

## TECHNICAL MEMORANDUM

SUBJECT:           **Green River Basin Plan II**  
                          *Basin Water Use Profile – Industrial*

DATE:               5/28/2009

PREPARED BY:     WWC Engineering

### **Introduction**

This Technical Memorandum has drawn heavily on the work done as part of the 2001 Green River Plan. The major effort in this technical memorandum was to update where necessary the work completed by Purcell Consulting and reported in the “Technical Memorandum Green River Basin Plan - Basin Water Use Profile- Industrial”.

The purpose of this technical memorandum is to provide existing water use information for the major industries in the Green River Basin.

The industries that obtain their primary water supply from surface water are:

1.     Electric Power Generation
  - a.     Jim Bridger Power Plant (Pacifcorp)-Green River
  - b.     Naughton Power Plant (Pacifcorp)-Ham's Fork River
  
2.     Soda Ash Production and Related Products
  - a.     FMC Granger-Green River
  - b.     FMC Westvaco-Green River
  - c.     General Chemical-Green River
  - d.     OCI Wyoming-Green River
  - e.     Solvay Minerals Inc.-Green River
  - f.     Church and Dwight-baking soda production-Green River
  
3.     Miscellaneous
  - a.     Exxon Shute Creek Plant-natural gas processing-Green River
  - b.     Simplot Phosphates-chemical fertilizer production-Green River

The technical memorandum, prepared by Purcell Consulting for the 2001 Green River Basin Plan, provides a summary for each of the ten (10) industrial surface water users. Each summary provides a brief description of the operations; a brief description of the water supply, the water supply system, and discharge system; estimates of annual water use; and a tabulation of principle water rights(Purcell, 2000). The ten (10) industrial surface water users presently operating in the basin are the same industries operating in 2000. Industrial surface water use has been updated to reflect current conditions.

The industries that obtain their primary water supply from groundwater are:

1. Coal Mining
2. Uranium Mining
3. Oil and Gas Industries

## **Methodology**

### **A. Existing Industrial Surface Water Use**

Information was obtained from the various industries primarily through the State Engineer's Office (SEO) Hydrographer's annual report (SEO, 2006) or direct communication with select industrial users. All of the soda ash facilities in the Green River area, with the exception of Solvay Minerals, Inc., have on-site power plants (Purcell, 2000). Therefore, a portion of the water diverted is used for power generation as well as the processing and manufacturing of soda ash.

All of the industries, with the exception of the Naughton Power Plant, have zero discharge facilities. Therefore, the depletions or impacts to surface water are equal to the amount of water diverted. Depletions for the Naughton Power Plant were calculated by deducting the estimated return flow from the estimated diversions (2001 Green River Basin Plan). The estimated surface water depletions for the 10 industries were calculated on a monthly basis to accommodate the modeling efforts for the planning study.

### **B. Existing Industrial Groundwater Use**

There is very limited available information regarding industrial groundwater use. Industries' use of groundwater is typically short-term and intermittent in nature. The best available information relating to industrial groundwater use is water rights issued by the Wyoming State Engineer's Office. The State Engineer's database shows that there are 207 groundwater right permits in the Green River Basin that indicate industrial use on the permit. Therefore, the State Engineer's water rights database in the Green River Basin and Great Divide Basin was used as the basis for estimates of existing industrial groundwater use.

The existence of water rights does not necessarily directly relate to water use, particularly for industrial water rights. Therefore, in order to get an indication of existing industrial groundwater use, the following assumptions were developed by Purcell (Purcell, 2000):

1. It is assumed that 50% of the wells with adjudicated water rights are active and are providing water at their permitted capacity 10% of the time on an average annual basis.
2. It is assumed that 10% of the wells with unadjudicated water rights are active and are providing water at their permitted capacity 10% of the time on an average annual basis.

