Husky Oil Operations Limited

Tucker Thermal Project

Commercial Scheme Approval No. 9835

Annual Performance Presentation
Alberta Energy Regulator

September 5, 2018
3.1.1. Subsurface

TABLE OF CONTENTS

1. BRIEF BACKGROUND – slide 3
2. GEOLOGY / GEOSCIENCES – slide 6
3. DRILLING AND COMPLETIONS – slide 33
4. ARTIFICIAL LIFT – slide 43
5. INSTRUMENTATION IN WELLS – slide 44
6. 4D SEISMIC – slide 47
7. SCHEME PERFORMANCE – slide 49
8. FUTURE PLANS – slide 82
1. Brief Background

PROJECT OVERVIEW

- AER Commercial Scheme Approval No. 9835
- 30,000 BOPD SAGD Project
- Clearwater and Grand Rapids Reservoirs
- 9-10° API Bitumen
- Integrated with Husky Pipeline & Upgrader
- First steam - August 20, 2006
- First production - November 29, 2006
1. Brief Background

PROJECT DEVELOPMENT AREA

- Approval Area:
  - Sections 28, 29, 32 & N/2 of 21 in 064-04 W4M
  - SE ¼ Section 23, SW ¼ Section 21, Section 17 LSD 16 & Section 16 LSD 13
- 35 Year Project Life
- 109 Horizontal Well Pairs & 7 Infill Producers
  - 32 original well pairs (Pads A, B, C)
  - Well pairs added:
    - Pad C East 2007 - 8 well pairs
    - Pad B Infill 2009-2010 - 3 well pairs
    - Pad A Infill & Replacements 2010/2011) - 16 well pairs
    - Pad Lower Grand Rapids (GA) 2011 - 1 well pair; 2012-2013 – 5 well pairs
    - Pad D East 2014 - 15 well pairs
    - Pad Colony (CN) 2015 - 6 well pairs & 7 infill producers
    - Pad D North 2016 - 8 well pairs
    - Pad C West Replacement 2016 – 8 injectors
    - Pad D West 2017 - 15 well pairs
1. Brief Background

SITE OVERVIEW

- Field Facilities – six well pads, infield pipelines and central pump station
- Central Plant:
  - Emulsion treating
  - Water Treatment – 120,000 bbl/day
  - Steam Generation – 99,000 bbl/day CWE
  - Utilities and Off-sites
- Water Source & Disposal Wells
- Metering and Export Pipelines to Cold Lake Terminal
### 2. Geology/Geosciences

**AVERAGE RESERVOIR CHARACTERISTICS AND OBIP**

<table>
<thead>
<tr>
<th>Clearwater</th>
<th>OBIP (X10^6 m³)</th>
<th>Thickness (m)</th>
<th>Φ</th>
<th>So</th>
<th>Viscosity (cP @ 20°C)</th>
<th>Original Pressure (kPa)</th>
<th>Original Temperature (°C)</th>
<th>Depth (m)</th>
<th>Vertical Permeability (mD)</th>
<th>Horizontal Permeability (mD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Approval Area</td>
<td>72.0</td>
<td>45</td>
<td>0.31</td>
<td>0.57</td>
<td>50,000-1,000,000</td>
<td>3,200</td>
<td>16</td>
<td>440</td>
<td>1,800</td>
<td>3,000</td>
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<tr>
<td>Operating</td>
<td>40.9</td>
<td>46</td>
<td>0.32</td>
<td>0.57</td>
<td>50,000-1,000,000</td>
<td>3,200</td>
<td>16</td>
<td>440</td>
<td>1,800</td>
<td>3,000</td>
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<table>
<thead>
<tr>
<th>Lower Grand Rapids</th>
<th>OBIP (X10^6 m³)</th>
<th>Thickness (m)</th>
<th>Φ</th>
<th>So</th>
<th>Viscosity (cP @ 20°C)</th>
<th>Original Pressure (kPa)</th>
<th>Original Temperature (°C)</th>
<th>Depth (m)</th>
<th>Vertical Permeability (mD)</th>
<th>Horizontal Permeability (mD)</th>
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<tbody>
<tr>
<td>GA Approval Area</td>
<td>3.7</td>
<td>33</td>
<td>0.29</td>
<td>0.55</td>
<td>100,000-300,000</td>
<td>2,600</td>
<td>14</td>
<td>370</td>
<td>1,300</td>
<td>1,800</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Colony</th>
<th>OBIP (X10^6 m³)</th>
<th>Thickness (m)</th>
<th>Φ</th>
<th>So</th>
<th>Viscosity (cP @ 20°C)</th>
<th>Original Pressure (kPa)</th>
<th>Original Temperature (°C)</th>
<th>Depth (m)</th>
<th>Vertical Permeability (mD)</th>
<th>Horizontal Permeability (mD)</th>
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</thead>
<tbody>
<tr>
<td>CN Approval Area</td>
<td>2.8</td>
<td>10</td>
<td>0.30</td>
<td>0.79</td>
<td>25,000</td>
<td>2,500</td>
<td>12</td>
<td>305</td>
<td>2,400</td>
<td>4,000</td>
</tr>
</tbody>
</table>

**Notes:**
- **Calculation:** OBIP interval: Top of Formation → oil water contact
- **OBIP = Area x Thickness x Φ x So**
2. Geology/Geosciences

REGIONAL STRATIGRAPHY

- Marginal marine deposits consisting of stacked incised valleys and shoreface deposits
2. Geology/Geosciences

ISOPACH MAP OF CLEARWATER SAGD NET PAY

Definition of Net Pay:
Top Clearwater – Top of Transition Zone
(So > 50%, Φ > 27%)

C.I. = 5 m
2. Geology/Geosciences

STRUCTURE MAP OF THE CLEARWATER TOP OF NET PAY
2. Geology/Geosciences

STRUCTURE MAP OF THE CLEARWATER BASE OF NET PAY

Legend:
- Clearwater Approval Boundary
- Lower Grand Rapids Approval Boundary
- Colony Approval Boundary
- Lease Boundary
- C.I. = 5 m
2. Geology/Geosciences

ISOPACH OF CLEARWATER BOTTOM WATER

Legend:
- Red: Clearwater Approval Boundary
- Green: Lower Grand Rapids Approval Boundary
- Orange: Colony Approval Boundary
- Blue: Lease Boundary
- C.I. = 5 m
2. Geology/Geosciences

ISOPACH OF CLEARWATER TRANSITION ZONE

- Clearwater Approval Boundary
- Lower Grand Rapids Approval Boundary
- Colony Approval Boundary
- Lease Boundary
- C.I. = 5 m
2. Geology/Geosciences

ISOPACH MAP OF LOWER GRAND RAPIDS SAGD NET PAY

Definition of Net Pay:
Top Sparky Pay – Base of Pay
(So >50%, Φ >27%)

C.I. = 5m
2. Geology/Geosciences

STRUCTURE MAP OF THE LOWER GRAND RAPIDS

- Clearwater Approval Boundary
- Lower Grand Rapids Approval Boundary
- Colony Approval Boundary
- Lease Boundary
- C.I. = 5 mASL

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2. Geology/Geosciences

STRUCTURE MAP OF THE LOWER GRAND RAPIDS BASE OF NET PAY

- Clearwater Approval Boundary
- Lower Grand Rapids Approval Boundary
- Lease Boundary

