



# **Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants**

**First Annual Report**

**November 2003**



**ALBERTA ENERGY AND UTILITIES BOARD**

**Statistical Series (ST) 101: Sulphur Recovery and Sulphur Emissions at Alberta Sour Gas Plants**

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## Contents

1	Introduction.....	1
2	Summary of Performance for Grandfathered Plants, 2000-2002.....	2
	2.1 Grandfathered Plants That Have Been Degrandfathered .....	2
	2.2 Sulphur Emission Performance Credits (Emission Credits).....	3
	2.3 Sulphur Emissions and Inlets at Grandfathered Plants, 2000-2002 .....	3
	2.3.1 Sulphur Emission Reduction.....	4
	2.3.2 Decline in Sulphur Inlet .....	5
3	Sulphur Baseline Capacity, 1999 .....	6
4	Summary of Performance for Nongrandfathered Plants, 2000-2002.....	6
	Appendix 1 Grandfathered and Nongrandfathered Gas Plants .....	7
	Appendix 2 Plants That Have Been Degrandfathered Since ID 2001-3 .....	11
	Appendix 3 Emission Credits Earned to Date.....	12
	Appendix 4 Sulphur Emission and Production Data for Sulphur Recovery Plants – A Comparison Between 2000 and 2002 .....	13
	Figure 1 Net sulphur emission credits over time .....	3
	Figure 2 Sulphur emissions from grandfathered plants.....	4
	Figure 3 Sulphur inlet for grandfathered plants.....	5

Download Excel version of Appendices 1 through 4



# 1 Introduction

In *Interim Directive (ID) 2001-3: Sulphur Recovery Guidelines for the Province of Alberta*, the Alberta Energy and Utilities Board (EUB) committed to monitoring the sulphur recovery of the grandfathered<sup>1</sup> sour gas plants and publishing an annual summary report on industry performance. This report covers both grandfathered sour gas plants (sulphur recovery and larger acid gas flaring sour gas plants) and nongrandfathered<sup>2</sup> gas plants (sulphur recovery and all acid gas injection sour gas plants). This is the first annual summary report following the implementation of *ID 2001-3*. A complete list of the grandfathered and nongrandfathered plants is in Appendix 1.

While *ID 2001-3* did not change the recovery levels expected for new gas plants, it set out clear expectations on when older grandfathered plants are required to meet the same requirements as new plants. The ID incorporates a phased approach to the more stringent requirements and encourages operators of sulphur recovery plants to take early action to improve performance.

Grandfathered sulphur recovery plants that perform better than the minimum requirements specified in *ID 2001-3* have the option to file sulphur emission performance credit report forms and may use the credits to meet a portion of the sulphur recovery requirements at a future date (i.e., operate for a longer time or at a higher inlet rate before having to degrandfather the plant). Most grandfathered sulphur recovery plants are now taking advantage of the emission credit program, and credits are continuing to grow.

Acid gas flaring plants have no ability to earn credits and are subject to more stringent requirements over time.

In the last three years, 7 plants have been degrandfathered,<sup>3</sup> 3 plants have been relicensed to meet the requirements for new plants, and 3 plants have been shut down. In addition, sulphur emissions have decreased substantially for both grandfathered acid gas flaring plants (emissions down 25 per cent) and grandfathered sulphur recovery plants (emissions down 15 per cent).

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<sup>1</sup> Grandfathered plants are those that do not meet the sulphur recovery requirements for new plants listed in *ID 2001-3*. This includes some sulphur recovery plants and larger (sulphur inlet greater than 1 tonne per day) acid gas flaring plants.

<sup>2</sup> Nongrandfathered plants are those with an approved sulphur inlet greater than 1 t/d meeting the requirements for new plants, as listed in *ID 2001-3*. This includes some sulphur recovery plants and all acid gas injection plants.

<sup>3</sup> Degrandfathered plants are those that did not meet the requirements of *ID 2001-3* for new plants but have recently undergone physical modifications that now allow them to meet the requirements for new plants.

## 2 Summary of Performance for Grandfathered Plants, 2000-2002

### 2.1 Grandfathered Plants That Have Been Degrandfathered

In the last three years, 7 plants have made modifications to improve or install sulphur recovery at their plants to meet the more stringent sulphur recovery requirements for new plants. In addition, 3 other plants have been relicensed to meet these more stringent sulphur recovery requirements, and 3 grandfathered plants have shut down.

#### **Plants making modifications to meet the requirements for new plants**

<b>Plant name</b>	<b>Operator</b>
1. Brazeau River	KeySpan
2. Garrington (Olds)	Esprit
3. Homeglen (Rimbey)	KeySpan
4. Bantry	AltaGas
5. Vulcan (Long Coulee)	Conoco Phillips
6. Wilson Creek	Petro-Canada
7. Rainbow	Husky

The 7 operators listed above made significant physical modifications to their plants to achieve higher sulphur recoveries.

#### **Plants relicensing to meet the requirements for new plants**

<b>Plant name</b>	<b>Operator</b>
1. Okotoks	Border Midstream
2. Crossfield East	PrimeWest
3. Sylvan Lake	NAL Resources

Of the 3 plants listed above, 2 were relicensed to a higher sulphur recovery efficiency with existing equipment and 1 was relicensed to a lower throughput.

#### **Grandfathered plants that have shut down**

<b>Plant name</b>	<b>Operator</b>
1. North Rosevear	Suncor
2. Bittern Lake	CNRL
3. North Caroline	BP

A detailed list of plants that have been degrandfathered in the last three years is in Appendix 2, along with the process used for improving the sulphur recovery.

Today there are 24 grandfathered sulphur recovery plants and 23 grandfathered acid gas flaring plants remaining (see Appendix 1).

## 2.2 Sulphur Emission Performance Credits (Emission Credits)

Emission credits can be earned by grandfathered sour gas plants with sulphur recovery that achieve recovery efficiencies higher than their required blended sulphur recovery efficiency. Credits cannot be transferred between facilities and do not apply to acid gas flaring plants.

Credit reports can help an operator

- operate at higher sulphur inlets,
- meet the required blended sulphur recovery efficiency, and
- defer upgrading for a longer period of time.

Each sulphur emission credit represents 1 tonne (t) of sulphur emissions that would have been emitted if the plant exactly met its minimum requirement. Credits must be earned before they can be used.

In order to earn credits, a credit report must be filed on time at the end of each quarter. The filing of credit reports is optional, but once an initial credit report is filed, the operator must continue to file them. Reports may not be filed retroactively.

Today most plants that are able to file credit reports are doing so, and the emission credits are growing, as one would expect in this initial period. As of the end of the first quarter of 2003, approximately 22 400 t of sulphur emission credits had been earned (see Figure 1).

