Peace River In Situ Oil Sands Progress Report

Commercial Scheme Approval 8143

December 8th, 2015
(revised January 28th, 2016)
# Today's Agenda

<table>
<thead>
<tr>
<th>Introductions and Background</th>
<th>Ivan Gonzalez</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Subsurface Issues Related to Resource Evaluation and Recovery</strong></td>
<td></td>
</tr>
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<td>Future Plans</td>
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**Surface Operations, Performance and Compliance**

Darcy Forman
- Located in Northwestern Alberta
- 100% Shell Share
- OBIP 239 Million m³ for the area in Approval 8143Z
**BLUESKY RESERVOIR PROPERTIES**

- **Thickness**: 25-30 m
- **Depth**: 550-600 m TVD
- **NTG**: 0.8-1.0
- **API Gravity**: 6-11°
- **Porosity**: 0.25-0.30
- **Viscosity**: 10,000-1,000,000 cP (dead oil)
- **Initial pressure**: 3,800 kPa (sub-hydro)
- **Initial temperature**: 18°C
- **Horizontal permeability**: 0.1 – 10 D (air)
- **Kv/kh**: 0.3 – 0.9
- **Oil saturation ($S_o$)**: 0.70 – 0.80
Cliffdale produced gas exported to Peace River. Most gas used in boilers to generate steam, excess gas stored in Three Creeks reservoir.
GAS INTEGRATION PEACE RIVER AND CLIFFDALE ASSETS

North Trans Canada Pipeline (Fuel Gas)
To Seal Battery and Nipisi Terminal
Rainbow Pipeline

- 100% Shell / 27kbpd liquid capacity
- Current 9.7 kbpd oil production
- 180 active oil wells
- 1 Water Disposal Well

Cliffdale Battery

Peace River Complex
- 100% Shell / 13kbpd bitumen license
- Current 4.7 kbpd oil production
- 70 producing wells, 24 injectors
- 3 water disposal wells, 1 gas storage well (Three Creeks)
PEACE RIVER PROJECT HISTORY

Experiment to Pilot to Demonstration to Commercial

PR Leases Obtained

Experiments

- PRISP = Peace River In Situ Pilot
- PCSD = Pressure Cycle Steam Drive
- PREP = Peace River Expansion Project
- SAGD = Steam Assisted Gravity Drainage
- CSS = Cyclic Steam Stimulation
- SR = Soak Radial
- SD = Steam Drive
- CCP = Carmon Creek Project

PRISP (PCSD)

PREP (PCSD)

SAGD

Conv (CSS) → SD

SR (CSS)

SR (SD) → SD

SR2000 (CSS) → SD

Pad 32/33 (CSS)

20 Ph3 inf

Pad 19 inf

Pad 30i & 31i

22-04 inj

CCP
**2015 OVERVIEW**

**Key 2015 PRC updates:**

- Abandoned 4 remaining wells on Pad 19 – Sat 3 with casing integrity issues in Q1-Q2 2015.
- Stopped solvent co-injection on Pad 19 – Sat 3 and continued monitoring solvent recovery through the emulsion line and casing-vent system.
- Started steam injection on new Pads 30i (4 wells) and 31i (6 wells).
- Suspended wells on Pad 40 & 41 to improve field SOR and profitability.
- Drilled and completed 1 new injector on Pad 22 (over Pad 21).
- Cleaned out skim and surge tanks to remove water processing constraints.
- No government reportable spills from October 2014 to end of October 2015.
- Wildlife crossing structures on above ground pipelines-All data from past 8 years was assessed under the Comprehensive Wildlife report and submitted to the AER.
- Good progress in reclamation research projects: Airstrip Project, IPAD Borrow Pit Project, In-Situ Pad Project.
Carmon Creek Project Status – Q4 2015

- Construction at Carmon Creek has been halted. Activity stopped with 100 utility and production wells drilled.
- Shell is looking to retain and maintain the subsurface leases in the area.
- In order to maximize the value of the asset Shell is investigating a number of go forward options with regards to the infrastructure, land disturbance and regulatory approvals associated with the project.
  - Ensuring the asset remains in a safe, secure, compliant state that does not create adverse environmental impact is a priority.
- Discussions will commence shortly with all key departments of AER to seek regulatory input and guidance in order to align on forward options for the project.
## TODAY’S AGENDA

### Introductions and Background
- Ivan Gonzalez

### Subsurface Issues Related to Resource Evaluation and Recovery

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### Artificial Lift
- Dan Syrnyk

### Instrumentation in Wells
- Dan Syrnyk

### Well Integrity
- Dan Syrnyk

### Scheme Performance
- Laura Mislans

### Future Plans
- Pasquale Riggi

### Surface Operations, Performance and Compliance
- Darcy Forman
APPROVAL AREA

Outline of Shell Land

Peace River Development Area 8143Z

PAD 33, PAD 32, PAD 30, PAD 20, PAD 19, PAD 107, PAD 106, PAD 21, PAD 22, PAD 31, PAD 31I, PAD 30I, PAD 40, PAD 41, PADS 50 & 51

Peace River Approval 8143

Date: 11/23/2015

500 1000 1500 2000 2500m

1:62750
- 9 Pads in current operation (outlined in pink)
- New this year:
  - Drilled 1 injector on Pad 22
  - Drilled Pads 106 & 107
  - Drilled and/or completed 6 Utility Wells (highlighted in pink)
CARON CREEK UTILITY WELLS (LEDUC)

DATA ACQUISITION:

- **C180-80** Well Completion
  - Failed In-situ stress test @ Ireton and Leduc

- **G180-80** and **G180-81**
  - Core on G180-81 @ Ireton and Leduc Formations
    - **Ireton** = 1591 – 1646 mMD
    - 2 Mercury Injection Capillary pressure
    - 5 thin sections
    - 3 multistage triaxle compressive strength
    - ultrasonic velocities
    - dynamic elastic parameters
  - **Leduc** = 1723.17 – 1764.15 mMD
    - 6 X-Ray Diffraction
    - 1 Mercury Injection Capillary pressure (failed)
    - 6 Thin Section
  - One successful pressure test @ Leduc, 16 failed tests

- In-situ stress tests
  - G180-80, openhole, Nisku Formation
  - G180-81 failed attempt @ Leduc. No fracture.
  - G180-80 step rate test.
DATA ACQUISITION:

- **Pad 106-90 Observation well**
  - Open hole logs
  - Two external pressure gauges @ 324 and 509 mMD
  - Cored BLSK
  - Core analysis: 9 viscosity samples, 9 particle size distribution, 9 thin sections

- **Pad 107-90 Observation well**
  - Open hole logs
  - Two external pressure gauges @ 310 and 510 mMD
  - Cored BLSK
  - Core analysis: 10 viscosity samples, 10 particle size distribution, 10 thin sections
**Methodology:** Well tops, 3D seismic surfaces (where available) and properties modeled in a 3D cellular static reservoir model (cell size: 50x50x1m)

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<tr>
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<th>Units</th>
<th>Development Area*</th>
<th>Operating Area</th>
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<tbody>
<tr>
<td>Original Bitumen In Place</td>
<td>$10^6 \text{m}^3$</td>
<td>239</td>
<td>55.6</td>
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<tr>
<td>Area</td>
<td>$10^6 \text{m}^2$</td>
<td>42.6</td>
<td>10.5</td>
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<tr>
<td>Average Net Pay</td>
<td>m</td>
<td>27</td>
<td>24</td>
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<tr>
<td>Average Porosity</td>
<td>1/1</td>
<td>0.27</td>
<td>0.28</td>
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<tr>
<td>Average Oil Saturation</td>
<td>1/1</td>
<td>0.81</td>
<td>0.81</td>
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<td>Bo</td>
<td>1/1</td>
<td>1.004</td>
<td>1.004</td>
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*Calculations are based on the 8143Z development scheme approval area*
- Ranges from 14-38m in the approved area
- Ranges from 70-86 m SS in the approved area
BASE BLUESKY STRUCTURE

- Ranges from 36-68 m SSTVD in approval area
Basal Water is a transitional zone of increasing water saturations in the Bluesky that is defined by a Sw > 0.31.
Cap rock: consists of the highly continuous Spirit River Formation (Wilrich/Falher/Notikewin) which has a minimum thickness of 240m over the approval area.

2012 Stress Testing:

- 12 in-situ cap rock stress tests, 3 wells @ 3 different depths in Wilrich, 1 depth top Bluesky
  - Measured Minimum Stress Wilrich = 19.6-22.7 kPa/m, avg 20.9 kPa/m
  - Calculated Minimum Stress Wilrich = 21.6-22.2 kPa/m
  - Measured Minimum Stress Bluesky = 14.7-20.2 kPa/m, avg 16.6 kPa/m

- 2 additional in-situ stress tests in 1 well in Notikewin and Fahler formations
  - Fahler Measured Breakdown Stress = 28.7 kPa/m
  - Fahler Measured Minimum Stress = 20.0 kPa/m
  - Fahler Calculated Minimum Stress = 21.3 kPa/m
  - Notikewin Measured Breakdown Stress = 29.1 kPa/m
  - Notikewin Measured Minimum Stress = 19.0 kPa/m
  - Notikewin Calculated Minimum Stress = 21.0 kPa/m
STRESS TESTING IN DEEP FORMATIONS

Q4 2014 Stress Testing:

- 3 tests were conducted on 3 of the Carmon Creek Utility Wells:
  - Nisku Formation In-situ stress test @ G180-80 (102/07-26-084-18W5/02)
    - Openhole test with 1.7m straddle packer used to obtain minimum horizontal stress (28.3MPa), Vertical stress (38.4MPa), Breakdown pressure (40.1MPa) at 1573m TVD
  - Leduc Formation In-situ stress test @ G180-81 (100/07-26-084-18W5/00)
    - Cased hole with 50m perforated zone (1694.9 - 1744.3m TVD) didn’t achieve fracture. Pressures reached 30.4MPa.
  - Leduc Formation Step rate test on G180-80 (102/07-26-084-18W5/02)
    - Cased hole with 50m perforated zone (1684.6 – 1734.4m TVD). Initial breakdown of 39MPa.
Relief on Debolt surface up to 35 meters - possible fault, or karst cliff

Legend:
- Wilrich Fm.
- Bluesky Fm.
- Gething Fm.
- Debolt Fm.

