 2.4. Total water demand allocation from all rights in the impacted sections in Wyoming.

Surface Source	Flowrate
Irrigation	13.149 cfs (5901.7 gpm)

Reservoir

Stock water rights appear to be tied to reservoirs sourced from surface water in Wyoming.

There are no stock water rights claims from in stream surface water flows in Wyoming.

In Wyoming, there are no listed stock or domestic water rights holders sourced from groundwater located in watersheds within the study area. There are domestic water rights holders in other sections. Domestic wells in Wyoming in the watershed study area may not be listed as having been assigned a water right. Groundwater rights in Montana and Wyoming represent significantly lower allocated water rights flow rates.

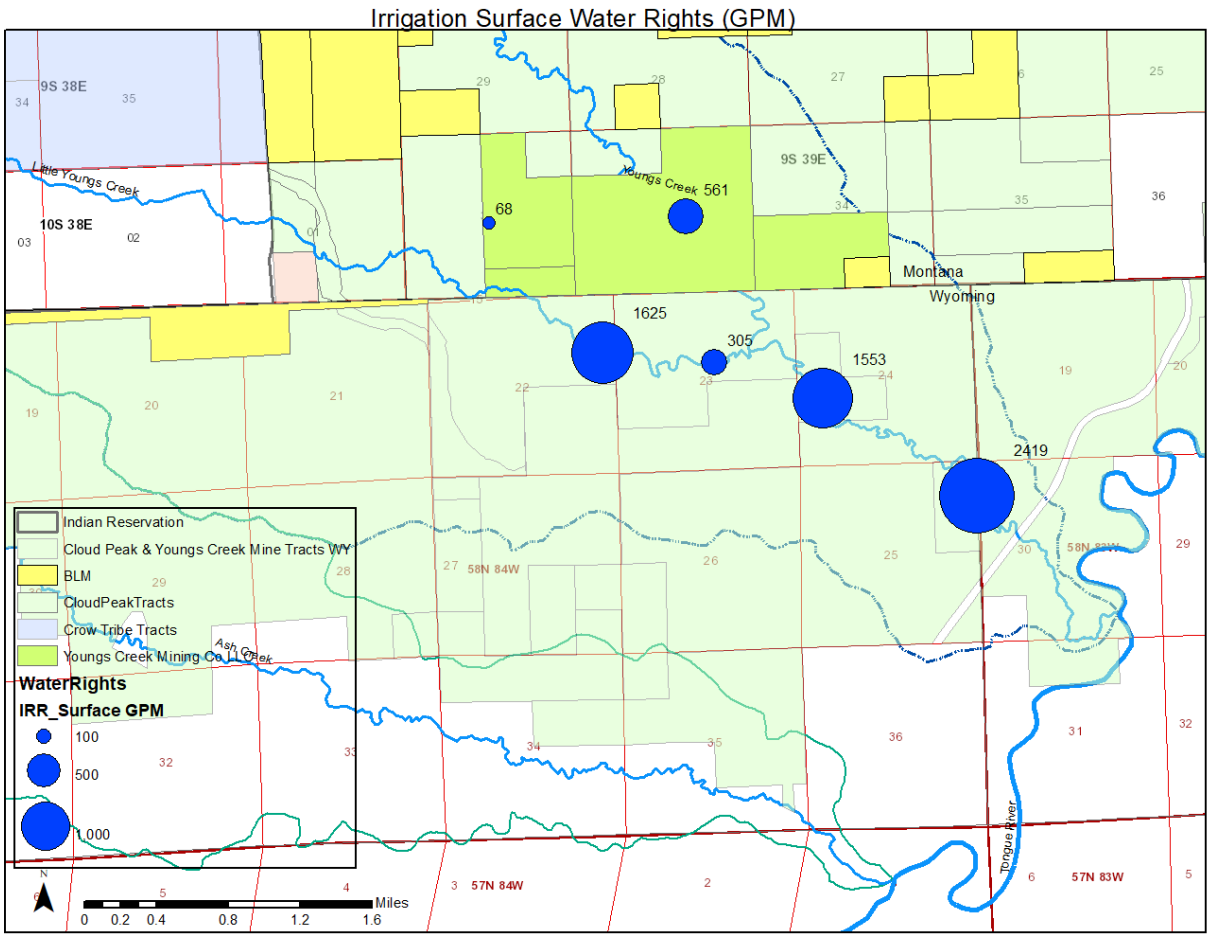

Figure 2.5. Irrigation surface water rights in CBM well development per section in gpm.

PERMITTED PRODUCED WATER COMPARED TO WATER RIGHTS

Amount Water Produced vs. Water Right

The temporary groundwater appropriation permits for beneficial use were issued to coal bed methane operators within the Youngs Creek basin. The amounts of produced water discharged would be limited by the beneficial use rate in the well permits in Wyoming. The produced water discharged in Montana was not limited by the MPDES permit. The amount of produced water seems to be based only on the discharge of the well for methane recovery in Montana. Discharge

was limited only by the resulting water quality of the receiving streams. Discharge levels then would only be subject to the monitoring of Tongue River water quality.

Amount Water Produced vs. Possible Permitted Volumes

Based on allowable beneficial use flow rates in Wyoming, all the wells in Montana could potentially equal the water right holders in the watershed. All surface water rights holders would have collectively 629 to 639 gpm, including a 10 gpm flow rate for all stock water users, in sections 32, 33, and 34. The permitted wells could potentially discharge an additional 650 gpm, 1.45 cfs, in Montana.

(An estimated water use would be 30 gpd/animal unit *40 animal units =1200 gpd

12 water rights*1200 gpd = 14400 gpd = 10 gpm)

Table 2.5. CBM producing wells in Montana assigned annual limits of Wyoming wells.

Montana	Flowrate	Max Annual Volume
26 wells	Undefined	Flood
Comparable to Wyoming		
26 wells	650 gpm	1007.5 acre –feet

Table 2.6. CBM producing wells annual limits in Wyoming.

Wyoming	Flowrate	Max Volume
Per Well	25 gpm	40.3 acre-feet
90 Wells	2250 gpm (5.01 cfs)	3627 acre–feet

In the event that all wells were discharging water at the permitted levels, the additional surface water would have significantly altered the flow volume in Youngs Creek and Little Youngs Creek. A maximum allowable flow rate capacity of 5 cfs from 90 producing wells would have represented a significant increase in surface flow depending on the time of year and base flow rate. The surface water rights for the affected sections are a total of 8.849 cfs in Youngs Creek through the ditches. Surface water rights in Little Youngs Creek represent an additional 4.3 cfs in affected sections. Total surface water rights in impacted areas within Wyoming represent 13.149 cfs or 5901.7 gpm. The permitted volume of discharged water to the amount of appropriated water rights was approximately 38 percent of the total flow of appropriated rights per year in Wyoming.

The average annual discharge flow rate for Youngs Creek at its mouth is 9.16 cfs (Hedges et al. 1974). The combined maximum potential discharge from producing wells in Montana and Wyoming would represent an additional 6.46 cfs in Youngs Creek and its tributaries.

Wells in Wyoming were permitted for beneficial use at rates of 25 gpm with a maximum discharge amount of 40.3 acre-feet per year. The majority of producing coal bed methane wells are listed as not having exceeded the annual maximum allowable amount of produced water over the productive lifespan of the well. A few wells exceeded 40.3 acre-feet of water over the life span of the well. The volume of produced water did not exceed the permitted levels in any of the wells.

According to well production records, the overall volume of produced water discharged from 1999 to 2010 in Wyoming was 1110 acre-feet. This represents a volume less than the permitted maximum annual volume for all 90 wells of 3627 acre-feet. The total discharged volume represents approximately 31 percent of the permitted volume of one year.

Significant portions of the wells drilled were non-productive or dry in the Youngs Creek watershed in both Montana and Wyoming. The permitted potential discharge for all wells drilled could have represented a significantly larger amount than the figures outlined.

SUMMARY

Permitting New Uses from Groundwater vs. Surface Water

Natural resource development in the watershed study area is facilitated by the assignment of groundwater resources. The assignment of the groundwater is on a temporary basis consistent with the lifespan of the developed well or coal mine. Water rights for groundwater are also allocated to support mine operations such as dust suppression and for facilities operations.

The beneficial use of livestock water originating from the discharge of produced water was a means of transferring groundwater to create the beneficial use as surface water. The term beneficial use allows operators to dispose of produced water into surface water drainages in Wyoming. However, the state water rights in Wyoming do not reflect that the water users

claimed livestock surface water rights within the Wyoming portion of the Youngs Creek watershed. Whereas in Montana, the water right for livestock represent a significant number of surface water claims in the watershed.

The majority of the beneficial use permits in Wyoming cited that the produced water would be used for livestock watering. Energy companies currently own the entire land surface in the impacted sections, and it is unlikely that the companies would continue cattle grazing and watering activities as previous water rights holders had conducted on the lands.

There were a few domestic well groundwater rights owners listed in the Youngs Creek watershed. In the event that the domestic wells were impacted, the operator would have to provide mitigation measures to fulfill the groundwater right. The domestic well owners appear to have leased and eventually sold surface land and any mineral rights to energy companies in the watershed. In acquiring all the surface land and adjoining water rights, the energy companies are limiting the water damage claims that can be brought against them as a result of mineral development activities.

