Table 1-1. Water quality concentrations of TDS, sulfate and barium of some outfalls and downstream sampling locations of oil and gas facilities in the Bighorn, Platte and Powder River basins.

Basin	Associated Oil/Gas Facility	General Location	Drainage or Outfall	Avg - TDS	Max-TDS	Avg - Sulfate	Max-Sulfate	Barium	Data source
Platte (Wind) River	S. Casper Creek field	North Platte and tributaries	Poison spider & Oregon Trail	3,153	3,450	1,561	1,746		Gene R. George & Assoc. 2005 (2002-2004 data)
Bighorn	Hamilton Dome field	Cottonwood Creek	Cottonwood B, WY0000680, WY0000175	4,011	7,320	1,640	3,270		SWWRC et al. 2002 (2002 data)
Bighorn	Oregon Basin oil field	Dry Creek	Maverick Springs	1,161		492			M. Blakesly, pers. comm
			Chatterton	1,204		511			
			Circle Ridge	703		80			
			Byron Battery #2 Injection			1,815			
			Garland Unit Battery	2,900		1,450			
			Battery #1 South Outfall	4,475	4,600	2,080	2,180		
			Battery #2 North Outfall	5,345	5,390	2,735	2,950		
			Battery #3-5 South Outfall	4,530	4,530	1,870	1,870		
			Battery #1 North	5,100		3,085			
			Pitchfork	2,065		772			
			Steamboat Butte - North	3,838		1,690			
			Steamboat Butte - South	1,297		532			
Powder River	Fidelity facilities	Downstream locations	Tongue River	1,508					R. Edds, pers. comm.
			Wrench Ranch	1,054					
			Lake de Smet	830					

Basin	Associated Oil/Gas Facility	General Location	Drainage or Outfall	Avg - TDS	Max-TDS	Avg - Sulfate	Max-Sulfate	Barium	Data source
Powder River	Anadarko facilities	Outfall	Alpha Pod #2	2,400		<10		1.7	J. Cline, pers. comm.
		Outfall	County Line Alpha Pod	3,000				1.9	
		Outfall	Delta/Epsilon Skew Inlet IMR	2,800	3,500	ND	ND	3.8	
		Outfall	County Line Beta Pod #1	2,708		64			
Powder River	Lance operations	Powder River	Powder River water compositions typical of Lance CBNG operations	2,500		4		1.6	D. Stephens, pers. comm.
Powder River	Salt Creek fields	Salt Creek	Salt Creek at main discharge area	3,995	4,580	1,132	1,680		RETEC 2004
		Salt Creek	Salt Creek downstream of discharges	3,876	4,610	1,235	1,700		
		Powder River	Powder River downstream of discharges	2,202	3,640	920	1,340		
			Petition Proposed effluent limits:	**2,000**		**500**		**0.2**	

Notes:
all results in mg/l
Data reflects samples collected between 2002 and 2006.
ND = non-detect

Table 1-2. Wildlife species recorded in the Cottonwood Creek area near the confluence of the Bighorn River.

Mallard duck
Blue-winged teal
Canada goose
Great blue heron
Sandhill Crane
Wilson's phalarope
Spotted Sandpiper
Killdeer
Mountain Plover
Gray partridge
Chukar
Sage grouse
Ring-necked pheasant
Mourning dove
Northern harrier
Red-tailed hawk
Golden eagle
Bald eage
Prairie falcon
Merlin
American kestrel
Great horned owl
Borrowing owl
Yellow-billed cuckoo
Belted kingfisher
Common nighthawk
Western kingbird
Cassin's kingbird
Horned lark
Black-billed magpie
Western meadowlark
Brewer's blackbird
Pine siskin
Vesper sparrow
Savannah sparrow
Grasshopper sparrow
Lark sparrow
Song sparrow

Table 1-4. Birds and mammals surveyed in the South Casper Creek field near Poison Spider Creek.

Mallard
Gadwall
Wigeon
Ruddy Duck
Virginia Rail
Sora
American Coot
Killdeer
Baird's Sandpiper
California Gull
Turkey Vulture
Golden Eagle
Northern Harrier
Greater Sage Grouse
Mourning Dove
Western Kingbird
Say's Phoebe
Western Flycatcher
Horned Lark
Unknown Swallow
Black-billed Magpie
House Wren
Gray Catbird
Sage Thrasher
European Starling
Wilson's Warbler
Common Yellowthroat
Brewer's Sparrow
Chipping Sparrow 1
Savannah Sparrow
Vesper Sparrow
Unknown Sparrow
Lark Bunting
Western Meadowlark
Brewer's Blackbird
Northern Oriole

Table 1-5. Exposure parameters for each indicator receptor.