V.E. = 90:1
<table>
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</tr>
</thead>
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CONTINUOUS REFLECTION MONITORING AT PAD 31

- Recording May 2014 – May 2016
- First steam on infill wells @ Nov 2014
- Time shifts are measurable
- Working to relate time shifts to production effects

- Initial steam conformance
- Connection to mobile zone
  - conformance suffers
- Reduce pump rate
  - conformance improves

Recording May 2014 – May 2016
First steam on infill wells @ Nov 2014
Time shifts are measurable
Working to relate time shifts to production effects
Cemented corner reflectors installation Feb 2015
Surface deformations (measured with InSAR) correlate well with reservoir pressure changes

Near surface disturbances (thawing, precipitation)

March '15  Calendar Time  →  September '15

Less stable
More stable

InSAR monitoring program over Pad 31

Cabin attached
REFRACTION TRIAL AT PAD 31

- Repeat refraction surveys on Pad 31 - seven acquisitions to date
- Data is currently being processed and analyzed

<table>
<thead>
<tr>
<th>Acquisition</th>
<th>Date</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline</td>
<td>Feb 17-18, 2015</td>
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<tr>
<td>First Repeat</td>
<td>Mar 16-17, 2015</td>
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<td>Second Repeat</td>
<td>Apr 14-15, 2015</td>
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<tr>
<td>Third Repeat</td>
<td>May 13-14, 2015</td>
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<tr>
<td>Forth Repeat</td>
<td>June 9-10, 2015</td>
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<td>Fifth Repeat</td>
<td>July 7-8, 2015</td>
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<td>Sixth Repeat</td>
<td>Aug 25-26, 2015</td>
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<td>Seventh Repeat</td>
<td>Sept 22-23, 2015</td>
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</tbody>
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Microseismic monitoring is ongoing at Pad 30, 31, 32, 33 and 40 to monitor caprock and wellbore integrity, as well for out of zone injection.

- Microseismic receiver arrays installed in the Observation wells
- Microseismic monitoring provides an early alert/detection of event activities which might correspond to possible casing failures and/or out of zone injection
- Any such event data is reported by the vendor and analyzed in-house to determine its significance for further follow-up action
- Follow-up actions can range from data gathering through to well interventions
- Microseismic events from 2003 to 2015
- Increased number of events correspond to steam cycle timing
- Arrow indicates last CSS cycle started in April 2011
- Very few events recorded in 2014/2015
- Magnitude typically in -1.5 to -3.5 range
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DRILLING AND 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 2015**
  - Pad F106
    - 46 wells + 1 Observation well
  - Pad F107
    - 46 wells + 1 Observation well
    - 2 Acid gas injection well & 1 monitoring well
    - 2 water back producers
WELL TYPE OVERVIEW

CSS 1996
Soak Radial
500m

CSS 2001
Haybob
1000m

CSS 2006
H- and J- Wells
1500m

CSS 2001
Tuning Fork
1500m

SAGD 1996
500-1000m
**REPRESENTATIVE WELL SPACING FOR INDIVIDUAL PADS**

- **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 21/22 (continued)**
  - 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
• Pads 30, 31, 40 & 41
• 9 5/8” Casing
• 7” Window sleeve
• 2 7/8” Liner
• Thermal 40F cement
• 4.5” tubing
• Insert pumps
• 550-700m laterals
• During full steam cycles, the pump is removed and steam is injected down the tubing of the well.
• For mini soaks (steam injection volumes 500-2000 t) the pump is unseated and steam is injected down the casing.
- Pads 32 & 33
- 7’’ Casing
- 4.5’’ perforated liner
- 4.5’’ Tubing
- Insert pumps
- Thermal 40M cement
- 500-700 m lateral
### Producer Well Design

**General Data:**
- Surface hole size: 374mm (14-3/4"), depth 250m – 310m
- Inclination in surface section: 0° - 20°
- Main hole size: 273 mm (10-3/4"), TD 590m – 688m MD (~585m TVD)
- Inclination at TD: 13° – 47°

**Casing Data:**
- Surface casing: 298.5mm (11-3/4") 62.5 kg/m (42 lb) H40 STC
- Production Casing: 219.1mm (8-5/8") 47.6 kg/m (32 lb) L80IRP TS3SB

**Cement:**
Both strings cemented to surface with RFC Thermal (thixotropic, ~40% silica, 1740 kg/m3)

**Tubing:**
88.9mm, 13.84kg/m, J55 EUE

### Injector Well Design

**General Data:**
- Surface hole size: 311mm (12-1/4"), depth 250m – 310m
- Inclination in surface section: 0° - 21°
- Main hole size: 216mm (8-1/2"), TD 599m – 646m MD (~585m TVD)
- Inclination at TD: 29° – 45°

**Casing Data:**
- Surface casing: 244.5mm (9-5/8") 47.6 kg/m (32 lb) K55 TBlue
- Production Casing: 177.8mm (7") 34.2 kg/m (23 lb) L80IRP TBlue

**Cement:**
Both strings cemented to surface with RFC Thermal (thixotropic, ~40% silica, 1740 kg/m3)

**Tubing:**
73mm, 9.67kg/m, J55 EUE
PAD 30I INJECTOR COMPLETION – START UP JAN 2015

- Pads 30i
- 4 Single Laterals
- Instrumented coil tubing with thermocouples
- 30 - 11 has DTS
- 8 5/8” Casing
- 2 7/8” tubing with 4 x ½” steam subs
- 5 1/2” wire wrap liner
- 400-800 m lateral
- **Pads 31i**
- 6 Single Laterals
- Instrumented coil tubing with thermocouples
- 31-10 & 31-13 have DTS
- 9 5/8” Casing
- 3 1/2” long string tubing
- 2 7/8” short string
- 7” wire wrap screen liner
- 950 m lateral
Well equipped with

- VIT from surface to 300 mKB
- 10 ICD subs at 4 Intervals
- 10 Type K thermocouples

### Surface Casing
- Size: 339 mm
- Weight: 81.1 kg/m
- Grade: J55 STC
- mKB: 301
- SC Cement Top: Surface

### Production Casing
- Size: 244 mm
- Weight: 59.53 kg/m
- Grade: L80 IRP T-Blue
- mKB: 859
- PC Cement Top: Surface

### Tubing
- Size: 88.9 mm
- Weight: 9.67 kg/m
- Grade: J55
- mKB: 830

### Liner
- Size: 177 mm
- Weight: 34.23 kg/m
- Grade: L80 DWC/C
- Liner, mKB: 1305
- Open hole TD, mKB: 1314
Two key findings led to the decision to proceed to recover bitumen in the resource development area using VSD, complemented by CSS:

- Vertical permeability in the Bluesky is much lower than expected based on results from core analyses and logs. This low permeability is created by small-scale shale barriers that prevent vertical gravitational flow (rising steam, sinking bitumen), and eliminate any recovery technique that relies on gravity drainage.

- Steam injectivity with vertical wells is high enough to allow bitumen recovery within the Bluesky because of initial water mobility in the formation, even above the bottom water zone.

Further details can be found in application #1637869 Volume 1, Section 4.2 - the Application for Approval of the Carmon Creek Project (AER approval #8143O).
CARMON CREEK PAD WELLS

- **Pad 106** production wells
  - 43 production wells, 3 surface holes
  - Drilled Sept 2014-Oct 2015
  - No completion
  - Standing, to be suspended

- **Pad 106-90** Observation well
  - Drilled Sept 2014-Sept 2015
  - Two external pressure gauges @ 324 and 509 mMD
  - No completion
  - Standing, to be suspended

- **Pad 107** production wells
  - 46 production wells
  - Drilled Apr – Aug 2015
  - No completion
  - Standing, to be suspended

- **Pad 107-90** Observation well
  - Drilled Apr 2015
  - Two external pressure gauges @ 310 and 510 mMD
  - No completion
  - Standing, to be suspended

- **Pad 101, 104, and 105**
  - Civil earthworks complete
  - Conductors installed

- **Pad 102 and 103**
  - Civil earthworks completed

- **Pad 108, 109 and 110**
  - Licensed, no field work executed
Softener regeneration waste water is currently disposed into the 16-27 well. 02/15-27 Standing back up brine disposal well.
TYPICAL PRODUCED WATER DISPOSAL WELL COMPLETION

02/16-23 & 02/14-25 dispose of produced water and boiler blowdown into the Leduc formation.

Casing Patch 33-42 mKB

Surface Casing:
339.7 mm, 81.1 kg/m, K-55, ST&C

Intermediate Casing:
244.5 mm, 59.5 kg/m, K-55, L-80 (429-719mKB)

Production Tubing:
177.8mm, 34.2 kg/m, L-80 LT&C
177.8mm, 34.2 kg/m, L-80 buttress

Baker FB-1 194-60 Packer
RN nipple
Perforated pup joint
Wireline re-entry guide

Openhole

02/16-23 (D323)
02/14-25 (D322)
The 8-11 sour gas injector was completed Nov 2009 as part of the Three Creeks Sour Gas Storage project.


NOTE: Inhibited water in the annulus
CARMON CREEK UTILITY WELLS (LEDUC)

Oct 2014 – Oct 2015:

- **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**, One monitor 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
<table>
<thead>
<tr>
<th>Section</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductions and Background</td>
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</tr>
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</table>
ARTIFICIAL LIFT – ROD PUMPING EQUIPMENT

Pumping Units:
- Pumpjacks: 144” – 260” stroke
  - Lufkin/Legrand Pump Jacks 280 m³/d
  - Rotaflex: 288” stroke 250 m³/d

Max. Capacity:

Automation:
- Pump Off Controllers (POC): load cells, motor sensor, crank sensor, VFD
- XSPOC: Real-time pump cards
- LOWIS: Pilot deployed in August 2015

Pumps:
- Insert rod pumps, 2.0 – 3.25” barrel, 1” continuous rod, rod string designs
- Continuous improvement initiatives ongoing (improved rod-string designs, POC pump checks, dynagraph verification, fluid shots, etc.), POC fluid level verification

Stuffing Boxes:
- High temperature stuffing boxes are installed on every pumping well. The cone packing is used while pumping and it has rubber elements with brass supports.
- Packing Leak Containment devices (complete with high-level- shut-down switches) have been installed on all wells.
- There have been no offsite emulsion releases in 2015
ARTIFICIAL LIFT – ESP WELLS

Pumping Units: Max. Capacity:

- Schlumberger ESP D2400N SA-3 360 m³/d
- Schlumberger ESP D1800N SA-3 280 m³/d

Automation:

- Downhole pressure and temperature monitoring to optimize subcool
- ESP’s equipped with VSD

ESP Completion
<table>
<thead>
<tr>
<th>Topic</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Todays Agenda</td>
<td></td>
</tr>
<tr>
<td>Introductions and Background</td>
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</tr>
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# ACTIVE OBSERVATION WELLS

