PEACE RIVER IN SITU OIL SANDS PROJECT
DIRECTIVE 54 ANNUAL PERFORMANCE
PRESENTATION

December 13, 2017

PREMIUM VALUE. DEFINED GROWTH. INDEPENDENT.
## Outline – Subsurface

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# Acronyms

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Description</th>
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<tbody>
<tr>
<td>AER</td>
<td>Alberta Energy Regulator</td>
</tr>
<tr>
<td>Avg.</td>
<td>average</td>
</tr>
<tr>
<td>bbl</td>
<td>barrel, petroleum, (42 U.S. gallons)</td>
</tr>
<tr>
<td>BHA</td>
<td>bottom hole assembly</td>
</tr>
<tr>
<td>bitwt</td>
<td>bitumen weight</td>
</tr>
<tr>
<td>CD</td>
<td>cyclic drive</td>
</tr>
<tr>
<td>CDOR</td>
<td>calendar day oil rate</td>
</tr>
<tr>
<td>CDSR</td>
<td>calendar day steam rate</td>
</tr>
<tr>
<td>cP</td>
<td>centipoise</td>
</tr>
<tr>
<td>CSOR</td>
<td>cumulative steam to oil ratio</td>
</tr>
<tr>
<td>CSS</td>
<td>cyclic steam simulation</td>
</tr>
<tr>
<td>Cumm</td>
<td>cumulative</td>
</tr>
<tr>
<td>DFIT</td>
<td>diagnostic fracture injection testing</td>
</tr>
<tr>
<td>DI</td>
<td>depletion index</td>
</tr>
<tr>
<td>dP</td>
<td>pressure differential</td>
</tr>
<tr>
<td>e3m3</td>
<td>thousand cubic metres</td>
</tr>
<tr>
<td>ESP</td>
<td>electric submersible pumps</td>
</tr>
<tr>
<td>ESRD</td>
<td>Environment and Sustainable Resource Development</td>
</tr>
<tr>
<td>FUP</td>
<td>follow up process</td>
</tr>
<tr>
<td>HP</td>
<td>horse power</td>
</tr>
<tr>
<td>hz</td>
<td>horizontal</td>
</tr>
<tr>
<td>ICP</td>
<td>intermediate casing point</td>
</tr>
<tr>
<td>IHS</td>
<td>Inclined hetreolithic stratification</td>
</tr>
<tr>
<td>InSAR</td>
<td>interferometric synthetic aperture radar</td>
</tr>
<tr>
<td>J-Well</td>
<td>horizontal wellbore with toe-up lateral trajectory</td>
</tr>
<tr>
<td>KB</td>
<td>Kelly Bushing</td>
</tr>
<tr>
<td>kg/m</td>
<td>kilograms per metre</td>
</tr>
<tr>
<td>kPA</td>
<td>kiloPascal</td>
</tr>
<tr>
<td>kPa/day</td>
<td>kiloPascal per day</td>
</tr>
<tr>
<td>LIDAR</td>
<td>laser imaging, detection and ranging</td>
</tr>
<tr>
<td>LPCSS</td>
<td>low pressure cyclic steam stimulation</td>
</tr>
<tr>
<td>m</td>
<td>metre</td>
</tr>
<tr>
<td>m³</td>
<td>cubic metres</td>
</tr>
<tr>
<td>m³/d</td>
<td>cubic metres per day</td>
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## Acronyms (...continued)

<table>
<thead>
<tr>
<th>Acronym</th>
<th>Definition</th>
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<tr>
<td>mD</td>
<td>milli-Darcy</td>
</tr>
<tr>
<td>mm</td>
<td>millimetre</td>
</tr>
<tr>
<td>MMbbl</td>
<td>million barrels</td>
</tr>
<tr>
<td>MPa</td>
<td>megapascal</td>
</tr>
<tr>
<td>mTVD</td>
<td>metres true vertical depth</td>
</tr>
<tr>
<td>OBIP</td>
<td>original bitumen in place</td>
</tr>
<tr>
<td>Obs</td>
<td>observation</td>
</tr>
<tr>
<td>ohm·m</td>
<td>ohm-metre</td>
</tr>
<tr>
<td>PV</td>
<td>pore volume</td>
</tr>
<tr>
<td>PVS, PVStm</td>
<td>pore volume steam</td>
</tr>
<tr>
<td>RF</td>
<td>recovery factor</td>
</tr>
<tr>
<td>SAGD</td>
<td>steam assisted gravity drainage</td>
</tr>
<tr>
<td>SF</td>
<td>steamflood</td>
</tr>
<tr>
<td>So</td>
<td>oil saturation</td>
</tr>
<tr>
<td>SOR</td>
<td>steam oil ratio</td>
</tr>
<tr>
<td>SPM</td>
<td>strokes per minute</td>
</tr>
<tr>
<td>SAR</td>
<td>synthetic aperture radar</td>
</tr>
<tr>
<td>Tbg.</td>
<td>tubing</td>
</tr>
<tr>
<td>TD</td>
<td>total depth</td>
</tr>
<tr>
<td>TVD</td>
<td>true vertical depth</td>
</tr>
<tr>
<td>VAF</td>
<td>volume over fill-up</td>
</tr>
<tr>
<td>WDI</td>
<td>water depletion index</td>
</tr>
<tr>
<td>WHT</td>
<td>wellhead temperature</td>
</tr>
<tr>
<td>YE</td>
<td>yearly</td>
</tr>
</tbody>
</table>
CNUL Peace River - Location

- Located in Northwestern Alberta
- OBIP 219 Million m³ for the area in Approval 8143DD Development Area
Peace River Approval Areas

Peace River Thermal Area
- Operating Pad
- Suspended Pad
- Lease Boundary
- Approved Project Area
- Approved Development Area

Peace River - Project and Development Areas

- Project Area 8143DD
- Development Area
- Peace River Complex
## Peace River - Bluesky Reservoir Properties

<table>
<thead>
<tr>
<th>General Properties</th>
<th>Approval Area</th>
</tr>
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<tbody>
<tr>
<td>Target Formation</td>
<td>Bluesky</td>
</tr>
<tr>
<td>Pay Thickness</td>
<td>15 – 30m</td>
</tr>
<tr>
<td>Depth</td>
<td>550 - 600 m TVD</td>
</tr>
<tr>
<td>API Gravity</td>
<td>6-11°</td>
</tr>
<tr>
<td>Porosity</td>
<td>0.25 – 0.30</td>
</tr>
<tr>
<td>Viscosity</td>
<td>10,000 – 1,000,000 cP (dead oil)</td>
</tr>
<tr>
<td>Initial pressure</td>
<td>3,800 kPa (sub-hydro static)</td>
</tr>
<tr>
<td>Initial temperature</td>
<td>18°C</td>
</tr>
<tr>
<td>Horizontal permeability</td>
<td>0.1 – 10 D (air)</td>
</tr>
<tr>
<td>Kv / Kh</td>
<td>0.3 – 0.9</td>
</tr>
<tr>
<td>Oil Saturation</td>
<td>0.70 – 0.85</td>
</tr>
</tbody>
</table>
Peace River - Zoom in on Operating Area Pads