Receptor class	Species	IR_{water} (L-day)	IR_{food} (kg wet-day)	BW (kg wet wt)
Rodent	rat	0.046 EPA 1988	0.028 US EPA 1988	0.35 US EPA 1988
Ruminant-juvenile	growing steer	29.5 Winchester and Morris 1956	6.24 NAS 2000	300 NAS 2000
Passarine bird	mallard	0.064 US EPA 1993	0.251 US EPA 1993	1.13 US EPA 1993
Ruminant-adult	adult steer	34.8 Winchester and Morris 1956	7.76 Winchester and Morris 1956	800 NAS 2000

Notes:

IRwater = ingestion rate of water

IRfood = ingestion rate of food

BW = body weight

Table 1-6. Ingestion rate equations.

Equation	Species	Reference
$IR_{water} = 0.059(BW)^{0.67}$	for birds (L-day)	Calder and Braun 1983
$IR_{water} = 0.10(BW)^{0.7377}$	for laboratory mammals (L-day)	US EPA 1988
$IR_{food} = 0.648(BW)^{0.651}$	for birds (g-day)	Nagy 1987
$IR_{food} = 0.056(BW)^{0.6611}$	for laboratory mammals (kg-day)	US EPA 1988

Notes:

IRwater = ingestion rate of water

IRfood = ingestion rate of food

BW = body weight

Table 1-7. Barium toxicity study database and selected studies to derive water quality concentrations

Constituent	Receptor type	Reference	Chemical Form Administered	Organism	Route of Administration	Endpoints	Study Duration	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)
Barium	**bird**	**Johnson et al. (1960)**	**BaOH2**	**chicken (chicks)**	**oral in diet**	**mortality**	**4 weeks**	**208**	**417**
Barium	bird	Taucins et al. (1969)	BaCl2 and BaCO3	chicken	oral in diet	weight gain, mortality		N/A	10.05
Barium	mammal (rat)	Borzelleca et al. (1988)	BaCl2	rats	gavage	growth, reproduction	10 days	138	198
Barium	**mammal (rat)**	**Dietz et al. (1992)**	**BaCl2**	**rats**	**oral in water**	**growth, reproduction, development, mortality**	**92 days**	**61.1**	**121**
Barium	mammal (rat)	McCauley et al. (1985)	BaCl2	rats	oral in water	absorption	16 to 46 weeks	N/A	N/A
Barium	**mammal (rat)**	**Perry et al. (1983)**	**BaCl2**	**rats**	**oral in water**	**growth, hypertension**	**16 months**	**13.2**	**N/A**
Barium	mammal (rat)	Schroeder and Mitchener (1975)	BaCl2	rats	oral in water	growth	lifetime	0.25	N/A
Barium	mammal (rat)	Tardiff et al. (1980)	BaCl2	rats	oral in water	adrenal weights	90 days	45.7	N/A

Notes:

Bolded text indicates studies selected to derive recommended water quality benchmarks for barium, sulfate and TDS.

Table 1-9. Sulfate toxicity study database and selected studies to derive water quality concentrations.