<table>
<thead>
<tr>
<th>Well Name</th>
<th>Type of observation well</th>
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<tbody>
<tr>
<td>TH33</td>
<td>Pressure and temperature</td>
</tr>
<tr>
<td>TH33A</td>
<td>Temperature and micro seismic</td>
</tr>
<tr>
<td>TH33B</td>
<td>Temperature</td>
</tr>
<tr>
<td>TH32A</td>
<td>Temperature and micro seismic</td>
</tr>
<tr>
<td>TH30A</td>
<td>Temperature and micro seismic</td>
</tr>
<tr>
<td>TH31A</td>
<td>Temperature and micro seismic</td>
</tr>
<tr>
<td>TH6</td>
<td>Temperature</td>
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<tr>
<td>TH7</td>
<td>Temperature</td>
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<td>TH8</td>
<td>Temperature</td>
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<td>TH9</td>
<td>Temperature</td>
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<td>TH10</td>
<td>Temperature</td>
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<tr>
<td>TH11</td>
<td>Temperature</td>
</tr>
<tr>
<td>TH12</td>
<td>Temperature</td>
</tr>
<tr>
<td>TH40A</td>
<td>Temperature and micro seismic</td>
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<tr>
<td>TH40B</td>
<td>Temperature</td>
</tr>
<tr>
<td>TH14</td>
<td>Temperature</td>
</tr>
<tr>
<td>TH41A</td>
<td>Temperature</td>
</tr>
<tr>
<td>D320 (5-19)</td>
<td>Temperature via DTS</td>
</tr>
<tr>
<td>D321 (11-19)</td>
<td>Temperature – DTS install to be Q4 2014</td>
</tr>
<tr>
<td>12-35</td>
<td>Pressure</td>
</tr>
</tbody>
</table>
Wilrich shale pressure and temperature are monitored. The Bluesky gauge failed in 2007.
Three Creeks pressure observation well 12-35

Stage 1 (1600-1042 m KB); 25.8 tonnes Class G cement. 3m3 cement returns.

Stage 2; 15.2 tonnes Class G cement (1042-650 m KB)
10.8 tonnes Class G (650-400 m KB).

219.1 mm, 35.7 kg/m, J-55. Cemented to surface with 26.7 tonnes Class G cement.
Cement Top from Bond log

73 mm, 9.67 kg/m L-80 EUE tubing
0.1% inhibited water in annulus
Retrievable Packer
Downhole Pressure Gauge
Bluesky Top. Bluesky Perfs 522.5-525 m KB

Lost Perf Gun
Bridge Plug
Perforations (550-555 m KB)

Bridge Plug
Perforations (586-591 m KB)

Bridge Plug
Perforations (656.5-661 m KB)

Bridge Plug
Perforations (998-1000 m KB)

Stage Tool

1600 m KB (TD)

139.7 mm, 23.1 kg/m, J-55 casing.
Thermocouples situated from the Wilrich to the Debolt formations to monitor steam chamber rise and temperature variations over cycle(s). The thermocouples are cemented in the well to surface.
Geophones located in Obs wells:
TH40A, TH30A, TH31A, TH32A, TH33A

Geophones placement

- Paddy/Cadotte
- Harmon Shale
- Notikewan
- Falher
- Wilrich
- Bluesky
- Detrital
- Debolt
2014 DTS INSTALLATION AT 00/05-19-85-18W5 (D320)

- The 5-19 water disposal well was drilled and completed with the 11-19 well in 1978 as part of the PRISP (Peace River In Situ Pilot) disposal scheme.
- The well injected produced water until 1986 and then water softener backwash brine, until 2009, into the Debolt formation.
- Observed casing head pressures of around 16MPa, though a hydraulic pressure test later confirmed casing and bridge-plug integrity.
- Obtained cement, behind-casing fluid, and integrity data by means of caliper, ultrasonic, and saturation logs on the 5-19 well.
- Well perforated in the Wilrich (520 – 520.9 mKB) and cement squeezed with T-Mix thermal cement.
- Drilled out cement and logged to evaluate isolation – Confirmed isolation to the Bluesky however wanted to ensure we had better isolation above.
- Re-perfed 507.85 – 508.75 – obtained no injectivity – confirmed pressure integrity to 10 Mpa at perf face.
- As per the AER requirements we perfed 264.55 – 265.45 mKB and performed a cement squeeze (to isolate the Paddy Cadotte).
- Isolation was confirmed - Installed DTS Fiber

**Wellhead Configuration**
- 7-1/16’ 3K Master Valve w/DTS packoff
- 2-1/16” 5K Casing Side Outlet Valve

**DTS Fiber Optic Line**
- (Landed @ 597.5mKB)

**Perf/Squeeze**
- (520-520.9mKB)
- 3.4m3 into Perfs (5MPa pressure squeeze)

**Perf/No Injection**
- (507.85-508.75mKB)
- No Injectivity

**Perf/Squeeze**
- (520-520.9mKB)
- 3.4m3 into Perfs (5MPa pressure squeeze)

**Sand**
- PBTD=605mKB
- TRBP=610mKB
**WELLHEAD CONFIGURATION**

**Before**

- 7-1/16” 3K Valve, 1/2” termination port for DTS Line

**After**

- 2-1/16” 5K Valve, 2”LP crossover to 1/2” NPT needle and Pressure Gauge
- Junction Box
<table>
<thead>
<tr>
<th>Topic</th>
<th>Speaker</th>
</tr>
</thead>
<tbody>
<tr>
<td>TODAY’S AGENDA</td>
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</tr>
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<td></td>
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All pads part of Shell’s well integrity management program (WIMS)

Risk based program that schedules preventative maintenance and associated repair times to the severity of the failure and AER regulations.

All well histories being updated in eWIMS repository.

Wellhead Integrity Tests (WITS) carried out on cycle basis:

- Majority of surface components (casing heads, trees, stuffing boxes, valves, BOPs etc are pressure tested before steam injection)

Subsurface Integrity Tests (SITS)

- Production casing (deformation, wall thinning, corrosion logging, hydraulic integrity, packer isolation tests)

SCVFs conducted on yearly basis

- 17 non-serious SCVF being monitored at present as per ID2003-01 (includes wells drilled for Carmon Creek (see Table 1)

SITs begin on a sample of CSS wells (1 well per pad/10% wells) beginning at their 5th CSS cycle. Addition logs (CEL, Caliper, Pressure test etc) run on ad-hoc basis based on non-invasive triggers (eg passive seismic, opportunity)
## WELL INTEGRITY: SCVF Wells

**Table 1:**

<table>
<thead>
<tr>
<th>UWI</th>
<th>LIC NUM</th>
<th>STATUS</th>
<th>COMMENT</th>
<th>WELL NAME/ALIAS</th>
<th>Date Checked</th>
<th>Results/Obsevations</th>
<th>24 Hour Build Up</th>
</tr>
</thead>
<tbody>
<tr>
<td>104/11-15-085-18W5/00</td>
<td>0310826</td>
<td>Open</td>
<td>Non Serious</td>
<td>SHELL P13 CADOTTE 11-15-85-18 (21-13)</td>
<td>22-Oct-15</td>
<td>No LEL/H2S, No vent flow observed - Could Close out - will monitor 1 more year</td>
<td>0 kPa</td>
</tr>
<tr>
<td>106/11-15-085-18W5/00</td>
<td>0361194</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL 22-01 CADOTTE 11-15-85-18</td>
<td>21-Oct-15</td>
<td>No LEL/H2S, Observed 60 bubbles/10 min</td>
<td>72 kPa</td>
</tr>
<tr>
<td>1F2/01-21-085-18W5/00</td>
<td>0411266</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL 547-D CADOTTE 1-21-85-18</td>
<td>16-Oct-15</td>
<td>Water Obs well, Observed 21 bubbles/10 mins</td>
<td>42 kPa</td>
</tr>
<tr>
<td>100/16-27-085-19W5/00</td>
<td>0389349</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL 89-01 CADOTTE 16-27-85-19</td>
<td>22-Oct-15</td>
<td>No LEL/H2S, Observed 60 bubbles/10 mins</td>
<td>64 kPa</td>
</tr>
<tr>
<td>104/06-20-085-18W5/00</td>
<td>0432193</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL HZ 20-20 CADOTTE 3-20-85-18</td>
<td>21-Oct-15</td>
<td>No LEL/H2S, Observed 100 bubbles/10 mins</td>
<td>71 kPa</td>
</tr>
<tr>
<td>105/03-20-085-18W5/00</td>
<td>0432195</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL HZ 20-22 CADOTTE 3-20-85-18</td>
<td>21-Oct-15</td>
<td>No LEL/H2S, No vent flow observed - Could Close out - will monitor 1 more year</td>
<td>0 kPa</td>
</tr>
<tr>
<td>106/03-20-085-18W5/00</td>
<td>0432196</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL HZ 20-23 CADOTTE 3-20-85-18</td>
<td>21-Oct-15</td>
<td>No LEL/H2S, Observed 6 bubble/10 mins</td>
<td>21 kPa</td>
</tr>
<tr>
<td>104/06-17-085-18W5/00</td>
<td>0464726</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL 31-13 CADOTTE 6-17-85-18</td>
<td>15-Jun-15</td>
<td>Installed dead weight tester to SCV - no pressure or flow observed</td>
<td>0 kPa</td>
</tr>
<tr>
<td>105/06-17-085-18W5/00</td>
<td>0464727</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL 31-14 CADOTTE 6-17-85-18</td>
<td>22-Oct-15</td>
<td>No LEL/H2S, No vent flow observed - Could Close out - will monitor 1 more year</td>
<td>0 kPa</td>
</tr>
<tr>
<td>105/12-20-085-18W5/00</td>
<td>0464729</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL TH30C CADOTTE 12-20-85-18</td>
<td>22-Oct-15</td>
<td>No LEL/H2S, No vent flow observed - Could Close out - will monitor 1 more year</td>
<td>0 kPa</td>
</tr>
<tr>
<td>104/09-19-085-18W5/00</td>
<td>0464733</td>
<td>Open</td>
<td>Non Serious</td>
<td>SCL 30-11 CADOTTE 9-19-85-18</td>
<td>22-Oct-15</td>
<td>No LEL/H2S, Observed 6 bubbles/10 mins</td>
<td>23 kPa</td>
</tr>
<tr>
<td>117/11-22-085-18W5/00</td>
<td>0459072</td>
<td>Open</td>
<td>Non Serious</td>
<td>F107-16</td>
<td>20-Oct-15</td>
<td>No LEL/H2S, 45 bubbles/10 mins</td>
<td>90 kPa</td>
</tr>
<tr>
<td>106/07-22-085-18W5/00</td>
<td>0465846</td>
<td>Open</td>
<td>Non Serious</td>
<td>F107-18</td>
<td>20-Oct-15</td>
<td>No LEL/H2S, 26 bubbles/10 mins</td>
<td>64 kPa</td>
</tr>
<tr>
<td>112/07-22-085-18W5/00</td>
<td>0459075</td>
<td>Open</td>
<td>Non Serious</td>
<td>F107-24</td>
<td>20-Oct-15</td>
<td>No LEL/H2S, 46 bubbles/10 mins</td>
<td>117 kPa</td>
</tr>
<tr>
<td>100/08-22-085-18W5/00</td>
<td>0459081</td>
<td>Open</td>
<td>Non Serious</td>
<td>F107-36</td>
<td>20-Oct-15</td>
<td>No LEL/H2S, 24 bubbles/10 mins</td>
<td>69 kPa</td>
</tr>
<tr>
<td>103/15-22-085-18W5/00</td>
<td>0459082</td>
<td>Open</td>
<td>Non Serious</td>
<td>F107-39</td>
<td>20-Oct-15</td>
<td>No LEL/H2S, 55 bubbles/10 mins</td>
<td>90 kPa</td>
</tr>
<tr>
<td>104/09-22-085-18W5/00</td>
<td>0459087</td>
<td>Open</td>
<td>Non Serious</td>
<td>F107-47</td>
<td>20-Oct-15</td>
<td>No LEL/H2S, 286 bubbles/10 mins</td>
<td>172 kPa</td>
</tr>
</tbody>
</table>
WELL INTEGRITY: ONGOING REMEDIATION/INVESTIGATION