- **Operating Pad**
- **Suspended Pad**
- **Lease Boundary**
- **Approved Project Area**
- **Approved Development Area**

**Peace River Thermal Area**

- **Suspended Pads:** Pads 40 & 41, Pads F106 & F107
- **Injector Pads:** Pads 30i, 31i, and 22
Peace River Project Area - Net Pay Isopach

Peace River Thermal Area
- Operating Pad
- Suspended Pad
- Lease Boundary
- Approved Project Area
- Approved Development Area
Project Area Volumetrics

<table>
<thead>
<tr>
<th></th>
<th>Average Pay Thickness (m)</th>
<th>Average Oil Saturation (%)</th>
<th>Average Porosity (%)</th>
<th>OBIP (E3 m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Project Area</td>
<td>21.6</td>
<td>79.3</td>
<td>26.6</td>
<td>440,000</td>
</tr>
<tr>
<td>Development Area</td>
<td>22.7</td>
<td>81.1</td>
<td>27</td>
<td>219,000</td>
</tr>
</tbody>
</table>

• Volumetric calculation:
  – Area × Pay Thickness × Oil Saturation × Porosity

  – **OBIP: Project Area**
    96,700,000 m² × 21.6 m × 0.793 × 0.266 = 440,000 E3 m³

  – **OBIP: Development Area**
    44,000,000 m² × 22.7 m × 0.811 × 0.27 = 219,000 E3 m³
The depositional environment of the Upper Bluesky (Sandstone) is a marginal marine estuarine complex.

1. Tidally-influenced estuary with fluvial influx
   - Estuary channels and channel bars
   - Fluvial bars

2. Wave dominated estuary
   - Ebb tidal delta/ flood tidal delta/ Tidal Inlet/ Bay Fill
Peace River - Type Log

- Wilrich
- Bluesky
- Debolt

Upper Bluesky Flood Tidal Delta (Clean Sand)

~1m Basal Transition Zone

Net Pay

Debolt Tight Bitumen Saturated

Green > 40 ohm

Pink = Carbonate
Peace River Structural Cross-Section

- Wilrich member of Spirit River Fm (Primary Caprock) ~ 80m
- Spirit River Formation minimum continuous Caprock Thickness ~ 240m
- Upper Bluesky Sand sitting on Debolt unconformity or Lower Bluesky filling lows in Debolt
- Reservoir Base Defined Sw = 30% cut-off (equivalent to Resistivity ~40ohms)

Top of Pay = Top of Bluesky (unless gas or lean zone present; not in project area)
Peace River Pay Top Structure

- Peace River Thermal Area
  - Operating Pad
  - Suspended Pad
  - Lease Boundary
  - Approved Project Area
  - Approved Development Area

- This is typically the top of the Bluesky unless gas or lean zone with $S_w > 30\%$ exist
- Top Lean zones or gas do not exist within the approved Development Area
Peace River Pay Base Structure

- Operating Pad
- Suspended Pad
- Lease Boundary
- Approved Project Area
- Approved Development Area

Peace River Thermal Area

- Cut-off for base of pay: Base of continuous sand from Top of pay (normally top of Bluesky) to $S_w \leq 30\%$; equivalent to $\text{Res}_D \sim 40\text{ohm}$
Peace River - Net Water Sand Isopach

This thickness map includes a basal transition zone (BTZ) with $S_w = 30-50\%$; and a basal water zone (BWZ) with $S_w > 50\%$.
Data Acquisition

• In 2017 one well was drilled and cored North of Pad 32;  
  100/03-30-085-18W5

• Data collected: Routine Core Analysis, Standard Log Suite, FMI (Bluesky), Viscosity Measurements
Caprock Integrity

- Caprock: consists of the highly continuous Spirit River Formation (Wilrich/Falher/Notikewin) which has a minimum thickness of 240m over the approval area.

- Reviewing caprock integrity in regards to the following:
  - In-situ stresses
  - Field observations within the caprocks
  - Potential surveillance improvements
  - Injected steam volume above fill-up
Drilling & Completion Overview

- PRISP & PREP (1979)
  - 31 wells and 212 wells, 7 spot pattern

- Disposal Wells (1978 & 2008)
  - 3 brine disposal, 2 water disposal

- Pad 19 (1996 and infills drilled in 2011)
  - 1 test hole and 15 producers, “soak radial” design
  - Pad 19 infill wells: 10 new producers and 8 new injectors (vertical wells)

- Pad 20/21 SAGD (1997 and phase 3 infills drilled in 2011)
  - 5 well pairs, 5 dual wellbores, 9 observation wells
  - Pad 20 phase 3 injectors (4 new horizontal wells)

- Pad 30/31/40/41 Multi Laterals (2000)
  - 8 “haybob”, 25 “tuning fork”, 6 observation wells

- Pad 20/21 Conversions, Infills, 19 SD (2004)
  - Converted SAGD well to CCS, drilled 7 single lateral infills, 2 steam wells on pad 19

- Pad 32/33 Horizontals (2005)
  - 16 wells per pad, 3 obs wells

- Pad 22 Steam Injectors (2006)
  - 2 steam injectors running over pad 21 conversions, acting as steam drive

- Pad 30 & 31 Steam Injectors (2014)
  - 10 steam injectors 4 over Pad 30 & 6 over Pad 31

- 2 Carmon Creek Wells (2014)
  - Brine disposal well (02/15-27-85-19W5)
  - Delineation well (AA/04-26-85-18W5, D&A)

- Pad 22 Steam Injector (2015)
  - Top down Steam Drive injector 22-04

- Carmon Creek Wells (2014/2015)
  - Pad F106
    - 43 wells, 3 surface holes, 1 Observation well
  - Pad F107
    - 46 wells, 1 Observation well
  - 2 Acid gas injection well & 1 monitoring well
  - 2 water back producers

- No Drilling Activity in 2016

- TH32C Delineation (2017)
Field Map

Peace River Thermal Area
- Approved Development Area
- 2017 Drills
Well Type Overview

CSS 1996
- Soak Radial
  - 500m

CSS 2001
- Haybob
  - 1000m
- CSS 2006
- H- and J- Wells
  - 1500m

CSS 2006

CSS 2001
- Tuning Fork
  - 1500m
- Deviated Vertical
  - 500-700m
- Steam Drive 2013
- CSS 2001

SAGD 1996
- 500-1000m
Well Spacing by Pad

- **Pad 19**
  - 100 m horizontal separation between injector and producer vertical wellbores
  - 150 m horizontal separation between producer vertical wellbores
  - Subsurface spacing variable due to soak radial geometry