Impacts to Downstream Users

Ground water was converted to surface water and claimed through a permitted beneficial use. The groundwater is of lesser quality with high total dissolved solids concentration and results in degraded resulting surface water quality in receiving streams. There does not appear to be

setback requirements from waterways and surface waters. Several wells had been located within 100 feet of Youngs Creek and Little Youngs Creek. The placement of the wells near the creeks may have been to facilitate the disposal of the produced water to the nearby waterways. This practice of produced water disposal was allowed when the majority of these wells were developed prior to 2010. The only mention of a setback for impoundments was from wetlands and riparian areas on BLM lands in the Montana APD development plan (USBLM 2003a.).

The volumes of groundwater pumped were shown to deplete the coal aquifers were coal bed methane wells were developed. Coal mine development has also been shown to lower water table heads in impacted coal aquifers within the region. Future coal mining within the watersheds on and downstream of the reservation would create large-scale hydraulic impacts within the study area. In the event that the headwaters of Youngs Creek and Tanner Creek are developed, resulting downstream flows would be negatively impacted in water quality and water quantity. The creeks are fully appropriated, and junior water rights holders and those owners actively irrigating with the surface water would be most impacted.

No new surface water rights were assigned within the watershed for temporary or permanent use. It appears that groundwater is the only viable means of supporting natural resource development projects in Montana and Wyoming as all the surface water in the basins are fully adjudicated. Additionally, within the Crow Reservation, reserved water rights on Youngs Creek and its tributaries have not been allocated. The lands upstream of the water diversions will need to fulfilled by surface water sourced from Youngs Creek should the tribal or allottee landowner

chose to irrigate their land. The reserved rights will have senior priority dates and will be protected reserved water rights within the Youngs Creek, Tanner Creek, and Little Youngs Creek watersheds in reservation.

CONCLUSIONS

The natural resource extraction of coal bed methane and coal mining will have lasting impacts on the watersheds flowing into the Tongue River and then downstream into Montana. The watersheds have all been fully appropriated in regard to surface water rights. The only means that energy companies have to facilitate development is through the use of groundwater. Ironically, the temporary permitted use of the groundwater would lead to the degradation of surface water quality downstream of coal bed methane and coal mine development. Further mineral development will detrimentally affect water quality and quantity of the fully appropriated surface waters within all watersheds

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CHAPTER 3

WATER RESOURCE MANAGEMENT, MINERAL RIGHTS AND LAND TENURE ON CROW TRIBAL LANDS.

ABSTRACT

I will explore the relationship between tribal land tenure and natural resource management in this chapter. Considering the detrimental policies placed upon the tribe, I want to examine challenges presented in land tenure, water resource management, and natural resource management as a result of Indian policies since the end of the treaty making era. This is a reality that many tribes and individual allottee owners have to endure, particularly in natural resource rich tribes in the Great Plains. I feel that the challenges presented are not explored and addressed considering the rights of individual allottee owners, tribal members, and tribal governments. I intend to focus on the rights of these members to land tenure authority, participation in land use and resource management, and interventions that would restore collective rights for all impacted members.

INTRODUCTION

The Crow Tribe has lost many lands and resources in its traditional territories since its initial treaties with the United States. The tribe inhabited the Powder River Basin, which holds a large amount of domestic coal reserves. Many regional rivers and watersheds such as the Yellowstone and Big Horn rivers and several mountain ranges were located in the traditional homeland including the Big Horn and Yellowstone National Park. The Crow held prized homelands rich in game and resources necessary for their lifestyle. The tribe had to defend their homelands first

from neighboring tribes vying for their prized territory. Eventually conflicts grew increasing intense as those tribes were pushed west into the Crow territory in the 18th and 19th centuries. The Crow were among the first tribes to maintain peaceful relationships with the federal government during the last uprising of plains tribes. Crow delegations traveled to the nation's capital to advocate for the future of the tribe through the preservation of its land base.

Despite, the early efforts of Crow tribal leaders to maintain a good faith relationship with the federal government, the tribe suffered from the impact of Indian policies after the United States ended the treaty making process with tribes. The tribes lost territories to the new states springing up around it in the region and through the opening of its lands to homesteading. The tribe lost a great portion of its members to disease and later was stripped of its children who were sent to Indian boarding schools. The tribe was forced to accept allotment that forever stripped individual tribal members of land rights. The final round of dispossession involved the tribes' natural resources, the takings of hydroelectric dam sites, and the loss of control of its water resources within its boundaries. Indian policies after treaty making ended were detrimental to the Crow Tribe as they devastated most tribal livelihoods throughout Indian Country.

In regard to the Crow Tribe's resources, both the federal government and State of Montana have directed the management of land use, and mineral and water resources in the tribe's treaty territory. The federal government will have an oversight role in maintaining trust responsibility through various federal agencies. Federal agencies control and maintain federally owned lands and infrastructure projects within the reservation. The State of Montana will manage state water rights of fee landowners within the reservation boundaries. The State will also represent the

interest of fee landowners land use rights on the reservation. Both the federal and state government will have oversight of infrastructure projects for water resource management that they have funded on tribal lands. These parties will govern islands within the tribal land base and exercise rights to water resources and associated infrastructure projects outside of the tribal resource management frameworks in place.

Contributing to the lack of authority over mineral and water resources, the Crow Tribe has weak regulatory institutions for managing its resources. The tribe has relied on the extraction of its coal resources to generate income for basic tribal operations. Similar to many plains tribes, the majority of the tribal members residing on the reservation have household incomes below the poverty level and unemployment levels are high. The Crow tribal government has basic natural resource and land management departments. These departments also lack qualified staff. The tribe has little resources and funding to invest in regulatory institutions for natural resource management.

For the tribe that once controlled the region expanding from the Powder River Basin to the Yellowstone River valley, the tribe now has to contend with the legacy of legal frameworks brought west since the homesteading era. The environment these policies have created should be examined from the perspective of the tribal government and the individual tribal member. It is these parties that have to live with the impacts of the Indian policies imposed upon them by the federal and then state governments. A more thorough account of the challenges would better inform federal, state, and tribal authorities on interventions to prevent and reform policies that

contribute to the further erosion of the tribe's ability to maintain control of its remaining land base, and mineral and water resources, and tribal members' entitlement to those resources.

Allotment Act

The most damaging policies to individual tribal members' land use authority started with the allotment era. The allotment act granted patent land title to individual allotment owners, or allottees. Presently, allottee land owners are tribal members who have inherited land allocations. Allottee lands are held in trust and entitled to reserved tribal rights including water rights.

During the allotment era, tribes lost two thirds of their land base. Currently, all tribal land bases cover 56 million acres held in trust. The Crow Tribe resisted homesteading and eventually was forced to open up its reservation land in 1903. The tribe entered the Crow Act to direct the allotment process when the ceding of land became inevitable.

Crow Allotment Act 1920

The Crow Act (41 Stat. 751) laid out the allotment of tracts within the Crow Reservation to enrolled tribal members. The act created a tribal enrollment roll from which all future enrolled membership in the Crow Tribe would be based. Enrolled tribal members were allotted between 320 and 640 acres depending on previous allotment, age, and status within the family household. The act also set protocols for the conveyance of land and the role of the Secretary of the Interior in managing allotted lands. Parcels of land in the Big Horn and Pryor Mountains were reserved from allotment. Eighty acres dedicated for municipalities were reserved in 6 communities. The

act also limited the acreage an individual, company, or corporation, could own, capping acquired lands purchased from Indians at 1,280 acres agricultural land or 1,920 acres grazing land. Tribal members could request to receive allotments in fee parcel if they were deemed competent. Approximately 4,000 Crow Indians were assigned allotments until 1928 (National Archives 1925).

Mineral Ownership Tribally and Allottee Owned Land - Crow Act Statute

Rights to mineral resources were reserved for allotment owners after a vested period of 50 years. Prior to the vesting period, the tribe would own all minerals in common;

"Sec. 6. That any and all minerals, including oil and gas, on any of the lands to be allotted hereunder are reserved for the benefit of the members of the tribe in common and may be leased for mining purposes, upon the request of the tribal council under such rules, regulations, and conditions as the Secretary of the Interior may prescribe, but no lease shall be made for a longer period than ten years, but the lessees shall have the right to renewal thereof for a further period of ten years upon such terms and conditions as the Secretary of the Interior may prescribe: Provided, however, That allotments hereunder may be made of lands classified as valuable chiefly for coal or other minerals which may be patented as herein provided with a reservation, set forth in the patent, of the coal, oil, gas, or other mineral deposits for the benefit of the Crow Tribe:" (41 Stat. 751)

The Crow Tribe currently owns a majority of mineral rights on the Crow Reservation.

Statutes granting allottee mineral rights were revised to extend the tribal ownership of those minerals indefinitely. Allottees on the Crow Reservation did not gain title to their mineral rights after a 50 year period of tribal ownership as stated in The Crow Act. Congress passed legislation in 1968 extending the mineral ownership on the Crow Reservation to the tribal government. The Supreme Court upheld law granting tribes perpetual ownership of allottee mineral rights in 1976 (425 U.S. 649).

Property Rights

The General Allotment Act is the foundation for the rights of allottee land owners. The interpretation of property rights of allotment owners is set by the Allotment Act. Section 7 of the General Allotment Act pertains to the water rights of allottee owners.