- **D320 (5-19) Suspended water disposal well**
  - Converted to temperature monitoring well via DTS installation.

- **D321 (11-19) Suspended water disposal well:**
  - During CEL assessment (Flexural Attenuation), a small hole/puncture was discovered in the casing joint at approximately 527-528m MDKB.
  - AER DDS submission (ID: 1328497) was entered on 13/7/12.
  - Remediation matured. AER engagement on 29th Oct 2012.
  - Conversion to permanent temperature monitoring well via DTS installation.

- **40-08 Suspended thermal well on steam-drive (Pad 40):**
  - MFC investigation and SIT revealed casing leak at 609m MDKB across the Wilrich shale. Well suspended with TRBP at 620 mMDKB.
  - AER DDS submission was entered November 2012.
  - Approval granted for low pressure (<6 Mpa) use.
WELL INTEGRITY: ONGOING REMEDIATION/INVESTIGATION

100/03-28-85-18W5 (SR -12) Soak Radial – Pad 19 Satellite 4:
- Parted casing detected at 120 mKB depth via a calliper log. Appears to be a pin-box (straight tensile) pull.
- Retrievable bridge plug was installed (top of BP at 556 mKB) with 20 m of Thermal cement for subsurface isolation.
- Abandonment planned in 2016

107/15-21-85-18W5 (19-3-PH{15}) and 103/03-28-85-18W5 (19-3-PK{17}) Pad 19 Satellite 3:
- A collapsed/buckled casing section was detected via a downhole camera run performed on October, 2013. Failure depth is ≈ 276mKB on 19-3-PH{15} and 190.3 mKB on 19-3-PK{17}.
- Both wells abandoned Jan 2014 as per Directive 20

Pad 19 Satellite 3: Injectors (4) with casing collapse
- A collapsed/buckled casing section was detected via a downhole camera runs performed Nov 2013. AER DDS submissions Dec 2013.
- All 4 wells successfully abandoned Q-1 2015. Cut and cap completed 2015.
Well shut in on January 15, 2015 for production optimization reasons. January 30th the wellbore was N2 purged to suspend the location.

On February 25, 2015 gas emission detected with an infrared camera during routine monthly inspection. Gas is intermittent (flares up and dies off). Readings of 50 to 75 PPM of H2S have been recorded around the wellhead. No H2S can be detected outside of a radius of 2 ft from the wellhead.

On March 14, 2015 we commenced an investigative workover program to inspect the production casing. We detected a pin-collar straight tensile failure had occurred at ~94m.

Shell continued to observe trace amounts of gas migration immediately around the production casing, and a decision was made to perform further logging to determine the source of the gas migration.

On May 14, 2015 we ran noise-temperature and CHAT tools to further investigate the potential source of gas.

On July 12, 2015 Perforate and attempt to squeeze 545 – 545.9mKB. Perfs would not take any fluid. July 13, 2015 perforate/acidize and attempt to squeeze 498 – 498.9 mKB - very limited injectivity (6-8 liters/min).

Swab wellbore down to 191.5 mKB – continue to shoot fluid levels, monitor bubbles around base of the wellbore, and observe H2S and pressure reading.

On August 20, 2015 install vent nanny on casing annulus.
• GM appears to be bleeding off, as build-up is much lower than previously measured

• Shell recently gathered gas samples for analysis

• Plan is to swab well down once again and perform flow-rate and build-up pressure tests. These will be compared to previous flow-rate and build-up tests to confirm the wellbore is bleeding off. Additionally, Compare gas analysis to typical Bluesky composition
PREVIOUSLY ABANDONED WELLS

Update required as per AER approval no. 8143W

Oct 2014 – Oct 2015:

- 1AA052708518W500
  - Pad 106 wells drilled 400m to south – no production
  - Closest production wells on Pad 19 > 1000m
- 1AA131508518W500
  - Low pressure injection on Pad 21/22
  - New steam injector well 22-04 (green) drilled
  - No changes observed
## TODAY’S AGENDA

<table>
<thead>
<tr>
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The basis for Scheme performance prediction estimation based on historical cOSR decline for steam drive pads, and water cut increase with recovery factor for blow down pads.

<table>
<thead>
<tr>
<th>Pad</th>
<th>Recovery Process</th>
<th>Date of Conversion</th>
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<tbody>
<tr>
<td>19 Sat 1 and 2</td>
<td>Lateral Steam Drive</td>
<td>Oct 2012</td>
</tr>
<tr>
<td>19 Infills</td>
<td>Vertical Well Steam Drive</td>
<td>July 2013</td>
</tr>
<tr>
<td>20 Conv</td>
<td>Top-Down Steam Drive</td>
<td>July 2012</td>
</tr>
<tr>
<td>20 Infills</td>
<td>Lateral Steam Drive</td>
<td>June 2012</td>
</tr>
<tr>
<td>21 Conv</td>
<td>Top-Down Steam Drive</td>
<td>Jan 2009</td>
</tr>
<tr>
<td>21 Infills</td>
<td>Lateral Steam Drive</td>
<td>Nov 2011</td>
</tr>
<tr>
<td>30</td>
<td>Top-Down Steam Drive</td>
<td>Dec 2014</td>
</tr>
<tr>
<td>31</td>
<td>Top-Down Steam Drive</td>
<td>Nov 2014</td>
</tr>
<tr>
<td>40</td>
<td>Suspended</td>
<td>Converted to LSD June 2012</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Blowdown June 2014</td>
</tr>
<tr>
<td></td>
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<td>Suspended October 2015</td>
</tr>
<tr>
<td>41</td>
<td>Suspended</td>
<td>Converted to LSD June 2012</td>
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<td></td>
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<td>Blowdown June 2014</td>
</tr>
<tr>
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<td>Suspended October 2015</td>
</tr>
<tr>
<td>32/33</td>
<td>Cyclic Steam Stimulation (CSS)</td>
<td>Converted to CSS August 2014</td>
</tr>
</tbody>
</table>
Peace River Cumulative Volumes (Post - Jan 1996)

- Cumulative SOR = 4.37
- Cumulative WSR = 0.74

- All data current as of Oct 2015
- Cum Oil: 6,756 Mm³
- Cum Wtr: 21,869 Mm³
- Cum Stm: 29,505 Mm³
PEACE RIVER PRODUCTION HISTORY

- 2015 YTD average
  - Oil rate = 763 m³/d
  - Injection rate = 4584 t/d
Production capacity limit raised to 2000 m$^3$/d (from 1900 m$^3$/d) annualized average on April 30, 2002 as part of Amendment F to 8143 approval.

Bitumen production has decreased from peak rates in Nov/Dec 2007 due to maturing pads.

Cycle 4 steaming on Pad 32/33 commenced in April 2011. Low production from these wells in 2011 due to cycle 4 steaming, most wells having cycle 4 peak production in 2012, and low end of cycle production in 2013 – 2015.

2013 - 2015 production has been impacted by produced water scaling issues, gas injection compressor issues and multiphase pump reliability issues. Excessive scaling in water processing side of facilities impacted water handling capacity from late 2012 until June 2013 when all lines where mechanically cleaned. Skim and surge tank cleanings undertaken in 2015 in order to increase emulsion processing capacity.
### PAD OBIP VALUES

<table>
<thead>
<tr>
<th>Pad</th>
<th>Area (m²)</th>
<th>Height (m)</th>
<th>NTG (frac)</th>
<th>Porosity (frac)</th>
<th>So (frac)</th>
<th>Bo (m³/m³)</th>
<th>PV (m³)</th>
<th>OBIP (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 1-3</td>
<td>199,482</td>
<td>23</td>
<td>1.00</td>
<td>0.290</td>
<td>0.83</td>
<td>1.01</td>
<td>1,330,545</td>
<td>1,093,418</td>
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<tr>
<td>SR 4-7</td>
<td>359,361</td>
<td>16</td>
<td>1.00</td>
<td>0.290</td>
<td>0.83</td>
<td>1.01</td>
<td>1,667,435</td>
<td>1,370,268</td>
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<tr>
<td>SR 8-11</td>
<td>256,081</td>
<td>22</td>
<td>1.00</td>
<td>0.290</td>
<td>0.83</td>
<td>1.01</td>
<td>1,612,254</td>
<td>1,306,774</td>
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<tr>
<td>SR 12-15</td>
<td>249,546</td>
<td>19</td>
<td>1.00</td>
<td>0.290</td>
<td>0.83</td>
<td>1.01</td>
<td>1,374,998</td>
<td>1,129,949</td>
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<tr>
<td>Pad 20 Infills</td>
<td>373,386</td>
<td>21</td>
<td>1.00</td>
<td>0.280</td>
<td>0.82</td>
<td>1.01</td>
<td>2,195,510</td>
<td>1,782,493</td>
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<td>Pad 20 Conv</td>
<td>410,545</td>
<td>22</td>
<td>1.00</td>
<td>0.280</td>
<td>0.82</td>
<td>1.01</td>
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<td>279,163</td>
<td>25</td>
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<td>Pad30</td>
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<td>Pad31</td>
<td>1,239,870</td>
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<td>0.285</td>
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<td>Pad41</td>
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<td>Pad 32</td>
<td>1,725,020</td>
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<td>1.00</td>
<td>0.275</td>
<td>0.78</td>
<td>1.01</td>
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<td>8,792,479</td>
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<td>Pad 33</td>
<td>1,805,980</td>
<td>24</td>
<td>1.00</td>
<td>0.275</td>
<td>0.78</td>
<td>1.01</td>
<td>11,919,467</td>
<td>9,205,133</td>
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<td><strong>Total</strong></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>55,599,562</td>
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</table>