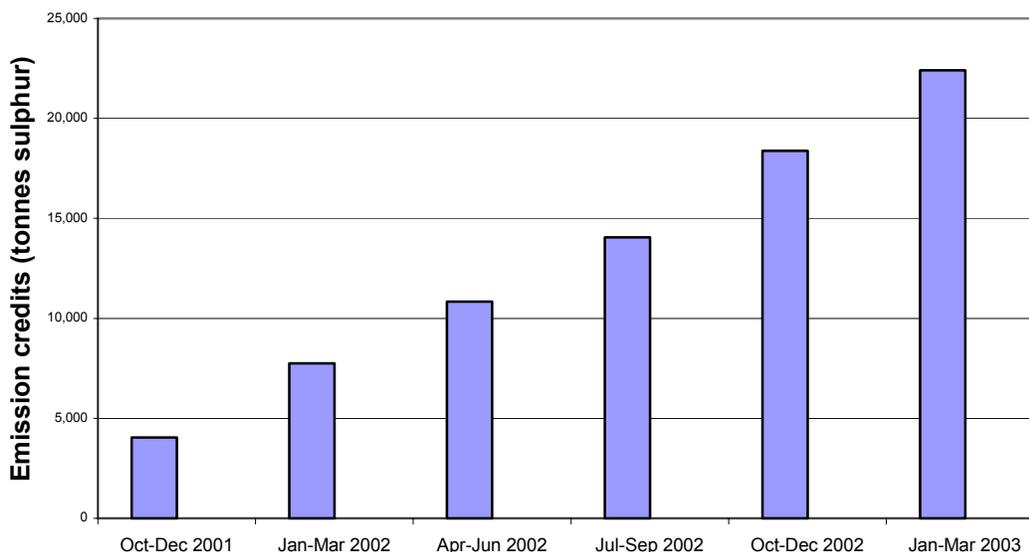


Figure 1. Net sulphur emission credits over time

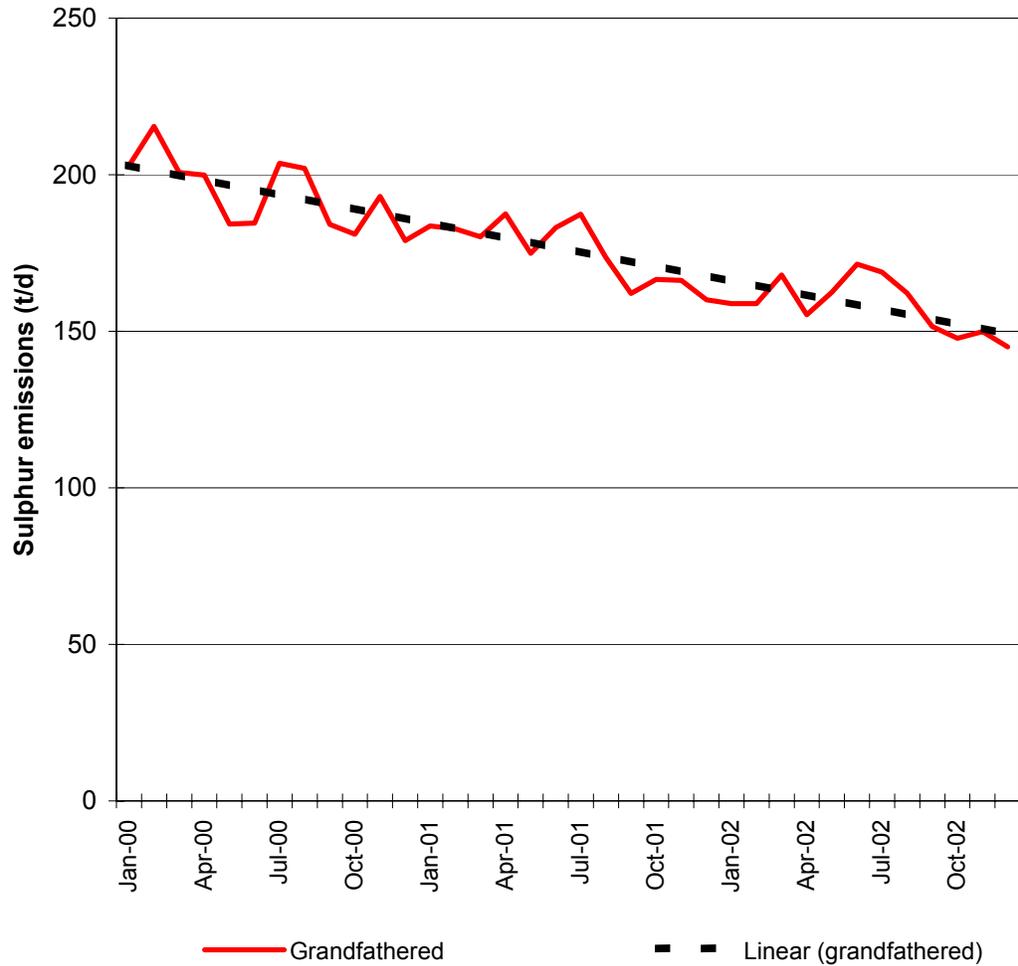
Appendix 3 lists credits that have been earned by each of the grandfathered sulphur recovery plants.

## 2.3 Sulphur Emissions and Inlets at Grandfathered Plants, 2000-2002

An analysis of the sulphur emissions and sulphur inlet for the specific plants that were listed in *ID 2001-3* as grandfathered follows in Sections 2.3.1 and 2.3.2. For the purpose of this analysis, plants that have degrandfathered since the ID was issued are included with the grandfathered plants.

### 2.3.1 Sulphur Emission Reduction

There have been substantial reductions in sulphur emissions from the grandfathered sulphur recovery plants between 2000 and 2002, as shown in Figure 2.



**Figure 2. Sulphur emissions from grandfathered plants**

The drop in emissions from grandfathered plants shown in Figure 2 is due to a decrease of about 25 per cent in emissions from the grandfathered acid gas flaring plants and a decrease of about 15 per cent from the grandfathered sulphur recovery plants between 2000 and 2002.

Appendix 4 lists sulphur production and emissions for each of the sulphur recovery plants for the years 2000 and 2002. Between 2000 and 2002, 25 of the 28 grandfathered sulphur recovery plants reduced emissions, as shown in Appendix 4.

### 2.3.2 Decline in Sulphur Inlet

In large part, the emission reduction observed is due to declining sulphur inlets. Figure 3 shows the decline in sulphur inlets for grandfathered gas plants.