The assumption that 50% of the adjudicated wells are active, while only 10% of the unadjudicated wells are active, is based on the assumption that the well owners with adjudicated rights invested the time and money for the adjudication process, thereby indicating they had more interest in the well and probably plan to use it on a more consistent and longer-term basis (Purcell, 2000). This assumption was presented to the SEO Groundwater Section and was confirmed to be reasonable and better information does not exist at this point in time (Verplancke, 2008).

## Analysis Results

### A. Existing Industrial Surface Water Use

Table 1 lists the ten (10) major industrial surface water users, their source of supply, point of diversion and principal water rights (Purcell, 2000). Table 2 provides the estimated monthly and annual water use (depletions) for the ten users as presented in the technical memorandum prepared for the 2001 Green River Basin Plan (Purcell, 2000). Table 3 provides reported diversion information or recent estimates of industrial diversion by the ten (10) major industrial surface water users. When the data are compared, the diversion patterns and actual use are comparable but do show some variation between 2001 and the current time. In most cases the 2005-2006 information is lower.

**Table 1 - Green River Basin Industrial Surface Water Users**

Water User	Industry	Source	Point of Diversion <sup>1</sup>	Principle Water Right <sup>2</sup>
Jim Bridger Power Plant	Power	Green	Lot 14-15-18-107	32112-62.8cfs
Naughton Power Plant	Power	Ham's Fork	Lot 40-27-22-116	22297-20.0cfs
FMC Granger	Trona	Green	NENW,16-20-109	22808-5cfs
FMC Westvaco	Trona	Green	SESE,16-20-109	20077-17.0cfs
General Chemical	Trona	Green	NESE,1-19-109	22748-6.5cfs
OCI Wyoming	Trona	Green	NESW,23-20-109	22075-8.72cfs
Solvay	Trona	Green	NE,E,1-19-109	26126-5.0cfs
Church & Dwight	Baking soda and laundry detergent	Green	NENW, 1-19-109	6304Enl.-1.78cfs
Exxon Shute Creek	Natural Gas	Green	NENW,18-23-111	29509-0.134cfs
Simplot Phosphates	Fertilizer	Green	Same as GR/RS/SC JPB <sup>3</sup>	NA

<sup>1</sup>Qtr-Qtr, Section, Township, and Range

<sup>2</sup>Permit Number, Amount in cfs

<sup>3</sup>Green River/Rock Springs/ Sweetwater County Joint Powers Board

Source: Technical Memorandum, Green River Basin Plan, Basin Water Use Profile - Industrial, 2001 and State Engineer's Office

**Table 2 - Current Industrial Surface Water Use in Green River Basin - Green River Basin Plan 2001**

**Average Monthly Industrial Water Use (acre-feet)**

<b>Month</b>	<b>January</b>	<b>February</b>	<b>March</b>	<b>April</b>	<b>May</b>	<b>June</b>	<b>July</b>
Jim Bridger Power Plant	1,900	1,900	2,850	2,850	3,600	3,750	3,860
Naughton Power Plant	1,100	1,000	1,100	1,100	1,200	1,200	1,200
FMC Granger	250	250	250	250	250	250	250
FMC Westvaco	500	500	500	500	500	500	500
General Chemical	300	300	300	300	300	300	300
OCI Wyoming	250	250	250	250	250	250	250
Solvay	190	190	190	190	190	190	190
Church & Dwight	15	15	15	15	20	20	25
Exxon Shute Creek	1	1	1	1	2	2	2
FS Industries	110	70	60	100	50	10	10
<b>Total Average Monthly Use</b>	<b>4,616</b>	<b>4,476</b>	<b>5,516</b>	<b>5,556</b>	<b>6,362</b>	<b>6,472</b>	<b>6,587</b>
<b>Month</b>	<b>August</b>	<b>September</b>	<b>October</b>	<b>November</b>	<b>December</b>	<b>Total</b>	
Jim Bridger Power Plant	3,860	3,100	2,850	1,900	1,900	34,320	
Naughton Power Plant	1,200	1,100	1,100	1,100	1,100	13,500	
FMC Granger	250	250	250	250	250	3,000	
FMC Westvaco	500	500	500	500	500	6,000	
General Chemical	300	300	300	300	300	3,600	
OCI Wyoming	250	250	250	250	250	3,000	
Solvay	190	190	190	190	190	2,280	
Church & Dwight	20	20	20	15	15	215	
Exxon Shute Creek	2	1	1	1	1	16	
FS Industries	10	20	40	50	30	560	
<b>Total Average Monthly Use</b>	<b>6,582</b>	<b>5,731</b>	<b>5,501</b>	<b>4,556</b>	<b>4,536</b>	<b>66,491</b>	

