Suncor MacKay River Project
2014 AER Performance Presentation: Subsurface Commercial Scheme Approval No. 8668

November 12, 2014
Reporting Period September 1, 2013 – August 31, 2014
To provide greater reliability and flexibility to our feedstock supplies, we produce bitumen through mining and in-situ recovery technologies and supplement that supply through third party agreements.

We produce natural gas as a natural price hedge against the cost of energy consumption at Suncor’s oil sands operation.

International and offshore assets are a source of steady cashflow to fund our oil sands growth.

Our investments in renewable wind energy and biofuels are a key part of Suncor’s climate change action plan.

A staged approach to increasing crude oil production capacity allows Suncor to better manage capital costs and incorporate new ideas and new technologies into our facilities.

Suncor takes an active role in connecting supply to consumer demand with a diverse portfolio of products, downstream assets and markets.
Suncor has high quality leases in close proximity
AER Directive 054
2014 Performance Presentation

Section 3.1.1 – Subsurface Issues Related to Resource Evaluation and Recovery
Table of Contents

• Introduction
• Geoscience
• Well Operations
• Scheme Performance
• Caprock Integrity
• Future Plans
MacKay River Project Overview

• Company’s first operated SAGD facility - located 60 km NW of Ft. McMurray
• Current Approved Bitumen Production Rate 11,600 m³/d (73 kbpd)
• Adjacent to Suncor Dover (UTF/AOSTRA) Project
• Horizontal production wells are placed in the McMurray Formation at a depth of 98 – 145m from surface
• No extensive underlying water or gas over bitumen issues in current development areas
• Initial development had 25 well pairs with first steam in September 2002 and first production in November 2002 (Phase 1)
• 73 well pairs have been subsequently added (98 well pairs in total)
  • Section 16 (Pad 40 – 2 well pairs) first steam October 2005
  • Phase 2 (Pad 22 – 14 well pairs) first steam January 2006
  • Phase 3 (Pad 23 – 7 well pairs) first steam September 2007
  • Phase 4 (Pads 24 & 25 – 10 well pairs) first steam 2008
  • Phase 5A (Pad 25 – 6 well pairs) first steam June 2011
  • Phase 5B-1 (Pad 24 – 6 well pairs) first steam February 2012
  • Phase 5B-2 (Pad 25 – 10 well pairs) first steam January 2013
  • Phase 5DF (Pad 24&25 – 18 well pairs) first steam May 2014
3.1.1  1

Project Area and Project Site

- Current Project Area (PA) approximately 24 ½ sections
Wellpads and Subsurface Patterns

- 78 producing well pairs at MacKay River (up to Phase 5B-2)
- 2 suspended well pairs (Pad 40)
- 18 Phase 5D/F well pairs started steaming Q2 2014

**Drilling**
- 23 well pairs and 2 single producers were drilled September 2012- Aug 2013
- 12 well pairs and 1 sidetrack single producer were drilled in 2014
Current Approval Amendments

- Historical approval amendments in Appendices

- Amendment 8668S
  - Approval to conduct a chemical injection test on Pad 21 (D-Pattern Injectors) issued September 5, 2013

- Amendment 8668T
  - Pad 819 approval issued January 23, 2014

- Amendment 8668U
  - Maximum Operating Pressure approval issued January 29, 2014

- Amendment 8668V
  - NCG Expansion Project and Phase 5D/F Chemical Injection approval issued April 29, 2014

- Amendment 8668W
  - MR CPF Modifications and Directive 081 Waiver approval issued May 9, 2014

- Amendment 8668X
  - Administrative reissue approval issued May 12, 2014

- Amendment 8668Y
  - WHIP for Phases 5B2, 5D and 5F Patterns approval issued June 19, 2014
Outstanding Approval Applications

• Application No. 1799772: Pad 28 (828) Category 2 application to reduce well pairs from three to two submitted June 17, 2014. SIR submitted on October 13, 2014

• Application No. 1799757: D-Pattern Chemical Injection Category 2 application to correct well UWIs submitted June 17, 2014.

• Application No. 1801826: Phase 1 NCG Category 2 application to amend design submitted July 14, 2014. SIR submitted on September 26, 2014
  • (Currently injecting NCG into B4 only – 108/08-05-093-12W4/0)

• Application No. 1804679: Phase 2 Chemical Co-Injection Category 2 application submitted August 8, 2014.
MacKay River Stratigraphy

2014 MacKay Bitumen Pay
Contour Interval = 5m

Log Corr
GR (gAPI)
0.0 150.0
SP (mV)
-130.0 0.0

Upper Clearwater
Clearwater Shale
Wabiskaw A Shale
Wabiskaw C Sand
Wabiskaw D

McMurray Formation
Beaverhill Lake

Approved PA
2013-14 Activities – Vertical & SAGD Drilling

- 16 vertical wells drilled in the PA
  - 11 Wabiskaw C monitoring wells
  - 2 McMurray OB wells
  - 3 high core wells

- Special core analyses conducted in PA:
  - geochemistry

- 12 SAGD well pairs drilled on Pad 751 East
  - 751WP1 to 751WP12

- G6P sidetrack
2013-14 Activities - Seismic

- Acquired 0.9 km² of high resolution 3D seismic shot along SE boundary of Pattern A, B, C, D
- Purposes:
  - To understand the steam growth to the SE direction
Proposed E1P Sidetrack – Seismic Cross Section

- 2013 Seismic survey aided in optimized placement of SAGD trajectory and location of E1P Sidetrack
Bitumen Pay Isopach

10 Weight Percent
Bitumen cutoff

Legend

Approved PA Boundary

2014 MacKay Bitumen Pay
Contour Interval = 5m
Base of Pay Structure Map

Legend

Approved PA Boundary

Base of Continuous Pay Structure
Contour Interval = 5m
Top of Pay Structure Map

Legend
- Approved PA Boundary
- Contour Interval = 5m
Oil Sands Facies and Gross Bitumen Pay

**Facies:**
Defined by visual mud index (VMI)

**Cutoffs:**
F1 (Sandstone) = 0-5% VMI
F2 (Sandy IHS*) = 5-15% VMI
F3 (IHS*) = 15-30% VMI
F4 (Muddy IHS*) = 30-70% VMI
F5 (Mudstone) = 70-100% VMI
F10 (Breccia) = variable

* IHS = inclined, interbedded, sand and shale

**Pay:**
Includes Facies F1, F2, and F10
Can include F3-F5, if < 2m thick

Weight percent bitumen > 10%

Generally > 30% Porosity
- PA averages 31.1% in clean sands

Permeability = 1 to 5 Darcies

> 15m for OBIP volumetrics
Pattern OBIP Calculation

**Gross Pay Volume (GRV)** = total rock volume derived from Continuous Pay map

**Net Pay Volume (NRV)** = product of Continuous Pay gross rock volume multiplied by the average Net Sand Ratio for each area

**Net Sand Ratio (NSR)** = a net-to-gross adjustment used to account for pay mapping being done on a continuous (gross) basis

- 15% VMI (visual mud index) cutoff plus the sand component of breccia intervals

**Original Bitumen in Place** = product of the Net Pay volume multiplied by the average Porosity, and the average Oil Saturation

\[ \text{OBIP} = \text{GRV} \times \text{NSR} \times \text{So} \times \text{Por} \]

New net-to-gross adjustment using Net Sand Ratio map allows for consistent application of a mudstone cutoff while: a) avoiding adjustments based on pattern averages, and b) allowing the differential treatment of sand- versus mud-rich breccias.
## Average Reservoir Properties and Volumes