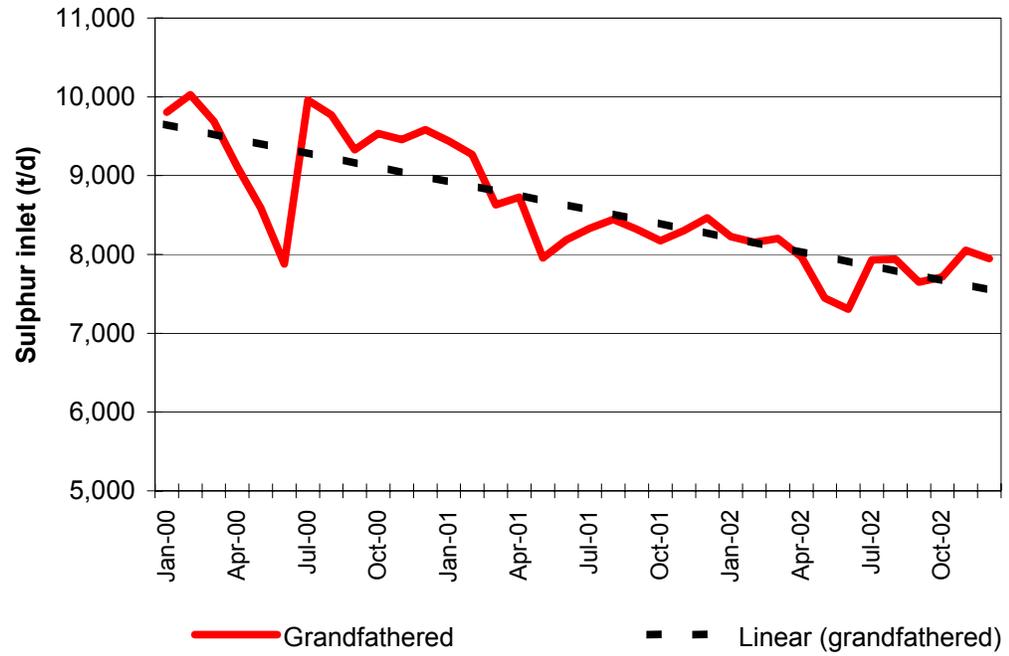


Figure 3. Sulphur inlet for grandfathered plants

### **3 Sulphur Baseline Capacity, 1999**

Two plants have had their 1999 baseline capacity revised, as shown in Appendix 1.

Apache Zama (plant code 1219) was revised from 24.5 to 38.6 t sulphur per day. This revision was made after considering the unusual downtime of the plant during the first six months of 1999. In the first half of 1999, the sulphur inlet rate averaged 10.3 t/d, while during the second half the inlet rate averaged 38.6 t/d.

Suncor consolidated its north and south Rosevear plants by shutting down the north Rosevear plant and sending the gas volumes to the south Rosevear plant. The 1999 baseline capacity of the south Rosevear plant was amended to 76.0 t sulphur per day inlet from 50.6 t/d, reflecting the combined baseline of the two plants. The new approval issued reflected the higher sulphur recovery of the two plants. Section 4.3 of *ID 2001-3* encourages gas plant consolidation, provided that the sulphur recovery efficiency becomes the higher of the two plants being consolidated.

### **4 Summary of Performance for Nongrandfathered Plants, 2000-2002**

The sulphur emissions and sulphur inlet for the specific sour gas plants (having a sulphur inlet greater than 1 tonne per day) that met the requirements for new plants when *ID 2001-3* was issued were also examined.

The drop in sulphur emissions from these plants was approximately 20 per cent, similar to that of the grandfathered plants. A much smaller reduction in sulphur inlet (about 2 per cent) occurred between 2000 and 2002. Details on these reductions on an individual plant basis for plants with sulphur recovery are in Appendix 4.

<b>Appendix 1. Grandfathered and Nongrandfathered Sour Gas Plants</b>							
				<b>Guideline</b>			
			<b>Current Approved</b>	<b>Recovery for</b>	<b>Daily</b>	<b>Baseline</b>	
			<b>Sulphur Recovery</b>	<b>Approved</b>	<b>Approved</b>	<b>Capacity</b>	
	<b>Plant</b>	<b>Efficiency</b>	<b>Sulphur Inlet</b>	<b>S Inlet</b>	<b>1999 S Inlet</b>	<b>Change in</b>	
	<b>Code</b>	<b>(%)</b>	<b>(%)</b>	<b>(t/d)</b>	<b>(t/d)</b>	<b>Status</b>	
						<b>(from ID 2001-3)</b>	
<b>Grandfathered Sulphur Recovery Gas Plants</b>							
1	Brazeau R. - KeySpan	1108	98.4	98.4%	400.0	67.3	Degrandfathered; became AGI in Jan/03
2	Brazeau R. (Nordegg) - KeySpan	1121	93.5	95.9%	49.8	38.2	
3	Burnt Timber - Shell	1131	96.5	98.4%	560.0	412.4	
4	Caroline (North) 1-11 - BP Canada	1374	69.7	69.7%	5.0	5.0	Plant shut down
5	Caroline (South) 4-20 - BP Canada	1104	85.0	89.7%	9.8	6.8	
6	Carstairs - Bonavista	1020	90.0	98.2%	72.2*	9.5	
7	Crossfield (Balzac) - Nexen	1050	98.0	98.5%	1,730.1	414.6	
8	Edson - Talisman	1084	97.9	98.4%	350.0	220.9	
9	Gold Creek - CNRL	1129	97.0	98.3%	100.0	64.1	
10	Jumping Pound - Shell	1037	96.2	98.4%	619.0	472.1	
11	Kaybob S. 1 & 2 - BP Canada	1107	98.4	98.5%	1,107.7	540.6	
12	Kaybob S. 3 - Chevron	1144	98.1	99.5%	3,629.7	1,009.6	
13	Lone Pine Ck. - ExxonMobil	1139	98.0	98.3%	165.4	129.5	
14	Minnehik B. L. - Penn West	1047	95.6	95.9%	39.7	22.0	
15	Okotoks (Mazeppa) - Border Midstream	1530	98.4	98.4%	586.6	263.4	Degrandfathered
16	Redwater - Imperial	1028	Fluctuating	95.9%	12.2*	3.1	
17	Rosevear (North) - Suncor	1206					Plant shut down
18	Rosevear (South) - Suncor	1268	95.6	98.3%	171.0	76.0	Plant consolidation
19	Simonette - Suncor	1113	96.5	98.3%	120.0	92.3	
20	Strachan (Ram River) - Husky	1141	98.1	99.5%	4,660.5*	2,301.8	
21	Strachan - KeySpan	1133	98.1	98.4%	971.1	264.9	
22	Sturgeon Lk. - Paramount	1112	94.0	98.3%	104.2	40.6	
23	Teepee - Talisman	1296	92.0	95.9%	25.0	17.5	
24	Waterton - Shell	1056	98.7	99.5%	3,148.0	2,099.6	
25	Wildcat Hills - Petro-Canada	1054	97.5	98.3%	287.5	181.3	
26	Wimborne - Devon	1081	95.5	98.3%	235.0	182.1	
27	Windfall (West Whitecourt) - BP Canada	1034	98.3	98.5%	1,356.1	777.6	
28	Zama - Apache	1219	92.0	98.2%	80.3	38.6	Baseline revision
	* Annual sulphur inlet.						