Source: Green River Basin Plan 2001

**Table 3 Current 2005-2006 Industrial Surface Water Use In Green River Basin  
Average Monthly Industrial Water Use (Acre-Feet)**

Month	January	February	March	April	May	June	July
Jim Bridger Power Plant <sup>1</sup>	2,642	1,939	2,626	1,815	1,879	2,122	3,134
Naughton Power Plant <sup>1</sup>	900	936	1,033	849	825	938	973
FMC Wyoming <sup>1</sup>	601	532	687	693	690	691	702
General Chemical <sup>1</sup>	294	291	307	289	298	287	312
OCI Wyoming <sup>1</sup>	263	201	200	220	273	286	223
Solvay <sup>1</sup>	204	169	194	197	190	195	218
Church & Dwight <sup>1</sup>	12	11	10	12	11	9	8
Exxon Shute Creek <sup>2</sup>	1	1	1	1	2	2	2
Simplot Phosphates <sup>3</sup>	48	46	57	54	44	51	54
<b>Total Average Monthly Use</b>	<b>4,965</b>	<b>4,126</b>	<b>5,115</b>	<b>4,129</b>	<b>4,212</b>	<b>4,581</b>	<b>5,627</b>
Month	August	September	October	November	December	Total	
Jim Bridger Power Plant <sup>1</sup>	2,781	2,620	2,537	2,343	2,122	28,560	
Naughton Power Plant <sup>1</sup>	1,062	980	941	822	855	11,114	
FMC Wyoming <sup>1</sup>	666	612	493	450	545	7,362	
General Chemical <sup>1</sup>	315	352	374	330	339	3,788	
OCI Wyoming <sup>1</sup>	310	260	249	247	262	2,994	
Solvay <sup>1</sup>	212	186	204	165	100	2,234	
Church & Dwight <sup>1</sup>	30	25	11	11	11	160	
Exxon Shute Creek <sup>2</sup>	2	1	1	1	1	16	
Simplot Phosphates <sup>3</sup>	56	48	53	45	49	605	
<b>Total Average Monthly Use</b>	<b>5,434</b>	<b>5,083</b>	<b>4,863</b>	<b>4,413</b>	<b>4,284</b>	<b>56,833</b>	

Source: <sup>1</sup> From SEO Hydrographer Annual Report Div. 4

<sup>2</sup> From 2001 Green River Basin Plan

<sup>3</sup> Green River/Rock Springs/Sweetwater County Joint Powers Board 4 year average June 2004 to March 2008

The estimated industrial surface use for the ten major users was approximately 66,500 acre-feet per year in 2001 and is estimated to be about 56,833 acre-feet currently based on reported use or new estimates. The "Wyoming Water Planning Report No. 3, Water and Related Land Resources of the Green River Basin, Wyoming," dated September, 1970 estimated 1967 industrial water use to be approximately 16,000 acre-feet per year and projected 2000 water use to be approximately 86,000 acre feet per year.