SEC. 7

That in cases where the use of water for irrigation is necessary to render the lands within any Indian reservation available for agricultural purposes, the Secretary of the Interior be, and he is hereby, authorized to prescribe such rules and regulations as he may deem necessary to secure a just and equal distribution thereof among the Indians residing upon any such reservations; and no other appropriation or grant of water by any riparian proprietor shall be authorized or permitted to the damage of any other riparian proprietor.

Competency Declaration

Tribal members could request to receive allotments in fee parcel if they were deemed competent. The Act focuses on the 'competency' status of tribal members receiving allotment, where incompetent tribal members are allotted parcels in trust and parcels remain under the oversight of the Secretary of Interior;

"Sec. 13. That every member of the Crow Tribe shall designate as a homestead six hundred and forty acres, already allotted or to be allotted hereunder, which homestead shall remain inalienable for a period of twenty-five years from the date or issuance of patent therefor, or until the death of the allottee: Provided, That the trust period on such homestead allotments of incompetent Indians may be extended in accordance with the provisions of existing law:"

And as detailed in initial and joint allotments;

"Priority of selection, up to three hundred and twenty acres, is hereby given to the members of the tribe who have as yet received no allotment on the Crow Reservation, and thereafter all members enrolled for allotment hereunder shall in all respects be entitled to equal rights and privileges, as far as possible, in regard to the time, manner, and amount of their respective selections: Provided, That Crow Indians who are found to be competent may elect, in writing, to have their allotments, except as herein provided, patented to them in fee. Otherwise trust patents shall be issued to them. No patent in fee shall be issued for homestead lands of a husband unless the wife joins in the application, who shall be examined

separately and apart from her husband and a certificate of the officer taking her acknowledgment shall fully set forth compliance with this requirement."

The right to property and to have agency to make decisions for that property were tied to the competency of the Indian landholder.

Fractionation

The problem of fractionation has not been thoroughly examined and analyzed and it continues to present land management challenges for heirs of allottee owners. In the sole study performed by the General Accountability Office in 1992, twelve reservations with highly fractionated tracts were evaluated (GAO 1992). In 1992, allotted tracts had 1,059,592 ownership records. In 2010, the same tracts had 2,110,838 ownership records (Russ and Stratmann 2016). The number of consolidated ownership interests in 1992 on these tracts was 704,562. In 2010, the consolidated ownership interests rose to 1,312,391. The total number of allotment tracts was 82,978 in the 1992 study, the average tract size was 199 acres. Initially, allottees had limited authority over their allotment tracts, presently, their heirs have limited authority and ability to use these allotment tracts as a result of fractionation. As of 2012, the average allotment tract has 31 individual owners (Shoemaker 2017).

Non-Indian Fee Land

Several allotments were sold to non-Indian landowners. These land tracts are now fee lands and are not within the jurisdiction of the tribal government. Fee lands on the reservation now cover a significant percentage of the Crow reservation land base. Lands within the ceded strip are

considered fee lands. Certain fee lands and mineral rights in the ceded strip were returned to the Crow Tribe after the Indian Reorganization Act era.

Water Settlement - Status of the Crow Tribe

The Crow Tribe entered into a Water Compact with the State of Montana in 1999 (MCA 85-20-901). The water compact was ratified by the federal government in the Claims Resolution Act of 2010 (P.L. 111-291). The Water compact recognizes the tribes' reserved rights to watersheds on tribal lands. The tribe had been without the authority or resources to manage their water resources until 2016. The tribal reserved rights were granted according to the conditions set by the State of Montana and the Secretary of the Department of the Interior.

The Water Compact entitles the Crow Tribe to the natural flow of the Little Big Horn River, Pryor Creek, and smaller watershed systems within the Crow reservation boundary. The ground water of these systems will also be included in the water right of the tribe. The Tribe will receive 500,000 acre feet of the Big Horn River. The tribe's reserved water rights to the watersheds and natural flow of the rivers will have a priority date of 1868. The tribe will receive 150,000 acre-feet of the Big Horn Reservoir storage with a priority date of 1962. In the event of a water shortage, the Crow Tribe will be entitled to an additional 150,000 acre-feet of water storage in the Big Horn Reservoir. The Crow Tribe may direct an additional 30,000 acre-feet of the flow of the Big Horn River for use within the ceded strip. In 2011, tribal members approved the ratification of water rights settlement compact with a vote of 2323 in favor and 938 opposed (USDOI 2012).

The Crow Tribe Water Rights Settlement Act of 2010 authorized the $460 million funding for the construction of municipal, rural, and industrial (MR&I) water system as well as the rehabilitation of irrigation infrastructure. The settlement will represent the largest single investment in the Crow Tribe's infrastructure. The annual operating budget of the Crow Tribal government averages around $30 million dollars in serving its 14,000 tribal members (CTL 2012a.). The tribe's main source of income is generated through the leasing of its coal reserves in southeastern Montana.

Historically, a tribe's primary means of attaining actual "wet" water delivery from "paper" entitlement of allocated water rights is through congressional or federal agency funding of water supply systems. The majority of the Crow Tribe's settlement funds, $246.4 million, are allocated to construct the MR&I water supply system as means to put the tribe's negotiated water right to beneficial use. The MR&I water system will be supplied from the Crow Tribe's allocated water right to Big Horn River. The MR&I system is projected to require 3,331 acre-feet per year at full system capacity (Bartlett & West 2014).

Self-Determination

The Crow Tribe has elected to administer the water settlement funds through the right to self-determination by the adoption of a Public Law 93-638 contract with the United States Bureau of Reclamation, USBR. In doing so, the water settlement contract funds will be processed through the Crow Tribal government. The USBR will act as the administrative authority to provide oversight of all water settlement projects.

MR&I System Ownership

Upon completion of MR& I facilities, the Secretary of Interior will transfer the title to the Crow Tribe as outlined in the Settlement Act. The Crow Tribe will operate the MR&I System upon receipt of system title from the federal government. The Tribe will then be entitled to charge for water delivery to cover operation, maintenance, and system replacement costs.

Winter's Rights

Winters v. United States (207 U.S. 564) outlined the reserved right of all resources on lands not explicitly excluded in treaty. The 1908 decision found that water was included as a reserved treaty right for tribes. The ruling determined no restriction of the tribal use of water.

The tribal reserved rights would be entirely owned and administered by the Crow Tribe. This would include all water uses permitted on tribal and allotted lands. Both water uses will originate from the tribe's reserved water right. The tribe's water rights include the natural flow of the stream, groundwater, and storage within the majority of the watersheds within the reservation and within the ceded strip.

Water Available to Allottees

Practical irrigable acreage of tribal lands has been the measure to allocate quantified tribal water rights. Allottees would were entitled to the amount of water required to irrigate their lands. *Arizona v. California* establishes tribes rights based on this metric.

Water Codes

The Secretary of the Department of the Interior has authorized the adoption of water codes for tribes that have received water settlements. Non-IRA tribes have adopted water codes without the approval of the Secretary. Water codes are necessary for the management of tribal water resources. The water code must provide for the management, regulation, and governance of all uses of the tribal water rights. The water code will establish the authority for tribal governance of water resources. The water code will ensure that governance structures are outlined. It will establish procedures for marketing water and issuing permits for associated water use. As a result, many tribes currently have not enacted laws for the regulation of water use and water management on tribal lands.

Tribal water codes can include provisions granting allottees water rights for agricultural uses. The allottee rights will represent portions of tribal water rights. The Shoshone-Bannock Tribes' water codes include provisions for the recognition of allottee water rights. "Any allottee holding an allotment that was allotted for agricultural purposes, pursuant to the General Allotment Act, 25 U.S.C. Section 381 (which secures water to allottees) is entitled to request and be provided an equitable distribution of a portion of the Tribal water right to carry out the agricultural purposes of the allotment."(SBT 2007) This allocation is included in the tribes' water code outlining the

tribal member's water right. Provisions for allottee water rights are often included in the tribe's water management regime at the time of the water settlement.

Allottees are entitled to water rights for agricultural purposes and these rights are generally not subject to loss due to non-use. The priority date of allottee rights is the same as the tribal reserved water right and subject to the tribal water authority. In times of shortage, the allottee rights will be subject to allocations outlined in tribal water code.

Non-Indian Water Users

Non-Indian users are often referred to as "Walton claimants" where the water rights are retained upon receiving title of allotment lands. Walton had to prove continued beneficial use of water and was awarded an allocation based on practical irrigable acreage of his property. Walton claimants must demonstrate continued use of water rights and are subject to loss of this right due to non-use. In this case, the tribe was able to retain regulatory authority over Walton's allocated right based on the watershed conditions which lie entirely within the tribal boundaries.

Colville Confederated Tribes v. Walton upheld the tribe's right to manage all water users within the reservation boundaries. *United States v. Andersen* ruled that states can authorize water rights allocation to non-Indian users within reservation boundaries. The *Montana* test was upheld in Colville but not in Andersen due to the location of the watersheds. Both rulings involved non-Indian fee land owners on tribal lands asserting rights to water within tribal boundaries.

In other watersheds which would demonstrate off-reservation impacts, Walton claimants in watersheds outside of tribal control are subject to state regulation and appropriation of water claims. Tribes will need to account for the amount of water right claimed by non-Indian users who are regulated by state authority in the tribal watershed in administering tribal water codes.

Ownership & Allocation

Tribal authority through its tribal water code permits the use of water, it does not grant the property right to water. "Unlike many state water permits, tribal permits do not constitute a vested private property right in the use of water. Instead, these permits represent a revocable permission to use the reservation waters."(Breckenridge 2006) Allottee water rights and in some cases, non-Indian water rights, are often treated as reserved rights.