<b>Appendix 1. Grandfathered and Nongrandfathered Sour Gas Plants (continued)</b>							
			<b>Guideline</b>				
			<b>Recovery for</b>			<b>Baseline</b>	
			<b>Approved</b>	<b>2002</b>	<b>Approved</b>	<b>Capacity</b>	<b>Changed</b>
	<b>Plant</b>		<b>Sulphur Inlet</b>	<b>S Emissions</b>	<b>S Inlet</b>	<b>1999 S Inlet</b>	<b>Status</b>
	<b>Code</b>		<b>(%)</b>	<b>(t/d)</b>	<b>(t/d)</b>	<b>(t/d)</b>	<b>(from ID 2001-3)</b>
<b>Grandfathered Acid Gas Flaring Plants</b>							
1	<b>Ansell (Galloway) - CNRL</b>	1417	69.7	0.36	1.40	1.3	
2	<b>Bantry - AltaGas</b>	1114	69.7	0.56	2.00	1.0	Degrandfathered; became SR in Apr/02
3	<b>Bellshill Lake - Viking Energy</b>	1280	89.7	2.24	5.77	3.8	
4	<b>Big Bend - CNRL</b>	1293	69.7	0.29	1.46	1.0	
5	<b>Bigoray - PennWest</b>	1138	69.7	0.93	2.96	1.8	
6	<b>Bittern Lake - CNRL</b>	1124	69.7	0.00	2.48	1.0	Plant shut down
7	<b>Boundary Lake S - PennWest</b>	1202	69.7	1.13	2.20	1.1	
8	<b>Boundary Lake S - Talisman</b>	1024	69.7	0.45	1.90	1.0	
9	<b>Carson Creek - ExxonMobil</b>	1062	69.7	0.38	1.00	1.0	
10	<b>Enchant - Vista Midstream</b>	1039	69.7	0.21	1.25	1.0	
11	<b>Forestburg - Signalta</b>	1365	69.7	1.58	4.50	4.0	
12	<b>Greencourt - CNRL</b>	1127	89.7	1.01	5.08	1.3	
13	<b>Harmattan - Elkton-Bonavista</b>	1083	69.7	0.31	1.60	1.0	
14	<b>Judy Creek - Pengrowth</b>	1069	69.7	2.35	3.60	2.7	
15	<b>Kaybob - Paramount</b>	1058	89.7	1.15	5.15	1.0	
16	<b>Killam (Sedgewick) - AltaGas</b>	1510	69.7	1.05	4.75	2.2	
17	<b>Leduc - Woodbend - Imperial</b>	1023	69.7	0.68	1.01	1.0	
18	<b>Little Bow (Travers) - ConocoPhillips</b>	1150	69.7	0.97	1.60	1.2	
19	<b>Retlaw (Turin) - Vista Midstream</b>	1191	69.7	1.79	2.40	1.7	
20	<b>Spirit River - Bonavista</b>	1560	69.7	0.79	2.60	1.0	
21	<b>Strome - CNRL</b>	1179	69.7	0.77	3.40	1.6	
22	<b>Sylvan Lake - NAL Resources</b>	1070	0	0.38	0.75	1.0	Degrandfathered
23	<b>Virginia Hills (Hope Creek) - Apache</b>	1135	89.7	6.03	9.80	5.2	
24	<b>Vulcan - (Long Coulee) ConocoPhillips*</b>	1100	69.7	0.51	4.90	2.7	Degrandfathered; became AGI in Feb/02
25	<b>West Drumheller - Acclaim</b>	1109	69.7	0.51	2.99	1.1	
26	<b>Whitcourt - Shining Bank</b>	1115	89.7	2.68	7.50	3.5	
27	<b>Wilson Creek - Imperial</b>	1399	69.7	0.21	1.68	1.0	
28	<b>Wilson Creek - Petro-Canada</b>	1096	69.7	0.18	4.70	2.3	Degrandfathered; became SR in Nov/01
	* ConocoPhillips Vulcan injected volumes in 2002 were 1.54 t/d.						

**Appendix 1. Grandfathered and Nongrandfathered Sour Gas Plants (continued)**

			Current Approved	
			Sulphur Recovery	Approved
		Plant	Efficiency	S Inlet
		Code	(%)	(t/d)
<b>Nongrandfathered Sulphur Recovery Plants</b>				
1	Basing (Hanlan Robb) - Petro-Canada	1360	98.5	1,270.0
2	Bonnie Glen - Imperial	1045	Fluctuating	35.6
3	Brazeau R. - Petro-Canada	1482	98.4	455.0*
4	Brazeau R. (West Pembina) - Atco Midstream	1458	98.4	526.8
5	Campbell-Namao (Carbondale) - Atco Midstream	1638	69.7	1.15
6	Caroline - Shell	1662	99.5	5,450.0
7	Crossfield E. - Primewest	1079	98.4	863.8
8	Garrington (Olds) - Esprit	1021	98.4	404.9
9	Harmattan - Solex	1060	98.6	82.7
10	Hays - Anadarko	1585	90.0	9.9
11	Homeglen Rimbey - KeySpan	1004	98.3	150.0
12	Nevis - Duke Energy	1002	98.4	300.0
13	Progress - Anadarko	1506	96.5	49.5
14	Progress - Suncor	1629	69.7	2.5
15	Quirk Ck. - Imperial	1134	98.3	306.4*
16	Rainbow - Husky**	1105	98.3	149.4
17	Rainbow - Gibson	1658	89.7	9.9
18	Saddle Hills - EnCana	1892	98.4	483.1
19	Savanna Ck. (Coleman) - Northstar	1051	98.6	800.0
20	Sinclair (Hythe Brainard) - EnCana	1147	98.3	132.2
21	Swalwell - Viking Keywest	1654	70.0	4.6
	* Annual sulphur inlet.			
	** Husky Rainbow became an AGI facility in Jan/02. Injected volumes were 81.4 t/d for 2002.			