<table>
<thead>
<tr>
<th>Pattern</th>
<th>Net Sand Ratio</th>
<th>So</th>
<th>Phi</th>
<th>So-Phi</th>
<th>OBIP (e³m³)</th>
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</thead>
<tbody>
<tr>
<td>A</td>
<td>91%</td>
<td>82%</td>
<td>31%</td>
<td>26%</td>
<td>2,389</td>
</tr>
<tr>
<td>B</td>
<td>95%</td>
<td>86%</td>
<td>32%</td>
<td>27%</td>
<td>3,319</td>
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<tr>
<td>C</td>
<td>95%</td>
<td>89%</td>
<td>32%</td>
<td>29%</td>
<td>4,238</td>
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<tr>
<td>D</td>
<td>96%</td>
<td>91%</td>
<td>31%</td>
<td>28%</td>
<td>2,741</td>
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<td>E</td>
<td>92%</td>
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<td>31%</td>
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<td>F</td>
<td>95%</td>
<td>89%</td>
<td>32%</td>
<td>28%</td>
<td>3,616</td>
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<tr>
<td>G</td>
<td>93%</td>
<td>86%</td>
<td>32%</td>
<td>27%</td>
<td>4,155</td>
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<td>H</td>
<td>94%</td>
<td>84%</td>
<td>31%</td>
<td>26%</td>
<td>1,756</td>
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<tr>
<td>NN (Phase 4/5)</td>
<td>95%</td>
<td>85%</td>
<td>32%</td>
<td>27%</td>
<td>7,010</td>
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<tr>
<td>OO (Phase 4/5)</td>
<td>93%</td>
<td>84%</td>
<td>31%</td>
<td>26%</td>
<td>5,251</td>
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<tr>
<td>QQ (Phase 4/5)</td>
<td>87%</td>
<td>84%</td>
<td>31%</td>
<td>26%</td>
<td>5,581</td>
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<tr>
<td>Section 16</td>
<td>81%</td>
<td>84%</td>
<td>31%</td>
<td>26%</td>
<td>711</td>
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<tr>
<td><strong>Subtotal</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td><strong>44,495</strong></td>
</tr>
<tr>
<td><strong>Total PA</strong></td>
<td>90%</td>
<td>84%</td>
<td>31%</td>
<td>26%</td>
<td><strong>172,190</strong></td>
</tr>
</tbody>
</table>

Average Reservoir Depth = 109 m TVD, $P_i = 400$ kPa, $T_i = 6-7$ °C, $K_{max} = 1.7-8.5$ D, $K_{min} = 1.1-6.5$ D
Phase 1

Clearwater

Wabiskaw C

Wabiskaw D

Top of Pay

Devonian
Beaverhill Lake

Pad 20

Pad 21

A Pattern

B Pattern

C Pattern

D Pattern

3.1.1 2 i)
Phases 2, 3 and 4
Phase 5

3.1.1 2) Clearwater Wabiskaw C Wabiskaw D Top of Pay Devonian Beaverhill Lake

Pad 24

Pad 25

NN Pattern

OO Pattern

QQ Pattern
Pad 750/751
MacKay Steam Chamber Edge as Defined by April 2013 3D Seismic

- 2013 3D first full seismic survey over project area
- Aided in estimating steam chamber growth in current operating areas
- Seismic interpretation currently underway to evaluate entire 2013 3D over full operating area
- First 4D seismic survey acquired Q1 2014 (refer to seismic activity slide 14 for 4D outline), used to establish steam chamber growth in SE direction
MacKay River Performance Presentation
Well Operations
Typical Well Completions – Phase 1 Type

Injector

Producer
Typical Well Completions – Phase 5 Type

**Injector**
- 473 mm surface casing @ mKB
- SHORT STRING: 114 mm tubing @ mKB
- HS-HT packer
- 340 mm casing @ mKB
- Instrument guide string
- 114 mm Long Tubing String @ mKB
- TD @ 1529 mKB (1280 mTVD)
- 244.5 mm Slotted Liner landed @ mKB

**Producer**
- 473.0 mm Surface Casing
- 44.5 mm gas lift
- 114.3 mm Short String Last Joint Perforated
- HS-HT packer
- 339.7 mm csg
- Instrument String
- Instrumentation guide string
- Bubble Tube
- 244.5 mm Slotted Liner
- 114 mm Long Tubing String
- TD @ mKB (133.1 mTVD)
Well Downhole Instrumentation

- **Phase 1** (25 well pairs)
  - Temperature optic fibre in 4 producers have been replaced and are functional today (A5, B2, C1, and C2)

- **Phase 2** (14 well pairs)
  - Temperature fibre optic installed in G6P
  - P/T gauge installed in G6I

- **Phase 3** (7 well pairs)
  - No instrumentation

- **Phase 4** (10 well pairs)
  - No instrumentation except temperature fibre optics in OO3 I & P
  - Temperature fibre optic installed in NN1P

- **Phase 5A** (6 well pairs)
  - Pressure - bubble tube to the toe in every producer
  - Two producers equipped with 6 point thermocouple bundle to the toe (QQ5, NN5)

- **Phase 5B-1** (6 well pairs)
  - Pressure - bubble tube to the toe in every producer except OO5
  - All producers equipped with 6 point thermocouple bundle to the toe except OO5 and OO9 which have temperature fibre optic
Well Downhole Instrumentation

• Phase 5B-2 (10 well pairs)
  • Pressure - bubble tube to the toe in every producer
  • All producers equipped with 6 point thermocouple bundle to the toe

• Phase 5D&F (18 well pairs)
  • Pressure - bubble tube to the toe in every producer except OO well pairs which have pressure gauges
  • All producers equipped with fibre optic to the toe

• Flow Control Devices
  • Installed in NN15 and OO12
  • To control vapour
  • Performance being monitored, no learnings to date
Artificial Lift

• All existing SAGD production wells designed for gas lift
  – Low cost completion
  – Recover gas
  – No downhole moving parts

• Wells with downhole pumps:
  – F1P, ESP since February 2009, current pump installed March 2011
  – OO3P, ESP since October 2009, current pump installed March 2012
Well Operations – Key Learnings

- **Wellbore stimulations** (5 wells) have been successful in lowering differential pressure (dP) across the slotted liner and help with wellbore conformance in the producers
  - November 2013 – QQ6, QQ9 and QQ10
    - Mixed results due to change in execution
  - July 2014 – QQ6, QQ7, QQ9 and OO7
    - All 4 wells saw a reduction in differential pressure (dP)

- **Wellbore integrity management** is a high priority focused on wellbore containment over wells’ full life cycle
  - Monitoring of SCVF on A3I
  - Repair of SCVF on G1I
  - Wellbore integrity workovers (liner patches, sidetracks etc.)
  - Well Abandonments of Pad 40 wells (S16 SP, S16 NP and S16 NI)
Well Enhancement – Key Learnings

• Redrills / Sidetracks
  • G6P - Sidetrack
    • sidetracked because the failure repair was rated as high risk
    • Original G6P is 125.5 m TVD, G6P sidetrack is 128.1 m TVD
    • Intent was to drill sidetrack at some elevation at original G6P well, execution resulted in sidetrack being 3 m lower than original well

• Well Enhancement Repairs
  • OO7 – Dual DSP
    • Implemented in January 2014, success is still being evaluated
  • NN6 – Liner Patch
    • Liner repair in August 2013, not successful – sidetrack planned for Q4 2014
  • H3P – Dual DSP
    • Implemented August 2014, success still being evaluated
Observation Wells
Observation Wells

- Total of 139 licensed observation wells at MacKay River
- Observation wells at MacKay River serve three main purposes:
  1. Reservoir optimization (steam chamber monitoring)
     - 32 wells with fibre optic cable from surface to TD
     - 12 wells with fibre optic cable and pressure sensors
     - 31 wells with thermocouple bundles and pressure sensors
     - 2 heave monitoring wells (extensometers downhole)
  2. Wabiskaw C pressure monitoring
     - 50 wells with a single pressure / temperature sensor
  3. Subsurface Monitoring (outside of producing area)
     - 5 wells with thermocouple bundles and pressure sensors
     - 2 wells with a single pressure / temperature sensor
     - 5 piezometer wells

- Current observation well design incorporates thermocouple measurement as this provides sufficient resolution for steam chamber monitoring and is preferred for remote well locations.