- **Pad 20**
  - 5m vertical separation between SAGD injectors and producers
  - 100m horizontal separation between SAGD pairs and J-wells
  - 100m horizontal separation between new phase 3 infill injectors
  - 50m horizontal separation between a phase 3 injector and an original SAGD well pair
  - Vertical separation between a phase 3 injector and an original SAGD well pair is 3m to 15m

- **Pad 21/22**
  - 5m vertical separation between SAGD injectors and producers
  - 100m horizontal separation between SAGD pairs and J-wells

- **Pad 22**
  - 90m horizontal spacing between pad 22 injectors
  - Pad 22 injectors are 10m to 17m above original SAGD producers

- **Pad 30**
  - Highly variable due to Haybob geometry
  - 2014 injector spacing – 150 – 250m

- **Pad 31**
  - 80 m horizontal separation between laterals
  - 2014 injector spacing 100m

- **Pad 32**
  - 150 m horizontal separation between horizontal wells

- **Pad 33**
  - 150 m horizontal separation between horizontal wells

- **Pad 40**
  - 80 m horizontal separation between laterals

- **Pad 41**
  - 80 m horizontal separation between laterals
Multi Lateral Completion

- Pads 30, 31, 40, 41
- 244.5 mm L80 Production Casing
- 177.8 mm Window sleeve
- 73 mm Liner
- Thermal cement
- 114.3 mm tubing
- Insert pumps
- 550-700m laterals
Single Lateral Completion

- Pads 32, 33
- 177.8 mm L80 Production Casing
- 114.3 mm Perforated Liner
- 114.3 mm Tubing
- Insert pumps
- Thermal cement
- 500-700 m lateral
- Pump is removed and steam injected down the tubing for high pressure CSS
Vertical Deviated Completion

- Pad 19, Satellite 3
- 298 mm Surface Casing
- 219.1 mm L80IRP Production Casing
- 88.9 mm Tubing
- Insert pumps
- Thermal cement
- 19-24 m perforation interval
Horizontal Injector Completion

- Pad 20 Phase 3, Pad 30/31 Infills
- 339 or 298 mm Surface Casing
- 219.1 or 244.9 mm L80IRP Production Casing
- 177.8 or 139 mm wire wrap screen liner
- 88.9 and/or 73 mm Tubing
- Select wells completed with Flow Control Devices
- Thermal cement
- 500-1000 m lateral
- Select wells completed with thermocouples and/or DTS
Source & Disposal Wells
02/16-23 & 02/14-25 dispose of produced water, boiler blowdown and brine into the Leduc formation.

00/15-27 brine regeneration disposal recently shut in due to pipeline integrity concerns.
The 8-11 sour gas injector was completed Nov 2009 as part of the Three Creeks Sour Gas Storage project.

Utility Well Completion

Drilled 2014/2015 – All wells suspended

- **C180-80** Brine Injection Well Completion
  - Drilled Mar/Apr 2014
  - Completed
  - Suspended

- **G180-80 and G180-81**, Two injectors
  - Drilled Sept-Dec 2014
  - G180-80 required acid wash, step rate test OK
  - Perforated (50m) liner across Middle Leduc
  - No completion hardware installed, suspended

- **G180-90**, Observation well
  - Drilled Sept-Dec 2014
  - TD in Winterburn Formation
  - No completion, suspended

- **C170-70 and C170-71**, Water back producers
  - Drilled Dec 2014 – Jan 2015
  - Did not reach target depth on either well
    - C170-70 cemented intermediate casing @ 1603 mKB, called TD
    - C170-71 int casing @ 1610 mKB, drilled and open to TD @ 1776 mKB
  - No completion, suspended
ARTIFICIAL LIFT
Rod Pumping Specifications

**Pumping Units:**
- Pumpjacks: 144” – 260” stroke
  - Pump Jacks
  - Rotoflex: 288” stroke

**Max. Capacity:**
- 280 m³/d
- 250 m³/d

**Automation:**
- Pump Off Controllers (POC): load cells, motor sensor, crank sensor, VFD
- XSPOC: Real-time pump cards

**Pumps:**
- Insert rod pumps, 2.0 – 3.25” barrel, 1” continuous rod, rod string designs
INSTRUMENTATION SUMMARY
# Observation Wells

<table>
<thead>
<tr>
<th>Well Name</th>
<th>Type of observation well</th>
<th>Well Name</th>
<th>Type of observation well</th>
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<tbody>
<tr>
<td>TH6</td>
<td>Temperature</td>
<td>TH32A</td>
<td>Temperature and micro seismic</td>
</tr>
<tr>
<td>TH7</td>
<td>Temperature</td>
<td>TH33A</td>
<td>Temperature and micro seismic</td>
</tr>
<tr>
<td>TH8</td>
<td>Temperature</td>
<td>TH33B</td>
<td>Temperature</td>
</tr>
<tr>
<td>TH2 (Obs 9)</td>
<td>Temperature</td>
<td>TH40A</td>
<td>Disconnected</td>
</tr>
<tr>
<td>TH10</td>
<td>Temperature</td>
<td>TH40B</td>
<td>Temperature</td>
</tr>
<tr>
<td>TH11</td>
<td>Temperature</td>
<td>TH41A</td>
<td>Disconnected</td>
</tr>
<tr>
<td>TH12</td>
<td>Temperature</td>
<td>12-35</td>
<td>Pressure (Three Creeks)</td>
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<tr>
<td>TH14</td>
<td>Temperature</td>
<td>D320 (5-19)</td>
<td>Temperature – DTS</td>
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<tr>
<td>TH30A</td>
<td>Temperature and micro seismic</td>
<td>D321 (11-19)</td>
<td>Temperature – DTS</td>
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<td>TH30C</td>
<td>Temperature, pressure and DTS</td>
<td>R3-19</td>
<td>Temperature – DTS</td>
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<tr>
<td>TH31A</td>
<td>Temperature and micro seismic</td>
<td>TH33</td>
<td>Pressure and temperature</td>
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<tr>
<td>TH31C</td>
<td>Temperature, pressure and DTS</td>
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<td></td>
</tr>
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</table>
Typical Temperature Observation Completion

- Thermocouples situated from the Wilrich to the Debolt formations to monitor steam chamber rise and temperature variations over cycle(s).

