INTRODUCTION

PROJECT DESCRIPTION AND STATUS

SUBSURFACE
- Geoscience
- Well Design and Instrumentation
  - Drilling and Completions
  - Artificial Lift
  - Instrumentation
- 4-D Seismic and Monitoring
- Scheme Performance
- Future Plans

SURFACE
- Facilities
- Measurement and Reporting
- Water Production, Injection and Uses
- Sulphur Production
- Compliance
- Future Plans
DEVELOPMENT OVERVIEW

- Project 1 – 1,908 m³/d (12,000 bbl/d) (March 2015 first steam)
- Project 2A – 1,272 m³/d (8,000 bbl/d) (current EIA application)
- Project 2B – 5,087 m³/d (32,000 bbl/d) (current EIA application)
- Project 3 – 4,770 m³/d (30,000 bbl/d) (current EIA application)
HS1 PROJECT

- First steam (downhole) achieved March 23, 2015
- First oil produced July 2015
- Last SAGD conversion mid March, 2016 (AC01 and AE05)
- As of October 31, 2017 there were 23 well pairs in SAGD mode and 2 well pairs were standing
  - The two standing wells were drilled as production assurance wells and will be brought on production when there is steam availability
DESCRIPTION

PROJECT DETAILS
- Located 20 km south of Fort McMurray, AB
- 5 production pads
- 25 horizontal well pairs (5 well pairs per pad)
- Central Processing Facility (CPF) and associated facilities
- Offsite services and utilities

INFRASTRUCTURE
- Fuel gas from TransCanada Pipeline (TCPL)
- Dilbit export to Enbridge Cheecham Terminal
- Diluent from Inter Pipeline (IPL)
<table>
<thead>
<tr>
<th>Area</th>
<th>Area (km²)</th>
<th>MCMR Cored Wells</th>
<th>Image Logs</th>
<th>Caprock Core</th>
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<td>26</td>
<td>31</td>
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<tr>
<td>Project Area</td>
<td>5.6</td>
<td>26</td>
<td>31</td>
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</table>
3D ACQUIRED IN 2011 AND 2012, MERGED IN 2012

- Total proprietary 2D ~ 450 km
- Total 3D area ~98 km² (merged)
  - Covers development area
- Total 4D area ~3.72 km²
  - Baseline acquired Q1 2014
  - First Monitor acquired Q1 2016 / Second Monitor acquired Q1 2017

3D/4D PARAMETERS

- Source line/source spacing: 60m/20m
- Receiver line/receiver spacing: 40-60m/20m
MIDDLE MCMURRAY TARGET RESERVOIR

<table>
<thead>
<tr>
<th>Stratigraphic Unit</th>
<th>Description</th>
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<tbody>
<tr>
<td>Quaternary</td>
<td>Quaternary Glacial Drift &amp; Till</td>
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<tr>
<td>Lower Grand Rapids</td>
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<tr>
<td>Clearwater FM</td>
<td></td>
</tr>
<tr>
<td>Wabiskaw</td>
<td></td>
</tr>
<tr>
<td>McMurray FM</td>
<td></td>
</tr>
<tr>
<td>Middle</td>
<td></td>
</tr>
<tr>
<td>Beaverhill Lake Group (Devonian)</td>
<td></td>
</tr>
</tbody>
</table>

Facies:
- Sand
- Sandy IHS
- Muddy IHS
- Mudstone
- Limestone
MIDDLE MCMURRAY
GROSS PAY
DEFINITION

- Calculated between Top and Base Pay
- Thickness >= 10 m
- GR < 70 API
- Density > 27%
- Resistivity > 18 ohm-m
- Water Saturation < 50%
- Includes < 1 m thick mud

Net pay thickness uses gross pay criteria but excludes mud
STRUCTURAL CROSS SECTION NW-SE ACROSS HS1 AREA