Note: some wells serve more than one purpose
Observation Well Instrumentation

McMurray Observation Well (Type 1):
- Capillary line loop cemented outside casing
- Fibre optic cable pumped into capillary line loop to provide temperature profile along entire vertical well depth
- Allows for close monitoring of steam chamber development

McMurray Observation Well (Type 2):
- Coiled tubing instrument string containing 14 thermocouples and 1 P/T gauge run inside 114 mm intermediate casing
- Perforated near the top of the McMurray oil sands zone
- Pressure / temp gauge positioned at MPP
- 14 point thermocouple bundle collects temperature data across the McMurray
**Observation Well Instrumentation**

**Wabiskaw C Observation Well:**
- Open hole into Wabiskaw C sand
- Wellbore does not penetrate Wabiskaw D mudstone or McMurray sand
- Pressure / temp gauge landed inside tubing
MacKay River Performance Presentation

SAGD Scheme Performance
# Summary of Operating Wells

<table>
<thead>
<tr>
<th>Pad</th>
<th>Pattern</th>
<th>Phase</th>
<th># Well pairs</th>
<th>First steam to Pad</th>
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<td>20</td>
<td>A</td>
<td>1</td>
<td>7</td>
<td>Sept 2002</td>
</tr>
<tr>
<td></td>
<td>C</td>
<td></td>
<td>6</td>
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<td>21</td>
<td>B</td>
<td></td>
<td>7</td>
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<td></td>
<td>D</td>
<td></td>
<td>5</td>
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<td>22</td>
<td>E</td>
<td>2</td>
<td>7</td>
<td>Jan 2006</td>
</tr>
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<td></td>
<td>G</td>
<td></td>
<td>7</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>F</td>
<td>3</td>
<td>7</td>
<td>Sept 2007</td>
</tr>
<tr>
<td>24</td>
<td>OO</td>
<td>4</td>
<td>3</td>
<td>Oct 2008 - Apr 2009</td>
</tr>
<tr>
<td></td>
<td>5B-1</td>
<td></td>
<td>6</td>
<td>Feb 2012</td>
</tr>
<tr>
<td></td>
<td>5DF</td>
<td></td>
<td>6</td>
<td>May 2014</td>
</tr>
<tr>
<td></td>
<td>H</td>
<td>4</td>
<td>4</td>
<td>Feb 2009 - Jun 2010</td>
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<tr>
<td>25</td>
<td>QQ</td>
<td>4</td>
<td>2</td>
<td>Nov 2008</td>
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<td></td>
<td>5A</td>
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<td>2</td>
<td>Jul 2011</td>
</tr>
<tr>
<td></td>
<td>5B-2</td>
<td></td>
<td>5</td>
<td>Jan - May 2013</td>
</tr>
<tr>
<td></td>
<td>5DF</td>
<td></td>
<td>6</td>
<td>June 2014</td>
</tr>
<tr>
<td></td>
<td>NN</td>
<td>4</td>
<td>1</td>
<td>Dec 2008</td>
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<tr>
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<td>5A</td>
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<td>4</td>
<td>Jun - Jul 2011</td>
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<td>5B-2</td>
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<td>Jan - Feb 2013</td>
</tr>
<tr>
<td></td>
<td>5DF</td>
<td></td>
<td>6</td>
<td>June 2014</td>
</tr>
</tbody>
</table>
Fluid Rates

3.1.17 a) ii, iii
Producing Well Count

Phase 1

Section 16

Phase 2

Phase 3

Phase 4

Phase 5A

Phase 5B-1

Phase 5B-2

Well Pair Count

Oil Rate [m³/d]

Well Count

Oil Rate
Cumulative Fluid Volumes

As of August 2014
Cum Oil 16.3 million m³
Cum Steam 39.0 million m³
Cum Water 39.3 million m³
CSOR 2.4
Average Oil Rate per Pattern

![Graph showing oil rate over time for different patterns](image)

- **Axes:**
  - Y-axis: Oil Rate (m$^3$/d/well pair)
  - X-axis: Months Since Start-up

- **Legend:**
  - A
  - B
  - C
  - D
  - E
  - G
  - F
  - H
  - NN
  - OO
  - QQ

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CSOR by Pattern

- QQ wells have the lowest CSOR
- H and OO wells have a mid range CSOR
- A Pattern has the highest CSOR
### Performance Summary by Pattern

<table>
<thead>
<tr>
<th>Pattern</th>
<th>OBIP [e³ m³]</th>
<th>Cum. Oil [e³ m³]</th>
<th>Recovery up to August 2013 [%]</th>
<th>CSOR [m³/m³]</th>
<th>ISOR (Aug. 2014) [m³/m³]</th>
<th>Ultimate Recovery [%]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pattern A</td>
<td>2,389</td>
<td>955</td>
<td>40.0</td>
<td>4.3</td>
<td>4.5</td>
<td>47</td>
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<tr>
<td>Pattern B</td>
<td>3,319</td>
<td>2,566</td>
<td>77.3</td>
<td>2.1</td>
<td>3.1</td>
<td>82</td>
</tr>
<tr>
<td>Pattern C</td>
<td>4,238</td>
<td>3,238</td>
<td>76.4</td>
<td>2.2</td>
<td>2.0</td>
<td>89</td>
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<tr>
<td>Pattern D</td>
<td>2,741</td>
<td>1,822</td>
<td>66.5</td>
<td>2.4</td>
<td>2.6</td>
<td>73</td>
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<tr>
<td>Pattern E</td>
<td>3,728</td>
<td>2,046</td>
<td>54.9</td>
<td>1.9</td>
<td>3.1</td>
<td>70</td>
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<tr>
<td>Pattern F</td>
<td>3,616</td>
<td>1,943</td>
<td>53.7</td>
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<td>81</td>
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<tr>
<td>Pattern G</td>
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<td>1,662</td>
<td>40.0</td>
<td>2.4</td>
<td>2.8</td>
<td>54</td>
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<td>Section 16</td>
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<td>Pattern H</td>
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<td>15.6</td>
<td>3.5</td>
<td>3.9</td>
<td>47</td>
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<td>Pattern NN</td>
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<td>614</td>
<td>13.8</td>
<td>2.8</td>
<td>2.8</td>
<td>58</td>
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<tr>
<td>Pattern OO</td>
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<td>437</td>
<td>14.8</td>
<td>3.4</td>
<td>3.9</td>
<td>52</td>
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<td>Pattern QQ</td>
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<td>584</td>
<td>15.0</td>
<td>1.9</td>
<td>1.4</td>
<td>55</td>
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<td>Total</td>
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<td>16,249</td>
<td>42.8</td>
<td>2.4</td>
<td>2.6</td>
<td>65</td>
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</tbody>
</table>

* Phase 5DF is not included
## Pattern Examples Based on Recovery

<table>
<thead>
<tr>
<th>Pattern</th>
<th>ISOR [m³/m³]</th>
<th>CSOR [m³/m³]</th>
<th>Cum Oil [10³m³]</th>
<th>Peak Oil Rate [m³/d/well pair]</th>
<th>Current Oil Rate [m³/d/well pair]</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>A Pattern</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
| Low Recovery | 4.5 | 4.3 | 955 | 73-149 | 5-35 | • Poor geology  
• 40% recovery to date (ultimate RF: 47%)  
• Producing for more than 10 years |
| **E Pattern** |  |  |  |  |  |  |
| Medium Recovery | 3.1 | 1.9 | 2046 | 125-235 | 26-77 | • Medium quality geology  
• 55% recovery to date (ultimate RF: 70%)  
• Producing for about 8 years |
| **C Pattern** |  |  |  |  |  |  |
| High Recovery | 2.0 | 2.2 | 3238 | 179-299 | 10-145 | • High quality geology  
• 76% recovery to date (ultimate RF: 89%)  
• Producing for more than 10 years |
A Pattern – Low Recovery
E Pattern – Medium Recovery
C Pattern – High Recovery
Steam Chamber Growth: OO1 vertical observation well