<b>Appendix 1. Grandfathered and Nongrandfathered Sour Gas Plants (concluded)</b>						
			Sulphur Recovery			2002
			Equivalent	Approved	2002	Sulphur
	Plant		Required	S Inlet	S Emissions	Injected
	Code		(%)	(t/d)	(t/d)	(t/d)
<b>Nongrandfathered Acid Gas Injection Plants</b>						
1	Acheson - EnerPro Midstream	1628	69.7	4.65	0.01	0.79
2	Bistcho Lk - Paramount	1975	95.9	25.00	0.26	15.46
3	Bigoray - EnerPro Midstream	1357	95.9	29.60	0.02	1.90
4	Boundary Lk S (Clear Hills) - CNRL	1880	95.9	15.35	0.20	7.76
5	Dizzy (Steen River) Penn West	1738	95.9	34.40	0.03	11.36
6	Dunvegan - Devon	1169	89.7	9.90	0.01	0.84
7	Eaglesham - (West Culp) Devon	1775	95.9	17.20	0.01	1.80
8	Galahad - Husky	1690	89.7	7.54	0.00	3.32
9	Golden Spike - Atco Midstream	1547	95.9	26.46	0.01	4.43
10	Gordondale - Duke	1668	98.2	54.30	0.06	25.04
11	Kelsey (Rosalind) - Thunder	1244	69.7	2.50	0.01	1.53
12	Leduc-Woodbend (Calmar) - Midcoast Canada	1676	95.9	15.54	0.02	3.05
13	Marlowe (Dizzy) - Bears paw	1765	95.9	19.70	0.03	4.11
14	Mulligan (Fourth Creek) - Duke	1895	89.7	10.00	0.01	6.24
15	Normandville - Devon	1990	69.7	1.90	0.00	0.08
16	O'Chiese - Burlington	1970	95.9	14.53	0.03	0.78
17	Paddle River - KeySpan	1089	69.7	1.50	0.01	0.86
18	Pembina - EnerPro Midstream	1402	95.9	29.70*	0.03	5.29
19	Pembina - Imperial	1625	69.7	4.20	0.03	1.64
20	Pouce Coupe - Duke	1746	95.9	26.20	0.09	9.05
21	Provost (Hansman Lk) - Husky	1698	89.7	10.00	0.01	5.52
22	Provost (Thompson Lk) - Husky	1695	95.9	12.00	0.04	5.78
23	Puskwaskau - Devon	1964	89.7	5.15	0.02	0.55
24	Rainbow - ExxonMobil	1155	95.9	20.10*	0.40	18.83
25	Rainbow - Husky	1105	98.3	149.40	0.44	81.40
26	Rycroft - Devon	1793	95.9	21.00	0.18	9.52
27	Watelet (Glen Park) - Atco	1672	69.7	3.30	0.00	0.75
28	Wayne-Rosedale - EnCana	1888	89.7	5.90*	0.02	1.83
29	Wembley - ConocoPhillips	1520	98.3	124.00	0.31	28.79
30	Zama - Apache	1878	98.2	247.00	0.09	40.22
	* Annual sulphur inlet.					

<b>Appendix 2. Plants That Have Degrandfathered</b>					
				<b>Approved S Inlet max daily (t/d)</b>	<b>Modification Process</b>
		<b>Plant Code</b>	<b>Plant Name</b>		
<b>Seven plants modified</b>					
1	Plant Mods	1108	Brazeau R. - KeySpan	400.00	(agi)
2	Plant Mods	1021	Garrington (Olds) - Esprit	404.90	(SuperClaus)
3	Plant Mods	1004	Homeglen Rimbey - KeySpan	150.00	(SuperClaus)
4	Plant Mods	1114	Bantry - AltaGas	2.00	(Xergy)
5	Plant Mods	1100	Vulcan (Long Coulee) - ConocoPhillips	4.90	(agi)
6	Plant Mods	1096	Wilson Creek - Petro-Canada	4.70	(Claus)
7	Plant Mods	1105	Rainbow - Husky	149.40	(agi)
<b>Three plants relicensed to higher S recovery efficiency or lower sulphur inlets</b>					
8	Relicensed	1530	Okotoks (Mazeppa) - Border Midstrear	586.60	
9	Relicensed	1079	Crossfield E. - Primewest	863.80	
10	Relicensed	1070	Sylvan Lake - NAL Resources	0.75	
<b>Other - Sulphur recovery not required, given the low approved sulphur inlet</b>					
	Plant Mods	1739	Bantry - EnCana	0.92	(Shell Paques/New Paradigm)

<b>Appendix 3. Sulphur Credits Earned</b>														
Plant Code	Credits						Cumulative Credits							
	Oct-Dec 2001	Jan-Mar 2002	Apr-Jun 2002	Jul-Sep 2002	Oct-Dec 2002	Jan-Mar 2003	Oct-Dec 2001	Jan-Mar 2002	Apr-Jun 2002	Jul-Sep 2002	Oct-Dec 2002	Jan-Mar 2003		
<b>Grandfathered Sulphur Recovery Gas Plants</b>														
1	1108	<b>Brazeau R. - KeySpan</b>						Degrandfathered - Dec 2/02						
2	1121	61.5	3.0	88.3	64.5	45.2	0.0	61.5	64.5	152.8	217.2	262.4	262.4	
3	1131	183.7	189.4	46.0	55.7	59.1	59.2	183.7	373.1	419.1	474.8	533.9	593.1	
4	1374	<b>Caroline (North) 1-11 - BP Canada</b>						Shut down						
5	1104	<b>Caroline (South) 4-20 - BP Canada</b>						Plant scheduled to shut down						
6	1020	22.4	10.8	17.6	13.6	22.5	14.6	22.4	33.2	50.8	64.4	86.9	101.5	
7	1050	160.2	132.4	41.5	168.8	172.8	202.9	160.2	292.6	334.1	502.9	675.7	878.6	
8	1084	16.9	39.8	41.1	1.4	8.2	14.8	16.9	56.7	97.8	99.2	107.4	122.2	
9	1129	<b>Gold Creek - CNRL</b>						-----						
10	1037	236.9	156.5	93.2	148.9	242.0	242.1	236.9	393.4	486.6	635.5	877.5	1,119.6	
11	1107	287.5	197.4	274.8	199.8	147.3	210.1	287.5	484.9	759.7	959.5	1,106.8	1,316.8	
12	1144	<b>Kaybob S. 3 - Chevron</b>						-----						
13	1139	<b>Lone Pine Ck. - ExxonMobil</b>						-----						
14	1047	<b>Minnehik B. L. - Penn West</b>						-----						
15	1530	<b>Okotoks - Border Midstream</b>						Degrandfathered						
16	1028	<b>Redwater - Imperial</b>						Plant with variable inlet rate						
17	1206	<b>Rosevear (North) - Suncor*</b>						Shut down						
18	1268	<b>Rosevear (South) - Suncor*</b>						-----						
19	1113	<b>Simonette - Suncor</b>						-----						
20	1141	1,393.6	1,289.3	1,408.1	900.4	1,459.9	1,698.8	1,393.6	2,682.9	4,091.0	4,991.4	6,451.3	8,150.1	
21	1133	158.2	125.2	65.0	28.9	44.3	64.2	158.2	283.4	348.5	377.3	421.6	485.8	
22	1112	<b>Sturgeon Lk. - Paramount</b>						-----						
23	1296	9.8	5.6	5.2	43.3	49.4	44.2	9.8	15.3	20.5	63.8	113.2	157.4	
24	1056	900.7	640.2	140.6	413.9	636.2	281.8	900.7	1,540.9	1,681.5	2,095.4	2,731.6	3,013.4	
25	1054	116.3	128.8	130.6	96.7	114.7	112.4	116.3	245.1	375.8	472.5	587.2	699.5	
26	1081	151.1	184.3	151.1	103.0	94.5	81.5	151.1	335.4	486.4	589.5	683.9	765.4	
27	1034	336.5	378.5	364.1	333.1	325.8	245.1	336.5	715.0	1,079.2	1,412.2	1,738.1	1,983.1	
28	1219	<b>Zama - Apache</b>						-----						
<b>Totals</b>		4,035.3	3,714.5	3,089.9	3,211.6	4,322.1	4,029.5	4,035.3	7,749.8	10,839.7	14,051.2	18,373.3	22,402.8	
* Plant consolidation.														