#### 1. Electric Power Production

Power plants are the largest industrial water users in the Green River Basin accounting for about 70% of the industrial water use. The Jim Bridger and Naughton Power Plants, both owned and operated by PacifiCorp, were estimated to deplete approximately 47,800 acre-feet of water per year in 2000 (Purcell, 2000). Based on industry reported diversions to the SEO, the two power plants depleted approximately 39,700 acre-feet under current conditions, 2005

– 2006 (SEO, 2006). Both power plants enjoy the security of storage water. Pacificorp maintains a contract for storage water from Fontenelle Reservoir for use at the Jim Bridger Power Plant during times of severe drought. Pacificorp owns and operates Viva Naughton Reservoir, which serves as the primary supply for the Naughton Power Plant. In both plants, water is used to produce steam for power production and is used in the cooling processes. The majority of the water is discharged through the cooling towers or lost through evaporation ponds. Some water is used for dust abatement and domestic use.

## 2. Soda Ash Production

There are four (4) major producers of soda ash in the Green River Basin. FMC Wyoming Corporation, General Chemical Company, OCI Wyoming, and Solvay Minerals, Inc. produced approximately 19.5 million tons of trona in 2005 (WDA&I, 2007). FMC operates two plants but is managed by one entity, FMC Wyoming. In 2000 there were two operations, FMC Granger and FMC Westvaco. Operations were consolidated under one management in 2002 (SWEDA, 2008). Under 2000 levels of production, these four producers were estimated to deplete approximately 17,900 acre-feet of water from the Green River. Under current levels of production and conditions these four (4) producers reported depletions of approximately 16,400 acre-feet of water from the Green River and, collectively, are the second highest industrial water users in the Green River Basin (SEO, 2006). The soda ash industry consumes over 29% of the industrial water used in the basin. Water is used in the soda ash production process. Typically, the raw mineral (trona) is dissolved in water to remove impurities. The product is dried using centrifuges and steam dryers.

All of the producers, with the exception of Solvay Minerals, Inc., have on-site power generation facilities, which also use a considerable amount of water. Water is also used for dust abatement and domestic supplies. All of the water at the facilities is discharged through cooling towers and evaporated from holding ponds.

Church and Dwight does not produce soda ash but produces a value added product. Church and Dwight purchases soda ash from the General Chemical plant and produces Arm and Hammer Baking Soda and powdered laundry detergent. The facility is located adjacent to General Chemical and uses the same diversion and pipeline for its water supply system. Presently, the facility obtains its water through its direct flow right on the Green River. The existing operations used an estimated 215 acre-feet of water per year in 2000 (Purcell, 2000). The current operation reported use of approximately 160 acre-feet per year (SEO, 2006). Church and Dwight maintains a contract with the State of Wyoming, through the Wyoming Water Development Commission, for 1,250 acre-feet of water per year from Fontenelle Reservoir as a future potential water supply.

## 3. Other Surface Water Users

While the following are not major water users in comparison to the power generation and soda ash industries, they collectively use approximately 1,874 acre-feet of water per year. Each of the following water users have an interest in storage water from Fontenelle Reservoir.

In the 2001 Green River Basin Plan it was reported that Exxon's Shute Creek natural gas plant facility obtains its water through its direct flow right on the Green River and groundwater wells. The operation uses approximately 16 acre-feet of water per year. Exxon maintains a contract with the State of Wyoming, through the Wyoming Water Development Commission, for 300 acre-feet of water per year from Fontenelle Reservoir (Purcell, 2000).

Simplot Phosphates produces chemical fertilizer. Simplot Phosphates purchased the interests of FS Industries in the facility located east of Rock Springs in 2003 (Simplot website, 2008). Presently, Simplot obtains its water through the water rights, diversion, water treatment plant and pipelines of the Green River/Rock Springs/Sweetwater County Joint Powers Board. In 2000, the facility used approximately 560 acre-feet of water per year (Purcell, 2000). The current operation used an annual average of 605 acre feet from 2004 to 2008 (Bracken, 2008). Simplot maintains a contract with the State of Wyoming, through the Wyoming Water Development Commission, for 10,000 acre-feet of water per year from Fontenelle Reservoir. The Fontenelle storage water would be used in the future when the Joint Powers Board needs the water it is currently supplying Simplot to meet its municipal demands.