Benefits of Tribal Water Code - Holistic Tribal Management Model

Through holistically managing water resources, the tribe will be able to require that certain amounts of water levels are maintained in rivers, reservoirs, and groundwater recharge rates of aquifers are maintained. Maintaining water levels can be critical when tribes choose to provide suitable habitats for fisheries and other species targeted by tribal priorities. Water resources can be managed so that all resources will work to preserve the amounts and quality of water in reservation lands.

In the event of a water shortage, the tribe can implement allocation policies that more equitably distribute water flows to all users. Depending on the watershed, non-Indian water uses can be recalled in the event that the tribe has reserved specifications on the uses of water by these users.

Secretary of Interior

1975 Secretarial Moratorium on Approving Tribal Water Codes

The Secretary of Interior imposed a moratorium to draft guidelines for tribal management practices (USDOI 1975). The resulting guidelines were rejected by tribes and states. Tribes did not accept federal guidelines which dictated management practices. No final guidelines were adopted and the moratorium remains as the Secretary will not approve tribal water codes. Tribes must seek alternatives to adopting water codes outlining water resource management procedures.

IRA

Under the Indian Reorganization Act of 1934 (P.L. No. 73-383), IRA, tribes were given the option to form model constitutions developed by the federal government. Tribes voted to adopt the IRA model of government or to reject the model and remain non-IRA tribes. Tribes that did not vote on their IRA status were included with the tribes accepting IRA model governments.

IRA Tribes' alternatives are to either develop their water code with state approval, or to amend their tribal constitutions to remove provisions of the Secretarial approval. Tribes can negotiate a water compact with a state, that typically includes a water management plan or code. State approval must be recognized by the federal government through congressional legislation and the water code would require Secretary of Interior approval. A tribe can chose to amend its constitution to incorporate provisions that secretarial approval is not required for tribal codes. An IRA tribe is limited in its ability to develop a water code in requiring approval from the state and federal government.

Negotiated tribal water settlements typically include provisions for the tribe to develop tribal water codes regardless of IRA status. With congressional approval of the settlement, the development of a tribal water code is generally granted. The tribe entering into the settlement with the federal government has been granted the authority to regulate their water resources.

Non-IRA Tribes

As a non-IRA tribe, Secretarial approval would not be required for the establishment of a tribal water code. The Navajo Nation is a non-IRA tribe with an established water code (NNC 1984). The tribe has administered the water code in managing tribal water resources. The validity of the Navajo Nation's authority through its tribal water code has not been challenged in state or federal court. Following this model, a non-IRA tribe could establish a water code without requiring state or Secretarial approval or through provisions included in a water settlement.

The Navajo Nation has entered into water settlements with the State of New Mexico. Negotiations with other states have been started, however, the tribal water code has been in place since 1984 before water settlements with any party had been approved by the federal government. This non-IRA tribe has demonstrated the ability to develop and administer a water code prior to receiving quantified water rights.

The Crow Tribe is a non-IRA tribe. From 1934 to 2001, the tribe has elected to govern the tribe by tribal member consensus vote at general tribal council meetings. In 2001, the Crow Tribe

transitioned to a three branch government that includes the newly established legislative body in place of the general tribal council.

State Control of Water Resources

There are structural differences between the state regulation of water resources and the application of tribal water code mechanisms in managing tribal water resources. Reserved water rights in watersheds are generally not distinguished between surface or ground water sources. Tribal water codes do not regulate groundwater and surface water separately, however, the state often governs groundwater and surface water under separate regulatory statutes in state water codes.

Jurisdiction

States in the West adhere to the state prior appropriation doctrine that affects water users in times of water shortage. Tribes can chose to apply procedures that take alternate approaches to apportion limited water sources during drought periods. The authority administering the tribal water code can prioritize where water resources will be used should water shortages occur. As many western states have experienced complete allocation of surface water flows, the prior appropriation doctrine will introduce further stress to water users under state controlled management. There is no other criteria other than priority date upon which the water will be allocated by the state.

Federal Regulation of Water Resources

Similar to the treatment of Indian trust lands as federal lands, tribal water resources are governed by federal water quality statutes. The Clean Water Act is the primary federal statute driving regulation of tribal waters. This statute effectively sets the water quality standards for tribal waterways. By extension of the Clean Water Act, the Environmental Protection Agency, EPA, exercises regulatory control over tribal waterways (USEPA 1984). The State of Montana does not have regulatory authority over water resources on tribal lands (MCA 85-20-901).

Tribes with Treatment As State, TAS, status have the greatest regulatory authority over their waterways (40 CFR 131.8). The Tribes have assumed the regulatory role from the EPA and will be allowed to manage regulatory programs over their land bases in the same manner that individual States have opted to manage their programs. Tribes applying for Treatment As State status have to demonstrate that they have the capacity to regulate waterways. Few tribes have been granted TAS status due to the lack of proven regulatory capacity. All of the statutes promoted by the Clean Water Act will apply to tribal waterways.

The United States Bureau of Reclamation owns and operates the Yellowtail Dam and the Big Horn Lake on the reservation. This dam was built under the Flood Control Act (P.L. 296, 61 Stat. 686) and effective Pick-Sloan plan in 1962. The dam site and Big Horn canyon that flooded creating Big Horn Lake were condemned and taken from the Crow Tribe by eminent domain. Similarly, all other Pick-Sloan plan dams were built on Indian lands in the same manner, by eminent domain and flooding significant portions of tribal lands within the respective

reservations. After the Water Settlement, the Crow tribe will regain rights to the flow of the Big Horn River and to a portion of the water stored behind the Yellowtail Dam (P.L. 111-291).

Funding Resources

Treated drinking water is only available to residents living within the service area of communities with a municipal drinking water system. This is limited to the communities of Crow Agency, Lodge Grass, Fort Smith, Pryor, and Wyola (Dowl HKM 2009). The majority of residents within the reservation receive domestic water supplies from ground water wells. Domestic water supplies are exempt from water permitting in the State of Montana (MCA 85-20-901). Community water supplies are permitted in reservation communities provided there is a viable water source.

The EPA and BIA generally fund water treatment plants and facilities in reservation communities. The BIA or other federal agency may also operate and maintain the water treatment facilities. In the absence of any authority over the water resources or funding base, the water system for tribal residents has been directed by federal agencies. The federal agencies have been the sole regulators of tribal waters as well. The drinking water systems have to meet EPA standards in maintaining operation in continuing to receive funding.

WATER RESOURCES

Water Resource Interventions

Establishing Water Management Program

Currently, many large land base tribes do not have water resource management departments or basic water authority programs. The majority of these tribes located in the Great Plains region do not have settled water rights. The tribes do not have the authority to manage water resources and would have less legal basis to manage those resources. To further make matter worse, tribes without water resource management programs experience high levels of natural resource development.

The Crow Tribe, which has recently established water rights, has not developed a water resource management program. Despite the tribe being a non-IRA tribe, a water code had not been established. A significant limiting factor to the Crow Tribe regulating its water resources, is the fact that the tribe did not have recognized rights to its water until 1999. The State of Montana attempted to resolve water rights with all tribes in the state of Montana beginning in 1980s. Presumably, the tribe would not attempt to manage a resource that it does not have the stated right to do so. In attempts to retain sovereignty, the tribe took rights to water and water bodies lawsuits to the Supreme Court (Montana et al. v. United States et al.). In every case, the tribe lost the rights to the water bodies, water ways, and associated water rights. This not only delivered a loss to the Crow Tribe, but set legal precedent for all other tribes to be denied rights to their tribal water ways and water rights. Up until the water compact with the state of Montana, the Crow

Tribe had lost all water rights and water ways rights cases including the loss of the Big Horn Canyon behind the Yellowtail Dam.

The tribe was not given the authority or resources from the State of Montana, until the initial water compact was recognized by the federal government. The State of Montana did not provide resources in the form of monetary support of $15 million dollars to the tribe until 2016, 6 years after federal legislation recognized the water rights of the Crow Tribe (MTDOJ 2016). The obvious causes for not developing the water code are lack of authority to govern water resources until 1999(State of Montana) and 2010(federal government), weak governmental institution, lack of technical workforce, and no viable funding source.

What would a sustainable water management program look like?

In order to sustain a water management program, the program would require subsidies from federal, state and tribal sources. The initial startup of the program would require the most resources, with continued operation, the management should require less resources with regular maintenance. The office staff may be able to integrate to other programming areas such as operation and maintenance of water facilities. The governing board would also need to establish governing principles and conduct permit approvals. Technical staff would be required to provide technical reviews of proposed permittee water withdrawals.

- Funding and Resources

Typically federally sanctioned water rights settlements include provisions for project funding. This funding is necessary to support water resource infrastructure over large reservation land bases with a sole viable water source.

- Building Technical Capacity

The tribes will need to develop the tribal capacity to run effective programs. This will include developing and retaining technical staff, and maintaining the wherewithal to run necessary programs and boards.

- Clear Authority/Regulatory Roles of Tribe, State, and Federal Government, co-management

The state will need to interact with the tribal programs to manage state water rights. The tribal programs will also need to extend out to environmental regulatory programs at the state and federal level.