Appendix 4.1 Gas Plants with Sulphur Recovery, Year 2002 minus Year 2000				
Change in Production and Emissions Year 2002 minus Year 2000				
	Plant		2002-2000	2002-2000
	Code	Field-Operator	S Production	S Emission
			(t/y)	(t S/y)
<b>Grandfathered Plants</b>				
1	1034	Windfall (West Whitecourt) - BP Canada	(89,695.90)	(2,568.90)
2	1037	Jumping Pound - Shell	(39,924.30)	(1,495.40)
3	1107	Kaybob S. 1 & 2 - BP Canada	(97,573.20)	(1,173.34)
4	1144	Kaybob S. 3 - Chevron	(38,333.10)	(829.70)
5	1056	Waterton - Shell	(114,476.80)	(748.20)
6	1206	Rosevear (North) - Suncor	(12,290.70)	(499.60)
7	1050	Crossfield (Balzac) - Nexen	(19,430.80)	(450.50)
8	1113	Simonette - Suncor	(9,947.30)	(287.81)
9	1141	Strachan (Ram River) - Husky	(120,083.82)	(274.80)
10	1108	Brazeau R. - KeySpan	3,418.80	(232.80)
11	1133	Strachan - KeySpan	(33,874.70)	(219.80)
12	1084	Edson - Talisman	(11,809.06)	(195.03)
13	1081	Wimborne - Devon	(6,808.26)	(154.67)
14	1112	Sturgeon Lk. - Paramount	(3,297.60)	(107.32)
15	1020	Carstairs - Bonavista	(639.20)	(96.40)
16	1047	Minnehik B. L. - Penn West	(1,997.35)	(95.72)
17	1219	Zama - Apache	(3,622.80)	(88.10)
18	1296	Teepee - Talisman	(253.30)	(69.79)
19	1129	Gold Creek - CNRL	(2,537.80)	(62.70)
20	1104	Caroline (South) 4-20 - BP Canada	(297.51)	(55.80)
21	1121	Brazeau R. (Nordegg) - KeySpan	130.70	(52.20)
22	1530	Okotoks (Mazeppa) - Border Midstream	(6,858.50)	(47.50)
23	1374	Caroline (North) 1-11 - BP Canada	(572.30)	(23.00)
24	1028	Redwater - Imperial	(111.84)	(11.99)
25	1054	Wildcat Hills - Petro-Canada	(332.50)	(6.60)
26	1131	Burnt Timber - Shell	(1,431.40)	58.10
27	1139	Lone Pine Ck. - ExxonMobil	3,366.96	178.95
28	1268	Rosevear (South) - Suncor	8,703.50	275.96
	<b>Totals</b>		<b>(600,580.08)</b>	<b>(9,334.66)</b>
<b>Nongrandfathered Plants (plants meeting the requirements for new plants)</b>				
1	1079	Crossfield E. - Primewest	(23,057.20)	(1,088.10)
2	1360	Basing (Hanlan Robb) - Petro-Canada	(37,393.45)	(999.79)
3	1105	Rainbow - Husky	(22,351.51)	(962.49)
4	1021	Garrington (Olds) - Esprit	(5,838.50)	(924.10)
5	1004	Homeglen Rimbey - KeySpan	(4,230.90)	(796.30)
6	1051	Savanna Ck. (Coleman) - Northstar	(18,964.90)	(135.40)
7	1060	Harmattan - Solex	(4,280.10)	(68.35)
8	1147	Sinclair (Hythe Brainard) - EnCana	774.32	(47.03)
9	1506	Progress - Anadarko	968.10	(20.17)
10	1585	Hays - Anadarko	370.10	(16.35)
11	1654	Swalwell - Viking Keywest	11.10	(0.48)
12	1629	Progress - Suncor	265.10	0.00
13	1638	Campbell-Namao (Carbondale) - Atco Midstream	(27.91)	1.19
14	1658	Rainbow - Gibson	268.90	5.36
15	1002	Nevis - Duke Energy	(3,611.80)	12.80
16	1045	Bonnie Glen - Imperial	1,107.15	17.30
17	1662	Caroline - Shell	(64,067.20)	95.30
18	1134	Quirk Ck. - Imperial	8,536.30	208.30
19	1482	Brazeau R. - Petro-Canada	43,531.30	211.70
20	1458	Brazeau R. (West Pembina) - Atco Midstream	34,480.90	305.10
21	1892	Saddle Hills - EnCana	7,022.80	319.97
	<b>Totals</b>		<b>(86,487.41)</b>	<b>(3,881.54)</b>
	<b>Grand Totals</b>		<b>(687,067.49)</b>	<b>(13,216.20)</b>

Note: Tables do not include Petro-Canada Wilson Creek and AltaGas Bantry, which degrandfathered during this period.