Net Pay Thickness, m

- Peaky
- Trough

GR RESISTIVITY
- High
- Low

Wabiskaw
McMurray
Top Pay
Base Pay
Paleozoic

Gross 36m
Net 26m
Gross 36m
Net 31m
Gross 38m
Net 22m
Gross 43m
Net 38m
Gross 44m
Net 39m
Gross 36m
Net 21m
STRUCTURE MAP OF TOP OF BITUMEN PAY

RANGE OF ELEVATION FROM 262 TO 301 MASL, HIGHEST OVER DRAINAGE PADS
STRUCTURE MAP OF BASE OF BITUMEN PAY

RANGE OF ELEVATION FROM 241 TO 262 MASL, LOW OVER DRAINAGE PADS

- **Wabiskaw**
- **McMurray**
- **Top Pay**
- **Base Pay**
- **Paleozoic**

Legend:
- **Pad Drainage Area**
- **Project Area**
- **Development Area**
- **1AA/03-31-086-09W4/00**
MIDDLE McMURRAY GAS HAS MINIMAL THICKNESS AND LIMITED DISTRIBUTION WITHIN THE DEVELOPMENT AREA
The permeability measured from core within the muddy interval between the bottom water and the bitumen reservoir through interval 193.80 to 193.85 m MD is 4.30 millidarcy (kV) and 71.0 millidarcy (kMax). Denoted on photo by ★.
ISOPACH MAP OF MIDDLE MCMURRAY LOW BITUMEN SATURATION

LOW BITUMEN SATURATION ZONE (LSZ)

- GR<60 API, density porosity >0.27 and resistivity 10-18 ohm-m and core water saturation >50%
- Core So= 0.36 and porosity = 0.37, thus the LSZ will still contribute to the overall bitumen production
NO NEW CAPROCK CORE, MINI-FRACT OR TRI-AXIAL TESTING IN 2016/17

- Caprock is defined as the unit between the top of the Clearwater and Wabiskaw
  - Two main units within the caprock; lower argillaceous and upper silty mud, are composed primarily of shales and siltstones
- Existing caprock core/mini-frac/triaxial well (2011) was used to define the maximum operating pressure
- One observation well (2012) with one piezometer and two thermocouples in the caprock
  - No pressure or temperature change has been observed in the Clearwater thermocouples or piezometer for the life of the project
RESERVOIR PROPERTIES

- Typical Producer Depth: 191 TVD (258 masl)
- Initial Reservoir Pressure @ 190m TVD: 600 kPa
- Initial Reservoir Temperature: 8°C
- Horizontal Permeability: 3,500-4,300 mD
- Vertical Permeability: 2,800-3,600 mD
- Bitumen Viscosity @ initial reservoir temperature: >1mln cP

Gross OBIP = Thickness from Top to Base Pay x Area x Porosity x So

<table>
<thead>
<tr>
<th></th>
<th>Avg Por (frac)</th>
<th>Avg So (frac)</th>
<th>OBIP (mln m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drainage Areas</td>
<td>0.36</td>
<td>0.72</td>
<td>15.6</td>
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<tr>
<td>Development Area</td>
<td>0.36</td>
<td>0.72</td>
<td>18.6</td>
</tr>
<tr>
<td>Project Area</td>
<td>0.36</td>
<td>0.72</td>
<td>18.6</td>
</tr>
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</table>
SAGD DRILLING SUMMARY

- 25 well pairs 650-850 m long laterals
- Typical well spacing is 100 m except between pads, which is 130 m
- No new drills during this reporting period

