Comparison of Coal Bed Natural Gas-Related Disposal to Receiving Drainage Hydrology Following 70% Conveyance Loss

Antelope Creek Near Teckla, Wyoming (Station 06364700)													
		Alternative											
		2003			2010			2015			2020		
Month	Receiving Drainage Streamflow (cfs)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)
		(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)
Oct	0.4	3.0	0.9	225.0%	10.9	3.3	825.0%	13.5	4.1	1025.0%	12.9	3.9	975.0%
Nov	0.4	3.0	0.9	225.0%	10.9	3.3	825.0%	13.5	4.1	1025.0%	12.9	3.9	975.0%
Dec	0.1	3.0	0.9	900.0%	10.9	3.3	3300.0%	13.5	4.1	4100.0%	12.9	3.9	3900.0%
Jan	0.3	3.0	0.9	300.0%	10.9	3.3	1100.0%	13.5	4.1	1366.7%	12.9	3.9	1300.0%
Feb	0.7	3.0	0.9	128.6%	10.9	3.3	471.4%	13.5	4.1	585.7%	12.9	3.9	557.1%
Mar	2.6	3.0	0.9	34.6%	10.9	3.3	126.9%	13.5	4.1	157.7%	12.9	3.9	150.0%
Apr	1.2	3.0	0.9	75.0%	10.9	3.3	275.0%	13.5	4.1	341.7%	12.9	3.9	325.0%
May	0.6	3.0	0.9	150.0%	10.9	3.3	550.0%	13.5	4.1	683.3%	12.9	3.9	650.0%
Jun	0.1	3.0	0.9	900.0%	10.9	3.3	3300.0%	13.5	4.1	4100.0%	12.9	3.9	3900.0%
Jul	2.5	3.0	0.9	36.0%	10.9	3.3	132.0%	13.5	4.1	164.0%	12.9	3.9	156.0%
Aug	0.4	3.0	0.9	225.0%	10.9	3.3	825.0%	13.5	4.1	1025.0%	12.9	3.9	975.0%
Sep	2.2	3.0	0.9	40.9%	10.9	3.3	150.0%	13.5	4.1	186.4%	12.9	3.9	177.3%

(1) Source: ENSR, October 2005
(2) CBNG Flow reduced assuming 70% conveyance loss
(3) Reduced CBNG Flow divided by Receiving Drainage Streamflow

Comparison of Coal Bed Natural Gas-Related Disposal to Receiving Drainage Hydrology Following 70% Conveyance Loss

Little Powder River above Dry Creek Near Weston, Wyoming (Station 06324970)													
Month	Receiving Drainage Streamflow (cfs)	**Alternative**											
		2003			2010			2015			2020		
		Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)
		(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)
Oct	0.3	5.3	1.6	533.3%	7.3	2.2	733.3%	7.0	2.1	700.0%	6.0	1.8	600.0%
Nov	0.4	5.3	1.6	400.0%	7.3	2.2	550.0%	7.0	2.1	525.0%	6.0	1.8	450.0%
Dec	0.5	5.3	1.6	320.0%	7.3	2.2	440.0%	7.0	2.1	420.0%	6.0	1.8	360.0%
Jan	0.4	5.3	1.6	400.0%	7.3	2.2	550.0%	7.0	2.1	525.0%	6.0	1.8	450.0%
Feb	5.7	5.3	1.6	28.1%	7.3	2.2	38.6%	7.0	2.1	36.8%	6.0	1.8	31.6%
Mar	6.5	5.3	1.6	24.6%	7.3	2.2	33.8%	7.0	2.1	32.3%	6.0	1.8	27.7%
Apr	4.8	5.3	1.6	33.3%	7.3	2.2	45.8%	7.0	2.1	43.8%	6.0	1.8	37.5%
May	7.7	5.3	1.6	20.8%	7.3	2.2	28.6%	7.0	2.1	27.3%	6.0	1.8	23.4%
Jun	3.7	5.3	1.6	43.2%	7.3	2.2	59.5%	7.0	2.1	56.8%	6.0	1.8	48.6%
Jul	1.0	5.3	1.6	160.0%	7.3	2.2	220.0%	7.0	2.1	210.0%	6.0	1.8	180.0%
Aug	2.7	5.3	1.6	59.3%	7.3	2.2	81.5%	7.0	2.1	77.8%	6.0	1.8	66.7%
Sep	0.2	5.3	1.6	800.0%	7.3	2.2	1100.0%	7.0	2.1	1050.0%	6.0	1.8	900.0%