- Net pay calculated based on the net pay map (shown in the Geology section)
- Area and OBIP for Pad 19 Sat 3 (SR8-11) have been modified to reflect new Pad 19 Infill wells
## PAD RECOVERY FACTORS

<table>
<thead>
<tr>
<th>Pad</th>
<th>OBIP (e3m³)</th>
<th>Cum Produced 30.09.2015 (e3m³)</th>
<th>Expected Ultimate Recovery (e3m³)</th>
<th>Actual RF at 30.09.2015 (%)</th>
<th>Estimated RF* (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR 1-3¹,⁴</td>
<td>1,093</td>
<td>272</td>
<td>272</td>
<td>25%</td>
<td>25%</td>
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<tr>
<td>SR 4-7⁴</td>
<td>1,370</td>
<td>232</td>
<td>232</td>
<td>17%</td>
<td>17%</td>
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<tr>
<td>SR 8-11⁴</td>
<td>1,307</td>
<td>230</td>
<td>352</td>
<td>18%</td>
<td>27%</td>
</tr>
<tr>
<td>SR 12-15⁴</td>
<td>1,130</td>
<td>223</td>
<td>223</td>
<td>20%</td>
<td>20%</td>
</tr>
<tr>
<td>Pad 20 Infills</td>
<td>1,782</td>
<td>183</td>
<td>277</td>
<td>10%</td>
<td>16%</td>
</tr>
<tr>
<td>Pad 20 Conv²</td>
<td>2,053</td>
<td>561</td>
<td>958</td>
<td>27%</td>
<td>47%</td>
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<tr>
<td>Pad 21 Infills</td>
<td>1,587</td>
<td>218</td>
<td>301</td>
<td>14%</td>
<td>19%</td>
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<tr>
<td>Pad 21 Conv³</td>
<td>2,431</td>
<td>536</td>
<td>801</td>
<td>22%</td>
<td>33%</td>
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<tr>
<td>Pad 30⁵</td>
<td>4,288</td>
<td>776</td>
<td>1,022</td>
<td>18%</td>
<td>24%</td>
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<tr>
<td>Pad 31⁵</td>
<td>6,598</td>
<td>709</td>
<td>1,284</td>
<td>11%</td>
<td>19%</td>
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<tr>
<td>Pad 40⁶</td>
<td>8,533</td>
<td>847</td>
<td>847</td>
<td>10%</td>
<td>10%</td>
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<tr>
<td>Pad 41⁶</td>
<td>5,429</td>
<td>483</td>
<td>483</td>
<td>9%</td>
<td>9%</td>
</tr>
<tr>
<td>Pad 32</td>
<td>8,792</td>
<td>779</td>
<td>979</td>
<td>9%</td>
<td>11%</td>
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<tr>
<td>Pad 33</td>
<td>9,205</td>
<td>706</td>
<td>922</td>
<td>8%</td>
<td>10%</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>55,598</strong></td>
<td><strong>6,756</strong></td>
<td><strong>8,953</strong></td>
<td><strong>12%</strong></td>
<td><strong>16%</strong></td>
</tr>
</tbody>
</table>

### NOTES:

1. SR 1-3: 17% recovery from CSS, additional recovery from steam drive from wells SR-16+17
2. Pad 20 Conv wells: 14% recovery from SAGD operations, additional recovery from CSS, expected RF from phase 3 infills Top down Steam Drive
3. Pad 21 Conv wells: 6% recovery from SAGD operations, 4% recovery from CSS, additional recovery from top-down steam drive
4. Pad 19 SR 1-3 are operating in steam drive, SR 6,7 are producing, SR 8-10 are part of the Pad 19 Infills and SR 12-15 are currently being re-started
5. Pad 30 and 31 had injectors added in 2014, will see remaining RF recovered via Top down Steam Drive.
6. Pad 40 and 41 to be ramped down starting in 2015 and remaining OBIP recovered through Carmon Creek
Pads 40/41 – Low performing CSS / lateral steam drive pads, suspended Oct 2015
Pad 19 – Overall medium recovery with CSS and vertical steam drive
Pads 20, 21/22 – High performing TDSD pads
Pad 20/21 infills – Medium-performing LSD pads
LOW RECOVERY EXAMPLE – PAD 41 CSS/SD

- 7 CSS cycles completed
  - Low pressure cycle 2 → lower cycle recovery
  - Poorer overall performance attributed to reservoir quality, steam injection volumes/cycle, and/or steam quality at the pad
- Converted to steam drive June 2012, poor lateral steam drive performance to date due to operational constraints – unable to produce pad at max rates or provide continuous steam. Wellbore configuration also plays a factor – multilaterals are more connected at the heels of the wells than the toes.

<table>
<thead>
<tr>
<th></th>
<th>As of 30.09.2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Oil</td>
<td>483 e^3 m^3</td>
</tr>
<tr>
<td>Current RF</td>
<td>9%</td>
</tr>
<tr>
<td>SOR</td>
<td>N/A (Pad Suspended)</td>
</tr>
</tbody>
</table>

As of 30.09.2015
Cumulative Oil 483 e^3 m^3
Current RF 9%
SOR N/A (Pad Suspended)
PAD 41 – CSS/SD PERFORMANCE

- Observation well is deviated
- Highest temperatures observed in cycles 5 & 6
- Cycle 7 and current temperatures cooling, as steam injection has been limited and pad is now suspended
- Lateral Steam Drive was chosen as the recovery process for Pads 40 & 41 based on their poor reservoir quality (low permeability, low Kv/Kh)

*Some data likely missing from older cycles*
MEDIUM RECOVERY EXAMPLE – PAD 19 CSS

- 15 Soak radial wells, 2 vertical injectors
- 8 CSS cycles completed on SR1-3; converted to steam drive Feb 2003
- 6 CSS cycles completed on SR 4-7
- 8 CSS cycles completed on SR 8-15
- SR 6 restarted – steam support from adjacent pad
- SR 14-15 restarted – steam support from Pad 19 Infills
- CSS cycles ongoing on select wells in order to improve steam drive recovery
- Steam solvent trial underway in 2014/2015, solvent injection completed in 2014
  - Estimation of solvent recovery was aided significantly by frequent sampling campaigns on Pad 19; 70-80% of solvent was recovered

<table>
<thead>
<tr>
<th></th>
<th>As of 30.09.2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Oil</td>
<td>956 e³m³</td>
</tr>
<tr>
<td>Current RF</td>
<td>20%</td>
</tr>
<tr>
<td>SOR</td>
<td>3.03</td>
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</table>

| 1998 | 97 | 98 | 99 | 2000 | 01 | 02 | 03 | 04 | 05 | 06 | 07 | 08 | 09 | 10 | 11 | 12 | 13 | 14 | 15 |
| 0    |    |    |    |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
| 1500 |    |    |    |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|      | 4500 |    |    |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|      |      | 3000 |    |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|      |      |      | 2000 |      |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|      |      |      |      | 1500 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|      |      |      |      |      | 6000 |    |    |    |    |    |    |    |    |    |    |    |    |    |    |
|      |      |      |      |      |      | 3000 |    |    |    |    |    |    |    |    |    |    |    |    |    |
|      |      |      |      |      |      |      | 2000 |    |    |    |    |    |    |    |    |    |    |    |    |
|      |      |      |      |      |      |      |      | 1500 |    |    |    |    |    |    |    |    |    |    |
|      |      |      |      |      |      |      |      |      | 1000 |    |    |    |    |    |    |    |    |    |
|      |      |      |      |      |      |      |      |      |      | 500 |    |    |    |    |    |    |    |    |
|      |      |      |      |      |      |      |      |      |      |      | 0  |    |    |    |    |    |    |    |

Axis 1: Completions Selected (33)
- Water Rate (CD) (m³/d)
- Oil Rate (CD) (m³/d)

Axis 2: Steam Inj Rate (CD) (m³/d)
- Completions Selected (33)
**PAD 21/22 HIGH RECOVERY EXAMPLE TDSD**

- **Pad 21 SAGD pairs [21-08 to 21-12]**
  - Injector legs 5 m above producer legs
  - SAGD operation from 1997 - 2003
  - CSS operation from 2003 - 2008
  - Steam injection through injection legs
  - Production from production legs
  - Steam drive from 2008 onwards

- **Pad 22 wells [22-01, 22-02]**
  - Two single laterals drilled perpendicular to existing wells higher in the reservoir
  - Initial cold production test in February 2007
  - Cold produced October 2007 to August 2008
  - Steam drive to Pad 21 conversion wells below since November 2008
  - Top-down steam drive was pursued for Pads 20 and 21 as a follow-up process to CSS, as CSS performance was worsening in subsequent cycles
  - Well configuration on Pads 20 and 21 was appropriate for TDSD as these wells were drilled as SAGD well pairs

### SD performance As of 30.09.2015

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
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</thead>
<tbody>
<tr>
<td>Cumulative Oil</td>
<td>304e3m3</td>
</tr>
<tr>
<td>Cumulative Steam</td>
<td>848 e3m3</td>
</tr>
<tr>
<td>Cumulative SOR</td>
<td>2.79</td>
</tr>
</tbody>
</table>

![Graph showing performance metrics](image-url)
PAD 21 INFILLS LATERAL STEAM DRIVE PERFORMANCE

- Pad 21 Infills [21-13, 21-14, 21-15]
  - 3 J-wells, drilled 2004
  - CSS operation, 4 cycles completed
  - Converted to lateral SD in November 2011
    - 21-14 converted to dedicated injector
    - TDSD was not pursued on Pad 20 Infills or Pad 21 Infills due to the J-well producer configuration (vertical spacing of infill injectors and producers is suboptimal)
  - Significant improvement in SOR performance once communication between injector and producer established