- Water Management Regime to Enforce for Environmental Regulation Statutes

When the tribe can successfully manage water resources, the tribe will be in a better position to co-manage environmental programs that will protect water resources and overall environmental health.

- Eventually Department can Become Self-sustaining

The department will need to reach a point that it will be self-sustaining in operations. Although it may receive resources, funding, technical support from federal agencies, the department should not rely on tribal resources for operating funds.

- Federal Role

With government funding, comes significant federal oversight. The federal oversight should not be so demanding that it detract from the few resources in place to implement the water management program. The federal government should dedicate more in-house staff to the projects that require significant oversight involvement.

Continuing to Operate Without a Water Code - Jurisdiction

Where tribes have not adopted a tribal water code, jurisdiction of the state control of affected water is not explicitly outlined. Other than local municipalities governing water use in tribal communities, there is no central tribal authority controlling water resources. Where the federal government does not act in a trustee role for the tribal and allottee reserved water right, the state is not granted authority and control of water resources. Non-Indian users on fee lands will be regulated by state control. Tribal and allottee reserved rights will be subject the trust responsibility of the federal government.

Limitations on Tribal Resource Management

Limitations of water management include non-tribally regulated water users within the tribal water management system. The conflict between state control and tribal control within the tribal water management model will need to be detailed. The exception of state water rights users will highlight inconsistencies in a holistic water management model as all water uses affect the hydrologic cycle within the watershed.

State imposed water uses will erode the tribal authority. This is particularly a problem where there are many non-Indian water users. Where states follow prior appropriation laws, the use of the water is tied to the land. Non-Indian water users can maintain water rights which are not junior to the tribe's water rights. The use of this water is then a vested property right to water among the permissive use of the rest of the tribe's water. The tribe will then have to administer and manage the permissive use of water around the vested property right of water uses. The tribal authority is therefore compromised as it will not be able to manage water uses by non-Indians according to its holistic management model.

Allottee Representation

All stakeholders in the water system will need to be included in the system allocation. The Crow tribal water code language for allottee allocation appears to be broadly defined. Allottee allocation also seems to depend on the availability of irrigation infrastructure and facilities for delivering water service to allottee tracts.

Highly fractionated allottee tracts would still remain alienated from allottee land use and thereby allottee participation in water management and right to use an allocated amount from the tribal reserved water right. Allottee land owners who would benefit the most from tribal water code management are those that control large or sole interests in tracts, particularly were irrigation infrastructure or water delivery service is available.

Trust Responsibility

The federal government is required to act as trustee in allowing a tribe to enact a water code. The government should uphold its trust responsibility to the tribe and the allottees in the management and protection of their tribal water resources. The tribes should be allowed to manage their water resources with a clear authority separate from state control. The federal government should be an agent in establishing tribal authority. The Secretary of Interior's moratorium on tribal water codes prevents tribes from proactively protecting tribal water resources and allottee water rights.

Tribes should be given the authority to regulate their resources rather than face increased challenges from ineffective federal policy. In the absence of a water code, control of tribal water resources is not clearly defined between state and federal jurisdiction. Without water codes, tribal and allottee reserved water rights are not protected and upheld by federal trust responsibility. Tribes face many challenges other than ineffective federal policies to manage water resources. Tribes will need to have technical expertise on the administration of the water code. As the water sources are managed based on the hydrologic functioning of all water resources, the technical expertise must be available to the tribe to make informed decisions on

water usage to optimize the functioning of the hydrologic system. Given the provisions to establish tribal water codes, tribes can start to build their capacity to manage their water resources in working toward realizing self-determination.

MINERAL RESOURCES

Statistics on Indian Mineral Reserves

Crow Tribal lands contain 3% of the United States coal reserves on the 2.2 million acre reservation located in south eastern Montana. The Crow Reservation has been shown to contain 17 billion tons of coal and 40 million barrels of oil. This estimate was taken from a DOI report in 1975 on the recoverable resources located on tribal lands. (Mapel et al 1975) The Crow Tribe has been involved in coal mining and receiving revenues for coal since 1974. The Crow Tribe relies primarily on proceeds from coal development revenues to operate the tribe's government budget (CTL 2012a).

Indian Coal Production

According to the Energy Information Administration, EIA, the amount of coal sales from Indian lands decreased to 19 million short tons in FY2012 (EIA 2013). The coal production from Indian lands has remained unchanged at 19 million tons through FY2014. (EIA 2014) The total 19 million tons came from three mines in Indian Country; Kayenta Mine at 8.1 million tons (2011), Navajo Mine at 7.8 million tons (2011), and Absaloka Mine at 5.5 million (2011). This represented 1.8% of all coal sales in the U.S. for the year 2012. This total coal production

decreased 14 percent from the previous year that totaled 22 million short tons in FY2011. The amount of coal sales from Indian lands has been decreasing each year since 2005.

Absaloka Mine

The Absaloka Mine is a surface coal mine located on and adjacent to the Crow Indian Reservation, owned and operated by Westmoreland Resources, Inc. The Absaloka Mine produces 5 to 7 million tons of coal per year. The company Westmoreland leases coal resources from the Crow Tribe. The mine site has historically been located off the tribal reservation in a portion of land adjacent to the exterior boundary. The land had been ceded to the State of Montana and later returned to the tribe. Although the mine initially did not lie within the boundaries of the tribal reservation, the tribe has maintained ownership of the subsurface mineral rights in this portion called "the ceded strip". The Absaloka mine has since extended south onto the official northern boundary of reservation with the Crow Tribe's signing of the lease an additional adjoining land parcel, the Tract II lease, to the Westmoreland company (USDOI and MTDEQ 2008). The lease of the Tract II is projected to extend the life of the mining operation until the year 2025.

The Absaloka Mine railroad spur was constructed around 1974 to carry coal shipments from the mine load out to the main rail line just east of Hysham, Montana, a distance of about 35 miles. All production is shipped by rail to electrical generation plants in the Upper Midwest. The Absaloka Mine employs about 210 workers with a yearly payroll of about $11 million (2011). The mining company claims to employ primarily Crow Tribal members in mining operations.

Westmoreland company promotes this large tribal employment percentage as an act of goodwill toward the tribe. The employment provided typically offers significantly higher wages and benefits as compared to the average income within the local economy.

Indian Coal Production Tax Credit

The Indian Coal Production Tax Credit was introduced into legislation by the Energy Policy Act of 2005. The tax credit has been renewed several times after expiring at the end of 2012 (CTL 2012b.). The Energy Policy Act prescribes $1.50 to $2.00 per ton of coal produced as a tax credit, where the amount is adjusted for inflation. In FY 2012 the credit averaged around $2.26 per ton coal produced. "The Credits are provided under Section 45(e) of the Internal Revenue Code to producers of Indian coal from facilities placed in-service by January 1, 2009, if such coal is sold to unrelated parties."(S.975 - 115 Congress) The credit is paid to the coal producing facilities that mine the Indian trust coal resources. Coal producing tribes continually lobby to have the tax permanently enacted into legislation. The credit had been extended through the end of 2016. Montana Senators Tester and Daines had introduced legislation to permanently extend the production tax credit in April 2017 (Ibid).

Westmoreland returns a share of the tax credit with the Crow Tribe. This share of the tax credit is dependent upon the quantity of the coal sold. The coal production sales have been decreasing since 2007 (EIA 2015). This translates into decreasing coal revenues for the tribes in form of royalties, tax credits shares, and associated state incentives for coal revenues. The instability of this revenue stream jeopardizes the budgeting ability of the tribal government annually based on the receipts expected each year. Surplus payments from coal sales are paid to tribal members in

the form of per capita payments. In the event of a budget shortfall, the tribe may use coal payments received from other bonus payments to supplement the deficit. Due to the decrease in coal demand by the client Xcel that experienced a fire at its power plant, the tribe received less coal production rents in 2012. The tribe applied its annual lease bonus payment from Cloud Peak Energy of $1.5 million to this shortfall. The Crow Tribe will receive this lease bonus payment for the initial 5 years of entering into the agreement with Cloud Peak for the development of the Big Metal mine (CPE 2013).

Montana Coal Tax

The State of Montana had previously collected state taxes on coal produced within the ceded strip. The state retains jurisdiction over the surface land, however, the tribe owns the mineral rights. The Crow Tribe and the State of Montana have been engaged in a long standing court battle over the right of the state to tax tribal coal. The state had been collecting state taxes on the coal since 1976. The tribe has contended that it is not subject to paying state taxes and instead, had wanted to impose its own tribal tax. 1988, the Supreme Court ruled that the tribe's minerals are not subject to state coal severance tax and the state must pay restitution of the taxes it had collected from Westmoreland mining company in *Crow Tribe of Indians v. Montana*. The ruling judgment was for the initial amount of $46.8 million, however, the tribe demanded full repayment of the $93 million collected as the state coal severance tax. The tribe lost a Supreme Court case brought by the tribe against the state for the loss of income from its own right to tax the coal resources and would not collect damages of $93 million (Montana v. Crow Tribe, 1998).

Future Energy Development

A large portion of the legislation introduced into the Crow Tribal Legislative branch recently pertain to coal, oil and gas, and energy development on Crow tribal lands. The legislation has granted tribal support for many energy development projects including a proposed coal-to-liquids plant which would require the lease of the tribe's coal and water resources to the plant developers (CTL 2008). The processing of coal into liquid hydrocarbon fuel products will require enormous amounts of water in the refining process. Several more approved legislation acts include projects which would support the development of coal fired power plants on tribal lands which would also require the tribe supply the water necessary for operating the plant.