- OO1 has mud beds and IHS within the continuous pay interval
- Steam chamber growth through the minor mud beds from 116.95-117.1 mSS
- Thicker mud beds at ~110 mSS, potential sandy IHS above red line
Steam Chamber Development: Surface Heave Monitoring

- 431 monuments exist over MacKay River for heave measurement and monitoring
- Survey History
  - 1st: Fall 2002
  - 2nd: Dec 2006
  - 3rd: Fall/Winter 2007/08
  - 4th: Nov 2008
  - 5th: Jan/Feb 2010
  - 6th: Nov. 2010
  - 7th: Dec. 2011
  - 9th: Oct 2013
2D Surface Heave: Change from Baseline to October 2013

Survey strategy
- Heave surveys are performed at different frequencies depending on well vintage
  - Oct 2013 heave survey only for Phase 4 and 5
  - Results are consistent with historical surveys

Heave monitoring application:
- Geomechanical model
- Field performance monitoring coupled with seismic
Key Learnings: Subsurface Instrumentation

- Downhole instrumentation can detect hot spots
- Aid in production throughout the horizontal and avoid localized production
- Mitigate against possible steam coning areas which could lead to future liner failures
- Instrumentation show that surface measurement may not fully explain downhole behaviour
- Aids in understanding impact of our operating process

![Graph showing temperature changes over depth](image)
Key Learnings: Subsurface Instrumentation Cont.

- Assist in managing temperature conformance
- Pre-workover temperature conformance was concerning
- Opportunity to do a proactive workover to improve conformance
  - $\Delta T$ improved from 30°C to 15°C

Sample historical data – Post workover

Sample historical data – Pre workover
Key Learnings: Revised Start-up Strategy for Phase 5D-F

Phase 5D-F circulation strategy remains consistent with Phase 5A and 5B-1/5B-2 with some key improvements

**Phase 5D-F Unloading Circulation Methodology**
- Emphasis on conformance and uniform heating versus duration
- Target lower rates (2-3m$^3$/hr) while maintaining steam-to-toe
- Target of 0-50 kPag delta P between injector and producer
  - Daily adjustments based on flowing bottom hole pressure (FBHP)
- Use of continuous fluid shots during the unloading process to minimize BHP uncertainty and accelerate unloading

**Phase 5D-F Conversion Methodology**
- Empirical analysis conducted to estimate optimal conversion targets to optimize conformance and accelerate SAGD conversions
Steam Injection Conditions

- Approved MOPs based on the methodology detailed in Application 1724610
- New approved Bottomhole MOP at 80% of the fracture closure pressure
- MOPs are set by shallowest point in each pattern to allow for intra-pattern communication
- Steam injection pressure limits are enforced at wellhead on tubing and annulus via pressure transmitters. Phase 1 wells are monitored via manual pressure measurement at the wellhead every second day
- Steam injection pressure is reduced as required to maintain estimated bottomhole pressure below MOP for neighbouring patterns in communication

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*Commercial Scheme Approval No. 8668U
Stewardship to maximum bottomhole operating pressure

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* D pattern July-Aug 2014 current pressure: 1230 KPag

- All of the Mackay wells in SAGD are currently operating at pressures below the new approved 80% maximum bottomhole operating pressure
- Alarm systems are in place to ensure the approved maximum bottomhole operating pressures are not exceeded.
- Steam injection pressure is reduced as required to maintain estimated bottomhole pressure below maximum bottomhole operating pressure

**Impact**
- May impact new well conversions in low MOP areas
- Small impact to mature wells performance
Stewardship to maximum bottomhole operating pressure

• For SAGD wells with no downhole instrumentation Step-down Tests (SDT) and Low Rate Tests (LRT) are performed and used to calculate estimated chamber pressure to ensure that the Maximum Bottomhole Injection Pressure (MBHIP) is not exceeded

• **SDTs** are conducted by lowering the steam injection rate in steps and allowing pressures to stabilize between steps

• **LRTs** are conducted on wells that do not have reliable SDT correlations by reducing the steam injection rates low enough to estimate the chamber pressure

• **SDT** is the preferred method for chamber pressure estimation as it allows for real time chamber pressure monitoring based on changing injection rates
Methodology for Predicting Scheme Performance

- Methodology for production forecasting has changed from last year. Use of historical analog data to better forecast future decline behaviour of wells with mature steam chambers

Phases 1 - 5
- Oil forecast is based on the following:
  - The SAGD theoretical flow equations for the rising and spreading of the steam chamber (Butler) are used to describe the profile trend
  - Production history matching is used to calibrate the analytical model
  - Exponential decline is now used for falling phase, instead of linear decline
  - Water & steam forecasts are based on historical performance trends

Future Phases
- Production profile predicted using a combination of numerical flow simulation and analytical forecast and analogs
Predicting Scheme Performance: SAGD Analytical Model

- Analytical model used to match performance history of wells in SAGD mode
- Focus on trend fitting current phase of well’s life, not individual points
- Exponential decline is used for the falling phase
- Forecast describes reservoir deliverability only
Pad Abandonment Outlook

• The strategy for future well and pad (including surface equipment) abandonments is under development
• Do not anticipate abandonment of operating Pads during the next 5 years
  • Pads 20 and 21 (A/C and B/D patterns) are the most mature and are expected to be under pressure maintenance within 5 years.
  • Individual wells may be suspended or abandoned but some wells may be required to remain operational
• Pad 40 expected to be abandoned within the next 5 years
  • Well abandonments (NP, NI and SP) in progress.
  • Considerations for surface equipment are under review
SAGD Wind-down Strategy Development

No negative impact to oil rate observed to date in B Pattern or surrounding patterns

Path Forward

- Plan to continue optimization of NCG and steam injection of B pattern
- Plan to maintain steady chamber pressure in Phase 1
- Expansion of wind-down to all of Phase 1 planned for 2015, pending approval
SAGD Wind-down Strategy Development

- A small degree of partial pressure cooling from October to December 2013
- No further temperature data from OB07 and OB09 after Dec 2013
NEW TECHNOLOGY PROJECTS

3 Different Chemical Trials

D Pad Chemical Pilot
- Wells D2, D4 and D5
- Proposed Injection Q4 2014
- Awaiting D51 approval

Chemical Surfactant Co-Injection
- All operating wells in Pads E, F and G
- Begin injection Q4 2015
- Awaiting scheme approval

Ph5D/F Batch Chemical Pre-Soak
- Well pairs NN11 and NN12
- Completed injection June 16, 2014
  - Before steam circulation
  - Early stages of performance evaluation
MacKay River Coupled Geo-Mechanics/Reservoir Workflow

1 - Data Gathering
  • Well Operations (Rate/Pressure)
  • Pressure (Piezometer)
  • Temperature (Thermocouple/Fiber)
  • Stress (mini-fracs)
  • Geo-mechanical (core tests)
  • Surface Heave (monuments)
  • Dilation (Extensometers)

2 - Data Interpretation
  Reservoir Physics
  • Well performance
  • Vertical Pressure Leak-off
  • Lateral Pressure Leak-off
  • Vertical heat conduction
  Geo-Science
  • Initial stress state
  • Material behavior
    ➢ shear strength
    ➢ dilation
    ➢ perm enhancement
    ➢ fractures
  • Surface Heave
  • Reservoir level deformations