<table>
<thead>
<tr>
<th>SD performance</th>
<th>As of 30.09.2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cumulative Oil</td>
<td>218 e3m3</td>
</tr>
<tr>
<td>Cumulative Steam</td>
<td>701 e3m3</td>
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<tr>
<td>Cumulative SOR</td>
<td>3.22</td>
</tr>
</tbody>
</table>
KEY LEARNINGS OF RECOVERY MECHANISMS IN PR

- **Pressure Cycle Steam Drive (PCSD)** 1979-2001
  - Approximate reservoir pressure range: 1-12 MPa
  - Need steam to rise and gravity to drain oil
  - Performance hindered if pressure interference exists
  - Demonstrated vertical well steam drive to be feasible

- **Steam Assisted Gravity Drainage (SAGD)** 1997-2003
  - Approximate reservoir pressure range: 2-6 MPa
  - Uneconomic due to low kv/kh in the Bluesky

- **Cyclic Steam Stimulation (CSS)** 1997 - present
  - Approximate reservoir pressure range: 1-12 MPa
  - Steam growth limited by low kv/kh with horizontal wells
  - Works well with vertical wells if reservoir is conditioned properly
  - Need higher pressure injection (~14+MPa surface) – demonstrated by Pad 41 cycle 2

- **Horizontal Well Steam Drive (SD)** 2005 - present
  - Approximate reservoir pressure range: 2-6 MPa
  - Need established fluid pathways
  - Maintain low pressure operation
  - Horizontal well steam drive demonstrated feasible in mature areas.
KEY LEARNINGS OF TOP-DOWN STEAM DRIVE IN PR

- Top-Down Steam Drive (TDSD) 2009-Present
  - Approximate reservoir pressure range: 1.5 – 6 MPa
  - Dedicated injectors effectively target unswept oil and reduce SOR and WC
  - Performance hindered if production offtake rates are not consistent across the pad or if there is not consistent steam delivery
  - Demonstrated to be feasible (Pads 20 and 21/22, 30/31 TDSD)
FACTORS IMPACTING RECOVERY

- **Well design**
  - Multi and single lateral J wells have no clear performance advantage
  - Difficult to control subsurface steam movement in multilaterals

- **Inter-well or Inter-pad Communication**
  - Examples include: pad 40-41, pad 32-30, pad 32-33, pad 20 infills-conv, pad 21 infills-conv
  - If evidence of well established communication exists:
    - Temporarily shut in well adjacent to steaming if necessary
    - Production may not require additional steam
  - If not well established
    - Monitor pressure and temperatures

- **Steam Drive**
  - Optimize within injection and production constraints

- **Geology**
  - The presence of shale layers is variable across the leasehold and shows some impact to injector / producer communication. However, good communication has been established in top-down steam drive pads which suggests that these shales act as baffles not barriers.
STEAM SCHEDULE

2016 Steam Targets

- Pad 19 SAT: Blowdown (No further steam injection)
- Pad 19 Infills: CSS / Steam Drive
- Pad 20 Phase 3: Top-Down Steam Drive
- Pad 20 Infills: Lateral Steam Drive
- Pad 21 Conv/Pad 22: Top-Down Steam Drive
- Pad 21 Infills: Lateral Steam Drive
- Pad 30: Top-Down Steam Drive
- Pads 31: Top-Down Steam Drive
- Pad 32/33: CSS
- Pads 40: Blowdown (No further steam injection)
- Pads 41: Blowdown (No further steam injection)

Steam Rate (t/d)

Jan-16 Feb-16 Mar-16 Apr-16 May-16 Jun-16 Jul-16 Aug-16 Sep-16 Oct-16 Nov-16 Dec-16

Steam Rate (t/d)

Pad 19 Sat 3 Wells
- Pad 20 TDSD wells
- Pad 20 Infill Wells
- Pad 21 TDSD
- Pad 21 Infills
- Pad X Wells
- Pad 32 Wells
- Pad 33 Wells
- Utility Steam Water
5-YEAR OUTLOOK OF PAD ABANDONMENT

- Plan to abandon 14 wells in 2016
- Any future uneconomic wells will be suspended as per Directive 13

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<th>Year</th>
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<th>2017</th>
<th>2018</th>
<th>2019</th>
<th>2020</th>
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January 28, 2016
PAD 22+2 (Pad 21) INFILLS

Purpose:
- To utilize PRC’s steam and production capacity and increase ultimate recovery from Pad 21 existing horizontal producing wells, located in the lower portion of Bluesky Formation. Two additional horizontal injection wells (to be placed in the upper part of Bluesky Formation) are proposed from existing surface location on Pad 22, expanding current TDSD process.
PAD 22+2 INFILL PROJECT

Scope:
- Drill 2 additional horizontal TDSD injection wells from existing Pad 22
- Tie in to existing steam lines and construct new steam lines to the new wells on Pad 22

Schedule:
- Scheme amendment approval received November 2014
- Drilling: September 2015
- Optimized our steam injection to the pad and decided to only drill one well (22-4)
- Steam Start-up: November 2015
Shell is planning to perform a Steam Foam Proof of Concept (PoC) injection trial into two wells (111/14-21-85-18W5/00 and 112/14-21-85-18W5/00) within the existing Pad 19 Satellite 3 in summer 2016.

- Surfactant injection will take place for up to 1 year
- The Steam-Foam technology is being trialed to determine if the technology can improve the sweep efficiency by overcoming gravity override, viscous fingering and channelling
# TODAY'S AGENDA

<table>
<thead>
<tr>
<th>Topic</th>
<th>Presenter</th>
</tr>
</thead>
<tbody>
<tr>
<td>Introductions and Background</td>
<td>Ivan Gonzalez</td>
</tr>
<tr>
<td><strong>Subsurface Issues Related to Resource Evaluation and Recovery</strong></td>
<td></td>
</tr>
<tr>
<td>Geology/Geoscience</td>
<td>Victoria Walker</td>
</tr>
<tr>
<td>Geophysics</td>
<td>Barbara Wingate</td>
</tr>
<tr>
<td>Drilling and Completions</td>
<td>Dan Syrnyk</td>
</tr>
<tr>
<td>Artificial Lift</td>
<td>Dan Syrnyk</td>
</tr>
<tr>
<td>Instrumentation in Wells</td>
<td>Dan Syrnyk</td>
</tr>
<tr>
<td>Well Integrity</td>
<td>Dan Syrnyk</td>
</tr>
<tr>
<td>Scheme Performance</td>
<td>Laura Mislan</td>
</tr>
<tr>
<td>Future Plans</td>
<td>Pasquale Riggi</td>
</tr>
<tr>
<td><strong>Surface Operations, Performance and Compliance</strong></td>
<td>Darcy Forman</td>
</tr>
</tbody>
</table>
Area 730: Cogen 3
- Piling Complete
Area 720: Cogen 2
- Piling + Foundations complete
- Equipment install and set up (GT, GTG, Electrical building, GSU TX,...)
- Cogen divert stack partially installed
- BU-37: high bay 35% complete
Area 710: Cogen 1
- Piling + Foundations complete
- Equipment install and set up (GT, GTG, Lube oil unit, Electrical building, Glycol cooler, GSU TX,...)
- Cogen divert stack partially installed
- BU-20 low bay completed, high bay 80% completed
Area 700: Substations
- Piling Complete
- Substation 240 KV, 34.5KV, 4160V install
- Transformer 240KV/34.5KV, 34.5 KV/4160 install

Area 700 : Substations
- Piling Complete
- Substation 240 KV, 34.5KV, 4160V install
- Transformer 240KV/34.5KV, 34.5 KV/4160 install

Area 630 : Product Tank
- BFW tank Excavation and ring wall complete
- Diluent Tank: Excavation and engineering fill complete

Area 900 : Blow down pond rough excavated only (2/3 of final dimension)
Area 910 : Sewage lagoon rough excavated

Area 470 : Water Tank
- Tank pad complete

Area 500: ACM Building
- Piling Complete
- Foundation complete (80%) - ACM pound excavate

North Sediment pond : complete
South sediment pond : Complete

ALL Other Areas (outside blue boxes) – earthworks and grading only

CARMON CREEK CPF CONSTRUCTION
PEACE RIVER PLANT
PR is a thermal facility

Recovery mechanism is a combination of steam drive and cyclical steaming.

- In cyclical steaming, the wells are left shut-in for a period of time to soak. Subsequently the wells are flowed back until they reach flowline pressure (1,300 kPa) at which point pumps are installed.
- In steam drive steam is injected through dedicated injectors and water and bitumen are produced through dedicated producers at some distance from the injectors.

Production is pumped into the production pipeline. The casings are vented into a casing vent line that runs on plant line pack (250 kPa). Pad 32/33 have multiphase pumps that compress the gas back into the production line.

Emulsion enters the plant for oil, water, and gas separation.

Bitumen treating consists of degassing, separating & treating. The separation process is enhanced by controlled heat exchange and addition of demulsifier & diluent.

The produced gas is compressed and injected into a formation for future usage.

Production averages around 40% of 2,000 m³/day licensed capacity.
Produced water is treated & disposed into two injection wells completed in the Leduc Zone

Produced water is:
- Taken off the separators and treaters
- Cooled using exchangers with boiler feedwater as the cooling medium
- Sent to the skim tank and surge tank for additional retention time and oil separation
- Passed through the sand filters
- Sent to disposal tank
- Sent to Leduc injection wells

Produced water recycle percent = 0%

Typical water quality:
- Produced water TSS 30 mg/L, Oil and Grease 75 ppm, Total Hardness 374 mg/L

Solids are periodically disposed of through approved waste stream treating companies

This year we took the produced water skim tank and surge tank off line for internal cleanings. Removed 40% volume in solids.

Designed produced water handling and injection capacity is 7977 m3/day.
PRC pulls water from the Peace River on a continuous basis. Shell has a source water treatment facility located on the east bank of the Peace River.

PRC is licensed to withdraw 4.3 $\times 10^6$ m$^3$ of water from the Peace River per year (11,813 m$^3$/day).

Historical water usage range is 5,000 m$^3$/day to 11,000 m$^3$/day.

- YTD fresh water withdrawal (as of Sep 30th) is 1.8 $\times 10^6$ m$^3$ or an average of 4,925 m$^3$/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

Water is clarified in a reaction clarifier. After passing through gravity sand filters, the water is vacuum deaerated.

The water is pumped to the main complex through a 20 km pipeline.

Main PRC water treatment consists of water softening using the sodium zeolite resin exchange process to remove calcium and magnesium.

2015 working on a project that will use shallow shell resin technology in the softeners.