<table>
<thead>
<tr>
<th>Pad</th>
<th>Average Net Pay thickness above producer (m)</th>
<th>Average Effective Lateral Length in producer (GR&lt;60 API) (m)</th>
<th>Average Percent Reservoir along producer lateral (%)</th>
<th>Well Spacing (m)</th>
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<tbody>
<tr>
<td>AA</td>
<td>23.7</td>
<td>715</td>
<td>86</td>
<td>100</td>
</tr>
<tr>
<td>AB</td>
<td>22.4</td>
<td>613</td>
<td>97</td>
<td>100</td>
</tr>
<tr>
<td>AC</td>
<td>24.3</td>
<td>674</td>
<td>94</td>
<td>100</td>
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<tr>
<td>AD</td>
<td>26.2</td>
<td>614</td>
<td>96</td>
<td>100</td>
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<tr>
<td>AE</td>
<td>22.6</td>
<td>746</td>
<td>93</td>
<td>100</td>
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</table>
- Mechanical lift required to bring fluids to surface
- 6 producer wells with all-metal progressing cavity pumps (PCP)
- 19 producer wells with electric submersible pumps (ESP)
ARTIFICIAL LIFT – TYPES

- All wells initially completed with all-metal PCP
- 19 wells converted to ESP
- Wells and facilities were built with the flexibility to easily convert to ESPs from PCPs

<table>
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<tr>
<th>Properties</th>
<th>PCP</th>
<th>ESP</th>
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<tbody>
<tr>
<td>Typical Minimum Rate (m³/d)</td>
<td>100</td>
<td>125</td>
</tr>
<tr>
<td>Typical Maximum Rate (m³/d)</td>
<td>600</td>
<td>825</td>
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<table>
<thead>
<tr>
<th>Well</th>
<th>Type</th>
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<tr>
<td>AA2</td>
<td>ESP</td>
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<tr>
<td>AA3</td>
<td>PCP*</td>
</tr>
<tr>
<td>AA4</td>
<td>ESP</td>
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<tr>
<td>AA5</td>
<td>PCP*</td>
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<td>AE3</td>
<td>ESP</td>
</tr>
<tr>
<td>AE4</td>
<td>ESP</td>
</tr>
<tr>
<td>AE5</td>
<td>ESP</td>
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</table>

*Production assurance well

Source: Baker Hughes

Typical Pump Operating Conditions

<p>| | |</p>
<table>
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<tr>
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<tbody>
<tr>
<td>Average BHP (kPag)</td>
<td>1,800</td>
</tr>
<tr>
<td>Average BHT (°C)</td>
<td>180</td>
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</table>
ARTIFICIAL LIFT – PERFORMANCE

**PCP PERFORMANCE**
- Effective for initial well completion
  - Successfully steamed through the pump
  - Allowed for quick conversion from circulation to SAGD
  - Managed a wide range of flow rates
- All-metal PCPs have performed as expected
- Wellhead pressure reduced on some wells to improve pump efficiency
- Plan to convert PCPs to ESPs as rates improve and wells mature

**ESP PERFORMANCE**
- 19 wells converted to ESPs
**INSTRUMENTATION – SAGD WELL PAIRS**

**TEMPERATURE**

- Two types of fiber for temperature measurements
  - Fiber Bragg Grating (FBG) and Distributed Temperature Sensing (DTS)
  
- Both systems adequate for temperature management along the wellbore

**PRESSURE**

- Injector BHP is measured with blanket gas
- Producer BHP is measured using optical gauges and/or bubble tubes

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**LEGEND**

**Producer Only:**
Fiber with 1 or 2 pressure sensors

**Producer and Injector:**
Fiber with 1 or 2 pressure sensors

**SS = Steam Splitters**
- 4 injectors, each with 2 ports
- AA4I and AB4I have slimbore 7" liner

No FCDs installed on producers to date
OBSERVATION WELLS

- Some pressure sensors have failed (typically after steam conditions observed)
- Instrumentation used to monitor reservoir pressure and temperature growth

**LEGEND**
- 10 Vertical delineation wells
- 5 Obs wells with 10 to 20 TCs
- 10 Obs wells with 10 to 20 TCs and 3-6 piezometers
- Obs well also monitoring above pay (U. McM, Wab and CLW caprock)
- Obs well with Reservoir Saturation Logging (2017)
SUBSURFACE
4D SEISMIC AND MONITORING
4D SEISMIC STRATEGY