Constituent	Receptor type	Reference	Chemical Form Administered	Organism	Route of Administration	Endpoints	Study Duration	NOAEL (mg/kg/d)	LOAEL (mg/kg/d)
Sulfate	**bird**	**Adams et al. (1975) (exp 1)**	**Na2SO4, MgSO4**	**chicken (hens)**	**oral in water**	**water/food intake, reproduction, mortality**		**101.2**	**404.9**
Sulfate	bird	Adams et al. (1975) (exp 2)	Na2SO4, MgSO4	chicken (hens)	oral in water	water/food intake, reproduction, mortality		303.7	1619.2
Sulfate	**bird**	**Harter and Baker (1978)**	**Na2SO4, KSO4**	**chicken**	**oral in diet**	**growth**	**28 days**	**N/A**	**288.3**
Sulfate	bird	Katz and Baker (1975)	KSO4	chicken	oral in diet	feed efficiency, growth rate	7 weeks	1.1	N/A
Sulfate	bird	Krista et al. (1961)	Na2SO4	chicken	oral in water	egg production, intake rate		1196.0	1214.4
Sulfate	bird	Leach et al. (1960)	L-methionine	chicken	oral in diet	feed efficiency, growth rate	8 days	N/A	81.9
Sulfate	bird	Sasse and Baker (1974)	L-methionine	chicken	oral in diet	growth	8 days	N/A	81.9
Sulfate	mammal (livestock)	Digesti and Weeth (1976)	Na2SO4	growing cattle	oral in water	food/water intake, weight gain	90 days	245.8	N/A
Sulfate	**mammal (livestock)**	**Embry et al. (1959) (exp 1)**	**Na2SO4**	**growing cattle**	**oral in water**	**food/water intake, weight gain**	**84 days**	**489.2**	**698.9**
Sulfate	mammal (livestock)	Embry et al. (1959) (exp 2)	Na2SO4	growing cattle	oral in water	food/water intake, weight gain	112 days	604.7	N/A
Sulfate	mammal (livestock)	Grout et al. (2006) (exp 1)	Na2SO4	growing cattle	oral in water	water intake	11 days	421.9	N/A
Sulfate	mammal (livestock)	Grout et al. (2006) (exp 2)	MgSO4	growing cattle	oral in water	water intake	11 days	270.1	170.3
Sulfate	mammal (livestock)	Johnson and Patterson (2004)	natural water sources	growing cattle	oral in water	food/water intake, weight gain (feedlot)	112 days	N/A	251.4
Sulfate	mammal (livestock)	Johnson and Patterson (2004) (exp 1)	natural water sources	growing cattle	oral in water	food/water intake, weight gain	63 days	570.7	N/A
Sulfate	**mammal (livestock)**	**Johnson and Patterson (2004) (exp 2)**	**natural water sources**	**growing cattle**	**oral in water**	**food/water intake, weight gain (open range)**	**112 days**	**360.4**	**N/A**
Sulfate	mammal (livestock)	Loneragan et al (2001)	natural or treated water sources	adult steers	oral in water	water intake, growth, feed efficiency	112 days	N/A	N/A
Sulfate	mammal (livestock)	Patterson et al. (2002)	natural/well water sources	adult steers	oral in water	food/water intake, weight gain, PEM	84 days	55.7	380.6
Sulfate	mammal (livestock)	Patterson et al. (2003)		growing cattle	oral in water	food/water intake, weight gain	3 months	N/A	N/A
Sulfate	mammal (livestock)	Patterson et al. (2004)	Na2SO4	adult cows	oral in water	water intake, weight gain, reproductive impacts	84 days	47.7	326.8
Sulfate	mammal (livestock)	Ward and Patterson (2004)	Na2SO4	adult cows	oral in water	water intake, weight gain, reproductive impacts	84 days	47.7	351.8
Sulfate	mammal (livestock)	Weeth and Caps (1972)	Na2SO4	growing cattle	oral in water	water intake, growth, feed efficiency	30 days	365.8	N/A
Sulfate	mammal (livestock)	Weeth and Hunter (1971)	Na2SO4	growing cattle	oral in water	food/water intake, weight gain	30 days	11.0	343.5
Sulfate	mammal (livestock)	Zimmerman et al. (2003)	MgSO4	cattle	oral in water	water intake, behavior	unknown	N/A	N/A
Sulfate	**mammal (rat)**	**Brown and Gamatero (1970)**	**Na2SO4**	**rats**	**oral in diet**	**feed efficiency, growth rate**	**28 days**	**18.08**	**N/A**
Sulfate	mammal (rat)	Cohen et al. (1958)	DL-methionine	rats	oral in diet	growth	72 days	N/A	412.8
Sulfate	mammal (rat)	Daniel and Waisman (1969)	L-methionine	rats	oral in diet	growth	24 days	172	516
Sulfate	mammal (rat)	Smith (1973)	methionine and CaSO4	rats	oral in diet	sulfate metabolism	7 days	16	N/A
Sulfate	**mammal (rat)**	**Weeth and Hunter (1971)**	**Na2SO4**	**rats**	**oral in water**	**growth**	**unknown**	**668.0**	**N/A**

Notes:

Bolded text indicates studies selected to derive recommended water quality benchmarks for barium, sulfate and TDS.