Green River flows are stored in Fontenelle and Flaming Gorge Reservoirs. Both of these dams have hydroelectric generating facilities. The production of hydropower is basically considered a non-consumptive use of water other than the associated evaporation losses.

#### 4. Fontenelle Reservoir

The water right for Fontenelle Reservoir indicates its primary purposes are irrigation, domestic, industrial, municipal, stockwatering, fish and wildlife and recreation; and when not required for the primary purposes, storage water can be used for power generation, the secondary purpose. However, the major existing benefits of Fontenelle Reservoir relate to industry. An in depth discussion of Fontenelle Reservoir is contained in the Green River Basin Plan, Technical Memorandum, Basin Water Use Profile – Industry prepared for the 2001 Green River Basin Plan (Purcell, 2000).

#### B. Existing Industrial Groundwater Use

Coal mines primarily use water for dust abatement. Black Butte Coal Company and Bridger Coal Company provide coal to the Jim Bridger Power Plant. Kemmerer Coal Company provides coal to the Naughton Power Plant. These companies have several permits for groundwater use. The water generally comes from wells or as a by-product of the mining operations. The Bridger Coal Company obtains water from the Jim Bridger Power Plant for domestic and fire protection use. Kemmerer Coal Company obtains domestic and fire protection water from Kemmerer/Diamondville Joint Powers Board.

The uranium industry is presently idle in the Green River Basin. Kennecott Uranium Company holds water rights for several groundwater wells at its inactive mine and processing facility in the Great Divide Basin. The water was used in the process that extracted the uranium from the ore (Watts, 2000). The presently active uranium mines in

other parts of Wyoming are all in-situ mines. The in-situ leaching process involves pumping an environmentally benign solution of water and sodium bicarbonate down an injection well where it flows through the deposit, dissolving the uranium. The uranium-bearing solution is pumped back to the surface through extraction wells, leaving the underground rock formation intact. The uranium is extracted at a central processing facility and the mining solution recycled. This mining technique produces no tailings and has significant operational and environmental advantages over conventional mining methods (WSGS, 2008).

Oil and gas companies often secure water rights to use the water for on-site purposes, such as producing drilling mud and dust abatement. The actual water use at the wells during the drilling process is typically short term and, often, the terms of the water rights are limited. If the terms of the water rights are not limited, the water rights are depicted in the records as active, while the wells may no longer exist.

Groundwater is a by-product of oil and gas production. After an oil or gas well is abandoned, it may continue to produce water. The oil and gas companies may not plug the wells, leaving the landowner use of the resulting water for stock watering or other purposes. It is difficult to determine the extent of this practice by reviewing the water rights. The landowner should apply for a new water right for the purpose which the well is being used, but this may or may not occur.

While these industries may use some surface water for domestic supplies or fire protection, their major water supplies come from groundwater wells or groundwater sources that are by-products of their operations. The permitted capacity of the industrial wells is typically much larger than the actual use, which is relatively small and temporary in nature. The fact that there is a water right for an industrial well cannot be considered a reliable indication of water use. The actual well may no longer be in use, or if it is being used, the duration of the actual use is probably limited. It is unlikely that industrial groundwater use in the Green River Basin has significant impacts on surface water flows due to its limited and sporadic use and the relative distance of most of the operations from major rivers and streams (Purcell, 2000).

Table 4 provides a tabulation of adjudicated and unadjudicated industrial and miscellaneous groundwater rights in the study area. The SEO groundwater rights include miscellaneous use as well as industrial use. The SEO Groundwater Division suggested that industrial permits and miscellaneous permits were closely associated and should be combined in the industrial groundwater use discussion (Verplancke, 2008).