C.I. = 5m
2. Geology/Geosciences

ISOPACH MAP OF LOWER GRAND RAPIDS BOTTOM WATER

- Clearwater Approval Boundary
- Lower Grand Rapids Approval Boundary
- Lease Boundary

C.I. = 5m
2. Geology/Geosciences

ISOPACH MAP OF LOWER GRAND RAPIDS TRANSITION ZONE

C.I. = 5m
2. Geology/Geosciences

ISOPACH MAP OF COLONY SAGD NET PAY

Definition of Net Pay:
Colony Top Pay– Colony Channel Base Pay (So >50%, Φ>27%)
C.I. = 2 m
# 2. Geology/Geosciences

## CLEARWATER FORMATION TYPE LOG

### Subsurface Stratigraphy

<table>
<thead>
<tr>
<th>Valley</th>
<th>Characteristics</th>
</tr>
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<tbody>
<tr>
<td>B Valley</td>
<td>Dominated by sand flat facies</td>
</tr>
<tr>
<td>C Valley</td>
<td>Dominated by sand flat facies</td>
</tr>
<tr>
<td>D Valley</td>
<td>Dominated by tidal-fluvial channel facies</td>
</tr>
</tbody>
</table>

### Cored Interval

- **McMurray Silt, Sand, Clay**
- **Calcite cemented zones**

### Grand Rapids sand and shale

- **Top**
- **Bottom**

### Depth and Lithology

<table>
<thead>
<tr>
<th>Correlation</th>
<th>Depth</th>
<th>Porosity</th>
<th>Density</th>
<th>Resistivity</th>
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<tbody>
<tr>
<td>GR</td>
<td></td>
<td></td>
<td></td>
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</tr>
<tr>
<td>GR</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### 100/14-28-064-4W400 KB 619.5m

- **Cored Interval**
- **Calcite cemented zones**

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2. Geology/Geosciences

SPARKY FORMATION TYPE LOG

Colorado Group

Upper Grand Rapids

Lower Grand Rapids

Clearwater

103/10-32-064-04W400

KB = 623.7 m

0.75 m

Bitumen saturated channel sand

Calcite

Water sand

Transition

Cored Interval
2. Geology/Geosciences

COLONY FORMATION TYPE LOG

100/04-21-064-04W00

16 m

Top

Bottom

0.75 m

Cored Interval
2. Geology/Geosciences

CORED WELLS AND SPECIAL CORE ANALYSIS

• Sparky Petrography

• Moderately well sorted sand, dominantly upper very fine grained

• Feldspar-rich (up to 28 wt % XRD) and lithic unconsolidated sandstone

• Monocrystalline quartz grains make up the majority of the detrital clasts (up to 60 wt% XRD)

• Lithic clasts: include chert, volcanics, organics, minor dolomite, and detrital clay (up to 23 wt. % XRD)

• Viscosity @ 20°C varies between 313,000 cp to more than 1,000,000 cp
2. Geology/Geosciences

REPRESENTATIVE STRUCTURAL N-S CROSS-SECTION THROUGH THE APPROVAL AREA
2. Geology/Geosciences

REPRESENTATIVE STRIKE CROSS-SECTION THROUGH THE SPARKY CHANNEL

- Sparky Shale
- Sparky A
- Sparky B
- GP
- REX
- SAGD Injector
- SAGD Producer
2. Geology/Geosciences

REPRESENTATIVE STRIKE CROSS-SECTION THROUGH THE COLONY CHANNEL
### 2. Geology/Geosciences

SURFACE/SUBSURFACE GEOMECHANICAL DATA/ANALYSIS

#### Capping Shale Properties

<table>
<thead>
<tr>
<th>Well Pad</th>
<th>Capping Shale Issues to date</th>
<th>Capping shale Fracture Pressure Exceeded</th>
<th>Shale Depth (m)</th>
<th>Measured Fracture Gradient (kPa/m)</th>
<th>Measured Fracture Pressure (kPa)</th>
<th>Fracture Regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>CN</td>
<td>No</td>
<td>No</td>
<td>305</td>
<td>20.0</td>
<td>6,100</td>
<td>Horizontal</td>
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<tr>
<td>GA</td>
<td>No</td>
<td>No</td>
<td>357</td>
<td>19.9</td>
<td>7,120</td>
<td>Horizontal</td>
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<tr>
<td>Clearwater</td>
<td>No</td>
<td>No</td>
<td>426</td>
<td>21.8</td>
<td>9,280</td>
<td>Horizontal</td>
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#### Sand Properties

<table>
<thead>
<tr>
<th>Well Pad</th>
<th>Sand Depth (m)</th>
<th>Measured Fracture Gradient (kPa/m)</th>
<th>Measured Fracture Pressure (kPa)</th>
<th>Fracture Regime</th>
</tr>
</thead>
<tbody>
<tr>
<td>GA</td>
<td>375</td>
<td>17.0</td>
<td>6,360</td>
<td>Vertical</td>
</tr>
<tr>
<td>Clearwater</td>
<td>446</td>
<td>16.0</td>
<td>7,140</td>
<td>Vertical</td>
</tr>
</tbody>
</table>
2. Geology/Geosciences

PAD A WELL SPACING SCHEMATIC

- Pad A original (A1 – A8 drilled 2005) injectors were converted into producers in 2015
- Pad A replacement producers (A9 – A24 drilled 2010/2011) are 10m - 15m directly above Pad A original producers
- Pad A infill producers are 10m - 15m above and mid distance from Pad A original producers
2. Geology/Geosciences

PAD B NORTH WELL SPACING SCHEMATIC

- Pad B North injectors (B9 – B12 drilled 2005/2006) converted into producers in 2014
- Pad B North infill producers (B9 – B11 drilled 2009/2010) are 10m - 15m above and mid distance from Pad B North
2. Geology/Geosciences

PAD C WEST WELL SPACING SCHEMATIC

- Pad C West (C1 – C8 drilled 2005)
- Pad C West replacement injectors (C1R – C8R drilled 2016) are 5m directly above injectors

Legend
- New Replacement Injectors
- Injectors / converted to producer
- Old Producers / shut in
## 2. Geology/Geosciences

### PAD INTER-WELL SPACING

<table>
<thead>
<tr>
<th>Well Pad</th>
<th>Inter-well Spacing (m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Original</td>
<td>100</td>
</tr>
<tr>
<td>A Infill and Replacements</td>
<td>50</td>
</tr>
<tr>
<td>B West</td>
<td>100</td>
</tr>
<tr>
<td>B North</td>
<td>100</td>
</tr>
<tr>
<td>B North Infill</td>
<td>100</td>
</tr>
<tr>
<td>C North</td>
<td>100</td>
</tr>
<tr>
<td>C West</td>
<td>100</td>
</tr>
<tr>
<td>C East</td>
<td>100</td>
</tr>
<tr>
<td>D East</td>
<td>50</td>
</tr>
<tr>
<td>D North</td>
<td>50</td>
</tr>
<tr>
<td>D West</td>
<td>50</td>
</tr>
<tr>
<td>GA (LGR)</td>
<td>75</td>
</tr>
<tr>
<td>CN (SAGD)</td>
<td>75</td>
</tr>
<tr>
<td>CN Infill</td>
<td>37.5*</td>
</tr>
</tbody>
</table>