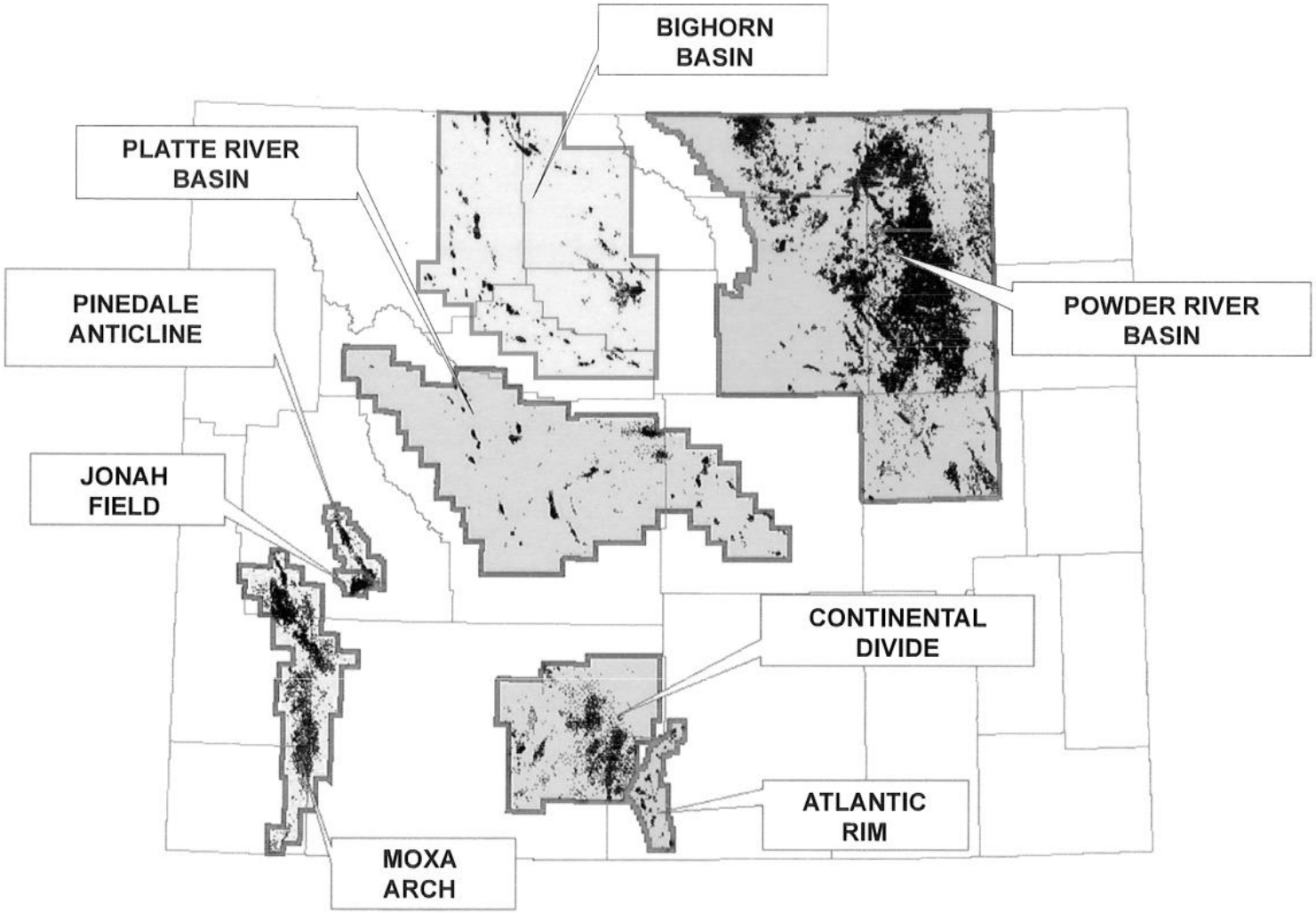

Figure reproduced from Wyoming Game and Fish Department, http://gf.state.wy.us/

GEOMEGA 1/4/07 C06450A WDEQ TDS Standards	Current active oil and gas wells in Wyoming.	**Figure** 1-1