The availability of water for these plants, at the time of approved legislation, was contingent upon the final approval of the tribe's proposed water settlement act. Upon the passage of the water settlement act, the tribe would gain water rights to the flow of the Big Horn River as well as an allocated amount of water stored in the Bighorn reservoir and receive funding to develop a water system which would supply municipal, rural, and industrial water needs throughout the reservation. The availability of the water after the construction of the MRI water system would then make the energy projects feasible with the supply of treated, high quality water sourced from the Big Horn reservoir behind the Yellowtail dam. The proposed projects have not materialized as the developers have failed to secure financial investors.

Appraisal Value

Minerals on tribal lands have historically been undervalued, not fully determined, or under reported. Often, mineral lands were noted as containing mineral resources by U.S. Geological Survey, USGS, surveyors at the time of allotment and have not been reevaluated since the initial determination (Ambler, 1990). This oversight leads to the undervaluing of mineral resources on allotted lands. The undervaluation has been problematic to the tribe and allottee owners in the event that tribal or allotted lands were entered into mineral leases or mineral rights were sold.

IRA

The IRA may have prevented reduction of land base or in the case of the Crow, later restored ceded land titles, but it froze the status of mineral lands. Lands that were declared as having mineral resources by loosely based federal surveys were then on the only lands to have mineral status within the reservation. Tracts that would later be discovered to have mineral resources were not appraised as having mineral resources by the Bureau of Indian Affairs. The appraisal value was often not changed despite evidence of mineral resources. This was problematic when a tribe would sell the land and mineral rights and would not be compensated for the actual value of the assets. This also opened the door for asset mismanagement of the tract when the tract was highly fractionated and the Bureau of Indian Affairs assumed signatory authority of the tract.

IMDA Indian Mineral Development Agreement

The Indian Mineral Development Agreement, IMDA (25 U.S.C. Secs. 2101-2108), has evolved to direct mineral development management on tribal lands due to the loss and mismanagement of mineral resource occurring after the allotment era. The agreement outlines the roles of the BIA and Department of Interior in approving mineral leases on tribal and allotted lands.

Tribal Energy Resource Agreement

The application for permit to drill approval process is complex and rigorous for oil companies seeking to drill on tribal lands. Permitting includes a 49 step approval process with approval required from several federal agencies including the Department of Interior, Bureau of Indian Affairs, Minerals Management Service, Bureau of Land Management, and the Environmental Protection Agency.(IMDA) The arduous approval process is unique to tribal lands as wells drilled on non-tribal lands are not required to receive these additional approvals. All energy development projects on tribal lands are required to complete the permit approval process.

In an attempt to simplify the approval process, the federal government has proposed that tribal governments put in place measures to approve permits to drill rather than seek the approval through the various agencies as is currently required. The Tribal Energy Resource Agreement, TERA, was enacted in the Energy Policy Act of 2005 (P. L. No. 109-58) in which tribes could accept conditions to demonstrate their ability to approve permits for energy development on tribal lands.

Federal Regulation

Coal mines on tribal lands are regulated by the Department of Interior's Office of Surface Mining, Regulation, and Enforcement, SMCRA (P.L. 95-87). SMCRA was developed in 1977 to regulate all surface mine activity.

Tribal SMCRA

The Crow Tribe has requested to run the SMCRA program on tribal mineral lands. Tribes can request the authority to run SMCRA programs as known as SMCRA primacy. Congress amended the SMCRA legislation in 2006 to provide the primacy authority to tribes.(P.L. 95-87) The Office of Surface Mining will provide oversight of tribal SMCRA programs. A tribal SMCRA code will establish regulatory procedures of the newly created Coal Crow Regulatory Office, CCRO (CTL 2010). New mining permits on tribal mineral lands would be permitted through the CCRO. The CCRO would also inspect mining activity, enforce regulatory statutes, and permit modifications to existing permits.

The tribal SMCRA code is modeled after the federal SMCRA. The Crow Tribal Legislature approved the tribal SMCRA code in 2010. The CCRO has received funding and technical assistance from the OSM in developing the tribal SMCRA code. The tribe currently administers the Abandoned Mine Lands program with funding support from the OSM. The Tribe will continue to receive funding from the OSM or other federal agency to supplement operation costs of the CCRO.

Mineral Resource Interventions

Building Technical Capacity

In order to operate a mineral resource development system, such as the Tribal SMCRA, the tribe will need to have an established and capable regulatory program in place. The tribe should not attempt to permit or regulate potential mining development projects on tribal lands until a proficient system is in place. Presently, the tribe has no other means of regulating mineral development projects in order ensure compliance with basic environmental regulations.

Tribal administration of the SMCRA code will encounter many of the administrative obstacles that the tribe has in administering the tribal water code. In attempting to run the CCRO under the tribal SMCRA code, the tribe will encounter similar problems with program capacity and technical staff. The CCRO will need to have technical in-house staff to administer the tribal SMCRA code. The program will need to generate revenue or receive subsidies from a federal agency to fund program operations.

If the tribe were able to successfully manage the tribal water and tribal SMCRA codes, this would represent a mechanism for the management of mineral and water resources on tribal lands. Both codes do not adequately address problematic land tenure issues with allottee lands. The

tribal SMCRA code would align more with the water code's managerial scope when reclaimed lands are restored to tribal watersheds.

The tribal SMCRA is modeled after the federal SMCRA. SMCRA regulations are enforced by federal agencies and the Montana Department of Environmental Quality approves mining permits. The tribe cannot be expected or expect to have the equivalent capacities of both of these entities. Seeing that there are only three tribes in the nation that have active mining operations on their land, the program does not have a basis for successful implementation. The only program the Crow Tribe has implemented has been the tribal abandoned mine lands program. The AML program is staffed with largely seasonal laborers, often with a high turnover rate, which is not conducive to building the technical skill of the program workforce.

Tax Credit

In order to correct the disconnect that may arise between state and tribal taxation, the federal government has issued a tax credit for tribal coal resources produced. As only three tribes actively mine coal resources, the tax program may not incentivize economically sound development projects. All of the tribes benefiting from the tax credit have experienced declining coal production each year.

Lessons from Fort Berthold

Fort Berthold Indian Reservation is an IRA tribe that was established by an initial treaty at Fort Laramie. Fort Berthold has also experienced high rates of fractionation, and as a result of allotment is highly checker-boarded with large portions of fee land. The tribe does not have reserved water rights. Generally, allottee owners in Fort Berthold have more minerals rights associated with their surface allotment tracts than on the Crow Reservation. The exception to the retention of allottee mineral ownership is the transfer of allottee mineral rights to tribal ownership that are now located under Lake Sakakawea. This may be the result of allotted lands at the time being perceived as having less mineral resources where coal was referred to as the dominant mineral right. The mineral resources at Fort Berthold have proven to be rich in shale oil and gas located in the Bakken formation that has seen increased production over the last decade.

Leasing on Indian lands is often complicated by numerous landowners holding title to a single tract. Fort Berthold allottee land and mineral ownership are highly fractionated.

"*The Mineral Leasing Act has been interpreted as requiring the Secretary of the Interior to secure the consent of all owners who have an undivided interest in a parcel of land that would be the subject of a mineral lease. Because of fractionated heirship problems associated with the manner in which Indian estates are inherited or devised, there can be hundreds of owners of an undivided interest in a parcel of land.*"(S. Rpt. 105-139)

Leasing land and resources owned by many heirs holding title to mineral rights can prove to be a complicated process. All heirs will need to be located and be in agreement to sign off on a mineral lease agreement.

Senate Bill 1079 (S 1079 105th Congress) reduced the landowner approval requirement to 51 percent. Tracts that will be developed for oil and gas production will be required to have 51 percent landowner approval as opposed to the previous requirement of all landowners. The following statement outlines the landownership complexities on the Ft. Berthold reservation.

"*In 1992, the General Accounting Office (GAO) conducted a study of the fraction problem on twelve Indian reservations, including the Fort Berthold Reservation. The GAO study found that of 2,610 tracts of land on the Fort Berthold Reservation, 352 had two Indian owners, 999 had three to ten Indian owners, 675 had eleven to twenty-five Indian owners, 377 had twenty-six to fifty Indian owners, 174 had fifty-one to one hundred Indian owners, and 33 had from one hundred one to three hundred Indian owners.*"(Ibid.)

Testimony of Edward B. Cohen, Deputy Solicitor, U.S. Department of the Interior, before the October 6, 1997 hearing of the Committee on Indian Affairs on Senate Bill 1079. Effectively half of the tracts of land on the Fort Berthold reservation have ten or more owners. Approximately 22 percent of the land tracts had 26 to 300 land owners.

Where tracts of land are greatly fractionated, the Bureau of Indian Affairs acts as a trustee on behalf of the landowners. The BIA and the tribal government would then be responsible for executing the minerals lease. The tribal authority would have incentive to enter into lease agreements on behalf of the tribe as it would receive a portion of the proceeds in oil tax revenue. The current tax agreement between the Three Affiliated Tribes and the State Governor was negotiated to split the standard production and extraction tax of 11.5% between the two entities. The tribe receives 50% of the extraction tax for oil produced on tribally owned or allotted land and state receives the remaining 50% share of tax revenue. In the case of non-trust land on the reservation, as fee land or non-tribal member owned land, 20% of the tax revenue is remitted to the tribes and the state retains the remaining 80% of tax revenue for oil produced on this land. The BIA approves the lease terms executed by the tribe on behalf of the many landowners.