* Spacing to SAGD producer
2. Geology/Geosciences

SURFACE HEAVE MONITORING PROGRAMS

• No surface heave monitoring programs have been conducted

• Operating near reservoir pressure, therefore unlikely to be any surface heave

• Husky is committed to further investigate the possible extent of surface heave if a change in operating conditions
2. Geology/Geosciences

3D SEISMIC DATA

- 2018 - 3D Seismic acquisition extended to cover Pad D East
- 10.4 km² of seismic data was acquired
3. Drilling and Completions

DRILLING RESULTS

- No wells drilled during the reporting period
- Pad D West: 15 well pairs completed (Q4 2017 to Q1 2018)
3. Drilling and Completions

SUMMARY OF WELL COMPLETIONS

Injectors (109 SAGD Injectors):
- All injectors completed with Slotted Liner: 109 (includes Pad D West)
- Injectors completed with Vacuum Insulated Tubing (VIT): 45
  - Pad C: 2
  - Pad D: 37
  - Pad CN: 6
- Injectors completed with Steam Splitters: 51
  - Pad B: 7
  - Pad D: 38
  - Pad CN: 6

Producers (116 Producers: 109 SAGD Producers and 7 Infill Producers):
- Producers completed with Slotted Liner: 38
  - Pad A: 8
  - Pad B: 12
  - Pad C: 18
- Producers completed with Wire Wrap Screen (WWS): 78
  - Pad A: 16
  - Pad B: 3
  - Pad C: 2
  - Pad D: 38
  - Pad GA: 6
  - Pad CN: 13
3. Drilling and Completions

SAGD WELL – INJECTOR WITHOUT VACUUM INSULATED TUBING (VIT)
3. Drilling and Completions

SAGD WELL – INJECTOR WITH VIT
3. Drilling and Completions

SAGD WELL PAD CN – INJECTOR WITH VIT

**Surface Casing**
- 339.7 mm (13 3/8”), 81.1 kg/m, J-55 LT&C
- Landed at 155.00 mKB

**Intermediate Casing**
- 244.5 mm (9 5/8”), 79.63 kg/m, L-80, Ternate Blue
- Landed at 598.00 mKB

**Circulation String**
- (will not be used after steam circulation phase)
- 73.0 mm (2-7/8”), 9.52 kg/m, J-55 Tenaris BTL Tubing w/ Shaved & Bevelled Collars
- Landed at 519.25 mKB MD

**Long Injection String**
- 114.3 mm x 88.9 mm Vacuum Insulated Tubing
- Surface to 541.76 mKB MD
- 114.3 mm, 17.52 kg/m, J-55 Tenare BTL Tubing
- 541.76 - 1,121.21 mKB MD
- 73.0 mm, 9.52 kg/m, L-55 Hydril 511 Tubing
- 1,122.28 - 1,284.90 mKB MD

**Weatherford Slotted Sub Steam Splitter**
- 114.3 mm x 114.3 mm
- Top Landed at 746.12 mKB MD, 930.49 mKB MD & 1,122.29 mKB MD
- TVD: 316.5 mKB
  - MD: 1,324.0 mKB
3. Drilling and Completions

SAGD WELL – PRODUCER WITH GAS-LIFT

13-3/8”, J-55, 81.1 kg/m BTC Surface Casing landed at 181 mKB

9-5/8” K-55, 59.53 kg/m, Tenaris Blue Intermediate Casing landed at 719 mKB.

Production Long String
3-1/2” 13.83 kg/m, FJ HYDRIL 511 WEDGE Long String landed @ 1734 mKB w/ 1-1/4” Combo Coil Inside

Gaslift / Instrumentation
31.8mm Combo Gaslift / LX Six Instrumentation Coil. Gaslift port @ 613 mKB & Bottom landed @ 1729 mKB.

Short String
2-7/8” L-80, 9.52 kg/m, FJ HYDRIL 511 WEDGE SAGD Short String landed @ 643 mKB w/ Gaslift Port @ 643 mKB with 2-3/8”, 6.85 kg/m, FJ HYDRIL 511 WEDGE inside 7” liner @ 725.9 mKB

0.014” x 7” K-55, 43.16 kg/m, BLUE SAGD WIRE WRAPPED SCREEN landed @ 1753 mKB

9-5/8” x 7” Liner Hanger @ 699 mKB

TVD: 477.41 mKB
MD: 1765 mKB
3. Drilling and Completions

SAGD WELL PAD CN – PRODUCER WITH ROD-PUMP
3. Drilling and Completions

INTERMITTENT STEAM STIMULATION WELL PAD CN – PRODUCER WITH ROD-PUMP
3. Drilling and Completions

INFILL WELL PAD CN – PRODUCER WITH ROD-PUMP

Surface Casing
244.5 mm (9.60") L-40 Steel, H-40 LT&C
Landed at 152.00 mKB

Intermediate Casing
177.8 mm (7"), 34.2 kpgm, L-80, Tenaris Blue
Landed at 688.00 mKB

Production String
114.3 mm, 17.62 kpgm J-55 Tenaris DTL Tubing,
Tubing drain & pump seating nipple
Tubing landed at 341.07 mKB MD
Pump landed at 352.97 mKB MD

Rods & Pump
38.1 mm (1.5") stainless steel polished rod
~ 60.8m of 50.8mm (2") sinker bar
25.4mm (1") X95010 Pro-rod G140K shear
Insert pump 40-325-RWA-FR-34.48

114.3 mm (4.5") Wire Wrapped Screen
0.254mm (0.010") slots

Pump Tangent 65°

177.8 mm x 114.3 mm Import Liner Hanger
Top Landed at 688.00 mKB

TVD: +/- 318.11 mKB
MD: +/- 1,438.00 mKB
3. Drilling and Completions

COMPLETIONS – KEY LEARNINGS

Production - Slotted Liners vs Wire Wrap Screens (WWS):

- Slotted liner scaling has been a chronic problem:
  - Short term solution - Acidization
  - Long term solution - perforated liners

- WWS, which increase the open area, used in producers drilled since 2009:
  - No scaling issues observed in these wells

- Current plan to complete future producers with WWS

Injection - Vacuum Insulated Tubing (VIT) and Steam Splitters:

- VIT:
  - Improve the wellbore integrity by slowing heat transfer through tubing
  - Deliver high quality steam downhole and improve production

- Steam Splitters:
  - Shift-able steam splitters enable proper circulation and allow steam distribution adjustments

- VIT combined with Steam Splitters:
  - Improve steam quality and distribution into the reservoir
4. Artificial Lift

WELL PADS

Rod-pump: 13 (Pad CN only)
- 6 SAGD producers (Tubing liner pump)
- 2 ISS producers (Insert pump)
- 5 Infill producers (Insert pump)
- Rod-pump operational parameters:
  - Pressure: 1,500 – 2,500 kPa
  - Bottom hole temperature: 130 – 180 ºC
  - Fluid production range: 65 – 420 m³/day

Gas-lift: 103, all producers except Pad CN
- 103 SAGD producers
- Gas-lift operational parameters:
  - Pressure: 2,400 kPa – 4,000 kPa
  - Bottom hole temperature: 200 – 240 ºC
  - Gas injection rate: 1,200 – 10,800 m³/day
5. Instrumentation in Wells