- 5 wells with DTS installed (Pads 30, 31 & 32)
Monitoring of Abandoned Wells

Update required as per AER approval no. 8143Z

Oct 2015 – Oct 2017:
- 1AA052708518W500
  - Pad 106 wells drilled 400m to south – no injection
  - Closest production wells on Pad 19 > 1000m
- 1AA131508518W500
  - Low pressure injection on Pad 21/22; Q3 2017 pad on blowdown
  - No changes observed

![Graph of Injection Casing Head Pressure](image)
SCHEME PERFORMANCE
## Scheme Recovery Processes

<table>
<thead>
<tr>
<th>Pad</th>
<th>Recovery Process</th>
<th>Date of Conversion</th>
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<tr>
<td>19 Sat 1 and 2</td>
<td>Steamflood</td>
<td>Oct 2012</td>
</tr>
<tr>
<td>19 Infills</td>
<td>Steamflood</td>
<td>July 2013</td>
</tr>
<tr>
<td>20 Conv</td>
<td>Steamflood</td>
<td>July 2012</td>
</tr>
<tr>
<td>20 Infills</td>
<td>Steamflood</td>
<td>June 2012</td>
</tr>
<tr>
<td>21 Conv</td>
<td>Steamflood</td>
<td>Jan 2009</td>
</tr>
<tr>
<td>21 Infills</td>
<td>Steamflood</td>
<td>Nov 2011</td>
</tr>
<tr>
<td>30</td>
<td>Steamflood</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>31</td>
<td>Steamflood</td>
<td>Nov 2014</td>
</tr>
<tr>
<td>32/33</td>
<td>Cyclic Steam Stimulation (CSS)</td>
<td>Converted to steamflood December 2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Converted to CSS August 2014</td>
</tr>
<tr>
<td>40</td>
<td>Suspended</td>
<td>Converted to steamflood June 2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blowdown June 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suspended October 2015</td>
</tr>
<tr>
<td>41</td>
<td>Suspended</td>
<td>Converted to steamflood June 2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blowdown June 2014</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Suspended October 2015</td>
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</table>
Peace River Production

Now utilizing full steam generation capability

Declining steam generation since 2007
Peace River Production

All data current as of Oct 2017
- cOil = 7,345 Mm³
- cWater = 25,431 Mm³
- cSteam = 31,238 Mm³
- Cumulative SOR = 4.3
- Cumulative WSR = 0.8
• Bitumen production has continued to decrease since 2007 peak due to maturing pads and reduced steam injection.
Peace River Performance Summary

• Returned to utilizing all steam capacity from PREP boilers in Q3 2017 after acquiring asset in June 2017

• 5 inactive wells restarted

• Conversion from single-well CSS to column CSS on Pad 32 to improve SOR

• Prioritized steam to steamflood pads by SOR

• Initiated liner cleanout program to improve liner access
## OBIP & Recovery Factors by Pad

<table>
<thead>
<tr>
<th>Pad</th>
<th>OBIP (E3 m³)</th>
<th>Area (m²)</th>
<th>Pay Thickness (m)</th>
<th>Porosity (%)</th>
<th>Oil Saturation (%)</th>
<th>Cum Oil (E3 m³)</th>
<th>Current Recovery (%)</th>
<th>Ultimate Recovery (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pad 19 S1</td>
<td>1,060</td>
<td>199,000</td>
<td>23</td>
<td>28</td>
<td>83</td>
<td>272</td>
<td>26</td>
<td>26</td>
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<tr>
<td>Pad 19 S2</td>
<td>1,370</td>
<td>361,000</td>
<td>16</td>
<td>28.5</td>
<td>84</td>
<td>236</td>
<td>17</td>
<td>29</td>
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<tr>
<td>Pad 19 S3</td>
<td>1,110</td>
<td>238,000</td>
<td>21</td>
<td>28</td>
<td>80</td>
<td>303</td>
<td>27</td>
<td>30</td>
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<tr>
<td>Pad 19 S4</td>
<td>1,200</td>
<td>249,000</td>
<td>20</td>
<td>29</td>
<td>84</td>
<td>224</td>
<td>19</td>
<td>29</td>
</tr>
<tr>
<td>Pad 20</td>
<td>2,040</td>
<td>423,000</td>
<td>22</td>
<td>27</td>
<td>82</td>
<td>642</td>
<td>31</td>
<td>34</td>
</tr>
<tr>
<td>Pad 20i</td>
<td>1,500</td>
<td>339,000</td>
<td>20</td>
<td>27</td>
<td>83</td>
<td>207</td>
<td>14</td>
<td>22</td>
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<tr>
<td>Pad 21</td>
<td>2,350</td>
<td>431,000</td>
<td>25</td>
<td>27</td>
<td>82</td>
<td>598</td>
<td>26</td>
<td>29</td>
</tr>
<tr>
<td>Pad 21i</td>
<td>1,520</td>
<td>287,000</td>
<td>25</td>
<td>26</td>
<td>83</td>
<td>235</td>
<td>15</td>
<td>31</td>
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<td>Pad 30</td>
<td>4,250</td>
<td>765,000</td>
<td>24</td>
<td>28</td>
<td>83</td>
<td>829</td>
<td>20</td>
<td>34</td>
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<td>Pad 31</td>
<td>6,520</td>
<td>1,232,000</td>
<td>23</td>
<td>28</td>
<td>83</td>
<td>744</td>
<td>11</td>
<td>34</td>
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<tr>
<td>Pad 40</td>
<td>8,790</td>
<td>1,676,000</td>
<td>25</td>
<td>26.5</td>
<td>80</td>
<td>881</td>
<td>10</td>
<td>26</td>
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<tr>
<td>Pad 41</td>
<td>5,990</td>
<td>1,134,000</td>
<td>26</td>
<td>26</td>
<td>79</td>
<td>842</td>
<td>14</td>
<td>23</td>
</tr>
<tr>
<td>Pad 32</td>
<td>9,650</td>
<td>1,953,000</td>
<td>22</td>
<td>27.5</td>
<td>83</td>
<td>847</td>
<td>9</td>
<td>17</td>
</tr>
<tr>
<td>Pad 33</td>
<td>9,800</td>
<td>2,044,000</td>
<td>22</td>
<td>27.5</td>
<td>80</td>
<td>483</td>
<td>5</td>
<td>14</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>57,150</strong></td>
<td><strong>7,345</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Pad 32 - Low Recovery

16 CSS Wells
Current RF: 9%

- Spacing: 150m
- Avg. Net Pay: 22m
- Avg. So: 78%
- Avg. Porosity: 28%
Pad 32 - Low Recovery

- Steaming in recent years has been single well CSS
- Aug 2017: east column of 8 wells returned to block CSS
- Oct 17, 2017: steam shut-in after a casing failure on well 32-01
- 2018 plans:
  - Repair and confirm casing integrity
  - Resume cyclic steam injection
Pad 20 Infills - Medium Recovery

4 well steamflood, initially CSS
Lateral Steamflood (J-Wells)

Current RF: 14%

- Spacing: 100m
- Avg. Net Pay: 20m
- Avg. So: 82%
- Avg. Porosity: 27%
Pad 20 Infills - Medium Recovery

- Steam injection increased in June 2017

- 2018 plans:
  - Monitor response to increased injection and adjust steam allocation based on observed performance
Pad 19 Sat 3 - High Recovery

14 well steamflood
Current RF: 27%
- Spacing: variable
- Avg. Net Pay: 21m
- Avg. So: 83%
- Avg. Porosity: 28%
• Steam injection increased in June 2017