3 - Coupled Reservoir Geo-Mechanics
  • Update material properties
  • Update pressures and stress state
  • Recalibrate field history match
  • Truth test model
  • Forecast/Design for all developments

4 - Learnings
  • Sensitize key variables within uncertainty range
  • Quantify geo-mechanical risks
  • Verify and update MOP
  • Recommend further measurements
  • Design lab tests

Geo-Mechanical analysis for safe optimal MacKay River operations
Dataset for Characterization of Natural Fractures

2005/06:
- Image logs for 15 wells

2007/09:
- Cores and/or image logs for 17 wells

2010/11:
- 17 wells with cores and image logs,
- 10 wells with only image logs

2011/12:
- Cored 6 wells
- FMI logs for 27 wells

2012/13:
- No wells were drilled

2013/14:
- Cored 3 wells
- FMI logs for 3 wells.
Geology - Observations of Natural Fractures

Dataset
– Over 800 individual fracture observations have been assessed, measured, and classified
– 3rd party has completed fracture analysis of 2013/14 cores and FMI data.
  • Caprock core logging and fracture identification of high cores
  • Analysis and integration of new image logs into MacKay River caprock dataset

Fracture Frequency
• Fracture frequency higher for the lower part of the Clearwater Shale and the Wabiskaw A Shale than for the Wabiskaw D Mudstone.
• No observed correlation between natural fracture frequency and proximity to SAGD operations

Fracture Orientations
• Orientations continue to be random in azimuth based on image log analysis
The Birch Channel does not affect the integrity of the Clearwater Caprock in the MacKay River Development Area
Monitoring: Wab C Pressure & Temperature

Average pressure increase of 28 kPa from September 2013 to August 2014

- Pressures are below hydrostatic and well below fracture pressures

9 Wabiskaw C wells with elevated temperatures directly above mature SAGD operations

- 3 wells between 90°C and 103°C - 6 wells between 30°C and 90°C
- Elevated temperatures are within the expected range as depicted by heat conduction calculations
- Ongoing analysis and simulation efforts are continuing to further understand underlying mechanisms
Monitoring: Wab C Alarms

- Observation well data is reviewed daily and automated alarms initiate proactive, more detailed review of data. The following alarm settings are used for the automated alarms
  - High pressure – set to alarm at 90% of hydrostatic pressure in the OB well
  - Rising pressure – set to alarm if the pressure increase is >10 kPa/day
  - High temperature – set to alarm if the temperature is +20 °C than $T_{\text{initial}}$, $T_i$ is temperature in OB well at the beginning of the year
  - Rising temperature – set to alarm if temperature increase is > 5 °C/day
  - Simultaneously another alarm captures OB wells with temperature >70 °C

- The set point for the proactive alarms are low and result in alarms daily however review of these alarms has results in no safety concerns
Monitoring: Wab C Response

- In the event that pressure or temperatures are nearing levels of concern Suncor will:
  - Confirm the alarm pressure or temperature, and if accurate
  - Decrease injection pressure in the offsetting injection wells as appropriate
  - Monitor the response and adjust operations as required
- No alarms have resulted in the above actions to be performed
Geo-Mechanics: Mini-frac Test

- One (1) mini-frac test was conducted since the last reporting period
  - JK-9 (1AB160409312W400)
  - Fracture gradient for caprock still holds at or above 21 kPag/m

Fracture gradient measured (kPag/m) from mini-frac test

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<td>24.1</td>
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</table>
Geo-Mechanics: Geo-mechanical Simulation Studies

Continued Calibration to Field Data, Pad specific modeling

- Re-calibrated the MacKay River geo-mechanical model utilizing
  - Most recent surface heave data
  - Pressure measurements in the WabC and McMurray
- Performed pad specific coupled geomechanical modeling for subsurface risk reviews
  - Based on current MOP design calculation
  - Verified sufficient factor of safety to tensile and shear failure in the caprock

Results

- Model predictions supported by field measurements indicating good characterization of the geomechanical model
- MOP design calculation continued to provide sufficient factor of safety to tensile and shear failure in the caprock
Geo-Mechanics: Ongoing Work/Future Plans

Geo-Science
• Ongoing interpretation and geo-mechanical analysis of new seismic

Monitoring
• Continuous monitoring and analysis of Wabiskaw C pressure and temperature data
• Designing options for Wabiskaw C production test
• Addition of more WabC observation wells and heave monuments over new phases

Geo-Mechanical Interpretation
• Continually tuning the geo-mechanical simulation model
  ➢ Identify opportunities for improved understanding of caprock behavior
  ➢ Operate the asset while ensuring caprock integrity
MacKay River Performance Presentation
Future Plans
Future Development: Pads 750/751

• To provide sustaining production for the existing MR1 central processing facility (CPF), as well as support potential growth for a future MR2 CPF

• Approval received August 7, 2012

• Approved Pads 750 & 751, 35 well pairs, 2 single producers

• Pad 751 West drilling completed March 2013

• Pad 750 drilling completed September 2013

• Pad 751 drilling completed June 2014

• Completions activities began in 2014. Estimated completion in 2015

• Vintage/orphan well abandonment review complete. Some wells were abandonments in 2013/2014 and some additional planned for 2014/2015 winter program
Brownfield Growth

- Original Pad 28 application had 3 well pairs being drilled in the DF area located between Pad 750 and the UTF areas
  - Also included the addition of new pad facilities

- The application was amended as follows:
  - Renamed to Pad 824 to match our new naming convention
  - Wells to be drilled from an area north of Pad 24 to utilize existing infrastructure instead of creating new facilities
  - Drill 2 well pairs instead of 3

- SIR responded to, currently awaiting amendment approval

- Additional brown field growth opportunities are currently under evaluation
Future Development: Pad 819 (JK pattern)

- JK pattern is the next proposed phase of horizontal wells to the south of existing infrastructure
- Directive 078 amendment submitted March 2013; SIR responses submitted; amendment approval received in January 2014
- Target drilling date currently being evaluated
Future Development: North Arm

- North Arm region is a future area of development within the MacKay River PA
- Directive 023 submission for the wells associated with the North Arm 1 area currently targeted for Q4 2014
- Currently reviewing well trajectory and facility requirements
- Key challenges of this area will be operating with the revised MOP limits and the remote distance from the CPF
MacKay River Performance Presentation

Appendices
Historical Approval Amendments

• Amendment 8668A
  • Changed annual average volume to 33,000 bpd (5,250 m³/d)
• Amendment 8668B
  • Increase to project area
• Amendment 8668C
  • Additional project area
  • Approval to inject non-condensable gas
• Amendment 8668D
  • Additions to project area
  • Increase to annual average volume to 72,964 bpd (11,600 m³/d)
• Amendment 8668E
  • Approval to drill four well pairs
• Amendment 8668F
  • Approval to change approval holder from Petro-Canada to Suncor
• Amendment 8668G
  • Approval to undertake amendments & modifications to CPF systems
  • Approval tie-in 6 well pairs to well testing facilities
• Amendment 8668H
  • Approval to conduct non-condensable gas injection test on Pad 21 wells
• Amendment 8668I
  • Approval to conduct non-condensable gas injection at the Section 16 Test Project

• Amendment 8668J
  • Approval to transfer portions of the Dover project area into the MacKay River project area
• Amendment 8668K
  • Approval to tie-in 16 well pairs to well testing facilities
• Amendment 8668L
  • Approval to the remove the limiting factor of a mole percent restriction for the B Pattern non-condensable gas injection test on Pad 21
• Amendment 8668M
  • Approval to inject chemical into Pad 22 wells
• Amendment 8668N
  • Approval to abandon 3 wells and suspend 1 well on Pad 20
• Amendment 8668O
  • Approval to change Phase 5F well trajectories
• Amendment 8668P
  • Approval to develop Pads 750/751/28 and add 2 sections to project area
• Amendment 8668Q
  • Approval to conduct a pilot of water treatment technologies
• Amendment 8668R
  • Approval to abandon well G1I
## MacKay River Project Well List