**Appendix 4.2 Gas Plants with Sulphur Recovery, Year 2000**

						<b>Year 2000</b>	
<b>Plant Code</b>	<b>Field-Operator</b>	<b>Total Inlet</b>	<b>Total Annual Emissions</b>	<b>Actual Sulphur Recovery Eff.</b>	<b>Current Required Sulphur Recovery Eff.</b>	<b>Total Annual Production</b>	
		<b>(t/y)</b>	<b>(t S/y)</b>	<b>(%)</b>	<b>(%)</b>	<b>(t/y)</b>	
<b>Grandfathered Plants</b>							
1	1034	Windfall (West Whitecourt) - BP Canada	286,311.3	4,616.6	98.4%	98.3	292,237.0
2	1037	Jumping Pound - Shell	161,744.1	5,509.7	96.6%	96.2	158,522.1
3	1107	Kaybob S. 1 & 2 - BP Canada	234,341.8	2,756.9	98.9%	98.4	250,134.3
4	1144	Kaybob S. 3 - Chevron	360,565.8	6,646.1	98.2%	98.1	369,708.4
5	1056	Waterton - Shell	671,377.4	6,233.1	99.1%	98.7	679,224.2
6	1206	Rosevear (North) - Suncor	10,771.6	499.6	96.1%	94.6	12,290.7
7	1050	Crossfield (Balzac) - Nexen	144,323.2	2,408.8	98.3%	98.0	141,245.3
8	1113	Simonette - Suncor	32,358.2	793.8	97.5%	96.5	31,239.2
9	1141	Strachan (Ram River) - Husky	791,052.9	7,877.7	99.0%	98.1	781,009.3
10	1108	Brazeau R. - KeySpan	36,697.0	2,152.6	94.2%	92.1	35,158.5
11	1133	Strachan - KeySpan	97,769.5	1,169.6	98.8%	98.1	97,129.6
12	1084	Edson - Talisman	73,009.3	1,421.2	98.1%	97.9	73,337.4
13	1081	Wimborne - Devon	57,618.0	1,833.9	96.7%	95.5	54,008.0
14	1112	Sturgeon Lk. - Paramount	18,698.9	729.2	96.2%	94.0	18,456.1
15	1020	Carstairs - Bonavista	3,815.5	324.6	91.2%	90.0	3,370.0
16	1047	Minnehik B. L. - Penn West	7,018.8	270.4	96.1%	95.6	6,748.4
17	1219	Zama - Apache	15,117.5	583.9	96.1%	92.0	14,405.1
18	1296	Teepee - Talisman	5,424.7	372.2	93.2%	92.0	5,070.9
19	1129	Gold Creek - CNRL	20,071.4	514.9	97.6%	97.0	20,883.0
20	1104	Caroline (South) 4-20 - BP Canada	2,483.7	349.5	86.2%	85.0	2,186.0
21	1121	Brazeau R. (Nordegg) - KeySpan	12,991.3	727.9	94.6%	93.5	12,842.1
22	1530	Okotoks (Mazeppa) - Border Midstream	95,120.2	1,260.7	98.7%	98.3	95,760.9
23	1374	Caroline (North) 1-11 - BP Canada	1,039.2	86.8	91.2%	89.7	903.1
24	1028	Redwater - Imperial	1,184.9	88.3	92.7%	Fluctuating	1,118.3
25	1054	Wildcat Hills - Petro-Canada	71,413.7	1,220.0	98.2%	97.5	66,931.2
26	1131	Burnt Timber - Shell	156,959.7	4,844.0	96.9%	96.5	152,115.5
27	1139	Lone Pine Ck. - ExxonMobil	38,390.2	599.7	98.4%	98.0	37,232.3
28	1268	Rosevear (South) - Suncor	16,104.4	457.5	97.6%	95.6	18,426.7
<b>Totals</b>			<b>3,423,774.2</b>	<b>56,349.2</b>	<b>98.4%</b>		<b>3,431,693.7</b>
<b>Nongrandfathered Plants (plants meeting the requirements for new plants)</b>							
1	1079	Crossfield E. - Primewest	170,668.1	3,028.6	98.2%	98.0	169,921.2
2	1360	Basing (Hanlan Robb) - Petro-Canada	299,824.2	3,434.8	98.8%	98.5	288,911.9
3	1105	Rainbow - Husky	25,910.0	1,123.5	95.2%	95.0	22,351.5
4	1021	Garrington (Olds) - Esprit	103,220.0	2,152.2	97.9%	97.1	101,783.0
5	1004	Homeglen Rimbey - KeySpan	19,957.4	1,003.0	94.8%	92.0	18,208.7
6	1051	Savanna Ck. (Coleman) - Northstar	137,197.0	1,369.9	99.0%	98.6	136,352.7
7	1060	Harmattan - Solex	11,515.1	164.6	98.6%	98.6	11,875.6
8	1147	Sinclair (Hythe Brainard) - EnCana	28,431.8	296.2	99.0%	98.3	28,291.8
9	1506	Progress - Anadarko	9,215.7	237.8	97.4%	96.5	9,060.8
10	1585	Hays - Anadarko	2,390.2	129.0	94.5%	90.0	2,217.5
11	1654	Swalwell - Viking Keywest	517.6	138.9	79.3%	70.0	533.4
12	1629	Progress - Suncor	389.1	0.0	100.0%	69.7	336.7
13	1638	Campbell-Namao (Carbondale) - Atco Midstream	364.6	0.2	100.0%	69.7	403.7
14	1658	Rainbow - Gibson	1,882.0	127.9	92.6%	70.0	1,597.4
15	1002	Nevis - Duke Energy	37,590.7	467.5	98.8%	98.4	37,091.8
16	1045	Bonnie Glen - Imperial	3,281.6	125.8	96.1%	95.9	3,062.0
17	1662	Caroline - Shell	1,833,270.9	2,458.5	99.9%	99.8	1,844,827.3
18	1134	Quirk Ck. - Imperial	86,771.0	1,002.1	98.9%	98.3	90,372.6
19	1482	Brazeau R. - Petro-Canada	97,601.0	917.1	99.1%	98.4	96,505.4
20	1458	Brazeau R. (West Pembina) - Atco Midstream	107,983.1	1,624.1	98.6%	98.4	112,615.2
21	1892	Saddle Hills - EnCana	125,906.9	1,292.3	99.0%	98.4	126,382.7
<b>Totals</b>			<b>3,103,888.0</b>	<b>21,094.0</b>	<b>99.3%</b>		<b>3,102,702.9</b>
<b>Grand Totals</b>			<b>6,527,662.2</b>	<b>77,443.2</b>	<b>98.8%</b>		<b>6,534,396.6</b>

Note: Tables do not include Petro-Canada Wilson Creek and AltaGas Bantry, which degrandfathered during this period.