OBSERVATION WELL MAP

2017/2018:
• Pad D West – 3 OBS wells
5. Instrumentation in Wells

OBSERVATION AND SAGD WELLS

• 47 OBS Wells with Instrumentation:
  • 39 wells: thermocouple only
  • 8 wells: both thermocouple & piezometer

• Planned: OBS Wells (convert existing well):
  • 1 well (Pad GB thermocouple and piezometers)

• SAGD Injectors – wells use blanket gas to measure pressure and for insulation

• SAGD Producers – equipped with combo instrumentation coil (gas lift & thermocouple or fiber)
  • Combo coil installed in the long production string delivers lift-gas for the long string and provides temperature measurement in the horizontal section

  • Pressure at the heel of producers is estimated from the gas pressure of the lift-gas injected into the annulus (annulus injection provides lift-gas for the short production string)
5. Instrumentation in Wells
THERMOCOUPLES AND PIEZOMETER OBSERVATION WELLS

Type 1 – Instrumentation Inside Tubing

Type 2 – Instrumentation Outside of Casing
6. 4D Seismic

4D SEISMIC DATA: TIME LAPSE MAP 2018 MONITOR

- 2018 time delay map shows the "heated zones" after ~ 11 years of steam injection
- Steam conformance varies across the field
- 2018 Monitor - analysis is ongoing
- Maximum delay of ~12 milliseconds on the Paleo horizon
6. 4D Seismic

4D SEISMIC DATA: TIME LAPSE MAP 2018 MONITOR

- 2018 Time delay map shows the “heated zones” after ~ 4.5 years of steam injection
- Steam conformance varies across the drainage pattern
- 2018 Monitor - analysis is ongoing
- Maximum delay of ~9 milliseconds on the Clearwater shale horizon
7. Scheme Performance

SCHEME PERFORMANCE PREDICTIONS METHODOLOGY

- Current performance prediction based on:
  - Updated geological model supplemented with simulation and analytical models
  - Observation of actual performance
  - Analysis of analogous SAGD projects
7. Scheme Performance

PRODUCTION AND INJECTION HISTORY
7. Scheme Performance

PRODUCTION VS. APPROVAL CAPACITY VARIANCE

- 32 original well pairs had poor performance due to:
  - Placement in the transition zone where oil saturation is low
  - Poor start-up strategy (bull-heading); currently use circulation

- Since 2008 all well pairs drilled to the base of SAGD net pay

- Revised completion of new wells
  - Dual string completions in both injector and producer
  - Injectors completed with VITs and steam splitters for Pads D and CN
  - Wire Wrapped Screens for all new producers to increase open area
  - Blanket gas installed on all wells to provide
    - Insulation
    - Casing protection
    - Down hole pressure measurement
7. Scheme Performance

PAD C WEST PERFORMANCE – LOW RECOVERY EXAMPLE
7. Scheme Performance

PAD C WEST HEEL OBSERVATION WELL
7. Scheme Performance

PAD C WEST MID OBSERVATION WELL
7. Scheme Performance

PAD C WEST TOE OBSERVATION WELL
7. Scheme Performance

DISCUSSION OF PAD C WEST WELL PERFORMANCE

- The OBS wells along well pair C3 shows non-uniform steam chamber development

- To improve production, new injector wells were drilled 5m above existing injectors and existing injector wells were converted to producers

- Pad C West performance indicators as of July 31, 2018:
  - Cum Oil: 495,542 m³
  - Cum Steam Injected: 4,487,796 m³
  - Cum Water Produced: 3,499,813 m³
  - CSOR: 9.1

- Pad C West performance for the reporting period:
  - Cum Oil: 32,827 m³
  - Oil Rate per well: 12.3 m³/day
  - SOR: 10.1
7. Scheme Performance

PAD A PERFORMANCE – MEDIUM RECOVERY EXAMPLE
7. Scheme Performance

PAD A WELLS HEEL OBSERVATION WELL
7. Scheme Performance
PAD A WELLS MID OBSERVATION WELL
7. Scheme Performance

DISCUSSION OF PAD A WELL PERFORMANCE

• The OBS wells near well pair A9 shows minimal steam chamber development

• Pad A performance indicators as of July 31, 2018:
  • Cum Oil: 1,485,886 m³
  • Cum Steam Injected: 8,938,273 m³
  • Cum Water Produced: 10,365,774 m³
  • CSOR: 6.0

• Pad A performance for the reporting period:
  • Cum Oil: 258,238 m³
  • Oil Rate per well: 30.5 m³/day
  • SOR: 4.0
7. Scheme Performance

PAD D EAST PERFORMANCE – HIGH RECOVERY EXAMPLE
7. Scheme Performance
PAD D EAST MID OBSERVATION WELL
7. Scheme Performance

PAD D EAST TOE OBSERVATION WELL
7. Scheme Performance

DISCUSSION OF PAD D EAST PERFORMANCE

• Since steam commenced in Q2 2015, high temperature has not been observed at the OBS wells

• Pad D East performance indicators as of July 31, 2017:
  • Cum Oil: 1,085,733 m³
  • Cum Steam Injected: 3,140,687 m³
  • Cum Water Produced: 3,121,871 m³
  • CSOR: 2.9

• Pad D East performance for the reporting period:
  • Cum Oil: 389,003 m³
  • Oil Rate per well: 71.0 m³/day
  • SOR: 3.1
7. Scheme Performance

PAD B NORTH PERFORMANCE
7. Scheme Performance

PAD B WEST PERFORMANCE
7. Scheme Performance

PAD C NORTH PERFORMANCE

![Graph showing performance metrics with key dates for plant turnaround and shutdowns marked.](image-url)
7. Scheme Performance

PAD C EAST PERFORMANCE

[Graph showing performance data with annotations for specific events such as plant turnaround and shutdowns.]

Husky Energy Inc.
7. Scheme Performance

PAD D NORTH PERFORMANCE

2017 warm lime softener repair
7. Scheme Performance

PAD D WEST PERFORMANCE
7. Scheme Performance

PAD LOWER GRAND RAPIDS (GA) PERFORMANCE

- Water-steam-ratio is due to high water mobility and bottom water
- Operating strategy at or slightly below the bottom water pressure to maintain the reservoir pressure and optimize steam efficiency
- Steam injection rates are optimized on a weekly basis based on well performance and total water produced from each well pair
7. Scheme Performance

DISCUSSION OF PAD GA PERFORMANCE

- Pilot well started in September 2011
- Remaining 5 well pairs started up September 2013

- Pad GA performance indicators as of July 31, 2018:
  - Cum Oil: 430,258 m³
  - Cum Steam Injected: 2,084,678 m³
  - Cum Water Produced: 2,767,327 m³
  - CSOR: 4.8

- Pad GA performance for the reporting period:
  - Cum Oil: 76,486 m³
  - Oil Rate per well: 34.9 m³/day
  - SOR: 4.7
7. Scheme Performance