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- Optimal well spacing is evaluated for each new development
- Currently evaluating feasibility / safety for infill wells
Suncor MacKay River Project
2014 AER Performance Presentation: Surface Commercial Scheme Approval No. 8668

November 12, 2014
Reporting Period September 1, 2013 – August 31, 2014
AER Directive 054
2014 Performance Presentation

Section 3.1.2 – Surface Operations, Compliance, and Issues not related to Resource Evaluation and Recovery
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- Facilities
- Central Processing Facilities (CPF) Performance
- Measurement and Reporting
- Water Production, Injection and Use
- Sulphur Production
- Environmental Performance
- Future Plans
MacKay River Performance Presentation
Facilities
MacKay River Project Site
CPF Plot Plan

Unit 800 ZLD
Unit 600 Fuel Gas Instrument Air
Unit 700 Bitumen Shipping
Unit 200 DeOiling
Unit 300 Water Treatment
Unit 500 Glycol
Unit 400 Steam generation
Unit 100 Bitumen separation
Simplified CPF Process Block Diagram

- Fluids From Wells
- Produced Vapours
- Produced Emulsion
- Fuel Gas to Steam Generators
- Pipeline Gas
- Pipeline to Market
- Fuel Gas to Steam Generators
- Produced Water
- Boiler Feed Water
- Recovered Water
- Blowdown Water
- Salt Cake to On-Site Landfill
- Makeup Water
- Water Treatment
- Steam Generation
- Solids to On-Site Landfill
- Zero Liquid Discharge
- Steam to Injection Wells
CPF Performance (September 2013-2014 YTD)

The reliability of the facility has been steady:
- Programs to enhance operational discipline
- Steady water treatment plant operation post March-2014

Major challenges:
- Major WLS Upset resulting in unplanned shutdown in February-2014
- Recovery from multiple power outages

Average 89.6%
(September 2013 to August 2014)
Historical Production (January 2003 – 2014 YTD)

MacKay River Sales

(m3/day)

August 2014

January 2003
Production (2013)
Production (2014 YTD)

Period Average: 4105.9 m³/d

- Duct Burner Trip
- Major WLS Upset
- Slowdown
- Steam Gens Trip
- Cogen Trip

(m³/day)
Water Treatment Technology

Warm Lime Softening (WLS) and Weak Acid Cation (WAC) softening for produced water

Zero Liquid Discharge (ZLD) System on blowdown slip stream:
- Evaporators: one steam and one mechanical driven
- Crystallizer: Steam driven
- Dryer: gas fired
- Filter press (2): back up for dryer
# Boiler Feed Water Quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Avg. Value (Sept 2013 – Aug 2014)</th>
<th>Max Value During Period</th>
<th>BFW Specifications</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature, °C</td>
<td>133.17</td>
<td>165.01</td>
<td>140 – 170</td>
</tr>
<tr>
<td>Hardness (Dissolved), mg/L</td>
<td>0.23</td>
<td>0.95</td>
<td>&lt; 1.0</td>
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<tr>
<td>Total Dissolved Solids, mg/L</td>
<td>6224</td>
<td>16539</td>
<td>&lt; 8000</td>
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<tr>
<td>Silica, as SiO2, mg/L</td>
<td>21.54</td>
<td>56.27</td>
<td>&lt; 50.0</td>
</tr>
</tbody>
</table>
Water Treatment Successes and Challenges

The WLS performance has been steady since March 2014:

• Reliability is 92%
  – Consecutive days within spec: 113 days Parameters: temperature, hardness, total dissolved solids, pH, silica, oil, free oxygen, total dissolved iron
  – Reliability of the line slurry system has improved due to new PM strategy adopted last year. Further improvement work is currently awaiting trial through the MOC process

Challenges:

– Lower than expected reliability due to major plant upset & unplanned shut-down in February-2014
  • Significant Oil Carryover from upstream process
  • Cold weather shutdown/start-up causing heavy work delays
Steam Generation (2013)

Steam Quality from Co-gen is maintained approximately 77% and OTSG is approximately 80%
Steam Generation (2014 YTD)

Steam Quality from Co-gen is maintained approximately 77% and OTSG is approximately 80%
Power Generation (2013)
Power Generation (2014 YTD)
Gas Consumption (2013)
Gas Consumption (2014 YTD)
Energy Intensity

Energy Intensity Formula

• Energy Intensity (GJ/m³) = Total energy consumed by site / Sales bitumen volume

• Total energy consumed by site (GJ) = Energy used to make steam in Cogen + Natural Gas imported to site + Solution gas to Cogen + Electricity consumed by site – Mixed gas to Cogen duct firing
  • Note that the term “site” does not include Cogeneration

• Energy used to make steam in Cogen (GJ) = BFW Mass Flow Rate to Cogen x Hourly average difference in enthalpy between steam and BFW
Energy exchange: TransCanada Energy (TCE) provides steam and electricity to Suncor in exchange for BFW and a “fee”

- Fee calculated as GJ of fuel gas equivalent in compensation for steam and electricity (energy equivalent value based on contractual formula)

- Suncor provides on-spec BFW and fuel gas, maintains MacKay River facility within specified outage hours and takes a minimum steam requirement

- Mixed gas supplied by Suncor to TCE credited against total gas “fee” requirement

- TCE required to provide all other excess gas for the operation of the cogeneration facility

- TCE sells excess electric energy generated by the cogeneration facility to the market
Energy Intensity (2013)

MacKay River Energy Intensity for Year 2013

Energy Intensity (GJ/m³ Bitumen)
Energy Intensity (2014 YTD)

MacKay River Energy Intensity for Year-To-Date 2014

Energy Intensity (GJ/m3 Bitumen)

Jan Feb Mar Apr May Jun Jul Aug
Measurement Accounting & Reporting Plan (MARP)

- MARP approved in April 2010

- MARP was updated on Feb 28, 2014

- MARP details all the required data in Directive 42
Well Testing Strategy

Test Separators are used to test all wells for production allocation

Pad 20 and Pad 21 Well Testing Strategy
- 12 active SAGD producers per pad, 4 hour tests (+ purge time)
- Fully compliant with Directive 017

Pads 22 Well Testing Strategy
- 23 active SAGD producers, 5.5 hour tests (+ purge time)
- Phase 5A (NN2-5, QQ4-5) are tested via Pad 22 Test Separator

Pads 23/24 Well Testing Strategy
- 14 active SAGD producers, 7 hour tests (+ purge time)
- Phase 5B1 (OO4-9) has been re-routed from Pad 23 to Pad 25 for testing
Well Testing Strategy

Pad 25 Well Testing Strategy

- V-100 Test Separator
  - 10 active SAGD producers, 5 hour tests (+ purge time)
- V-1100 Test Separator
  - 12 circulating wells
- V-1150 Test Separator
  - 1 circulating well
  - 11 SAGD producers, 6 hours test (+ purge time)
- Fully compliant with Directive 017
Proration of Oil

- Year 2013: Oil Factor = 0.95  Water Factor = 1.1
- Year 2014 YTD: Oil Factor = 0.95  Water Factor = 1.12
Multi-Phase Flow Meter (MPFM) Trial

Pad 25 Vx Meter Test

- Trialing Schlumberger Vx Meter
- Vx Meter to be located on Pad 25 beside V-1100
- Vx will be used to test Phase 5D/F QQ & NN wells
- Estimated commissioning and start-up for trial:
  - Q2 2015
CPF Water Traffic
Fresh Water

Source Water Wells
- *Water Act* Licence No. 00188229-02-00 (511,000 m3/y) Birch Channel Aquifer (Renewal issued September 2012)