Waste brine is disposed down a disposal well (16-27) in the Leduc formation.
Peace River Complex pulls water from the Peace River through our source water facility.

The removal of water is covered under three Water Act Licences:
- 00030033-00-00
- 00030034-00-00
- 00030035-00-00

Each of the licences have been amended three times.
PRC generates 80% steam quality from four once through steam generators.

The four steam generators have a total capacity of approximately 8,000 tons of 80% quality per day. 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 are now using a mixture of 60% Cliffdale and 40% Natural Gas by volume as their fuel source.

Currently doing detailed engineering work to convert the Peace River steam system back to 100% steam quality to the field. Targeting an implementation date of mid 2016.
Four PREP boilers at 2000 tons/d capacity each
FACILITY PERFORMANCE: POWER USAGE

Power Consumption MWh

FACILITY PERFORMANCE: ENERGY INTENSITY

- Gas Consumed = Steam Generated x Boiler Efficiency
- Delay from steaming to production on any given well lag behind up to 6 months
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.
Three Creeks Gas injection facility has been operational for five 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.

Well acid stimulation completed October 3, 2015

Compressor turnaround completed June 2015

2015 Injection facility reliability is currently 99 %. This includes planned maintenance shutdowns.
PRC produced gas is no longer consumed in boilers but injected into the Three Creeks reservoir since September 2010.
Data as per Three Creeks annual progress report submitted in Oct 2015
Cumulative Volume of Gas Stored

Cum Gas Stored @ 31-Oct-2015: 203 e6m3
Remaining Three Creeks storage capacity (in million sm³ as of Q3 2015) to initial reservoir pressure (3564 kPa)

- Empirical Method: 67
- Numerical Reservoir Simulation: 121

Asset life span matrix (forecasted as of Nov.1 2015)

The asset is forecasted to maintain a gas injection rate between 100 and 150 e3m3/d in the future. The table below provides fill up dates (up to initial reservoir pressure) for different average gas injection rates:

<table>
<thead>
<tr>
<th>Injection Rate (e3m³/d)</th>
<th>Empirical Method Fill-up date</th>
<th>Numerical Simulation Fill-up date</th>
</tr>
</thead>
<tbody>
<tr>
<td>100</td>
<td>Aug-2017</td>
<td>Aug-2019</td>
</tr>
<tr>
<td>120</td>
<td>May-2017</td>
<td>Oct-2018</td>
</tr>
<tr>
<td>150</td>
<td>Jan-2017</td>
<td>Dec-2017</td>
</tr>
</tbody>
</table>

There is a chance that the initial reservoir pressure will be reached before the expiry of the current D81 waiver (Nov-2017). A D65 amendment will be submitted to increase maximum reservoir pressure in the Three Creeks gas cap.
Three Creeks Subsurface Information

- Injected gas stream is analyzed once every month. The table below presents the gas analysis for July, August and September 2015.

<table>
<thead>
<tr>
<th>Component</th>
<th>July 2015</th>
<th>August 2015</th>
<th>September 2015</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hydrogen</td>
<td>0.00606</td>
<td>0.00727</td>
<td>0.00585</td>
</tr>
<tr>
<td>Helium</td>
<td>0.00009</td>
<td>0.00008</td>
<td>0.00009</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.00280</td>
<td>0.00361</td>
<td>0.00215</td>
</tr>
<tr>
<td>Carbon Dioxide</td>
<td>0.31813</td>
<td>0.34520</td>
<td>0.36354</td>
</tr>
<tr>
<td>Hydrogen Sulfide</td>
<td>0.00750</td>
<td>0.00740</td>
<td>0.00850</td>
</tr>
<tr>
<td>Methane</td>
<td>0.64438</td>
<td>0.60577</td>
<td>0.59934</td>
</tr>
<tr>
<td>Ethane</td>
<td>0.00797</td>
<td>0.00911</td>
<td>0.00791</td>
</tr>
<tr>
<td>Propane</td>
<td>0.00530</td>
<td>0.00536</td>
<td>0.00491</td>
</tr>
<tr>
<td>Isobutane</td>
<td>0.00147</td>
<td>0.00238</td>
<td>0.00097</td>
</tr>
<tr>
<td>n-Butane</td>
<td>0.00213</td>
<td>0.00400</td>
<td>0.00162</td>
</tr>
<tr>
<td>Isopentane</td>
<td>0.00166</td>
<td>0.00481</td>
<td>0.00224</td>
</tr>
<tr>
<td>n-Pentane</td>
<td>0.00130</td>
<td>0.00340</td>
<td>0.00173</td>
</tr>
<tr>
<td>Hexanes</td>
<td>0.00078</td>
<td>0.00112</td>
<td>0.00085</td>
</tr>
<tr>
<td>Heptanes+</td>
<td>0.00043</td>
<td>0.00049</td>
<td>0.00030</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>1.00000</strong></td>
<td><strong>1.00000</strong></td>
<td><strong>1.00000</strong></td>
</tr>
</tbody>
</table>
A MARP was approved in July 2009. Most recent MARP update was submitted on February 27, 2015.

No significant changes to the Measurement, Accounting and Reporting Plan since the last submission.
PRODUCTION WELL TESTING

- Each well is directed to a test vessel near 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>21</td>
<td>2 phase</td>
<td>~3-8 hrs</td>
<td>~24 hrs</td>
<td>3-4x/month</td>
</tr>
<tr>
<td>19 sat 1-2-4 &amp; 20</td>
<td>3 phase</td>
<td>~1 to 8 hrs</td>
<td>~10 hrs</td>
<td>3-4x/month*</td>
</tr>
<tr>
<td>19 sat 3</td>
<td>2 phase</td>
<td>~0.5 hrs</td>
<td>~24 hrs</td>
<td>3-4x/month</td>
</tr>
<tr>
<td>30, 31</td>
<td>2 phase</td>
<td>~0.5 hrs</td>
<td>~10 hrs</td>
<td>4-5x/month</td>
</tr>
<tr>
<td>32, 33</td>
<td>2 phase</td>
<td>~0.5 hr</td>
<td>~10 hrs</td>
<td>4-5x/month</td>
</tr>
</tbody>
</table>

*Pad 20 tests for ESP wells average 1-2/month, due to operational changes required for chemical injection/decreasing production

**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

Reliability

- 100% compliance was not achieved for the year. April, July, Sept and October 2015 are compliant.
- Made use of Application No. 1812468 (Directive 17 Section 12.3 Waiver for testing Pad 20 ESP wells) until August 2015, after which point upgrades were made to test separator PV 17.03 which allowed for testing of ESP wells in accordance with Directive 17.

Test compliance issues:

- January 2015 - Repaired steam control valve (no pressure control for test separator, Pad 19)
- January – March, May 2015 - AGAR meters issues, showing unacceptable test results on Pad 32, Level control issues on Pad 31, switched devices and tests are acceptable (DP transmitter to radar probe)
- June 2015 – MPP down for maintenance on Pad 32, not able to keep pressure on test separator, insufficient well test data.
- August 2015 – Steam outage on Pad 19 lasted longer than expected, no pressure support for test separator.

Improvement Plans

- Field wide AGAR calibration campaign to be executed. Samples to be obtained prior, to implement new curves. (Health check completed for the software/hardware)
- Natural gas adaptation for pressure management of the vessels to commence in 2016 (to begin with 19sat3)
- Ongoing troubleshooting of pad 31 test separator (replaced leaky ESD, to troubleshoot leaking rotary valve, to implement an in-line check valve upstream of the original check valves for a producer, and possible natural gas adaptation instead of make-up steam for pressure management)
### Steam Proration

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Steam</td>
<td>0.97 – 1.22</td>
<td>1.13</td>
</tr>
</tbody>
</table>

![Proration Chart](chart.png)
In November 2015 we did a field wide well sampling and AGAR meter calibration program.
### Water & Gas Proration

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Gas</td>
<td>1.00 – 1.11</td>
<td>1.03</td>
</tr>
<tr>
<td>Water</td>
<td>1.00 – 1.18</td>
<td>1.10</td>
</tr>
</tbody>
</table>

- Battery Level GOR x Prorated Well Oil Volume used for reporting PRC Produced Well Gas Volumes (May 2015 forward). Implemented the steam volumes used for winterization and test separator pressure into the water recycle calculation to correct the produced water volume.
Brine Water Disposal Well (100/16-27-85-19W5)

- Disposing into the Leduc formation
- Used for boiler feed water softener regeneration waste
- Average Disposal Volume/Day = 111 m³/d
- Average Upstream Pressure = 2,780 kPa
- Max Wellhead Pressure = 3385 kPa* (Approved pressure = 4,500 kPa)
- Typical Total Dissolved Solids (TDS) is 9000 g/m³
- Approval up to 4500 kPag wellhead injection pressure (as per approval no. 9953A)

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 = 2,624 m³/d
  - Average Pressure = 5,507 kPa
  - Max Pressure = 8,341 kPa (Approved pressure = 18,000 kPa)
  - Average Temperature = 61 °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 = 2,054 m³/d
  - Average Pressure = 5,307 kPa
  - Max Pressure = 8,019 kPa (Approved pressure = 18,000 kPa)
  - Average Temperature = 62 °C
  - Typical Total Dissolved Solids (TDS) is 5300 g/m³
  - Approval up to 18,000 kPag (as per approval no. 6308)
Disposal Volumes injected into D323 decreased in January 2015 due to the drilling of the Carmon Creek Disposal Wells.
WASTE DISPOSAL

- Newalta-Red Earth (12-13-87-9W5)
  - Treatment, Recovery & Disposal (TRD) Facility
  - 208 m³ to October 2015
  - COEMUL and SLGHYD

- Newalta Seal Lake (11-07-82-15W5)
  - Treatment, Recovery & Disposal (TRD) Facility
  - COEMUL and SLGHYD
  - 561.3 m³ to October 2015

- RBW Waste Management
  - To Edmonton Facility for disposal 3907-69 Ave.
  - 1.6 m³ of waste solids (SOILCO) to October 2015
Tervita Corporation– Peace River (12-24-85-19-W5)
- Treatment, Recovery & Disposal (TRD) Facility
- Primarily hydrocarbon sludge (NON-DOW, SLGHYD, COEMUL, SOILCO, WSHWTR)
- 7238.1 m³ to October 2015

Tervita (Hazco) Environmental (1/4-03-25-22W4)
- Tervita Waste Management (TWM)
- SOILRO and FILOTH
- 13.17 m³ to October 2015

Tervita Corporation– Spirit River (12-31-77-5W6)
- Tervita Waste Management (TWM)
- Activated Carbon ACTCRB
- 16.9 m³ to October 2015
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.
GREEN HOUSE GAS EMISSIONS

CO2e

- Jan and Feb high mostly due to increased filter backwashes. Second reason was blanket gas eductor during SV-606 cleaning.
Static/Passive Air Monitoring
- Twelve passive stations
- Gathers data on Sulphur Dioxide and Hydrogen sulphide
- 2014/2015 monitoring and reporting satisfactory

Continuous Ambient Monitoring data
- Continuous Monitoring - Monitored parameters: sulphur dioxide, hydrogen sulphide, wind speed and direction, Methane and Non-Methane
There were no Ambient Air Exceedences at the PRC Environmental Trailer (EPEA Approval 1642-02-07) from October 2014-October 2015. The air trailer maintained over 90% uptime each month as per license requirements.