Depending on the leasing practices of the BIA leasing office, the acting trustee may "rubber stamp" these leases in order to satisfy oil exploration demand.(Crane-Murdoch 2012) Oil companies prefer leasing large tracts in aggregate to ensure that the development is successful. The Senate Bill 1079 encouraged the leasing as prospective oil companies were not able to secure total landowner consent from all owners.

The BIA leasing process presents several instances of neglect in the protection of landowner rights. A single landowner or even a group of landowners would not have significant involvement or the effective right to preside over the leasing of the land. In greatly fractionated land tracts, the landowners would receive a marginal amount of compensation and in most cases landowners would not be aware that their minute fraction of the land was being developed to produce oil. This landownership problem disenfranchises the rights of the individual landowners and results in the leasing of land without an effective, empowered advocate.

TERA & Permitting

To date, no tribal government has entered into a Tribal Energy Resource Agreement TERA (P. L. No. 109-158), contracting process. The agreement proposes to allow the tribe to approve all energy development leases without the approval of the Secretary of the Interior. The Secretary's approval is required as the tribal lands are subject to the trust responsibility of the government. The process, as described by the agreement, requires that the tribe set environmental review requirements as well as serve as the regulatory authority to ensure compliance. Through this agreement, the government is exempt from all liability associated with any permit for the

development project. The government is therefore abrogating its trust responsibility to tribes. Few tribal governments have the expertise or capacity to perform environmental reviews for the leases. Adversaries of the TERA policy claim that tribal lands will be effectively treated as public lands and that the tribes will be subject to additional requirements such as the National Environmental Policy Act, NEPA, review where state lands are not required to complete the review. Governing tribal trust lands, the tribes are not required to receive approval from the State.

The permitting process is taxing on tribal governments with limited capacity to process extensive application criteria. The NEPA process also places additional financial burden on tribes that have limited in-house personnel to process the environmental review. Additionally, the tribes lack adequate personnel to enforce extensive permitting requirements for wells producing on the reservation.

Consolidated Permitting Processes, One-Stop Shop

The Three Affiliated Tribes have advocated for a more streamlined application to drill permitting process. Initially, the entire review permitting process took several years to complete. With the introduction of the One Stop Shop (USBLM 2011) initiative formed in cooperation with the Bureau of Land Management, Bureau of Indian Affairs, as well as other required permitting agencies, the process duration was shortened to 45 days.(Donovan 2012) The Three Affiliated Tribes required an application fee of $40,000 for each well drilled to cover costs associated with the extensive permitting approval process.

Companies operating on the reservation must register with the tribal government's Tribal Employment Rights Office, TERO. Based on tribal policy, the tribe may mandate that a certain percentage of the non-tribal company's employees are tribal members or that qualified tribal members are given preference in employment or contracting capacities. Most federally recognized tribes have a TERO administration which is operated within the tribal government as adopted into the tribal governance code. The TERO authority requires a significant registration fee per well from companies operating on the Fort Berthold reservation to offset tribal regulatory costs.

Funding and Resources

The tribe will need to have adequate funding and resources to set up an efficient regulatory program. Based on the tribe's revenues received from tax agreements, the tribe may elect to dedicate a portion of the income to building resource management programs. As implemented in Fort Berthold, a tribe may elect to require a permitting and TERO fee for each well completed in the reservation boundary to offset the tribe's incurred permitting and regulatory expenses.

The People's Fund

The Three Affiliated Tribes have established a fund from the mineral resource income received from the oil boom in the last decade. The People's Fund will be for the benefit of tribal members after the mineral income streams have subsided. As of 2014, the fund had $200 million dollars (MHA 2017). The principle of this fund will be invested and the interest will be paid out to all tribal members over the age of 21. Payments to tribal members under the age of 21 will remain

in an interest bearing account that members will receive upon reaching the age of 21. Annual payments of $500 dollars are projected to be paid to tribal members in perpetuity of the fund. Tribal members have been receiving annual payments from the People's Fund as well as percapita payments from the tribal general fund since 2014.

Tribal Dependence on Natural Resource Extraction Income

Ideally, the tribes would not need to depend on resource development income for basic tribal operations. The Crow Tribe's potential coal development projects depend upon the approval of coal export terminals to overseas markets. The domestic demand for coal has decreased steadily over the last decade. Recent federal legislation has discouraged the continued investment in coal fired power generation. Ultimately, the tribe may not be able to find customers for its coal resources and will have to forego development of additional coal resources.

Land Valuation

There is also a disconnect between the valuation of the land for mineral resources and the surface land appraisal. More detailed information on all natural resources and updated land and mineral appraisal values. Tribal and allotted tracts have historically been undervalued and have not had adequate mineral appraisals. Allottees have minimal to no input on the fate of their land bases when the tribe has decided to develop tribal mineral rights.

Split Estates/Tribal Agreements

In the event that the allotment tract has a split estate in terms of mineral rights, the allottee owner would only be able to consent to the sale of the surface land. Without mineral rights, the allottee owner would not share in the sale of mineral assets under the surface tract. As allottees did not enter into the mineral lease, allottees are not consulted about the potential loss of surface land. When the development company decides to include the allotment tract in the mine permit area, allottee owners will receive an offer for the purchase of the land. In this case, allottees owning significant percentages of interest title or sole land owners would be able to authorize the sale of surface land.

Surface fee land owners also would not be consulted on the leasing and development of tribal minerals. Fee land owners also owning mineral rights would be party to and consulted on the leasing of their mineral rights. The Shell Oil Company owns fee minerals on the reservation land where development was proposed in 1980 (USDOI 1981). Cloud Peak Energy will lease the minerals from fee owners in the proposed Big Metal mine development as well as in the Youngs Creek mine permit area. The federal government is not a mineral owner in the reservation.

The Youngs Creek Mine permit area is entirely on fee land and federal land. The federal government and agencies such as the BLM own minerals within the permit area. All surface and minerals not owned by Cloud Peak Energy will be leased from fee land owners or federal agencies.

Allottees were to be granted title to mineral rights after a period of 50 years from the date of their land patents. Upon the expiration of the 50 year period, minerals would be transferred from tribal ownership to the allottees. When the period was to expire in the 1960s, the Crow and Northern Cheyenne tribal governments were concerned about the development of coal minerals that were not under tribal control. The Northern Cheyenne was concerned about allottees living off the reservation facilitating the development surface strip mines to the detriment of tribal members living on the reservation. The Crow Tribe was in favor of developing mineral resources and was concerned about losing tribal control of mineral deposits through the sale of potential allottee development to private energy companies (Ambler, 1990). The BIA had also issued undervalued coal mineral leases to energy companies on both reservations as well as Fort Berthold prior to the expiration of communal tribal mineral ownership. The leases were rescinded upon the objection of the tribes as the leases were severely undervalued. The tribes felt that the tribal governments should control all future coal mineral development and Congressional legislation and Supreme Court rulings granted mineral rights to a majority of the allottee mineral interests(Ibid).

Fee Land Development

Landowners off the reservation face similar difficulties when faced with mining permits. Landowners must be compensated for impacts and disruption to groundwater sources. The fee land owners in the watersheds will also have to agree to sell or lease their surface land and agree to be compensated for damages to water resources. Surface fee land owners have been allowed to object to development of federal minerals under their lands since 1977.

Tribes have faced problematic policy challenges as outlined with the development of coal, oil and gas. The Three Affiliated Tribes entered into undervalued mineral leases on highly fractionated lands. The rights of allottee land and mineral owners continue to be overlooked by both tribal and federal governments in leasing agreements. The tribes have experiences difficulties in maintaining regulatory and resource management programs despite increased mineral income. Few policy interventions have been successful for the Three Affiliated Tribes and other tribes wishing to develop mineral resources on highly fractionated lands should expect to encounter similar challenges.

LAND USE

Fractionation Interventions

The problem of fractionation is often framed in terms of the administrative costs that the extensive record keeping has burdened BIA land management offices. Finding a solution to the problem promotes consolidating the small interests to alleviate the administrative expense. The cost does prove enormous and the result is to produce extremely small lease income dividends to owners. The income received is a fraction of the administrative costs associated with managing the tract. The BIA is responsible for managing Individual Indian Money accounts on behalf of the individual owners of the allotment tracts.

Tribal Government vs. Allottee Land Owners

Tribes and allottees are often at odds with regard to managing water resources, developing mineral rights, and land use. The tribe will have an agenda for the use of tribal lands, that may

not consider the lands owned by allottees. The allottee lands are subject to the agreements entered by the tribe. Allottees have little rights in split estate surface ownership.

Very few allottees can participate in water resource management on their lands as many highly allotted tracts remain idle. Those allotted lands located by irrigation infrastructure may not be able to use those facilities due to disrepair and age of infrastructure. Allotted lands that are not idle are likely leased by non-Indian leasees that typically maintain the land for grazing, non-agriculture use.

Income Generation

Over 50 percent of allotment lands held by more than one owner remain idle or generate no income. Along with lower mineral resource and surface land appraisal, highly fractionated lands often remain idle. "It is estimated that more than half of Indians' jointly owned trust lands are currently idle or generating no income, and other economic analyses repeatedly demonstrate that reservation land is categorically less productive than similarly situated off-reservation land. In many cases, it is simply too expensive to transact at all—much less, profitably—within this unpredictable and cumbersome legal landscape."(Shoemaker 2017) The lands generate less income than comparable fee lands.