1. 13-05-093-12W4 (GD-SW-212-53; formerly WSW-1), max.rate 450 m3/day
2. 04-08-093-12W4 (GD-SW-213-86; formerly WSW-2), max.rate 1368 m3/day
3. 04-08-093-12W4 (GD-SW-215-91; formerly WSW-3), max.rate 1411 m3/day

Domestic Water Well
- *Water Act* Licence No. 00249470-01-00 (25,550 m3/y) Birch Channel Aquifer

4. 12-05-093-12W4 (CWSW-SW-218-55), max.rate 123 m3/day
- Monthly reporting done through Water Use Reporting System (WURS)
## Raw Water Source Wells

<table>
<thead>
<tr>
<th>test</th>
<th>water analysis</th>
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<tr>
<td>physical</td>
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<tr>
<td>EC (μS/cm)</td>
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<tr>
<td>pH (units)</td>
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<tr>
<td>Tot Hard as CaCO₂ (mg/L)</td>
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<tr>
<td>Tot Alk as CaCO₃ (mg/L)</td>
<td>402</td>
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<tr>
<td>indicators</td>
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<tr>
<td>Chloride:D (mg/L)</td>
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<tr>
<td>Sulphate:D (mg/L)</td>
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<td>Iron:D (mg/L)</td>
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<td>Manganese:D (mg/L)</td>
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<td>TDS-calculated (mg/L)</td>
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<tr>
<td>cations, anions &amp; ion balance</td>
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<tr>
<td>Calcium:D (mg/L)</td>
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<td>Magnesium:D (mg/L)</td>
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<tr>
<td>Potassium:D (mg/L)</td>
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<td>Sodium:D (mg/L)</td>
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<td>Bicarbonate:D (mg/L)</td>
<td>490</td>
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<td>Carbonate:D (mg/L)</td>
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<tr>
<td>Hydroxide:D (mg/L)</td>
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<td>Fluoride:D (mg/L)</td>
<td>0.23</td>
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<tr>
<td>Ion balance % (%)</td>
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<tr>
<td>nitrogen parameters</td>
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<td>NO₂ as N (mg/L)</td>
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<tr>
<td>NO₃ as N (mg/L)</td>
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<td>NO₂ + NO₃ as N (mg/L)</td>
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<td>DKN (mg/L)</td>
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<tr>
<td>TKN (mg/L)</td>
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<tr>
<td>Tot Amm N (mg/L)</td>
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<td>phenols</td>
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<tr>
<td>phenols (mg/L)</td>
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</tr>
<tr>
<td>PAH</td>
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<tr>
<td>Naphthenic Acids (mg/L)</td>
<td>---</td>
</tr>
</tbody>
</table>

**Typical water quality assessment parameters**

Monitoring station GD-SW-212-53 (formerly WSW-1)
Cumulative Raw Water – Source Wells (2013)

- Regulatory allowable limit from Water Act Licence No. 188229 is 1.4e³ m³/day (511e³ m³ per year - black line shown on chart)
• Regulatory allowable limit from Water Act Licence No. 188229 is $1.4 \times 10^3$ m$^3$/day (511 m$^3$ per year – black line shown on chart)
Cumulative Raw Water – Domestic Well (2014)

- Water well casing failure September 9, 2011; well was abandoned and a replacement well drilled July 2013. No water has been withdrawn (2014 YTD)
Water Balance

- **Steam:**
  - Present method:
    \[
    \text{Steam Injected} = \sum \text{All Meters to injection wells}
    \]
    \[
    \text{Steam Injected} = \sum (\text{BFW} \times \text{Steam Quality})
    \]
  - MARP approved method: HP steam ultrasonic meter pending resolution on foaming issue (a new, longer wave guide was installed in the ultrasonic meter during 2012 September turnaround)

- **Raw Water** = \( \sum \text{Water Source wells} \) (3 water source wells)

- **Produced Water:**
  - MARP approved method

- **Vapour losses are estimated:**
  - LP Steam vent losses minimized by the installation of new exchanger
  - ZLD has vapour loss to atmosphere

- Details of measurement and reporting procedures may be found in the MARP
Water Balance (2013)
Water Balance (2014 YTD)
Recycle Rate (%) = (Steam Injected-Fresh Water)*100/Produced Water

Average for the year: 96.8% > Target 90%
Water Recycle (2014 YTD)

Average for Year-to-Date 95.5% > Target 90%
Low Pressure Blowdown Recycle (2013 & 2014 YTD)

**Blowdown Recycle = 100%**
- Blowdown treated in the Water Plant
  - YTD: 38,502 m³/month (lower due to Feb.2014 WLS upset)
    2013: 45,745 m³/month
  - Blowdown treated in the Zero Liquid Discharge (ZLD) Plant
    - YTD: 40,187 m³/month
      2013: 41,116 m³/month

**Trucked volumes from Diversion Lagoon:**
- 47,793 m³ (January 1, 2013 – December 31, 2013)
- 43,336 m³ (January 1, 2014 – August 31, 2014)

**Note:** The diversion lagoon is filled by crystallizer concentrate during purges and by landfill leachate after periods of rain
MacKay River Landfill / Waste Management

AER Approval WM-072 Class II Oilfield Landfill

• Volumes of solids (salt/lime) to landfill
  • 2013: 25,393 m³
  • 2014 YTD: 14,708 m³ *

• Total volume of landfill fluids to facility
  • 2013: 15,222 m³
  • 2014 YTD: 13,734 m³

• 2013 Waste Survey completed on June 30 and July 1, 2013 (Phases II&III)
  • Phase III: 7,164 m³
  • Phase II Cell (A&B): 74,002 m³ (approved for 86,000m³)
  • Phase I of the MacKay River Landfill is closed and is in post-closure monitoring period

• Waste services contract in place
  • Addresses hazardous, scrap metal, domestic waste

• Waste Tracker software used to track and submit manifests to AER

*Volumes estimated in August 2014
Off-Site Brine Water Disposal

Location of disposal site:

- Tervita Lindbergh (WPF, SFC)
- 05-26-056-05 W4M
- Application No: 1652609
- Approval No: WM061 (Amendment I)

- Brine water is disposed of off-site when the diversion tank and diversion lagoon reach capacity and the ZLD system cannot process the boiler blowdown from Unit 400.

- Water sources in the diversion lagoon include: precipitation, leachate from the MacKay River Landfill and excess boiler blowdown water during upset conditions.
Off-Site Brine Water Disposal (2013)

- Volumes reported via Petrinex
Off-Site Brine Water Disposal (2014 YTD)

- Volumes reported via Petrinex
Sulphur Production

• Currently there are no sulphur recovery facilities at the MacKay River Project
Sulphur Dioxide Emissions (2013)

- S0₂ emissions are calculated from monthly produced gas samples
Sulphur Dioxide Emissions (2014 YTD)

- $\text{SO}_2$ emissions are calculated from monthly produced gas samples
• H₂S concentrations are measured in semi-monthly produced gas samples. Suncor increased sampling frequency in 2013 to reduce chance of sampling error and to improve consistency.
H₂S Concentration (2014 YTD)

- H₂S concentrations are measured in semi-monthly produced gas samples.
Solution Gas Flared (2013)
Solution Gas Flared (2014 YTD)
Solution Gas Recovery (2013)
Solution Gas Recovery (2014 YTD)
GE/AI Water Treatment Testing Technology AER APP NO.1740058

- Regulatory application for technology pilot approved by AER (Application No.1740058).
- Pilot designed to test new coarse deoiling and fine solids removal technology (including membrane treatment), as an alternative to current deoiling and water treatment technology.
- Pilot delivery and installation completed Q4-2013; commissioning and start-up of testing of the first coarse deoiling technology occurred during Q1-2014; testing of coarse deoiling technologies is ongoing and anticipated complete during Q4-2014.
- Pilot testing of membrane based fine solids removal technology to continue during 2015/2016.
- New project partners (CPC and Devon) added to project in collaboration with COSIA.
- No impact on water recycle or disposal rates at the Mackay River project.
MR1 Debottleneck HPSS Installation AER APP NO.1746126