• Restarted 2 inactive wells

• 2018 Plans
  – Restart additional wells that can be incorporated into steamflood process
  – Adjust steam allocation based on observed performance
  – Explore increased steam support to producers to utilize artificial lift capacity
Factors Impacting Recovery

• Well design
  – Multi-well designs have no clear performance advantage
  – Lack of sand control has resulted in significantly plugged portions of liners
  – Unable to re-enter some wells for cleanouts due to complexity of well design and/or small liner diameters
  – No control of steam placement in laterals

• Inter-well and Inter-pad Communication
  – Reduces thermal efficiency by suboptimal placement of injected steam, and/or quenching of heated reservoir with cooler fluids
  – Examples include: Pad 40-41, Pad 32-33, Pad 32 to Pad 30,31
Key Learnings – Liner Access

• Liner access is limited
  – Majority of liners have no sand control: Perforated pipe only.
  – Tagged hard near heel on 19 wells on Pads 20, 32 and 33
  – Hard fill through 60-80% of liner
  – Flushed liners to the toe

• Difficult to cleanout wells with 2-7/8” liners
  – Pads 30, 31, 40, 41
Key Learnings - Casing Integrity

• CNUL recently became aware of external casing corrosion in Peace River.
  – Corrosion within 1.5m of ground elevation where casing is in contact with soil conditions
  – Inspections ongoing on Pads 32/33
  – At least one well inspected on all active pads

• Remediation Plans
  – Upper sections of casing are being replaced when confirmed unsuitable for process conditions
  – Casing is also being coated where required to prevent further corrosion.
2018 Depletion Strategy

- Evaluating CSS vs. steamflood on Pads 32/33 for resumption of steam injection when casing repairs are complete (Q1-2018)

- Continue to optimize steamflood areas

- Continue liner cleanouts to improve steam conformance and drainage
5 Year Outlook of Pad Abandonments

• No pads are scheduled for abandonment from 2018 to 2022
Future Development Plans

- Peace River asset was acquired June 1, 2017.
  - Evaluating future development plans
DIRECTIVE 54 SECTION 3.1.2
SURFACE OPERATIONS, COMPLIANCE, AND ISSUES
NOT RELATED TO RESOURCE EVALUATION AND RECOVERY
Peace River Plant
Thermal Production Treating: Process Flow Diagram

- Source Water
- TCPL
- Cliffdale Gas
- Diluent

**Water Treating**
- Boiler Feedwater

**Steam Generation**
- Steam

**Wells**
- Emulsion

**Separation**
- Bitumen Blend
- 3rd Party Oil

- Produced Gas to Injection
- Pipeline
- Produced Water Disposal
2017 Facility Modifications

• Two 1.25 MW power generators (installed late 2016)

• Berm runoff project completed (with exception of Pad 32, which will be completed in spring 2018)

• Brine pipeline shut down (brine co-injected with produced water)
Plot Plan with 2017 Modifications

1.25 MW Power Generators
Facility Performance: Production & Oil Treating

• Production averaged between 30-40% of 2,000 m³/day licensed capacity in 2017

• Production Separator 1 was cleaned to improve separation

• Demulsifier chemical was changed for cost reduction purposes

• Oil treatment has largely not been an issue due to low oil volumes
Facility Performance: Source Water

- PRC pulls water from the Peace River on a continuous basis. Source water treatment facility located on the east bank of the Peace River.
- PRC is licensed to withdraw 4.3 e⁶ m³ of water from the Peace River per year (11,813 m³/day).
- Historical water usage range is 5,000 m³/day to 11,000 m³/day.
  - YTD fresh water withdrawal (Jan 1 to Sep 30) is 1.4 e⁶ m³ or an average of 5,092 m³/day.
  - Before being sent to the main complex, fresh water from source water is treated to:
    - less than 5 ntu, and less than 0 ppm oxygen.
- The water softeners were converted to shallow shell technology in 2016.
- Waste brine previously disposed down disposal well (16-27) in the Leduc formation but now co-mingled with produced water before disposal down wells at 14-25 and 16-23.
Facility Performance: Produced Water

• Typical produced water quality:
  – Produced water TSS 30 mg/L, Oil and Grease 75 ppm, Total Hardness 374 mg/L, Chlorides 3,190 mg/L

• Solids are periodically disposed of through approved waste stream treating companies

• Design produced water handling and injection capacity is 7,977 m³/day
  – Disposal pump capacity currently limited to 7,400 m³/d
  – Investigation underway to understand cause
Produced Water Treatment & D81 Compliance

• Directive 81 (D81) Compliance
  – Application submitted Q2 2016, waiver extension granted Q3 2016
  – Approval subject to construction of a commercial produced water treatment and recycling facility before end of 2020

• Electrocoagulation (EC) Demonstration
  – EC Commercial Demonstration trial postponed while options for future development of Peace River leases are being evaluated
  – EC trial summary in Appendix

• Water Treatment Plans
  – Seeking to match the produced water treatment solution to the reservoir strategy and corresponding steam water specification
  – Conventional water treatment technologies such as evaporation and warm lime softening are also being investigated
Electrocoagulation (EC) Trial Summary

- EC trial conducted in Q1, 2016 using 20 gpm pilot scale system
  - Objective: Remove hardness and silica levels to OTSG BFW quality specifications
- Results and conclusions:
  - Proof of Concept (PoC) achieved
    - High levels of silica and hardness removal at >60% power (current density of 0.4 A/in²)
    - Complete H₂S removal at all power levels
    - Removals significantly better at boiler feedwater pH of ~9
    - TSS levels increased significantly at >60% indicating substantial coagulation is occurring
  - Mechanical / reliability issues and significant downtime of pilot equipment resulted in inconclusive data and need to consider further technology demonstration with respect to the following:
    - Soluble iron observed in effluent at very low at <60% power levels
    - Foaming due to hydrogen gas liberation was observed – requires solution
    - Incomplete data obtained regarding CIP and electrode fouling tendency
    - Incomplete data obtained regarding solids dewaterability
    - No estimate of electrode replacement frequency
Facility Performance: Steam Generation

- PRC generates 80% steam quality from four once through steam generators.
- The four steam generators have a total capacity of approximately 8,000 t/d.
- Steam pressures of 14 MPa and 335°C.
- The main complex takes formation steam off the high pressure injection line and utilizes it in the utility steam system. The utility steam uses 700 to 1,500 t/d based on seasonal requirements.
- PRC has a 100% utility steam system blowdown recycle back in to the plant steam condensate recovery system.
- All Steam Generators use a mixture of up to 75% Cliffdale and 25% Natural Gas by volume as their fuel source.
- 100% steam quality switch was deferred pending future development plans.
Facility Performance: Steam Generated

- Four PREP boilers at 2000 tons/d capacity each
Facility Performance: Power Usage

Power Consumption MWh

Was unsuccessful in obtaining power consumption data from Shell for the period prior to June 2017
Facility Performance: Gas Usage