PAD COLONY (CN) PERFORMANCE

2017 warm lime softener repair
7. Scheme Performance

DISCUSSION OF PAD CN PERFORMANCE

- First steam in February 2016
- 6 SAGD well pairs and 7 infill wells

- Pad CN performance indicators as of July 31, 2018:
  - Cum Oil: 435,022 m³
  - Cum Steam Injected: 1,077,448 m³
  - Cum Water Produced: 1,069,794 m³
  - CSOR: 2.5

- Pad CN performance for the reporting period:
  - Cum Oil: 143,650 m³
  - Oil Rate per well: 65.5 m³/day
  - SOR: 2.8
7. Scheme Performance

NEW DEVELOPMENT

- Pad C East Infill Well Application (No. 1908154) was approved March 26, 2018
7. Scheme Performance

OBIP AND RECOVERIES BY WELL PAD

• OBIP for each pad is calculated from the formula:

\[
OBIP = L \times W \times H \times (1-S_w) \times \Phi \times 1/B_o
\]

Where

- \( L \) = Effective Average Length of wells
- \( W \) = Lateral Width covered by the wells
- \( H \) = Thickness from the top of pay to the producer elevation
- \( \Phi \) = Average Porosity in the Pay zone
- \( S_w \) = Average Water Saturation in the Pay zone
- \( B_o \) = Oil Volume factor/Shrinkage factor (taken as 1)
## 7. Scheme Performance

### OBIP AND RECOVERIES BY WELL PAD

<table>
<thead>
<tr>
<th>Well PAD</th>
<th>Thickness (m)</th>
<th>Area (10^3 m²)</th>
<th>Pad Volume¹ (10^3 m³)</th>
<th>So</th>
<th>PhiE</th>
<th>OBIP (10^6 m³)</th>
<th>Recovery to Date 7/31/2017 (10^3 m³)</th>
<th>Recovery Factor to Date (%)</th>
<th>Estimated Ultimate Recovery (10^6 m³)</th>
<th>Ultimate Recovery Factor (%)</th>
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<tr>
<td>Pad A</td>
<td></td>
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<tr>
<td>Pad B</td>
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<td>B West (8 well pairs)</td>
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<td>7.3</td>
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<td>B North (4 well pairs)</td>
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<td>B North Infills (3 well pairs)</td>
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<td>Pad C</td>
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<tr>
<td>C West (8 well pairs)</td>
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<td>0.60</td>
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<td>Pad D</td>
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<td>D East (15 well pairs)</td>
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<td>Pad CN (6 well pairs + 7 infill)</td>
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<td>1.6</td>
<td>436</td>
<td>28</td>
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</tbody>
</table>

**Note:**

OBIP – volume x So x Phi-E

¹ Due to rounding of values, the calculated values may not equal the individual values presented in the table

² Pad C North future development not included in the table. The OBIP is equal to 1.1X10^6 m³
7. Scheme Performance

5-YEAR OUTLOOK OF EXPECTED PAD ABANDONMENT

- No pad abandonment anticipated in the next 5 years
7. Scheme Performance

TEMPERATURE, PRESSURE AND QUALITY OF STEAM

- High pressure steam separator delivers steam at a 100% quality
- Steam quality losses are experienced during transportation to the pads
- Steam quality at the wellhead is estimated to be 95%
7. Scheme Performance

COMPOSITION OF OTHER INJECTED/PRODUCED FLUIDS

• Not applicable for the reporting period
7. Scheme Performance

SUMMARY OF KEY LEARNINGS

- Well placement is key for well performance
- Circulation is the optimal start-up strategy for establishing thermal communication
- Wire-wrapped screens are used to avoid scaling problem of the production liner
- Steady operating conditions are key to obtaining good steam chamber conformance
- To maintain steady operations and prevent water inflow a constant operating pressure is needed and retain bottom water pressure
8. Future Plans

FUTURE PLANS 2019/2020

• Pad Colony Infill Wells:
  • Evaluate options to enable these wells to produce as soon as possible

• Pad B West Replacement Wells:
  • Future development based upon the performance of Pad C West Replacement wells

• Pad C East Infill Wells:
  • Application approved in March 2018
  • Plan to commence drilling in 2019

• Pad Lower Grand Rapids B Development:
  • Target Application submission Q4 2018

• Pad C North Future Development:
  • On-going evaluation of strategies for optimizing the resource recovery
3.1.2 Surface

TABLE OF CONTENTS

1. Facilities – slide 84
2. Facilities Performance – slide 92
3. Measurement, Accounting and Reporting – slide 100
4. Water Production, Injection and Uses – slide 110
5. Sulphur Production – slide 123
6. Environmental Issues – slide 128
7. Compliance Statement – slide 137
8. Non-Compliance Events – slide 139
9. Future Plans – slide 141
1. Facilities

LAYOUT – SOUTHEAST

- Pad A
- Pad B
- Pad CN
- Pad C
- Pad D
- Pad GA
- CPF
1. Facilities

LAYOUT - NORTH
1. Facilities

PAD D

Pad D North

Pad D East

Pad D West
1. Facilities

CENTRAL PROCESSING FACILITY (CPF)
1. Facilities

CENTRAL FIELD FACILITIES (CFF)
1. Facilities

CENTRAL PROCESSING FACILITY - PLOT PLAN
1. Facilities

FACILITY SCHEMATIC
1. Facilities

FACILITY MODIFICATIONS

• Pad D West well pairs D1–D15 Commissioning:
  • Surface facility commissioning and circulation Q4 2017 to Q1 2018
  • First oil in Q1 2018

• Colony Intermittent Steam Stimulation (ISS) wells CN7 and CN9 start-up:
  • Wells on production July 2018
2. Facility Performance

OPERATING LIMITATIONS

• Brackish water wells producing excessive amounts of sand
  • Replaced gravel pack, downhole screen, tubing and wellheads on wells 1F1/08-25-064-04 W4M and 1F1/11-30-064-04 W4M
  • Work-over on remaining well 1F1/12-30-064-04 W4M planned for Q4 2018

• De-oiled water quality KPIs exceeded:
  • Several Total Suspended Oil (TSO) targets exceedences caused when commissioning Pad D West, diluent outages and treating resulted in thick, heavy sludge in Warm Lime Softener (WLS) and off-spec boiler feed water (BFW)
  • WLS rake stalled in thick sludge - December 2017
  • De-scaled (Pigged) OTSG B-7400 - Q3 2017 (as a precaution)
2. Facility Performance

PROCESS WATER DE-OILING

- The de-oiling process consists of 2 skim-tanks (in series), IGF and 2 oil-removal-filters

- Treating challenges were experienced early in the year. Recent moves have brought water chemistry well within specifications

- De-Oiling TSO KPI’s:
  - FWKO – 1,000 ppm (average 240 ppm)
  - IGF Inlet – 100 ppm (average 69 ppm)
  - IGF Out – 40 ppm (average 52 ppm)
  - ORF Outlet – 20 ppm (average 32 ppm)
2. Facility Performance

WARM LIME SOFTENER (WLS)

- Primary water treatment to produce boiler feed water
- Feed sources:
  1. De-oiled produced water
  2. Brackish water make-up
  3. Sludge pond water
- Reduces water contaminants:
  1. Hardness - primarily Calcium and Magnesium
  2. Silica - main contaminant due to thermal recovery process
  3. Turbidity - suspended solids
- Produces sludge as waste product - stored in ponds
- Mechanical turbine, rake drives
- Main zones: Mixing, Reaction, Settling
- Produces water effluent with hardness ~20 ppm and silica ~50 ppm
2. Facility Performance