Consequently, the land use of these idle lands can be used to project the percentage of land owners actively using tribal water resources as a portion of their allotted PIA right. We can

assume that the water resources are not being used or managed on half of the allotment tracts that are owned by 2 or more allottee heirs.

The Crow Irrigation Project, CIP, contains 63,365 acres in eleven irrigation projects. The irrigation systems were constructed on the reservation lands from 1885 to 1940 (DOWL HKM 2007). The last accounting of lands actually serviced by the projects in 1999 with 28,514.19 acres held in trust and 18,202.65 acres in fee land status. Approximately, 61 percent of lands within the CIP service area are trust lands.

Fee land owners would be more likely to be actively using and generating income from the land, and therefore employing associated water resources. The state appropriated rights are subject to revocation if the land owner does not continually use the allocated amount. The fee land owners with appropriation rights to water, have more incentive to actively use water rights.

The fee land owners have existed with land title and water use title whereas the allottee owners are not exercising the right to water without the benefit of land use authority. Where allottees are able to generate income from their tracts, they would be more likely to participate in the management of the land.

Typically fee land owners on the reservation have acquired tracts located in alluvial valleys with access to river water sources. Allottees wishing to develop irrigation infrastructure on their lands were often indebted to the federal government for the construction of the facilities as well as

operation and maintenance expenses. This presented another means for allottees to lose title to their lands prior to the IRA and other legislation that prevented loss of allottee title.

Cobell Land Buy Back

The Crow Tribe has been increasingly purchasing fee lands and formerly allotted lands on the reservation in the attempt to restore the land base to tribal ownership within the reservation.

The Obama administration has been favorable to returning fee land on tribal land bases to tribal trust status. The Claims Resolution Act of 2010 provided the means for tribes to purchase highly fractionated land interests from allottee owners through the Land Buy Back program.

Despite recent legislation attempting to address the problem, allotments continue to remain highly fractionated. Several probate reform acts have been implemented to reduce the degree to which lands will have an increased amount of owners. Currently, lands with less than five percent ownership interest will be transferred to one heir only, the oldest living heir.

Restoring Tribal Control - Tribal/BIA Role

A benefit to transferring the fractionated allotment titles to the tribe are that the lands are less likely to be lost through sale to non-Indian landowners and transferred to fee land after the tribes take ownership. Where the tribal government owns significant land interests, the tribe can use collective power to demand higher lease prices and set minimum pricing levels across the reservation land base. For majority fractionated individual interests, the Bureau of Indian Affairs

assumes leasing approval authority and may not necessarily advocate for collecting higher leasing rates.

Better Understanding of the Role and Problems Fractionation Presents

After the Land Buy Back program, within highly fractionated tracts, the tribe and allottee owners will now own tracts of land allotted through The Crow Act as well as prior allotment acts on the reservation. The consolidation of allottee ownership interests provide adequate incentive for the Department of Interior and BIA to attempt to address the fractionation problem, however, proposed policies do little to protect the allottee interests. The land is staying in tribal trust but is transferred from the individual allottees and their descendants to the tribal government. All parties have no incentive to advocate for and protect allottee rights. The tribal government will have more control over regions where it owns the entire land surface. Tribal officials can develop the tracts without having to consult with individual allottees or involve the BIA on behalf of individual owners. The BIA's responsibility is simplified when it has to only deal with the tribe, and can approve land use and development leases, which are generally more uniform under sole tribal control. The BIA and Department of Interior incur less expense in not having to administer highly fractionated allotment tracts.

The original intent of the allotment to eventually dispose the individual Indian of land is ultimately on course to achieve its goal. The Department of Interior should implement more measures to assess the fractionation problem on each reservation with allotments. The BIA has to maintain its trust responsibility to allottee owners. All federal entities up to Congressional level

are obligated to uphold the rights of the allottee owners. Further research on the extent of the fractionation problem would benefit from updated data on allottees' ownership interest.

Furthermore, allottee interests will continually diminish. As tribal enrollments grow, less individual members will be able to own and control allottee land within the reservation. There are currently 14,000 enrolled Crow tribal members. Allotments were issued to approximately 4,000 individual members. After several generations, few tribal members are sole owners of an allotment tract.

Allotments are one of the only means for individual tribal members to participate in land use and resource management. These original tracts were the foundation for preserving the land base of the tribe when treaty territories were being carved out. The allottees maintain unique property rights to their lands and their title rights must be upheld by the presiding federal entities.

Crow Tribe Policy Interventions

A few successful policy interventions were implemented early in the Crow Tribal government's formation. Since then, the relationship with the federal government for the tribe has been a receivership of regulations imposed on and occasionally bestowed upon it.

Crow Act

The Crow Act may have been an early template for how tribes would state and effectively claim sovereignty. The act outlined limitations on non-Indians and served as a means to preserve tribal control of mineral and water resources for the tribe and allottee owners. Since the passage of the act, no other legislation has been as influential to the modern development of the tribe. It was the tribe's last comprehensive attempt at preserving tribal and allottee rights prior to the formation of tribal IRA governments.

The Crow Tribe has attempted to enforce Section 2 of the Crow Act preventing large fee land holders. The tribe filed suit against the Campbell Farming Corporation that owned over 45,000 acres in fee title on the reservation in 1994. The Tribe lost their appeal of a motion to dismiss the suit in the 9th Circuit Court of Appeals (Crow Tribe of Indians v. Campbell Farming Corp.) The Court upheld the District Court of Montana's decision to dismiss the case based on language clarity of the plaintiff identified in the Crow Act. The case was also dismissed based on the expiration of the statute of limitations in Montana.

The Crow Act did uphold its statutes through the critical period of 1920 to 1934 when the tribe was most at risk of losing it's land base. The Act also preserved mineral resources for the tribe and attempted to preserve the Big Horn Canyon from being taken by eminent domain. Crow students were allowed to attend local schools that were built in the tribal communities. This may have been to ensure that Crow children would attend local schools and were not forced to attend boarding schools outside the reservation. Less pertinent statutes were not upheld such as offering

homestead tracts to war veterans, where such statutes were likely included as a means to appease the federal government.

Although the Crow Tribe chose not to accept the IRA model for governance, the tribe did benefit from the new era of tribal governance. The Indian Reorganization Act closed the reservation border to homesteaders and prevented any further allotment to Indians. The IRA held off further erosion of tribal reservation land base and loss of mineral rights. In the IRA era, mineral and land title of the ceded strip were restored to the tribe.

SUMMARY

In discussing the legacy of legal frameworks in Indian country, the perspective of the tribal government and the individual tribal member is highlighted. A more thorough account of the policy challenges posed are outlined to address further erosion of the tribe's ability to maintain control of it's remaining land base, and mineral and water resources, and tribal members' entitlement to those resources.

An account of resource management challenges on tribal lands from the perspective of individual tribal members and tribal government provides a more informed view of the regulatory environment. These policies may detrimentally affect more than one form of resource management. Fractionation affects land use management and water and mineral resource management. This may arise from the fact that the allottee owner has minimal or no authority to actively manage the highly fractionated land tracts. Tribal governments do not benefit from the

separation of allottee owners' authority from vast land bases within its sovereign boundaries. The federal government often then assumes the authority in advancing land use and mineral resource leases on highly fractionated lands and will continue to bare administrative burdens to the complex land title.

This is one factor that detrimentally impacts the management of every resource associated with the land base. I have outlined challenges incurred with each form of resource management in the regulatory environment pertaining to tribal lands. Some challenges are exacerbated by weak regulatory structures within the tribal government. A common finding was that tribes need to develop and build capacity to effectively manage their resources. The development and extraction of natural resources will magnify negative impacts to water resources and land use where the tribe does not have sufficient management capacity of each resource.

Decisions directing tribal government policies need to be made with allottee owners' rights in mind. The protection of these rights should not be the responsibility of the tribal government alone. Particularly, when the tribal government may not be in the position to run basic natural resource management programs.

The Crow Water Settlement projects, including the rehabilitation of the Crow Irrigation Project, will provide a means for irrigation service to reach tribal and allottee lands. In addition to the infrastructure investment, the tribal water code will enforce a water management program for all water users on the reservation. The tribal water code is one of the few legislative measures that

recognizes and addresses allottee entitlement to water. When the allottees are given the entitlement and means to use the water resources, allottee lands will be more effectively managed and preserved for individual allottees. The same case can be made for tribe, itself, and the tribal reserved water rights, of which the allottee shares an interest.

Lands with more Indian owner authority will be more likely to generate income. Lands that are generating income for land owners are likely to be better and more actively managed. When tribal members are given the authority, resources, and infrastructure, allottee and tribal land owners will be better positioned to manage and benefit from their lands.

CONCLUSIONS

My thesis has focused on the relationship between water resources and natural resource extraction, particularly the development of coal resources. In examining how tribal land tenure policy impacts water resource management on tribal lands, I wanted to address the lack of regulatory authority and institutions within the Crow Tribe. In order to enforce regulatory programs associated with the tribal water code and to manage natural resources, the tribal government will need to have the capacity to operate effective programs. This ability of the tribe to manage its resources represents a critical step toward self-determination and ultimately toward exercising tribal sovereignty.

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