(1) Source: ENSR, October 2005
(2) CBNG Flow reduced assuming 70% conveyance loss
(3) Reduced CBNG Flow divided by Receiving Drainage Streamflow

Comparison of Coal Bed Natural Gas-Related Disposal to Receiving Drainage Hydrology Following 70% Conveyance Loss

(Upper) Belle Fourche River Below Moorcroft, Wyoming (Station 06426500)													
Month	Receiving Drainage Streamflow (cfs)	**Alternative**											
		2003			2010			2015			2020		
		Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)
		(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)
Oct	0.4	14.4	4.3	1075.0%	13.1	3.9	975.0%	9.9	3.0	750.0%	7.3	2.2	550.0%
Nov	1.2	14.4	4.3	358.3%	13.1	3.9	325.0%	9.9	3.0	250.0%	7.3	2.2	183.3%
Dec	1.0	14.4	4.3	430.0%	13.1	3.9	390.0%	9.9	3.0	300.0%	7.3	2.2	220.0%
Jan	0.7	14.4	4.3	614.3%	13.1	3.9	557.1%	9.9	3.0	428.6%	7.3	2.2	314.3%
Feb	8.3	14.4	4.3	51.8%	13.1	3.9	47.0%	9.9	3.0	36.1%	7.3	2.2	26.5%
Mar	23.7	14.4	4.3	18.1%	13.1	3.9	16.5%	9.9	3.0	12.7%	7.3	2.2	9.3%
Apr	5.0	14.4	4.3	86.0%	13.1	3.9	78.0%	9.9	3.0	60.0%	7.3	2.2	44.0%
May	7.2	14.4	4.3	59.7%	13.1	3.9	54.2%	9.9	3.0	41.7%	7.3	2.2	30.6%
Jun	3.6	14.4	4.3	119.4%	13.1	3.9	108.3%	9.9	3.0	83.3%	7.3	2.2	61.1%
Jul	19.3	14.4	4.3	22.3%	13.1	3.9	20.2%	9.9	3.0	15.5%	7.3	2.2	11.4%
Aug	3.0	14.4	4.3	143.3%	13.1	3.9	130.0%	9.9	3.0	100.0%	7.3	2.2	73.3%
Sep	1.2	14.4	4.3	358.3%	13.1	3.9	325.0%	9.9	3.0	250.0%	7.3	2.2	183.3%

(1) Source: ENSR, October 2005
(2) CBNG Flow reduced assuming 70% conveyance loss
(3) Reduced CBNG Flow divided by Receiving Drainage Streamflow

Comparison of Coal Bed Natural Gas-Related Disposal to Receiving Drainage Hydrology Following 70% Conveyance Loss

(Upper) Cheyenne River Near Spencer, Wyoming (Station 06395000)													
Month	Receiving Drainage Streamflow (cfs)	**Alternative**											
		2003			2010			2015			2020		
		Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)
		(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)
Oct	4.2	2.5	0.8	19.0%	2.8	0.8	19.0%	2.4	0.7	16.7%	1.9	0.6	14.3%
Nov	3.6	2.5	0.8	22.2%	2.8	0.8	22.2%	2.4	0.7	19.4%	1.9	0.6	16.7%
Dec	1.1	2.5	0.8	72.7%	2.8	0.8	72.7%	2.4	0.7	63.6%	1.9	0.6	54.5%
Jan	15.5	2.5	0.8	5.2%	2.8	0.8	5.2%	2.4	0.7	4.5%	1.9	0.6	3.9%
Feb	7.7	2.5	0.8	10.4%	2.8	0.8	10.4%	2.4	0.7	9.1%	1.9	0.6	7.8%
Mar	4.6	2.5	0.8	17.4%	2.8	0.8	17.4%	2.4	0.7	15.2%	1.9	0.6	13.0%
Apr	7.9	2.5	0.8	10.1%	2.8	0.8	10.1%	2.4	0.7	8.9%	1.9	0.6	7.6%
May	28.2	2.5	0.8	2.8%	2.8	0.8	2.8%	2.4	0.7	2.5%	1.9	0.6	2.1%
Jun	12.8	2.5	0.8	6.3%	2.8	0.8	6.3%	2.4	0.7	5.5%	1.9	0.6	4.7%
Jul	3.0	2.5	0.8	26.7%	2.8	0.8	26.7%	2.4	0.7	23.3%	1.9	0.6	20.0%
Aug	0.8	2.5	0.8	100.0%	2.8	0.8	100.0%	2.4	0.7	87.5%	1.9	0.6	75.0%
Sep	4.7	2.5	0.8	17.0%	2.8	0.8	17.0%	2.4	0.7	14.9%	1.9	0.6	12.8%