WLS CHEMISTRY / PERFORMANCE

- Chemistry:
  - Lime – primary hardness control
  - Magnesium Oxide (MagOx) – primary silica reduction
  - Caustic – water pH control, aids softening
  - Sodium Carbonate (soda ash) – permanent hardness removal
  - Polymer – coagulants and flocculants establish sludge bed control

- Performance:
  - The WLS has performed well to date

- Key KPIs:
  - Soluble Hardness – 25 ppm (average 11 ppm)
  - Silica – 50 ppm (average 44 ppm)
  - Turbidity – 20 NTU (average 20 NTU)
2. Facility Performance

POWER CONSUMPTION
2. Facility Performance

GAS USAGE
2. Facility Performance

FLARING AND VENTING

- 7 flaring events that were either over 4 hours in duration or over a volume of 30,000 m³:
  - December 7, 2017 - WLS rake stuck
  - March 15, 2018 - CPF & field trip
  - May 2, 2018 – Emergency Shut Down (ESD) system upgrades tripped CPF & field
  - May 28, 2018 - High temperatures caused CPF trip
  - June 9, 2018 - Power outage due to storm
  - July 6, 2018 - Maintenance activities tripped CPF and field
  - July 18, 2018 - Maintenance activities tripped CPF and field

<table>
<thead>
<tr>
<th>Month</th>
<th>FQI8440 - HP</th>
<th>FQI8477 - LP</th>
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<tbody>
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<tr>
<td>Sep-17</td>
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<td>Oct-17</td>
<td>14.8</td>
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<td>Nov-17</td>
<td>6.3</td>
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<td>Dec-17</td>
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<td>Jan-18</td>
<td>12.1</td>
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<td>Feb-18</td>
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<td>Mar-18</td>
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<td>Apr-18</td>
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<td>May-18</td>
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<td>Jun-18</td>
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<td>1.0</td>
</tr>
<tr>
<td>Jul-18</td>
<td>178.7</td>
<td>1.0</td>
</tr>
</tbody>
</table>
2. Facility Performance

GREEN HOUSE GAS (GHG)

- Emission sources considered include stationary combustion associated with steam generators and glycol heaters, flaring, venting and fugitive emissions
- 739,409.19 tonnes of Carbon Dioxide Equivalent were emitted in 2017 (information taken from the Tucker Thermal 2017 Compliance report submitted under the Specified Gas Emitters Regulation)
- 243,884 emission performance credits generated (currently being audited by Alberta Environmental and Parks)
3. Measurement, Accounting and Reporting

BATTERY SCHEMATICS – AB BT 0089133-344
3. Measurement, Accounting and Reporting

INJECTION FACILITY SCHEMATIC – AB IF 0089451-506
3. Measurement, Accounting and Reporting
MEASUREMENT AND REPORTING – PAD D WEST TESTING
3. Measurement, Accounting and Reporting

MEASUREMENT AND REPORTING – STEAM INJECTION
3. Measurement, Accounting and Reporting

ESTIMATING WELL PRODUCTION

- Oil and Water Estimated by well test:
  - Battery level measurement prorated to wells based on the estimates
  - Correction factor applied to calculated well steam fraction volume

- Three Test Separator Designs (well tests):
  1. Blow-Case (Pads A Original, B, C East, C West):
     - Load-cell or level
     - Vortex for steam + natural gas
     - AGAR water-cut analyzer
  2. Conventional (Pad B North, A Infill & Replacement Wells, Pad GA, Pad D):
     - Coriolis meter for liquid
     - Vortex for steam + natural gas
     - AGAR water-cut analyzer
  3. Horizontal (Pad CN)
     - Coriolis meter for liquid
     - Orifice plate for steam + natural gas
     - Phase Dynamics water-cut analyzer

- Steam fraction calculated (from $P_{\text{sat}} / P_{\text{meas}}$) for all three designs

- Gas Measured at the Battery (proration = 1):
  - GOR for August 1, 2017 to July 31, 2018 = 46.4 m$^3$/m$^3$
3. Measurement, Accounting and Reporting

WATER BALANCE

- Steam Injection:
  - Vortex meters on each well toe and heel
  - Total steam to field measured at the battery
  - Steam Proration = 1.007 m³/m³

- Water Proration Factors (see next slide):
  - Average 12-Month Rolling Proration Factors
    - Water = 1.137
    - Oil = 0.993

- Water / Steam Meter Calibrations:
  - Metering equipment inspected / calibrated annually
  - Annual well steam injection meters inspection as per Directive 017
  - AGAR water cut analyzer calibration program as per Directive 017
  - MARP updated to include all new measurement meters and changes

- Metering Accuracy:
  - Accounting meters meets requirements as per Directive 017 single point measurement accuracy
3. Measurement, Accounting and Reporting

ESTIMATING WELL PRODUCTION – PRORATION FACTORS

![Diagram showing proration factors for different categories of production over time.]
### WELL TEST AVERAGES

<table>
<thead>
<tr>
<th>Test Separator</th>
<th>Wells</th>
<th>Average Test Duration (hours)</th>
<th>Average # of Tests for each Well Per Month</th>
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<td>V-151/152 A1 - A8</td>
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<td>4.5</td>
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</table>
3. Measurement, Accounting and Reporting

SOLVENTS AND CONDENSABLE GAS

- Bitumen production accounts for diluent flash and volumetric shrinkage
- No solvent injection to reservoir
- No non-condensable gas injection
3. Measurement, Accounting and Reporting

MEASUREMENT INITIATIVES – CONTINUOUS IMPROVEMENT

- MARP updated February 28, 2018

- Implemented improvements:
  - Added Pad D West wells (D6-D15) and test separator V-420
  - Added water source battery and disposal facilities to MARP
  - 2 LACT Dilbit meters were added

- Future opportunities:
  - Review findings from AER MARP and internal Enhanced Protection Audit Program (EPAP) audit
  - LP and HP flare meters upgraded to ultrasonic meters in September 2018
4. Water Production, Injection and Uses

BRACKISH WATER

- Make-up water for steam generation
- McMurray Formation

- 3 Source Wells:
  - 1F1/11-30-064-04 W4M
  - 1F1/12-30-064-04 W4M
  - 1F1/08-25-064-04 W4M
4. Water Production, Injection and Uses

WATER USAGE

- Brackish water ~20,000 ppm Total Dissolved Solids (TDS) for steam generation (when required)

- No fresh water is used in process
4. Water Production, Injection and Uses

BRACKISH WATER CONSUMPTION
4. Water Production, Injection and Uses

FRESH WATER

- Water Diversion License No. 00194427-00-01
  - Location well: 12-28-064-04-W4 (CPF)
  - Bonnyville Aquifer
  - Domestic use only:
    - Safety showers/eye-wash stations
    - Cleaning water
    - Washroom/kitchen use

- No Temporary Diversion License (TDL) required during the reporting period
4. Water Production, Injection and Uses

FRESH WATER CONSUMPTION
4. Water Production, Injection and Uses

PRODUCED WATER & STEAM INJECTED
4. Water Production, Injection and Uses

WATER DISPOSAL LIMITS

![Graph showing water disposal limits and actual disposal from August 2017 to July 2018.](image)