The estimates of industrial groundwater use are based on the following assumptions (Purcell, 2000):

1. Fifty percent (50%) of the wells with adjudicated water rights are active and are providing water at their permitted capacity 10% of the time on an average annual basis.
2. Ten percent (10%) of the wells with unadjudicated water rights are active and are providing water at their permitted capacity 10% of the time on an average annual



basis.

Table 5 shows the estimated groundwater used by industry using the assumptions listed above.

**Table 4 - Green River Basin Industrial Groundwater Rights - 2006**

Water Right	Adjudicated Rights	Unadjudicated Rights
	(gpm)	
Industrial Groundwater	2645	29857
Miscellaneous Groundwater	4634	54892
<b>Total</b>	<b>7279</b>	<b>84749</b>

Source: Framework Plan, SEO GW Database (through 2006)

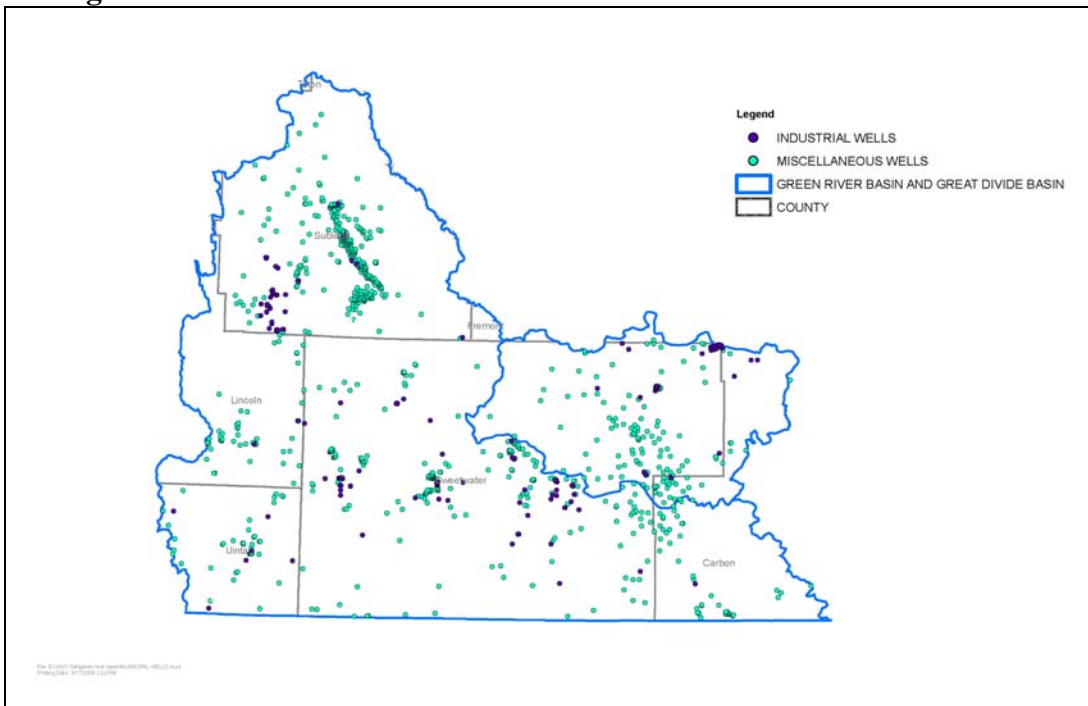
**Table 5 - Estimated Industrial Water Use-Groundwater**

Water Right	Estimated Water Use
	(acre feet/year)
Adjudicated	587
Unadjudicated	1367
<b>Total</b>	<b>1954</b>

Source: Framework Plan, Green River Plan 2001

Figure 1 shows the locations of the industrial and miscellaneous groundwater wells.

**Figure 1 – Green River Basin Industrial and Miscellaneous Groundwater Wells**



Source: Wyoming Framework Water Plan, 2007

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