Government (AER and/or AESRD) reportable spills and releases at PRC
- No government reportable spills from October 2014 to end of October 2015
- 3 releases to atmosphere from tanks (venting) October to December 2014
  - Total volume vented for this period was 0.0076 e3m3
- 6 releases to atmosphere from tanks (venting) January to October 2015
  - Total volume vented for this period was 0.8693 e3m3
To the best of Shell’s knowledge, operations at Peace River are consistent with all conditions of the 8143 approval.

<table>
<thead>
<tr>
<th>Amendment</th>
<th>Approval Date</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>N, O</td>
<td>October 2, 2012, April 26, 2013</td>
<td>Carmon Creek Phases 1 and 2 Project, Carmon Creek changes to CPF designs and adding third separator to all well pads.</td>
</tr>
<tr>
<td>P</td>
<td>Oct. 4, 2013</td>
<td>Carmon Creek changes to CPF designs and adding a third separator to all well pads.</td>
</tr>
<tr>
<td>Q</td>
<td>Dec 9, 2013</td>
<td>Peace River Project X-two injection pads for Pads 30 and 31</td>
</tr>
<tr>
<td>R</td>
<td>Dec 12, 2013</td>
<td>Carmon Creek conversion of well pads from injection to CSS producers</td>
</tr>
<tr>
<td>S</td>
<td>March 6, 2014</td>
<td>Carmon Creek updates to the CPF</td>
</tr>
<tr>
<td>T</td>
<td>April 15, 2014</td>
<td>Directive 81 variance application for PRC</td>
</tr>
<tr>
<td>U</td>
<td>Oct 10, 2014</td>
<td>Peace River Pad 20 AGAR meter installation</td>
</tr>
<tr>
<td>V</td>
<td>Nov 7, 2014</td>
<td>Peace River Pad 22 addition of 2 infill wells</td>
</tr>
<tr>
<td>W</td>
<td>4 May 2015</td>
<td>Carmon Creek application – Removing condition to re-abandon, re-enter two wells in our original approval.</td>
</tr>
<tr>
<td>X</td>
<td>6 Apr 2015</td>
<td>Carmon Creek – 7 pressure monitoring wells – variance application to not drill these wells.</td>
</tr>
<tr>
<td>Y</td>
<td>14 Apr 2015</td>
<td>Peace River Pad 19-Sat 2 -6 additional wells application</td>
</tr>
<tr>
<td>Z</td>
<td>21 May 2015</td>
<td>Carmon Creek Development area expansion and additional 13 pads application.</td>
</tr>
</tbody>
</table>
EPEA Operating Approval 1642-02-03 had 2 amendments during 2014/2015. 1642-02-06 amendment outlined adjustments to the Carmon Creek air emissions limits.

1642-02-07 amendment granted the option for PRC to send domestic wastewater to any domestic wastewater facility with its own registration under the Act.

2 amendments were made to each of PRC’s EPEA Water Diversion permits in 2014. (30033-00-02, 30034-00-02, and 30035-00-02). These amendments provided detailed point of use locations as well as added the additional purpose for withdrawal to support oil and gas drilling. (Sept 2014)

Shell’s Surface Lands department deals with many amendments to leases as a part of day to day business
Soil Monitoring Program
Drilling program for soil monitoring and sampling was executed in October 2014. Reports were submitted March 2015.
2015 soil monitoring program is ongoing.
Results to be reported in annual report.

Groundwater Program
Per EPEA 1642-02-07, 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 November 2015.
Results will be reported in the 2015 annual report.
Shallow groundwater monitoring program
Groundwater testing occurred in November 2015 on plant piezometers. Final results will be received by PRC in late 2015. 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 contamination seen in these wells with little variation at a majority of the monitoring locations. Monitoring continues per Alberta Environment Approval. Sampling occurred November 2015.

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))
Tested and monitoring continues per EPEA Approval
Wildlife crossing structures on above ground pipelines—All data from past 8 years was assessed under the Comprehensive Wildlife report and submitted to the AER in 2015.

Multiple wildlife studies including bird surveys, winter mammal study and owl surveys and continental trumpeter swan survey with Fish and Wildlife departments.

Partnered with the Miistakis Institute in their Wildwatch Program.

EDNA partnered with the Alberta Conservation Association on a 3 year amphibian study beginning in 2014.

Peatland Reclamation Research with NAIT and the Boreal Research Institute.

Airstrip Reclamation in progress (15 ha)
Two separate former storage areas were identified at E ½-23-85-19W5

Worley Parsons was contracted to perform a remedial option analysis which included soil and groundwater sampling as part of an environmental site assessment
NAIT Boreal Research Institute (nBRI) in Peace River, Alberta, is to receive $2.2 million over five years from the Natural Sciences and Engineering Research Council of Canada (NSERC) to support boreal forest reclamation research. Shell is a partner in the research, contributing over $500,000.

Initial commitment for a 3 year program, at $70,000 per year.

Agreement for additional 5 years of funding, at $75,000 per year.

Shell has allocated five well pads and one sump site and the airstrip at its Peace River Complex for applied research.

Results so far:

- To date there has been some success establishing various moss families using the fragmentation technique developed by Dr. Line Rochefort at Laval University.

2015 Research:

- Seed collection of native boreal plant species
- Continued restoration of Inversion Pad Trail #1
  - Studying vegetation performance, hydrology, and substrate chemistry on restored site.
2015 Research Cont…

Inversion Trials #2 and #3 new well pad locations were identified in the spring, planning in progress.

Linear Features

- NBRI is conducting a small trial to restore a stretch of winter access road near inversion pad trial 1.
- Goal of program is to promote tree growth canopy and reduce the line of site.

Airstrip Project 2015

The research objectives are as follows:

- Compare different soil adjustment techniques that will restore physical soil properties and hydrological function and create a variety of microsites for plant establishment.
- Compare sequences and combinations of vegetation management to reduce the time required to successfully establish appropriate woody and herbaceous vegetation.
- Examine the potential for using improved ‘super’ aspen seedlings for reclamation.
- Evaluate the suitability of various woody boreal species against tested reclamation methods.
Airstrip Project Con’t

- Wetland portion (4 ha)
  - Site was recontoured and graded to the natural surrounding wetland level
  - The culvert on one site was removed and vegetation and subsoil were salvaged and redistributed onsite which will enhance soil organic content and aid in water holding capacity and provide additional seeds/propagules.
  - Re-vegetation was completed in 2015 including direct seeding, transplanting, cuttings and planting of stock plants.

- Upland portion (14 ha)
  - Re-plowing on four 120x30 meter wide strips in order to compare the impact of surface soil adjustment on native plant establishment and weed management was completed.
  - Two organic amendments were deployed including DMI biosolids and Humalites. This was conducted in partnership with Alberta Innovates Technology Futures.
  - Production of tree and shrub seedlings complete. Planting occurred May 2015. Approximately 40,000 seedlings planted on this site along with grasses, shrubs and willows.
2015 Research Cont…

IPAD Borrow Pit

- Research objectives:
  - Compare growth and survival of three woody shrubs and three tree species.
  - Monitor short-medium term recruitment/natural ingress of forest vegetation.
  - Seedlings were planted spring of 2014 for white spruce, aspen, buffaloberry and western dogwood, growing well in 2015
  - The cover crop trial portion of the study was assessed and results are being compiled. Initial observations indicated good establishment with some native grasses and indian paintbrush.
IN-SITU PAD RESEARCH

Objectives of the research are as follows:
- Restore surface hydrologic connectivity with the surrounding peatland;
- Create a stable saturated-but not inundated-peat surface; and
- Establish plant community similar to the surrounding natural peatland.

Three main methods were applied to adjust the site:
- Complete pad removal and peat fluffing;
- Complete pad removal and peat inversion; and
- Partial pad removal and peat inversion.

Pad material was returned to the borrow pit where it was taken from; the borrow pit was then added to the upland reclamation research program to test decompaction methods.
Peat from nearby donor sites was spread on the surface using the fragmentation method once it was confirmed that subsurface flow was reconnected with the surrounding poor fen. Straw was applied to increase humidity.

**Vegetation**

- The vegetation restoration on the Inversion Pad is being monitored through the NBRI peatland program.
- **Hydrology, water flows**
- Water table fluctuations and connectivity with natural peatland were monitored for a fourth growing season in 2015.
- The data from monitoring programs will be used to compare key ecological parameters on the restored site to the surrounding natural peatlands to evaluate progression towards a functional peatland over time.
- NBRI is currently conducting surveys of natural peatlands in the boreal region to establish a series of reference peatland sites to provide baseline information in setting reasonable restoration targets and progress goals.
Water chemistry

- Basic water chemistry was collected regularly in monitoring wells on the Inversion Pad itself and in the surrounding natural peatlands.

Surface topography

- Surface topography has fluctuated following the pad removal. In an effort to understand how the peat profile is impacted by the removal of pad, the topography was intensively surveyed for a second season last year. A last data set was collected in October 2013.

Donor site monitoring

- The peatland area where donor material was collected was surveyed. Vegetation recovery and peat physio- and chemical properties were assessed. The same surveys will be performed every summer in next two years to document the natural recovery of these locations.
NAIT Boreal Research Institute using existing airstrip for their peatlands work for the next 4 years.

Various sites assessed for reclamation certificates in 2015 – consultant currently working on reports.

10-2-86-19 W5 reclaimed road and lease with trees planted 2015

11-34-85-19W5 reclamation complete. Assessed and applied for reclamation certificate from AER.

2-26-85-19W5 Airstrip reclamation in progress. Site is within airstrip project boundaries and will be applied for within airstrip project.

15-26-85-19 cut and capped one well due to access being through airstrip. Will assess status in 2016.

Pad removal in the muskeg 2015 fall 8-22 removing pad and filling in borrow pit (location directly north of Carmon Creek CPF)