- AOC has buried geophones over the five drainage areas to monitor steam growth and conformance using 4D seismic
  - Baseline was acquired in Q1 2014
  - First monitor was successfully acquired Q1 2016
  - Second monitor was successfully acquired Q1 2017
  - Next monitor scheduled for Q1 2019
- Buried geophones allow for year round shooting if needed

ACQUISITION PARAMETERS

- Area: 3.72 km²
- Source line interval: 60 m, source interval: 20 m
- Receiver line interval: 40 m, receiver interval: 20 m
- Buried receiver depth: 3 m
- Source depth: 6 m

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<tbody>
<tr>
<td></td>
<td>Q1</td>
<td>Q2</td>
<td>Q3</td>
<td>Q4</td>
<td>Q1</td>
<td>Q2</td>
</tr>
<tr>
<td>Phase 1</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
<td>★</td>
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</table>

★ Baseline  ★ First Steam  ★ Monitor
4D SEISMIC SECOND MONITOR

- Acquired in March 2017
  - Approximately 24 months after first steam
  - SAGD conversions range from 13–20 months prior to 4D acquisition
- Well pairs AA3 and AA5 are production assurance wells (not on production)
- Steam growth seen on 4D monitor correlates with temperature and RST logs on associated observation wells
DENSITY VOLUME (2017 MONITOR)
RESERVOIR SATURATION TOOL (RST) RESULTS

- Originally acquired saturation curves on one well per pad in 2012
- In February 2016, acquired saturation logs on 7 different wells, one of which overlapped the baseline curves
- In February 2017 acquired saturation logs on 8 different wells
- RST results show steam chamber thickness correlates with observation well temperature profiles
SURFACE HEAVE MONITORING

HEAVE MONUMENT PLACEMENT

- 31 permanent surface heave monuments (0.30 x 0.30 m plate)
- Primary means for measuring heave across field
- 15 monuments located at the observation wells and 16 along pipeline corridors and pads

2017 SURVEY/RESULTS

- Real-time Kinematic (RTK) survey method was used. Datum for this survey is ICP009 and position is confirmed by PPP solution
- RTK survey tolerance range is +/- 2 cm
- Minimal change was observed between February 2016 and February 2017 (only two wells outside survey accuracy range)
- The maximum change observed between February 2015 and January 2017 was 5 cm. This occurred over AE Pad which had the greatest steam injection volumes

2015-16 HEAVE DIFFERENCE, CM

2015-17 HEAVE DIFFERENCE, CM
- Continuing production ramp-up and field optimization
- Maximum monthly bitumen rate 1,511 m³/d (9,502 bbl/d) with SOR of 4.6 (Oct 2017)
  - Currently 23 of the 25 SAGD well pairs on production
  - SOR decline will continue as reservoir reaches target operating pressure and upper portions of the reservoir begin to drain
  - Improving field sub-cools
  - As expected, water retention has reduced over time - providing evidence that the reservoir is bounded
MAXIMUM OPERATING PRESSURE (MOP)

- Approved Maximum Operating Pressure is 2,100 kPag during startup/circulation and SAGD operations.
- Request increase of MOP in February 2016 from 1,900 kPag to 2,100 kPag during SAGD mode was approved November 2016.
- Injection wells reached new operating pressure targets in October 2017.
  - Average injection pressure of 2,050 kPag.
  - Currently evaluating results of MOP increase as reservoir pressure continues to increase.