- **Disposal Limit**
- **Actual Disposal**
4. Water Production, Injection and Uses

MONTHLY INJECTION WATER BALANCE

Imbalance: \[
\frac{(\text{Total Water IN} - \text{Total Water OUT})}{\text{Total Water IN}} \times 100
\]
4. Water Production, Injection and Uses

OTSG BLOW-DOWN RECYCLE

- OTSG blow-down is recycled to the WLS at a percentage that allows the total dissolved solids, out of the OTSG, to remain below 50,000 uS/cm

- Brackish water make-up has a very high TDS and affects OTSG blow-down recycle

- Recycle approximately 36% of blow-down back to the WLS
4. Water Production, Injection and Uses

DISPOSAL WELLS

• AER Class 1 Wastewater Disposal Wells

• Boiler blow-down disposal:
  • 1AA/12-21-064-04 W4M (AER Approval 10591)
  • 1F1/11-28-064-04 W4M (AER Approval 10591)
  • 00/04-28-064-04W4/0 (AER Approval 10591A) – licensed

• Water treatment process disposal:
  • 00/14-29-064-04 W4M (AER Approval 10591)
4. Water Production, Injection and Uses

DISPOSAL WELLHEAD INJECTION PRESSURE & VOLUMES
4. Water Production, Injection and Uses

LANDFILL WASTE HANDLING

- No landfill within facility
- All landfill waste streams disposed off-site at licensed facilities
4. Water Production, Injection and Uses

WASTE VOLUMES

- Waste summary for 12-28-064-04-W4 (CPF)
- Summary does not include RBW waste for June and July 2018 or Tervita waste for April to July 2018

<table>
<thead>
<tr>
<th>Waste Code</th>
<th>Waste Description</th>
<th>Location Sent To</th>
<th>Final Handling Method</th>
<th>Quantity</th>
<th>Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>BLBDWT</td>
<td>Water EBD &lt;12.5 PH</td>
<td>Tervita - Lindbergh</td>
<td>Cavern</td>
<td>49.94</td>
<td>m³</td>
</tr>
<tr>
<td>COEMUL</td>
<td>High Solids: Solids &gt;40%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>190.5</td>
<td>m³</td>
</tr>
<tr>
<td>Interphase &gt; 20%, Oil &lt;= 30%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>1805.5</td>
<td>m³</td>
<td></td>
</tr>
<tr>
<td>Interphase 0 - 10%, Oil &lt;= 30%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>9440.5</td>
<td>m³</td>
<td></td>
</tr>
<tr>
<td>Interphase 10.1 - 20.0%, Oil &lt;= 30%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>1314.5</td>
<td>m³</td>
<td></td>
</tr>
<tr>
<td>Waste Oil - Solids</td>
<td>Tervita - Lindbergh</td>
<td>Cavern</td>
<td>43.79</td>
<td>m³</td>
<td></td>
</tr>
<tr>
<td>CWATER</td>
<td>Specific, Ice And Snow</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>55.5</td>
<td>m³</td>
</tr>
<tr>
<td>DOMWST</td>
<td>Garbage Domestic Waste</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>36.68</td>
<td>m³</td>
</tr>
<tr>
<td>DOMWST-HZ</td>
<td>Contaminated Waste Non Recyclable</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>29.26</td>
<td>m³</td>
</tr>
<tr>
<td>EMTCON</td>
<td>Plastics</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>2.725</td>
<td>m³</td>
</tr>
<tr>
<td>EMTCON-A</td>
<td>Aerosol Cans Empty</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>0.41</td>
<td>m³</td>
</tr>
<tr>
<td>EMTCON-SB</td>
<td>Empty Container Sample Bottles</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>1.68</td>
<td>m³</td>
</tr>
<tr>
<td>FILAPC</td>
<td>Filters Air Pollution Control Cardboard</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>0.28</td>
<td>m³</td>
</tr>
<tr>
<td>FILOTH</td>
<td>Filters</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>2.1</td>
<td>m³</td>
</tr>
<tr>
<td>INOCHM</td>
<td>Chemicals Inorganic</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>9.8</td>
<td>m³</td>
</tr>
<tr>
<td>N/A</td>
<td>Industrial Waste</td>
<td>Tervita - Marshall Landfill</td>
<td>Class II Landfill</td>
<td>30.2</td>
<td>Tonnes</td>
</tr>
<tr>
<td>OILABS</td>
<td>Absorbents</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>6.3</td>
<td>m³</td>
</tr>
<tr>
<td>OILRAG</td>
<td>Rags Oily</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>1.37</td>
<td>m³</td>
</tr>
<tr>
<td>SAND</td>
<td>Shake-off Sand, NON - DOW</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>2.5</td>
<td>m³</td>
</tr>
<tr>
<td>SLGHYD</td>
<td>Interphase 0 - 10%, Oil &lt;= 30%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>30</td>
<td>m³</td>
</tr>
<tr>
<td>Interphase 10.1 - 20.0%, Oil &lt;= 30%</td>
<td>Elk Point Service Centre</td>
<td>Oilfield Waste Processing Facility</td>
<td>12</td>
<td>m³</td>
<td></td>
</tr>
<tr>
<td>SLGSWT</td>
<td>Gas Sweetening Sludge</td>
<td>Tervita - Lindbergh</td>
<td>Cavern</td>
<td>0.5</td>
<td>m³</td>
</tr>
<tr>
<td>SMETAL</td>
<td>Metal Scrap</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>3.04</td>
<td>m³</td>
</tr>
<tr>
<td>SOILCO</td>
<td>Contaminated Debris and Soil Crude Oil Condensate</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>12</td>
<td>m³</td>
</tr>
<tr>
<td>SOILCO-DW</td>
<td>Contaminated Debris and Soil Non Processable Waste</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>1.12</td>
<td>m³</td>
</tr>
<tr>
<td>WSTMIS-R</td>
<td>Waste Hydraulic Hoses</td>
<td>Rbw Waste Management Ltd</td>
<td>Recycling Facility (excluding used oil)</td>
<td>1.12</td>
<td>m³</td>
</tr>
</tbody>
</table>
5. Sulphur Production

SULPHUR DIOXIDE (SO₂) SOURCES

- Six Once-Through Steam Generators (OTSG)
- One High Pressure Flare Stack
- One Low Pressure Flare Stack
### 5. Sulphur Production

**QUARTERLY SO$_2$ EMISSIONS**

<table>
<thead>
<tr>
<th>Quarter</th>
<th>Emissions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Q3 2017</td>
<td>111.74 tonnes</td>
</tr>
<tr>
<td>(August 2017 – October 2017)</td>
<td></td>
</tr>
<tr>
<td>Q4 2017</td>
<td>107.20 tonnes</td>
</tr>
<tr>
<td>(November 2017 – January 2018)</td>
<td></td>
</tr>
<tr>
<td>Q1 2018</td>
<td>123.60 tonnes</td>
</tr>
<tr>
<td>(February 2018 – April 2018)</td>
<td></td>
</tr>
<tr>
<td>Q2 2018</td>
<td>127.11 tonnes</td>
</tr>
<tr>
<td>(May 2018 – July 2018)</td>
<td></td>
</tr>
</tbody>
</table>
5. Sulphur Production

SO$_2$ EMISSION TRENDS

- SO$_2$ emission limit = 1.96 tonnes/day
5. Sulphur Production

PEAK AND AVERAGE SO$_2$ EMISSIONS

- August 1, 2017 to July 31, 2018:

<table>
<thead>
<tr>
<th>SO$_2$ Emissions</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Daily (highest)</td>
<td>1.29 tonnes</td>
</tr>
<tr>
<td>Maximum Daily (highest)</td>
<td>1.48 tonnes</td>
</tr>
</tbody>
</table>

- Limit under EPEA Approval is 1.96 tonnes/day

- No exceedances
5. Sulphur Production

AMBIENT AIR MONITORING

- Ambient air quality is currently monitored by the Lakeland Industry and Community Association (LICA) - Air Shed committee. LICA is under contract from Alberta Environmental Monitoring and Science Division (EMSD) of Alberta Environment and Parks (AEP) to provide these services.