• Natural gas is purchased from TransCanada for use as fuel.
• Since June 2010, CVG from the Cliffdale field is being imported to PRC as a fuel source to the boilers.
• EPEA licence restrictions limit using sour fuel in the boilers to events less than 72 hours in duration. While Peace River has the capability to burn sour mixed gas it has not been done since 2010.
Facility Performance: Gas Usage

Gas Consumption

- TCPL Purchased Gas
- Cliffdale Gas

Gas Usage (e3m3/d)

Oct-16  Nov-16  Dec-16  Jan-17  Feb-17  Mar-17  Apr-17  May-17  Jun-17  Jul-17  Aug-17  Sep-17
Facility Performance: Three Creeks Compressor

• Three Creeks Gas injection facility has been operational for six years.
• Gas is currently analyzed once per month at the Three Creeks dehydration outlet to the Three Creeks gas injection pipeline. Analysis done by a outside lab.
• 2017 Injection facility reliability is currently 99%. This includes planned maintenance shutdowns.
• Some injectivity concerns observed in 2017. Acid workover did not significantly improve injectivity. Asphaltines not identified in system. Consideration is being given to requesting a higher injection pressure into the reservoir. Increasing the MOP of the surface facilities would also be required to permit higher injection pressures.
Three Creeks Subsurface Information

- Data as per Three Creeks annual progress report submitted Oct 31, 2017
- Obtain D65 approval May 30, 2017 to store gas up to 5,000 kPa(a) static reservoir pressure
Three Creeks Subsurface Information

Cumulative Volume Of Gas Injected

Cum Gas Stored @ 31-Oct-2017: 264 e6m3
Three Creeks Subsurface Information

- Injected gas stream is analyzed once each month. The graph below presents the gas analysis from Nov 2016 to Oct 2017.

Gas Composition 2017

May Data Added

Similar to other months.
Three Creeks Subsurface Information

- Injected gas stream is analyzed once every month.
- The table presents the gas analysis for July, August and September 2017.

<table>
<thead>
<tr>
<th>COMPONENT</th>
<th>JULY</th>
<th>AUGUST</th>
<th>SEPTEMBER</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mole Fraction (as received)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hydrogen (H₂)</td>
<td>0.01124</td>
<td>0.00560</td>
<td>0.01367</td>
</tr>
<tr>
<td>Helium (He)</td>
<td>0.00013</td>
<td>0.00008</td>
<td>0.00006</td>
</tr>
<tr>
<td>Nitrogen (N₂)</td>
<td>0.00454</td>
<td>0.00201</td>
<td>0.00476</td>
</tr>
<tr>
<td>Carbon Dioxide (CO₂)</td>
<td>0.45182</td>
<td>0.32813</td>
<td>0.44080</td>
</tr>
<tr>
<td>Hydrogen Sulfide (H₂S)</td>
<td>0.01640</td>
<td>0.00630</td>
<td>0.01360</td>
</tr>
<tr>
<td>Methane (C₁)</td>
<td>0.46535</td>
<td>0.62267</td>
<td>0.48456</td>
</tr>
<tr>
<td>Ethane (C₂)</td>
<td>0.01440</td>
<td>0.01207</td>
<td>0.01500</td>
</tr>
<tr>
<td>Propane (C₃)</td>
<td>0.00906</td>
<td>0.00683</td>
<td>0.00842</td>
</tr>
<tr>
<td>Isobutane (iC₄)</td>
<td>0.00396</td>
<td>0.00254</td>
<td>0.00305</td>
</tr>
<tr>
<td>n-Butane (nC₄)</td>
<td>0.00687</td>
<td>0.00439</td>
<td>0.00533</td>
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<tr>
<td>Isopentane (iC₅)</td>
<td>0.00643</td>
<td>0.00404</td>
<td>0.00479</td>
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<tr>
<td>n-Pentane (nC₅)</td>
<td>0.00550</td>
<td>0.00318</td>
<td>0.00381</td>
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<tr>
<td>Hexanes (C₆)</td>
<td>0.00292</td>
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<td>0.00164</td>
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<tr>
<td>Heptanes (C₇+)</td>
<td>0.00138</td>
<td>0.00067</td>
<td>0.00051</td>
</tr>
<tr>
<td>TOTAL</td>
<td>1.00000</td>
<td>1.00000</td>
<td>1.00000</td>
</tr>
</tbody>
</table>
Measurement, Accounting & Reporting Plan (MARP)

• The following changes to the Measurement, Accounting and Reporting Plan were included in the last submission:
  – Removed Pad 41 wells (suspended)
  – Added the disposition of gas used as fuel at the Power Generation
Production Well Testing

- Each well is directed to a test vessel on the pad, except pad 19 sat 1,2,4 & 20
- Well test duration/frequency largely dependent on purge time & number of wells tied into each test separator:

<table>
<thead>
<tr>
<th>Pad</th>
<th>Separator</th>
<th>Purge time*</th>
<th>Duration</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>January-May → June-October</td>
<td>January-May → June-October</td>
</tr>
<tr>
<td>21</td>
<td>2 phase</td>
<td>~3-8 hrs</td>
<td>16 hours</td>
<td>2-3x/month → 2x/week</td>
</tr>
<tr>
<td>19 sat 1-2-4 &amp; 20</td>
<td>3 phase</td>
<td>~1 to 8 hrs</td>
<td>18 hours → 12 hours</td>
<td>2-3x/month → 1-2x/week</td>
</tr>
<tr>
<td>19 sat 3</td>
<td>2 phase</td>
<td>~0.5 hrs</td>
<td>24 hours</td>
<td>3-4x/month → 3x/week</td>
</tr>
<tr>
<td>30, 31</td>
<td>2 phase</td>
<td>~0.5 hrs</td>
<td>20 hours</td>
<td>2-3x/month → 6x/week</td>
</tr>
<tr>
<td>32, 33</td>
<td>2 phase</td>
<td>~0.5 hr</td>
<td>20 hours</td>
<td>2-3x/month → 6x/week</td>
</tr>
</tbody>
</table>

* Purge time varies for each test, as it is dependent on the production rate of the well. A pre-determined purge volume is applied to each vessel

- Flow rates are measured by a Coriolis meter
- Water/bitumen cuts are determined by inline BS&W analyser
- Reported volumes are prorated based on measured total volumes at the plant
- Details of measurement and reporting procedures can be found in the Peace River MARP
Well Testing

• Year To Date Activities
  – Attempted to test flowback wells from CSS cycle (first time @ PRC)
  – More frequent AGAR calibration done by Operations (1/year → 1/month)
  – Implemented new logic for test volume calculation for each separator
  – Conducted investigation and go-forward plan on natural gas adaptation for pressure management on Pad 19’s test separator
  – Detailed investigation on-going to identify testing deficiencies in all pads
## Bitumen Proration