- Regulatory application for MR1 Debottleneck (38kbd) approved by AER (Application No.1740058)

- New HPSS-D unit installed as part of MR1 38kbd Debottleneck project scope to insure 99.5% quality steam is delivered to Pad HP steam distribution header

- Project currently undergoing Commissioning and Start-up phase

- Expected to be in operation by end of October 2014
MacKay River Performance Presentation
Environmental Performance
Greenhouse Gas Emissions (GHG)

Submitted the annual SGER report to ESRD and NPRI GHG report to Environment Canada
- GHG calculation methodology developed to improve transparency

Total direct emissions for 2013:
- 199,920 tonnes of CO₂equiv
- Total emissions have been reported to ESRD

Total direct emissions for 2014 (YTD):
- 171,674 tonnes of CO₂equiv*
- Total emissions will be reported to ESRD

Approved baseline emissions intensity:
- 0.1173 tCO₂e/m³

* 2014 YTD estimated. Numbers to be verified in 2015.
Ambient Air Monitoring

• 4 passive air monitoring stations at MacKay River

• Monthly ambient air quality monitoring performed by a site representative and sample analysis reports submitted to ESRD by Suncor site personnel for H₂S, NO₂, O₃ and SO₂

• Ambient air quality data available for viewing on WBEA website

• No air quality exceedances at MacKay River

• In 2013 average H₂S concentration was 0.13 ppb and SO₂ concentration was 0.7 ppb collected from the passive stations

• In 2014 (as of August 31) average H₂S concentration was 0.09 ppb and SO₂ was 0.6 ppb collected from the passive stations
Total Flared Gas (2013)
Total Flared Gas (2014 YTD)

Flare Volumes (e3m3/month)

Jan: 300
Feb: 200
Mar: 100
Apr: 50
May: 25
Jun: 25
Jul: 25
Aug: 25
Sep: 0
Oct: 0
Nov: 0
Dec: 0

Suncor
ESRD Site Visit

- June 4, 2013
  - Site visit to evaluate reclamation piles/borrow pits at MacKay River/Dover projects

AER Site Visit

- June 18, 2013
  - Site visit to view spill on Pad 22
Regulatory Compliance (2014 YTD)

Environment Canada Site Visit

- May 14, 2014
  - Audit of bird deterrent systems on ponds
Release Management – Reportable Releases

**AER Reportable Releases for 2013**
- Nine AER reportable releases

**AER Reportable Releases for 2014 (YTD)**
- Five AER reportable releases

**Environmental Awareness Training**
- Core training requirement
- Highlights Spill Awareness, Waste Management, Flaring etc.
Current Amendments

AER Approval No. 8668

- **Amendment 8668S**
  - Approval to conduct a chemical injection test on Pad 21 (D-Pattern Injectors) issued September 5, 2013
- **Amendment 8668T**
  - Pad 819 approval issued January 23, 2014
- **Amendment 8668U**
  - Maximum Operating Pressure approval issued January 29, 2014
- **Amendment 8668V**
  - NCG Expansion Project and Phase 5D/F Chemical Injection approval issued April 29, 2014
- **Amendment 8668W**
  - MR CPF Modifications and Directive 081 Waiver approval issued May 9, 2014
- **Amendment 8668X**
  - Administrative reissue approval issued May 12, 2014
- **Amendment 8668Y**
  - WHIP for Phases 5B2, 5D and 5F Patterns approval issued June 19, 2014
Current Amendments / Applications

AER Approval 8668

- Application No. 1799772: Pad 28 (828) Category 2 application to reduce well pairs from three to two submitted June 17, 2014. SIR submitted on October 13, 2014
- Application No. 1799757: D-Pattern Chemical Injection Category 2 application to correct well UWIs submitted June 17, 2014.
- Application No. 1801826: Phase 1 NCG Category 2 application to amend design submitted July 14, 2014. SIR submitted on September 26, 2014
- Application No. 1804679: Phase 2 Chemical Co-Injection Category 2 application submitted August 8, 2014.

ESRD Water Act Licences

- Licence No. 00289164-00-00 for MR2 diversion of water issued January 11, 2013; expiry January 10, 2015; renewal application submitted July 11, 2014
- Licence No. 00307934-00-00 for dust suppression on AOSTRA road issued June 13, 2013; expiry June 12, 2023; amendment for additional location submitted May 14, 2014.
Current Amendments / Applications

EPEA Approval – no amendments within this reporting period

AER Pipeline Licences
• Suncor continues its work at the MacKay River site with the In-Situ Pipeline Compliance Rapid Response Team to address any licencing inconsistencies, and to assess and ensure pipelines are in compliance with Directive 056

ESRD
• New Wildlife Research Permit (54825) and Collection License (54826) issued on April 16, 2014
Environmental Initiatives

Suncor is an active member of:

- Cumulative Environmental Management Association (CEMA)
- Regional Aquatics Monitoring Program (RAMP)
- Wood Buffalo Environmental Association (WBEA)
- Alberta Biodiversity Monitoring Institute (ABMI)
- Alberta Water Council (Watershed Planning Advisory Council)
- Oil Sands Developers Group (OSDG)
- Canada’s Oil Sands Innovation Alliance (COSIA)
- Industrial Footprint Reduction Options Group (iFrog)
- Oil Sands Spill Coop Area Y

Suncor is in ongoing consultation with:

- Regional stakeholders
- Aboriginal Communities and the local Municipality
2013 Conservation & Reclamation report was submitted to ESRD in March 2014. No reclamation activities are underway at MacKay River.

- **Total area of land cleared in 2013 was 21.6 ha:**
  - Pad 750 – 20.0
  - BEST Fuel Gas Line ROW – 1.6

- **Estimated total area of land to be cleared in 2014 is 78.3 ha:**
  - MR2 Central Processing Facility – 24.3
  - Soil Stockpile Area – 9.0
  - Pad 819 – 18.5
  - Pad 28* – 3.4
  - Borrow Pit – 7.1
  - Remote Sump – 8.3
  - Observation Wells – 7.7

* Pad 28 name change pending

Note: Estimated numbers do not include exploration programs
Regulatory Compliance

- Suncor Energy Inc. is in compliance with all regulatory approvals, decisions, regulations and conditions as described in Decision Report 2000-50; specifically pertaining to:
  - Plant and waste management facility location,
  - Ground level ozone and VOC monitoring,
  - Groundwater monitoring wells,
  - Surface water quality monitoring, and
  - Participation in Regional Initiatives
Summary of Key Learnings (Operations)

- 2013 landfill solidification pilot was successful
- Group transfer pump reliability gains from previous years have been maintained (ops/mtce procedures). Next step is to ‘right size’ pumps.
- Desand drum: Upgraded metallurgy is showing positive results
- Learnings from WLS outage were quickly incorporated into shift operations - enhanced monitoring and control of process metrics
- Reliability of steam generation assets is an area of focus
- Commissioning of 38kbbbl/day CPF assets nearing completion
MacKay River Performance Presentation
Future Plans
## Future Plans

<table>
<thead>
<tr>
<th>Project Description</th>
<th>Comments</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>MR2 Central Processing Facility Amendment</td>
<td>Amendment to approved MR2 CPF due to equipment modifications.</td>
<td>Commercial Scheme amendment approved May 2014. EPEA amending application submitted August 29, 2014. Approval pending</td>
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<tr>
<td>MR1 Debottlenecking/Optimization</td>
<td>Series of equipment modifications/improvements building towards an increase in MR1 production capacity</td>
<td>Series of submissions over the next few years</td>
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</table>