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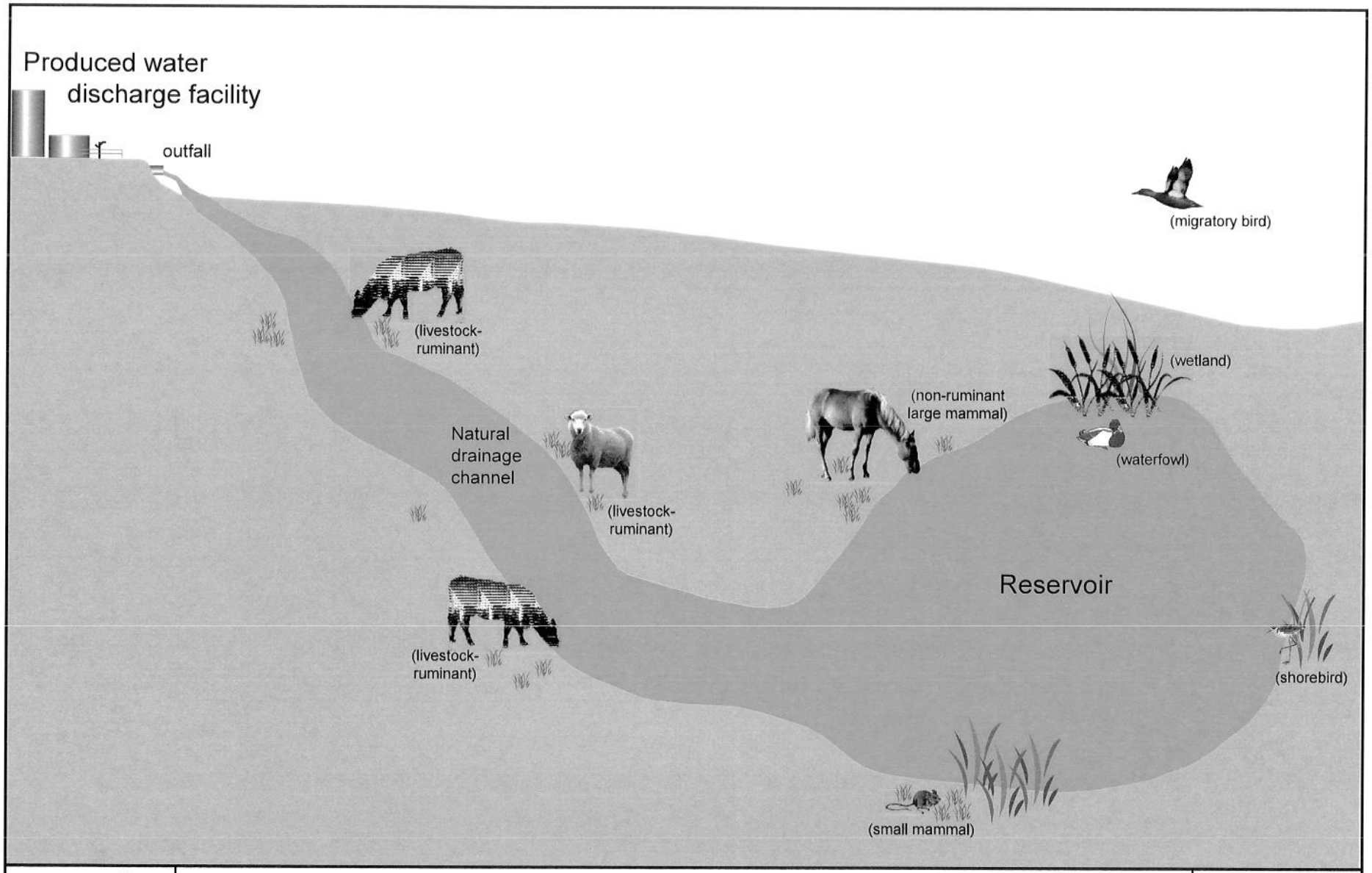

GEOMEGA

1/4/07

C06450A
WDEQ TDS Standards

Ecological conceptual model of source-receptor relationships between produced water discharge facilities and livestock and wildlife receptors.

Figure
1-2

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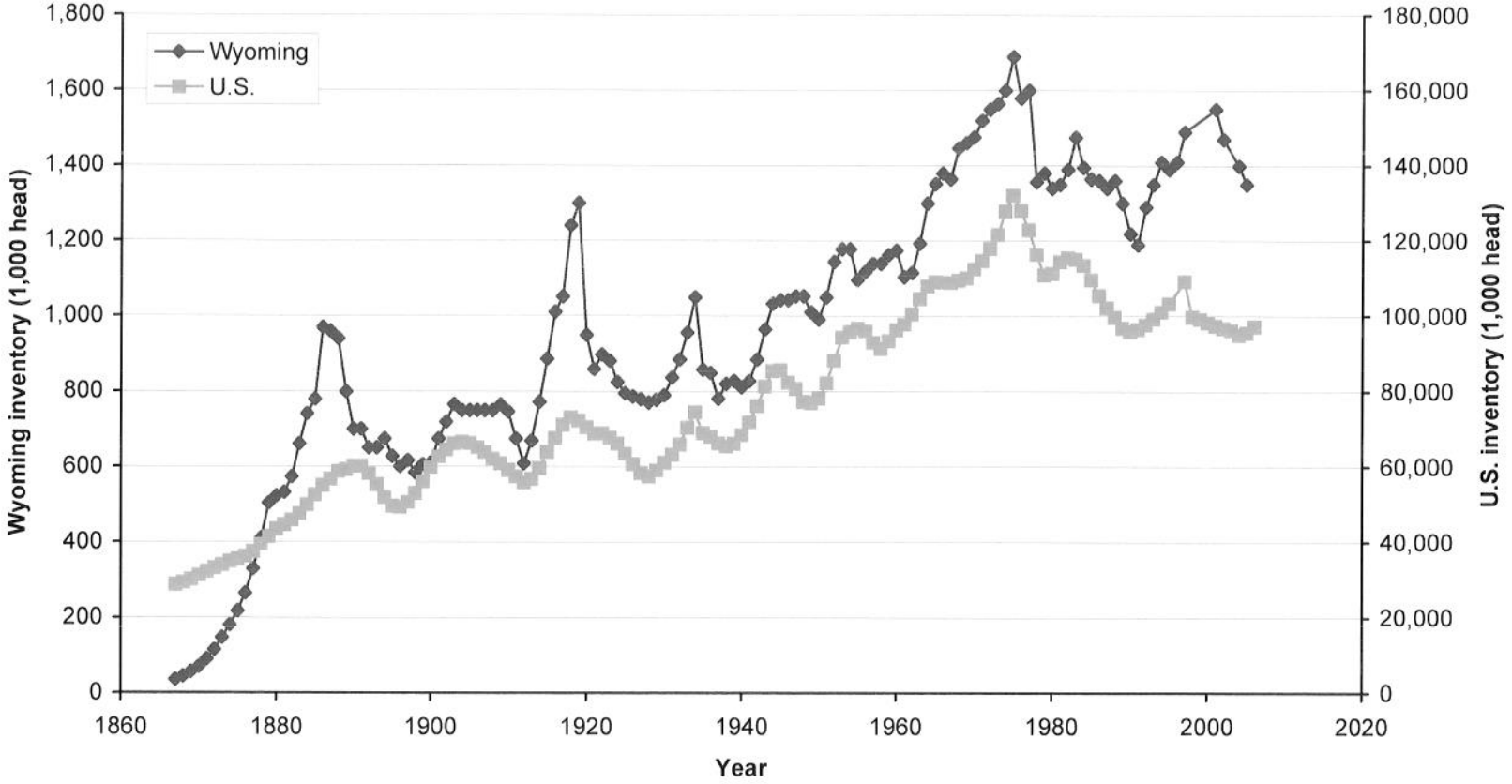