**Appendix 4.3 Gas Plants with Sulphur Recovery, Year 2002**

			Year 2002				
Plant Code	Field-Operator	Total Inlet (t/y)	Total Annual Emissions (t S/y)	Annual Sulphur Recovery (%)	Current Required Sulphur Recovery Effic. (%)	Total Actual Production (t/y)	
<b>Grandfathered Plants</b>							
1	1034	Windfall (West Whitecourt) - BP Canada	202,347.3	2,047.7	99.0%	98.3	202,541.1
2	1037	Jumping Pound - Shell	122,380.7	4,014.3	96.7%	96.2	118,597.8
3	1107	Kaybob S. 1 & 2 - BP Canada	144,611.7	1,583.6	99.0%	98.4	152,561.1
4	1144	Kaybob S. 3 - Chevron	347,962.7	5,816.4	98.3%	98.1	331,375.3
5	1056	Waterton - Shell	565,888.4	5,484.9	99.0%	98.7	564,747.4
6	1206	Rosevear (North) - Suncor	Shutdown	0.0	0.0%	0.0	0.0
7	1050	Crossfield (Balzac) - Nexen	122,185.5	1,958.3	98.4%	98.0	121,814.5
8	1113	Simonette - Suncor	21,921.7	506.0	97.7%	96.5	21,291.9
9	1141	Strachan (Ram River) - Husky	662,467.0	7,602.9	98.9%	98.1	660,925.5
10	1108	Brazeau R. - KeySpan	40,842.9	1,919.8	95.3%	92.1	38,577.3
11	1133	Strachan - KeySpan	62,844.3	949.8	98.5%	98.1	63,254.9
12	1084	Edson - Talisman	59,815.7	1,226.2	98.0%	97.9	61,528.4
13	1081	Wimborne - Devon	49,883.5	1,679.2	96.6%	95.5	47,199.8
14	1112	Sturgeon Lk. - Paramount	15,928.1	621.9	96.1%	94.0	15,158.5
15	1020	Carstairs - Bonavista	2,828.5	228.2	92.3%	90.0	2,730.8
16	1047	Minnehik B. L. - Penn West	4,925.6	174.7	96.5%	95.6	4,751.0
17	1219	Zama - Apache	11,331.2	495.8	95.6%	92.0	10,782.3
18	1296	Teepee - Talisman	5,130.7	302.4	94.1%	92.0	4,817.6
19	1129	Gold Creek - CNRL	17,170.5	452.2	97.6%	97.0	18,345.2
20	1104	Caroline (South) 4-20 - BP Canada	2,277.4	293.7	86.5%	85.0	1,888.5
21	1121	Brazeau R. (Nordegg) - KeySpan	13,442.8	675.7	95.0%	93.5	12,972.8
22	1530	Okotoks (Mazeppa) - Border Midstream	91,456.0	1,213.2	98.7%	98.4	88,902.4
23	1374	Caroline (North) 1-11 - BP Canada	505.9	63.8	83.8%	69.7	330.8
24	1028	Redwater - Imperial	1,070.6	76.3	93.0%	80.0	1,006.5
25	1054	Wildcat Hills - Petro-Canada	68,908.1	1,213.4	98.2%	97.5	66,598.7
26	1131	Burnt Timber - Shell	155,586.2	4,902.1	96.8%	96.5	150,684.1
27	1139	Lone Pine Ck. - ExxonMobil	40,994.9	778.7	98.1%	98.0	40,599.2
28	1268	Rosevear (South) - Suncor	27,885.6	733.5	97.4%	95.6	27,130.2
		<b>Totals</b>	<b>2,862,593.5</b>	<b>47,014.5</b>	<b>98.4%</b>		<b>2,831,113.6</b>
<b>Nongrandfathered Plants (plants meeting the requirements for new plants)</b>							
1	1079	Crossfield E. - Primewest	147,202.5	1,940.5	98.7%	98.4	146,864.0
2	1360	Basing (Hanlan Robb) - Petro-Canada	259,176.8	2,435.0	99.0%	98.5	251,518.5
3	1105	Rainbow - Husky	32,168.8	161.0	99.5%	98.3	Injected(29 712.1)
4	1021	Garrington (Olds) - Esprit	96,920.0	1,228.1	98.7%	98.4	95,944.5
5	1004	Homeglen Rimbey - KeySpan	12,075.6	206.7	98.5%	98.3	13,977.8
6	1051	Savanna Ck. (Coleman) - Northstar	125,476.9	1,234.5	99.0%	98.6	117,387.8
7	1060	Harmattan - Solex	7,864.4	96.3	98.7%	98.6	7,595.5
8	1147	Sinclair (Hythe Brainard) - EnCana	26,557.7	249.2	99.2%	98.3	29,066.1
9	1506	Progress - Anadarko	10,220.1	217.6	97.9%	96.5	10,028.9
10	1585	Hays - Anadarko	2,700.5	112.7	95.8%	90.0	2,587.6
11	1654	Swalwell - Viking Keywest	602.1	138.4	79.7%	70.0	544.5
12	1629	Progress - Suncor	630.4	0.0	100.0%	69.7	601.8
13	1638	Campbell-Namao (Carbondale) - Atco Midstream	358.9	1.4	99.6%	69.7	375.8
14	1658	Rainbow - Gibson	1,966.9	133.3	93.3%	89.7	1,866.3
15	1002	Nevis - Duke Energy	33,935.3	480.3	98.6%	98.4	33,480.0
16	1045	Bonnie Glen - Imperial	4,582.3	143.1	96.7%	95.9	4,169.1
17	1662	Caroline - Shell	1,770,965.5	2,553.8	99.9%	99.5	1,780,760.1
18	1134	Quirk Ck. - Imperial	97,581.4	1,210.4	98.8%	98.3	98,908.9
19	1482	Brazeau R. - Petro-Canada	137,530.2	1,128.8	99.2%	98.4	140,036.7
20	1458	Brazeau R. (West Pembina) - Atco Midstream	144,346.2	1,929.2	98.7%	98.4	147,096.1
21	1892	Saddle Hills - EnCana	140,226.2	1,612.3	98.8%	98.4	133,405.5
		<b>Totals</b>	<b>3,053,088.6</b>	<b>17,212.5</b>	<b>99.4%</b>		<b>3,016,215.5</b>
		<b>Grand Totals</b>	<b>5,915,682.0</b>	<b>64,227.0</b>	<b>98.9%</b>		<b>5,847,329.1</b>

Note: Tables do not include Petro-Canada Wilson Creek and AltaGas Bantry, which degrandfathered during this period.