<table>
<thead>
<tr>
<th>Proration</th>
<th>Oct 2016 – Sep 2017 Range</th>
<th>Oct 2016 - Sep 2017 Average</th>
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</thead>
<tbody>
<tr>
<td>Bitumen</td>
<td>0.98 – 1.19</td>
<td>1.08</td>
</tr>
</tbody>
</table>

### Proration Factor

![Proration Chart]

The proration factor for Bitumen varies monthly from October 2016 to September 2017. The range is from 0.98 to 1.19, with an average of 1.08.
Water Proration

<table>
<thead>
<tr>
<th></th>
<th>Oct 2016- Sep 2017 Range</th>
<th>Oct 2016- Sep 2017 Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water</td>
<td>0.91 – 1.08</td>
<td>0.99</td>
</tr>
</tbody>
</table>

Implemented the steam volumes used for winterization and test separator pressure into the water recycle calculation to correct the produced water volume.
Steam Injected & Produced Water

Water (Steam) Injected vs Water Recovered

- **Injected Steam**
- **Recovered Water**

<table>
<thead>
<tr>
<th>Month</th>
<th>Oct-16</th>
<th>Nov-16</th>
<th>Dec-16</th>
<th>Jan-17</th>
<th>Feb-17</th>
<th>Mar-17</th>
<th>Apr-17</th>
<th>May-17</th>
<th>Jun-17</th>
<th>Jul-17</th>
<th>Aug-17</th>
<th>Sep-17</th>
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</thead>
<tbody>
<tr>
<td>Injected Steam</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Recovered Water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Water Disposal

• Brine Water Disposal Well (100/16-27-85-19W5)
  – Disposed into the Leduc formation until July 2017
  – Used for boiler feed water softener regeneration waste
  – Average Disposal Volume/Day = 63.3 m³/d
  – Average Upstream Pressure = 2,780 kPa
  – Max Wellhead Pressure = 3602 kPa
  – Typical Total Dissolved Solids (TDS) is 9000 g/m³
  – Approval up to 4500 kPag wellhead injection pressure (as per approval no. 9953A)

• Ion Exchange Brine Disposal
  – Brine pipeline shut down due to integrity concerns Q2 2017
    ▪ Based on pipeline risk assessment, no leaks detected
    ▪ Pigged, dewatered and nitrogen purged
  – Brine from Ion Exchange regens now being co-disposed with produced water
Water Disposal

• Produced Water Disposal Well 322 (102/14-25-85-19W5)
  • Disposing into the Leduc formation
  • Used as produced water disposal well
  • Average Disposal Volume/Day = 3,093.2 m³/d
  • Average Pressure = 5,952 kPa
  • Max Pressure = 6,352 kPa
  • Average Temperature = 64 °C
  • Typical Total Dissolved Solids (TDS) is 5300 g/m³
  • Approval up to 18,000 kPag (as per approval no. 6308)

• Produced Water Disposal Well 323 (102/16-23-85-19W5)
  • Disposing into the Leduc formation
  • Used as produced water disposal well
  • Average Disposal Volume/Day = 2,534.3 m³/d
  • Average Pressure = 6,048 kPa
  • Max Pressure = 6,476 kPa
  • Average Temperature = 66 °C
  • Typical Total Dissolved Solids (TDS) is 5300 g/m³
  • Approval up to 18,000 kPag (as per approval no. 6308)
Water Disposal Monthly Volumes

Three fewer days in Feb

Monthly Injected Volume (m3)

Well 322
Well 323
Well 16-27
• 16-27 Brine Disposal well shut-in September 2017 due to pipeline integrity concerns
Waste Disposal

- Tervita Corporation– Peace River (12-24-85-19-W5)
  - Treatment, Recovery & Disposal (TRD) Facility
  - Primarily hydrocarbon sludge
  - 5,181 m³ to October 2017
New AER Operating License has 0.99 T/Day continuous SO2 Sulphur emissions have reduced since 2010 due to PRC produced gas injection into Three Creeks.
Greenhouse Gas Emissions

- Peace River Complex Greenhouse Gas Emissions
  - November 2017 data is estimated
  - Power Generation totals from onsite generators

<table>
<thead>
<tr>
<th>Month</th>
<th>Nov 2016-Nov 2017 Total (tCO2e)</th>
<th>PRC Plant</th>
<th>Power Generation</th>
</tr>
</thead>
<tbody>
<tr>
<td>November</td>
<td>22,000</td>
<td>22,000</td>
<td>0</td>
</tr>
<tr>
<td>December</td>
<td>24,400</td>
<td>24,400</td>
<td>0</td>
</tr>
<tr>
<td>January</td>
<td>24,200</td>
<td>23,300</td>
<td>900</td>
</tr>
<tr>
<td>February</td>
<td>21,600</td>
<td>20,600</td>
<td>1,000</td>
</tr>
<tr>
<td>March</td>
<td>23,100</td>
<td>22,000</td>
<td>1,100</td>
</tr>
<tr>
<td>April</td>
<td>22,700</td>
<td>21,500</td>
<td>1,200</td>
</tr>
<tr>
<td>May</td>
<td>23,200</td>
<td>21,900</td>
<td>1,300</td>
</tr>
<tr>
<td>June</td>
<td>22,000</td>
<td>20,700</td>
<td>1,300</td>
</tr>
<tr>
<td>July</td>
<td>26,800</td>
<td>25,400</td>
<td>1,400</td>
</tr>
<tr>
<td>August</td>
<td>32,700</td>
<td>31,600</td>
<td>1,100</td>
</tr>
<tr>
<td>September</td>
<td>34,600</td>
<td>33,400</td>
<td>1,200</td>
</tr>
<tr>
<td>October</td>
<td>30,800</td>
<td>29,600</td>
<td>1,200</td>
</tr>
<tr>
<td>November*</td>
<td>32,700</td>
<td>31,500</td>
<td>1,200</td>
</tr>
<tr>
<td>13 Month Total</td>
<td>340,800</td>
<td>327,900</td>
<td>12,900</td>
</tr>
</tbody>
</table>
The high flare volume in December was a result of Blanket Gas Issues from Tank high levels and VRU’s down.
Ambient Air Monitoring

• Static/Passive Air Monitoring
  – Twelve passive stations
  – Gathers data on sulphur dioxide and hydrogen sulphide
  – 2017 monitoring and reporting satisfactory

• Continuous Ambient Monitoring data
  – Continuous Monitoring - Monitored parameters: sulphur dioxide, hydrogen sulphide, methane, non-methane hydrocarbons, total hydrocarbons, total reduced sulphur, ambient temperature, wind speed and direction.
Environmental Compliance

• There were no Ambient Air Exceedances at the PRC Environmental Trailer (EPEA Approval 1642-02-10) from October 2016-October 2017. The air trailer maintained over 90% uptime each month as per license requirements.