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C06450A
WDEQ TDS Standards

Cattle and calf inventories (1,000 head) for Wyoming and the U.S. between 1860 and 2006.

Figure
2-1

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Appendix A

Interviews with Local Ranchers in the Bighorn and Powder River Basins

January 16, 2007

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Introduction

A field-based data gathering and analysis exercise was undertaken to gather effects data specific to users of water bodies in Wyoming. In-person and telephone interviews were conducted on a handful of ranchers in the Bighorn and Powder River structural basins in Wyoming to gather information on the nature and extent of produced or natural water usage and effects noted from use. Where available, data was obtained from these ranchers to quantitatively evaluate the effects from exposure to the various sources of water. Interviews were given with:

Name	Basin Affiliation
1. Mr. Greg Flitner, and Mr. Dave Flitner	Bighorn
2. Mr. Mick McCarty	Bighorn
3. Mr. Don Meike	Powder River
4. Dr. Trey Patterson	Powder River
5. Mr. Don Schlaf	Bighorn
6. Mr. Frank Shepperson	Powder River

The following sections describe the information given by the various ranchers during the interviews.

In-person interview with Mr. Greg and Dave Flitner, 10/24/06

The Flitners manage beef cattle, sheep and some horses. They ranch all their cows (~950 head in 2005) in the spring and fall on BLM lands adjacent to Dry Creek near the Cody Highway. Dry Creek has average sulfate and TDS concentrations of 2,720 mg/L and 5,080 mg/L, respectively. Produced water sources account for 100% of water availability on these lands, because drought has eliminated other natural reservoirs. The Flitners have additional, private lands in the Bighorn basin and leases on Heart Mountain and Johnson County, and the cattle typically graze there during the summer months. Water resources in these areas originate from natural sources, with estimated concentrations of 1,180 mg/L and 2,310 mg/L sulfate and TDS, respectively, based on average background concentrations.

In 2005, herd size on produced water pastures totaled 950 cows. Total herd size was 950 cows, 800 yearlings, 150-200 qtr horses. Due to drought, herd size has been reduced an estimated 50% since 1997.

The Flitners noted no variation in cattle quality between lands containing produced water discharges and natural waters, and in fact related that sometimes production from pastures utilizing produced water is better due to increased water availability. No cattle refusal of water was noted. Weaning weights were recorded in calves that started out the spring in various produced water and natural water-associated pastures (Table A-1). These records demonstrate that no adverse effect on weaning weights occurred on calves that drank the produced water containing elevated sulfate and TDS relative to natural sources. Seven-year average weaning weights from the Dry Creek (produced water) pastures were in fact higher than the pastures that did not have produced water availability. The Flitners do not utilize a supplemental mineral program.

If produced water were to stop being available, Mr. Greg Flitner estimates they would have to cut ~50% of the herd size, with associated employee cuts. The Flitners currently employ 40 full and part time jobs. In addition, the Flitners stated that loss of the produced water in Dry Creek would result in them vacating these pastures, as they would no longer be economic to graze. Conflicts between cattle, wildlife, and wild horses would be expected to increase without the produced waters.