(1) Source: ENSR, October 2005
(2) CBNG Flow reduced assuming 70% conveyance loss
(3) Reduced CBNG Flow divided by Receiving Drainage Streamflow

Comparison of Coal Bed Natural Gas-Related Disposal to Receiving Drainage Hydrology Following 70% Conveyance Loss

(Upper) Powder River at Arvada, Wyoming (Station 06317000)													
Month	Receiving Drainage Streamflow (cfs)	**Alternative**											
		2003			2010			2015			2020		
		Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)
		(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)
Oct	124.3	7.8	2.3	1.9%	26.6	8.0	6.4%	31.9	9.6	7.7%	30.0	9.0	7.2%
Nov	144.9	7.8	2.3	1.6%	26.6	8.0	5.5%	31.9	9.6	6.6%	30.0	9.0	6.2%
Dec	115.2	7.8	2.3	2.0%	26.6	8.0	6.9%	31.9	9.6	8.3%	30.0	9.0	7.8%
Jan	114.9	7.8	2.3	2.0%	26.6	8.0	7.0%	31.9	9.6	8.4%	30.0	9.0	7.8%
Feb	181.9	7.8	2.3	1.3%	26.6	8.0	4.4%	31.9	9.6	5.3%	30.0	9.0	4.9%
Mar	303.5	7.8	2.3	0.8%	26.6	8.0	2.6%	31.9	9.6	3.2%	30.0	9.0	3.0%
Apr	234.7	7.8	2.3	1.0%	26.6	8.0	3.4%	31.9	9.6	4.1%	30.0	9.0	3.8%
May	344.5	7.8	2.3	0.7%	26.6	8.0	2.3%	31.9	9.6	2.8%	30.0	9.0	2.6%
Jun	158.3	7.8	2.3	1.5%	26.6	8.0	5.1%	31.9	9.6	6.1%	30.0	9.0	5.7%
Jul	93.8	7.8	2.3	2.5%	26.6	8.0	8.5%	31.9	9.6	10.2%	30.0	9.0	9.6%
Aug	45.7	7.8	2.3	5.0%	26.6	8.0	17.5%	31.9	9.6	21.0%	30.0	9.0	19.7%
Sep	38.9	7.8	2.3	5.9%	26.6	8.0	20.6%	31.9	9.6	24.7%	30.0	9.0	23.1%

(1) Source: ENSR, October 2005
(2) CBNG Flow reduced assuming 70% conveyance loss
(3) Reduced CBNG Flow divided by Receiving Drainage Streamflow

Comparison of Coal Bed Natural Gas-Related Disposal to Receiving Drainage Hydrology Following 70% Conveyance Loss