• Reportable spills and releases at PRC
  – October 2017 there was a casing failure on pad 32-01 during a steam cycle
    ▪ Approximately 28.08 m³ of kill fluid was used to stop the release.
  – 1 release to atmosphere from tanks (venting) occurred between November 1 and December 31, 2016.
    ▪ Total volume vented for this period was 0.0028 e³m³.
  – 1 release to atmosphere from tanks (venting) occurred between January 1 and October 31, 2017 2016.
    ▪ Total volume vented for this period was 0.14 e³m³.
  – AER granted approval in fall to release sewage lagoon at elevated TSS levels (BOD was within limits) but lagoon has not been dumped yet
    ▪ Currently evaluating options to manage discharge
Scheme Approval 8143

- Operations at Peace River are consistent with all conditions of Thermal Scheme No. 8143

- Amendments to Scheme Approval no. 8143 received in previous 12 months are provided below.

<table>
<thead>
<tr>
<th>Amendment</th>
<th>Approval Date</th>
<th>Description</th>
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</thead>
<tbody>
<tr>
<td>CC</td>
<td>May 30, 2017</td>
<td>Approval Transfer</td>
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<tr>
<td>DD</td>
<td>June 29, 2017</td>
<td>SAGD Pilot</td>
</tr>
</tbody>
</table>
EPEA Approval 1642-02-10

• EPEA Operating Approval Amendments between October 2016-October 2017:
  – 1642-02-09: Removal of three natural gas turbines from approval
  – 1642-02-10: Transfer of Approval
Environmental: Monitoring Program Summary

• Groundwater Program
  – Per EPEA 1642-02-08, PRC has requirements for both groundwater and deep well water testing. Testing and reporting are both required on an annual basis.
  – Testing was completed in October 2017.
  – Results will be reported in the 2017 annual report.

• Soil Monitoring Program
  – Testing was completed in November 2017.
  – Results to be reported in 2017 annual report.
**Environmental: Monitoring Program Summary**

- **Shallow groundwater monitoring program:**
  - Groundwater testing occurred in October 2017 on plant piezometers.
  - Results of the GWMP will be summarized in the 2017 Groundwater Monitoring Program Peace River Complex Project Report and submitted in March 2018.
  - Continued groundwater monitoring per EPEA approval.

- **Shallow groundwater wells around reclaimed PSDS (Produced Solids Disposal Site):**
  - PSDS has been reclaimed and well Pad 32 was built on the location.
  - Piezometers remain around perimeter of well pad
  - No impacts observed in these wells with little variation at a majority of the monitoring locations.
  - Results of the GWMP will be summarized in the 2017 Groundwater Monitoring Program Peace River Complex Project Report and submitted in March 2018.
  - Recommendations were made in the 2016 EPEA GWMP report to discontinue the PSDS monitoring program in 2016. AER was notified of the change.
Environmental: Monitoring Program Summary

• Deep Regional Wells
  – 2004 drilling program (50 and 105 meter depth)
  – 2005 drilling program (70 meter depth)
  – 2009 drilling program (3 wells (each approximately 60, 120 and 270 meters deep)
  – Results of the deep regional well GWMP will be summarized in the 2017 Groundwater Monitoring Program Peace River Complex Project Report (Matrix, 2017) and submitted to AER in March 2018.
  – Continued groundwater monitoring per EPEA approval.
Environmental Studies Program

- Wildlife crossing structures monitored on aboveground pipelines.
  - This data will continue to be assessed and incorporated into the Comprehensive Wildlife Report. The next report is due in 2018.
- Multiple wildlife studies including bird surveys, winter mammal tracking, owl surveys, bat surveys, and amphibian surveys completed in 2015-2017.
- All wildlife data for these surveys is uploaded into the Fish & Wildlife Management Information System (FWMIS) and incorporated into the Comprehensive Wildlife Reports.
- eDNA partnered with the Alberta Conservation Association (ACA) on a 3-year amphibian study beginning in 2014 and concluding in 2016.
- Ongoing peatland reclamation research with NAIT Boreal Research Institute.
## Environmental Studies Program

<table>
<thead>
<tr>
<th>EPEA Requirement</th>
<th>Report Name</th>
<th>Due Date</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>CCP - Schedule VI (1)</td>
<td>Groundwater Monitoring Program (GWMP)</td>
<td>March 31, 2014</td>
<td>Submitted to Alberta Energy regulator (AER) on March 31, 2014; received written authorization from the Director on March 5, 2015.</td>
</tr>
<tr>
<td>CCP - Schedule IX (39)</td>
<td>Wetland Reclamation Trial Program Proposal</td>
<td>December 31, 2016</td>
<td>Submitted to AER on December 21, 2016 - AER written authorization received on January 12, 2016. The wetland reclamation trial is being conducted by NAIT Boreal Research Institute at the Airstrip</td>
</tr>
<tr>
<td>CCP - Schedule IX (44)</td>
<td>Reclamation Monitoring Program (RMP) Proposal</td>
<td>December 31, 2016</td>
<td>Submitted to AER on January 26, 2017 - AER written authorization received on February 10, 2017</td>
</tr>
<tr>
<td>CCP - Schedule XI (26)</td>
<td>Project-Level, Conservation, Reclamation and Closure Plan (PLCRCP)</td>
<td>October 31, 2017</td>
<td>In February 2016, the AER has issued new guidelines to the preparation of the PLCRCP. The due date has been amended to October 31, 2018 [E-File No. 4101-00001642-07].</td>
</tr>
</tbody>
</table>
Reclamation Summary

Shell acquisition inventory: June 1, 2017

• Reclamation activities in 2017:
  – Re-vegetation Program consisted of reforesting 8.17 hectares
  – Approximately 19,400 trees were planted
    ▪ 5 wellsites/2 borrow pits and associated access roads
  – Vegetation assessment and management completed on 28 sites
    ▪ 18 sites – 30.3 hectares – weed control conducted
  – Evaluation of 7 sites for planning full surface reclamation
  – Detailed site assessments (DSA) completed on 4 sites – 3.64 hectares

• Proposed activities in 2018:
  – Reclamation certification application submitted for 5 sites – 4.44 hectares
  – Inventory continues to be evaluated for 2018 budget
    ▪ Vegetation assessment, monitoring and control, tree planting, DSA, Reclamation applications to continue
Environmental Research led by NAIT

• Peatland Restoration
  – Funding is supporting peatland research around the Peace River area (IPAD, pad removal and restoration study, wetland reclamation project at Airstrip and a third project in around the Carmon Creek area that is looking at impacts of linear disturbances on wetland function (carbon, plants etc.)

• Forest Reclamation
  – Airstrip Research: field deployment and monitoring of mixed species container stock (hitchhiker planting), utilization of organic amendments on reclaimed sites, riparian area species selection and timing of plant deployment and integrated approaches (site preparation and native cover crops) to manage undesirable plants on reclaimed sites. Ongoing monitoring.
Future Plans

• Facility modifications to accomplish revised reservoir strategy

• Steam water specification to be developed to coincide with reservoir strategy

• Water treatment options being considered that will align with both the asset development strategy and steam water specification
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