In-person interview with Mr. Mick McCarty, 10/23/06

McCarty Ranching, LLC, a family owned company, operates several ranches in the Bighorn basin, with a total herd size of about 2,000 head. They utilize 4 pastures totaling 1600 acres of private and 28,000 acres of BLM lands which contain exclusively produced water sources originating from the Oregon Basin facility. The herd size on these lands is between 400 and 600 head, all cattle. The pastures include Avon, South/North Oil Wells, Lake and Highway pastures. The produced water from the Oregon Basin is discharged into Dry Creek, which runs throughout these pastures. Oregon Basin produces approx. 500,000 barrels of water/day, of which 100,000 BPD is surface discharged and the rest reinjected (M. Blakesley, pers. comm). Surface water concentrations near these pastures average 4,830 mg/L TDS and 2,300 mg/L sulfate, with maximums as high as 5,390 mg/L TDS and 3,100 mg/L sulfate (measured between 2002 and 2006). Lake pasture has 1 water well in addition to the produced water sources. Mr. McCarty noted that the cattle seem to prefer drinking the water near the outfall point where the produced water is discharged to Dry Creek, perhaps due to the warmer temperature of the water.

The cows utilize the produced water pastures between November and May. Two out of 4 pastures are used per year (allowing a 2-year fallow period). The cattle only forage on the open range, plus they are given a mineral supplement package and protein formulated by Dr. Trey Patterson. They prefer winter fat, kochia, grasses, and salt sage where available. There are other ranches owned or leased by McCarty Ranching LLC that receive only natural water sources.

Upon acquiring the land associated with produced water sources, Mr. McCarty Ranching, LLC retained Dr. Trey Patterson to design a supplemental protein and mineral package to maximize production from these pastures. Because Dr. Patterson's experience is that the higher sulfates in the water can render copper and other trace metals less available for absorption by the cattle, the mineral package contains a chelated copper form which remains bioavailable even when consumed with water containing high sulfates. Dr. Patterson related that the cattle in the area perform very well, above industry standards and production numbers.

Mr. McCarty noted that there were no adverse effects on the livestock that use the pastures with produced water as compared to their pastures at which there are natural water sources. He related the following measurement comparisons:

Measure:	Produced water	Natural water
1) Body condition	5	same
2) Breeding percentage	96%	same
3) Death rate	2%, cows	same
4) Calf weaning rate	94-95%	same
5) Weaning weight	Varies by calving time.	same

A few other natural water bodies used to exist on some of the land but have dried up due to drought. The pastures east of highway 120 rely exclusively on produced water sources. The droughts have also reduced their total herd size, from about 2,500 to 1,700 this year, and perhaps another drop in herd size next year.

The presence of produced water on the BLM lands has resulted in cost savings for McCarty Ranching LLC, since obtaining other water sources (wells, hauling water) would be very expensive. Ranching would not be economic to them without the produced water. He speculates that it would also affect hundreds of other ranchers in the Bighorn basin.

Telephone interview with Mr. Don Meike, 11/1/06

Mr. Don Meike ranches cattle (500 head) and sheep (2,500 head) on 45,280 acres along the in the Powder River basin near the juncture of Salt Creek and Powder River. He has ranched in this area since 1901. Herd sizes have declined 50% due to drought and rabbit infestation. Mr. Meike recalled that before 1950, Salt Creek and Powder River were unusuable 9 months out of the year due to the high salinity concentrations in the water. Cattle were typically moved to a meadow pasture or to lower Powder River, or to land in the mountains. In addition to the chemical concentrations causing adverse effects on cattle, physical risk of cattle getting stuck in the muddy river bottom was a concern.

With the advent of produced water, Salt Creek and Powder River are now usable on a year-round basis. Management of the herds has increased, and flexibility of management is greater, as a result of the increased water supply. No adverse effects on the cattle herds were seen using produced water sources compared to natural water sources previously. The cattle graze on the open range and also receive a mineral supplement package.

Telephone interview with Dr. Trey Patterson, 11/1/06

Dr. Patterson is a manager at the Padlock Ranch located in north central Wyoming and Southern Montana. The ranch is large, one of the top six in the US. From their website (www.padlockranch.com), the Padlock Ranch employs 45 people, and raise and market over 9,000 calves a year. The ranch grazes cow-calf pairs on native grassland in Montana and Wyoming. Grazing lands are a mixture of private and leased land. In support of grazing operations, the ranch irrigates 5,000 acres of farmland, including an annual production of 10,000 tons of dry hay, 20,000 tons of corn silage, 15,000 tons of hay silage and barley. The production supports the winter feeding program and feedlots.