Dry Fork Cheyenne River Near Bill, Wyoming (Station 0634700)													
Month	Receiving Drainage Streamflow (cfs)	**Alternative**											
		2003			2010			2015			2020		
		Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)	Annual CBNG Disposal (1)	Ultimate CBNG Flow (2)	Percent Increase (3)
		(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)	(cfs)	(cfs)	(%)
Oct	0.00	0.00	0.00	#DIV/0!	0.09	0.03	#DIV/0!	0.15	0.04	#DIV/0!	0.15	0.04	#DIV/0!
Nov	0.02	0.00	0.00	0.00	0.09	0.03	150.0%	0.15	0.04	200.0%	0.15	0.04	200.0%
Dec	0.02	0.00	0.00	0.00	0.09	0.03	150.0%	0.15	0.04	200.0%	0.15	0.04	200.0%
Jan	0.00	0.00	0.00	#DIV/0!	0.09	0.03	#DIV/0!	0.15	0.04	#DIV/0!	0.15	0.04	#DIV/0!
Feb	0.04	0.00	0.00	0.00	0.09	0.03	75.0%	0.15	0.04	100.0%	0.15	0.04	100.0%
Mar	0.08	0.00	0.00	0.00	0.09	0.03	37.5%	0.15	0.04	50.0%	0.15	0.04	50.0%
Apr	0.10	0.00	0.00	0.00	0.09	0.03	30.0%	0.15	0.04	40.0%	0.15	0.04	40.0%
May	0.07	0.00	0.00	0.00	0.09	0.03	42.9%	0.15	0.04	57.1%	0.15	0.04	57.1%
Jun	0.00	0.00	0.00	#DIV/0!	0.09	0.03	#DIV/0!	0.15	0.04	#DIV/0!	0.15	0.04	#DIV/0!
Jul	0.18	0.00	0.00	0.00	0.09	0.03	16.7%	0.15	0.04	22.2%	0.15	0.04	22.2%
Aug	0.00	0.00	0.00	#DIV/0!	0.09	0.03	#DIV/0!	0.15	0.04	#DIV/0!	0.15	0.04	#DIV/0!
Sep	0.00	0.00	0.00	#DIV/0!	0.09	0.03	#DIV/0!	0.15	0.04	#DIV/0!	0.15	0.04	#DIV/0!

(1) Source: ENSR, October 2005
(2) CBNG Flow reduced assuming 70% conveyance loss
(3) Reduced CBNG Flow divided by Receiving Drainage Streamflow

Dry Year Conditions

	Antelope Creek Near Teckla, Wyoming (1)	Little Powder River above Dry Creek Near Weston, Wyoming (2)	Belle Fourche River Below Moorcroft, Wyoming (1)	Cheyenne River Near Spencer, Wyoming (1)	Powder River at Arvada, Wyoming (2)	Dry Fork Cheyenne River Near Bill, Wyoming (1)
Station Number:	06364700	06324970	06426500	06386500	06317000	06365300
Month	Streamflow (3)	Streamflow (3)	Streamflow (3)	Streamflow (3)	Streamflow (3)	Streamflow (3)
	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)	(ac-ft)
Oct	22	19	26	259	7,643	0
Nov	24	26	70	216	8,622	1
Dec	9	30	61	67	7,085	1
Jan	18	24	41	953	7,065	0
Feb	38	319	464	430	10,102	2
Mar	161	399	1,460	283	18,663	5
Apr	69	284	299	473	13,967	6
May	39	474	443	1,734	21,182	4
Jun	8	220	212	762	9,420	0
Jul	153	64	1,189	187	5,767	11
Aug	27	169	183	51	2,810	0
Sep	130	13	71	280	2,314	0
Total	695	2,044	4,517	5,695	114,639	30

Note:

(1) HKM Engineering, Inc. 2002a. Northeast Wyoming River Basins Plan, Surface Water Hydrology, Tasks 3A and 3B Memorandum
(2) HKM Engineering, Inc. 2002b. Powder/Tongue River Basins Plan, Surface Water Hydrology, Tasks 3A and 3B Memorandum
(3) Average Streamflow for 1970-1999 in Acre-Feet