- No exceedances were recorded during the reporting period.

- Airshed quality results available on LICA website or Clean Air Strategic Alliance (CASA) Data Warehouse.

  - [http://www.lica.ca/](http://www.lica.ca/)

  - [http://www.casadata.org/](http://www.casadata.org/)
6. Environmental Issues

ENVIRONMENTAL – COMPLIANCE TO APPROVALS

• EPEA Approval:
  • No compliance issues during this reporting period

• AER:
  • No compliance issues during this reporting period

• AEP:
  • No compliance issues during this reporting period

• DFO:
  • No compliance issues during this reporting period
6. Environmental Issues

ENVIRONMENTAL – AMENDMENT TO EPEA APPROVAL

- Produced Gas Handling System amendment application (No. 1906604)
  - EPEA Approval No. 147753-01-01
6. Environmental Issues

ENVIRONMENTAL - WILDLIFE

- As part of the regulatory approval, Husky has developed and implemented a Wildlife Monitoring Program (WMP) for:
  - Canadian toad distribution, abundance and population status
  - Above Ground Pipeline (AGP) monitoring to ensure wildlife can cross under the lines
  - Wildlife Habitat Enhancement Program (WHEP)

- Annual WMP report describes the observations and results collected during the previous year

- Worked with Cold Lake High school to construct replacement bat houses
6. Environmental Issues

ENVIROMENTAL – INDUSTRIAL WASTEWATER

• Disposal Locations:
  • Boiler blow-down disposal wells 12-21-064-04W4M and 11-28-064-04W4M
  • Water treatment process disposal well 14-29-064-04W4M
  • 958,857 m$^3$ water disposed

• Domestic Wastewater:
  • Domestic waste sludge is disposed of at the Cold Lake Municipal Treatment Facility or the Bonnyville Municipal Treatment Facility

• Industrial Run-off (from 2017 Annual Waste Water Report):
  • Total of six discharge locations (Well Pads: A, B, C, D, GA, CN and the run-off retention pond located on CPF)
  • A total of 70,722 m$^3$ surface water was discharged due to a very wet year
  • All discharges were in compliance with EPEA approval
6. Environmental Issues

ENVIRONMENTAL - SOILS

- Soil sampling program was completed in Q4 2017 and the report was submitted to AER on March 27, 2018. A total of 32 locations within the CPF and well pads were sampled.
6. Environmental Issues

ENVIRONMENTAL - AIR

• Air related monitoring, reporting and studies are conducted by Lakeland Industry and Community Association (LICA) under contract from Alberta Environmental Monitoring and Science Division (EMSD)

• The LICA airshed monitoring network consists of:
  • 4 continuous monitoring stations
  • 26 passive monitoring stations
  • 2 volatile organic compound and polycyclic aromatic hydrocarbon samplers, and
  • 2 soil acidification monitoring plots
6. Environmental Issues

ENVIRONMENTAL – GROUND WATER

• Groundwater monitoring program includes:
  • CPF Groundwater: monitors shallow groundwater quality beneath the CPF
  • Pad-specific Groundwater: monitors possible impacts to groundwater quality
  • Regional Groundwater: monitors possible effects on regional groundwater quality between the project areas and the local lakes and streams

• Expansion to Groundwater Monitoring Program:
  • No additional expansion to the monitoring network occurred during the reporting period
6. Environmental Issues

ENVIRONMENTAL - INITIATIVES

- Alberta Environmental Monitoring and Science Division (EMSD)

- Participation in the Lakeland Industry and Community Association (LICA)
  - Board of Directors
  - Beaver River Watershed Alliance
  - Airshed

- Participation in Alberta Biodiversity Monitoring Institute (ABMI)
6. Environmental Issues

ENVIRONMENTAL - RECLAMATION

- Objectives of the Annual Report (demonstrate and document):
  - Compliance with the development and reclamation approval
  - Site conditions and successful reclamation
  - General project development (surface disturbances) and reclamation activities
  - Problem areas and resolution

- Site Clearing and Timber Salvage:
  - No site clearing or timber salvage occurred during the reporting period

- Vegetation Monitoring:
  - Annual weed monitoring and control as per Husky’s best practices

- Reclamation Activities:
  - No permanent reclamation activities were completed during the reporting period
7. Compliance Statement

COMPLIANCE

AER:

• All conditions of AER License F-32143 as well as all scheme approvals for the Project were met during the reporting period

• All conditions of the EPEA approval 147753-01-01 were met during the reporting period
7. Compliance Statement

SELF DECLARATIONS

• No self declaration during the reporting period
8. Non-Compliance Events

AER REPORTABLE

- AER Contravention report - CIC # 334732:
  - February 15, 2018 - Water Act temporary diversion licence violation. Unable to download data from the transducer because it was stuck in the well, this is now repaired

- AER Contravention report - CIC # 334731:
  - February 15, 2018 - Water Act temporary diversion licence violation. Unable to take a water level measurement daily because the transducer was stuck in the well, this is now repaired

- AER Contravention report - CIC # 335878:
  - March 19, 2018 - Emulsion pump seal failure causing release of emulsion. Clean-up is complete

- AER Contravention report - CIC # 337475:
  - April 30, 2018 - CEMS Code 90% uptime requirement

- AER Inspection 476494:
  - June 18, 2018 - Low Risk for secondary containment not designed, constructed, sized and maintained as required
8. Non-Compliance Events

SCFV/GM UPDATE SUMMARY – WELL C13S

- C13S SCVF Update:
  - No SCVF; continue to trickle-in steam
  - Multiple temperature deviations along tubing
  - Maximum temperature of approximately 194 °C at depth of 388 m
  - Increased temperature due to loss-of-insulating properties in the Vacuum Insulated Tubing (VIT)
  - Temperature log trend deviation commenced in June 2015
  - Currently, quarterly monitoring of H2S, SCVF and temperature

- Yearly monitoring of existing non-serious vent flows in accordance with AER ID 2003-01; on-going

- Plan:
  - To evaluate and engage AER on path forward
9. Future Plans

FUTURE PLANS 2018/2019

• Complete Phase 1 debottleneck of the Produced Gas Handling System (September 2018)
• Phase 2 debottleneck of the Produced Gas Handling System (Q4 2019)
  • Submit application to AER for review and approval Q4 2018
• Facility turn-around in 2020