Cattle graze year round in the area. The ranch lands receive produced water from a CBNG facility near Decker, Montana. The produced water is discharged to a reservoir which is fenced off, and into stock tanks.

Water quality samples are taken periodically.. Concentrations generally reported are between 1 mg/L and < 500 mg/L sulfate and up to ~3600 mg/L TDS (as measured in 2001 and 2002). Sodium is a large proportion of the total TDS. At times, the sodium level is high enough that the mineral supplementation program for the cattle is altered.

In contrast, some natural water in the area has much higher sulfate and TDS, between 1,500 and 2,000 sulfate and up to 3,700 TDS. Produced water contributions have helped to lower the levels of sulfate and TDS in year-round water that cattle consume.

No negative effects of consuming produced water on cattle have been seen or noted. Weaning weights recorded over several years do not indicate any difference between cows raised on land with produced water compared to land with other water sources. Generally, Dr. Patterson notes that the increase in available water has resulted in an increase in cattle performance and forage utilization. Costs to the rancher are reduced because additional water does not have to be hauled.

The drought has affected manynatural water sources, limiting their use or rendering them unususable. At times, the ranch has had to wean earlier due to drought levels.

Dr. Patterson also related that his experience with cattle ranch in South Dakota. Natural water sources at the ranch containing about 4,000 mg/L sulfates resulted in incidences of polio in the cattle that consumed this water source. A supplemental mineral program was instituted there to help mitigate the effects of the high sulfates, and although some cattle continued to be affected, the ranch continued to use the water source because it was the only water available in the area. Despite this, the ranch was able to make a profit.

Telephone interview with Mr. Don Schlaf, 11/1/06

Mr. Schlaf has ranched his lands since 1904. He currently ranches cattle (~300 head), and historically has also ranched sheep. Mr. Schlaf utilizes BLM pastures associated with the Dry Creek drainage, east of Cody. These allotments include Elk, 15-mile and Dorsey. He rotated his cattle on a 5-month schedule on each of the pastures at Dry Creek. At times, Dry Creek was the only source of water available as other stock ponds had dried up. Mr. Schlaf had a cow die inexplicably in the past, and sent brain tissue samples into the veterinarian for analysis of sulfate levels, as sulfates were typically higher in Dry Creek than for other water bodies. The results showed that the sulfate levels in Dry Creek did not cause the death of the cow. Lab results indicated, "the amount of sulfur in the tissue sample was not sufficient to cause polio."

Mr. Schlaf also related that, in the past when Dry Creek was an intermittent stream, incidences of polio and blindness occurred in his cattle as a result of drinking evapoconcentrated pools of water.

Telephone interview with Mr. Frank Shepperson, 11/1/06

Mr. Frank Shepperson owns ~1,500 head of cattle on 80,000 acres in the Salt Creek valley of the Powder River basin in Wyoming (Commerce, Natrona and Johnson counties). The ranch includes the bulk of the Salt Creek oil field. It has 25.8 miles of frontage on Salt Creek, including the sections immediately adjacent to the discharge points. It also has access to several tributaries (such as Coal Draw and Castle Creek).

Salt Creek is the main water source on his lands. Other creeks in the area (above Salt Creek) include Teapot and Castle creeks, both of which have natural water sources. The natural water sources contain an average of 2,000 mg/L TDS and 1,200 mg/L sulfates in 2003 and 2004, but concentrations are at times as high as 4,000 mg/L sulfate and 7,000 mg/L TDS. Downstream of produced water inputs, concentrations average 1,100 mg/L sulfate and 4,300 mg/L TDS.

Mr. Shepperson's cattle use both the natural and produced water sources, and he notes that produced water sources are the preferred water to use for his cattle. The use of natural waters in the area have, at times, caused breeding rates and number of head to decline relative to other areas in Wyoming receiving natural water sources. Other effects of the natural water sources included dehydration, blindness, disorientation and death typically due to consumption of evapoconcentrated puddles of water left in the dry creek beds. Wildlife densities also appeared to decline when only natural water sources were available. According to Mr. Shepperson, weight data collected by the University of Wyoming indicated that cattle weights were significantly affected in areas where access was limited to only natural water sources. Conversely, the weight data did not indicate that produced water sources adversely affected cattle weights.

Another positive effect of produced water sources is that the creeks now run year-round, instead of being intermittent. The intermittent nature of the creeks before the event of produced water resulted in isolated, concentrated water puddles surrounded by thick mud. The cattle would not only drink the concentrated water, but would also get stuck in the mud, causing physical injury.

Mr. Shepperson also noted that wildlife appeared to be using the water downstream of the outfalls, and densities appear greater than populations present upstream of the outfalls. Mr. Shepperson speculates that this phenomenon is a result both of changing water quantity as well as quality.