Summary of Annual Coal Bed Natural Gas-Related Disposal to Receiving Drainages

Sub-Basin	Annual CBNG-Related Disposal (mmgpy) [1]				Annual CBNG-Related Disposal (cfs)			
	2003	2010	2015	2020	2003	2010	2015	2020
Antelope Creek	710	2575	3185	3038	3.0	10.9	13.5	12.9
Dry Fork Cheyenne River	0	22	35	35	0.0	0.1	0.1	0.1
Little Powder River	1239	1716	1659	1421	5.3	7.3	7.0	6.0
Upper Belle Fourche River	3405	3085	2332	1713	14.4	13.1	9.9	7.3
Upper Cheyenne River	593	650	560	447	2.5	2.8	2.4	1.9
Upper Powder River	1833	6273	7532	7066	7.8	26.6	31.9	30.0
Total	7780	14321	15303	13720	33.0	60.7	64.9	58.2

Summary of Coal Bed Natural Gas-Related Discharge Water Quality

Sub-Basin	EC			SAR				Data used in Draft Report (12/2005)	
	95%lower	mean	95%upper	95%lower	mean	95%upper		EC	SAR
Antelope Creek	908.5711	929.4581	950.3451	6.8012275	7.615577	8.429927	See note	905	7.1
Dry Fork Cheyenne River	908.5711	929.4581	950.3451	6.8012275	7.615577	8.429927	See note	905	7.1
Little Powder River	1493.365	1508.912	1524.46	9.9514769	10.49116	11.03085		1271	11.1
Upper Belle Fourche River	1102.166	1109.774	1117.382	8.4426895	8.834127	9.225564		970	8.2
Upper Cheyenne River	908.5711	929.4581	950.3451	6.8012275	7.615577	8.429927		599	6.4
Upper Powder River	2160.573	2180.179	2199.786	21.615331	22.57612	23.53691		2163	19.5

note: no data were obtained specific to these sub-basins(antelope creek and dry fork cheyenne river)

Summary of Conveyance Losses

Sub-Basin	EC
Antelope Creek	0.7
Dry Fork Cheyenne River	0.7
Little Powder River	0.7
Upper Belle Fourche River	0.7
Upper Cheyenne River	0.7
Upper Powder River	0.7

Water Quality Standards

	Most Restrictive		Least Restrictive		
	EC	SAR	EC	SAR	
Antelope Creek	2,000	10	2,500	10	wdeq
Dry Fork Cheyenne River	2,000	10	2,500	10	wdeq
Little Powder River	2,000	5	2,500	9.75	montana deq standards
Upper Belle Fourche River	2,000	6	2,500	10	sar (6) from south dakota reg's
Upper Cheyenne River	2,000	10	2,500	10	wdeq
Upper Powder River	2,000	5	2,500	9.75	montana deq standards

Background Water Quality Data (Greystone, 2003)

	Antelope Creek		Upper Belle Fourche		Upper Cheyenne		Upper Powder		Little Powder		Dry Fork Cheyenne	
	EC	SAR	EC	SAR	EC	SAR	EC	SAR	EC	SAR	EC	SAR
Jan	2335	2.74	2887	6.29	4229	8.58	2482	6.4	2953	6.33	2335	2.74
Feb	2251	2.71	1907	4.08	3911	8.01	2366	6.12	2477	5.57	2251	2.71
Mar	1782	2.52	1564	3.64	4127	8.66	2051	5.28	1785	4.44	1782	2.52
Apr	1949	2.77	1722	4.34	3630	7.87	2213	5.84	2457	5.55	1949	2.77
May	1800	2.82	1532	3.81	3155	6.88	1803	4.92	2013	4.81	1800	2.82
Jun	2005	2.8	1821	3.98	2895	5.93	1797	4.76	2333	5.29	2005	2.8
Jul	1661	2.48	1182	3.1	2250	5.69	2716	6.79	2174	5.29	1661	2.48
Aug	1684	2.47	1955	5.06	1972	4.82	2992	6.97	2860	6.57	1684	2.47
Sep	2214	2.52	2231	5.76	2271	5.63	3400	7.83	2810	6.44	2214	2.52
Oct	2354	2.6	2346	5.75	2916	6.46	2537	6.71	2289	5.73	2354	2.6
Nov	2460	2.74	2877	7.02	3565	7.22	2650	6.42	3044	6.7	2460	2.74
Dec	2372	2.79	2755	6.77	3405	7.39	2906	6.61	3300	6.94	2372	2.79