STEAM QUALITY

- Steam quality leaving the plant is approximately 98% (incl. Continuous Blow Down (CBD)) at typically 6,000 kPag.
- Steam quality decreases to wellheads and is not measured, but has been modelled and estimated to be 95%.
- These conditions align with the original design.
o Piezometers placed throughout the field at various elevations

o Field average pressure indicates the pressure has increased from the Baseline and approaching the MOP pressure of 2,100 kPag
  • Evidence of vertical and horizontal pressure communication throughout pay across entire field
  • No pressure change in caprock

LEGEND
- 10 Vertical delineation wells
- 5 Obs wells with 10 to 20 TCs
- 10 Obs wells with 10 to 20 TCs and 3-6 piezometers
- Obs well also monitoring above pay (U. McM, Wab and CLW caprock)
- Obs well with Reservoir Saturation Logging (2017)
Pressure data shows evidence of pressure communication across entire pay.

Pressure difference between top and bottom of pay is decreasing.

Average daily field pressure at base, middle and top of reservoir:

- Circulation
- SAGD

Average daily injection pressure in each Pad:

- Pad AA
- Pad AB
- Pad AC
- Pad AD
- Pad AE

- Maximum Operating Pressure

*Pressure represents average of several piezometers from OBS wells at various depths.
### PAD RECOVERY

<table>
<thead>
<tr>
<th>Pad</th>
<th>Well Pairs</th>
<th>Average Lateral Length (m)</th>
<th>Average Net Pay above Producer (m)</th>
<th>Oil Saturation (frac)</th>
<th>Total Net Pay Porosity (frac)</th>
<th>SAGD-able OBIP (10⁶ m³)</th>
<th>OBIP (10⁶ m³)</th>
<th>SAGD-able Predicted Recovery Factor (%)</th>
<th>SAGD-able Recovery Factor (%)</th>
<th>OBIP-based Recovery Factor (%)</th>
<th>Current Recovered (10³ m³)</th>
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<tbody>
<tr>
<td>AA</td>
<td>3/5</td>
<td>850</td>
<td>23.7</td>
<td>0.71</td>
<td>0.35</td>
<td>2.68</td>
<td>3.30</td>
<td>50-70</td>
<td>5.4</td>
<td>4.4</td>
<td>144.4</td>
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<tr>
<td>AB</td>
<td>5/5</td>
<td>640</td>
<td>22.4</td>
<td>0.73</td>
<td>0.37</td>
<td>2.21</td>
<td>2.90</td>
<td>50-70</td>
<td>15.3</td>
<td>11.7</td>
<td>338.5</td>
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<td>AC</td>
<td>5/5</td>
<td>750</td>
<td>24.3</td>
<td>0.70</td>
<td>0.36</td>
<td>2.52</td>
<td>3.00</td>
<td>50-70</td>
<td>5.8</td>
<td>4.9</td>
<td>145.6</td>
</tr>
<tr>
<td>AD</td>
<td>5/5</td>
<td>670</td>
<td>26.2</td>
<td>0.71</td>
<td>0.35</td>
<td>2.52</td>
<td>3.20</td>
<td>50-70</td>
<td>6.7</td>
<td>5.3</td>
<td>168.5</td>
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<td>AE</td>
<td>5/5</td>
<td>830</td>
<td>22.6</td>
<td>0.70</td>
<td>0.35</td>
<td>2.53</td>
<td>3.20</td>
<td>50-70</td>
<td>6.8</td>
<td>5.4</td>
<td>172.9</td>
</tr>
<tr>
<td>TOTAL</td>
<td>23/25</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.46</td>
<td>15.6</td>
<td>50-70</td>
<td>7.8</td>
<td>6.2</td>
<td>969.9</td>
</tr>
</tbody>
</table>

- SAGD-able OBIP values are based on actual producer well placement and reservoir height above producer well. OBIP is gross oil volume between base and top of pay.
- Included 25 m at Heel and Toe of Well in both OBIP volumes.
PAD PERFORMANCE

- Variation of pad performance depends on geology, pad boundary, well pair trajectories, pump performance and subcool conformance
  - Pads AB, AD and AE selected as examples of high/medium/low performing pads
    - Selection based on cumulative oil recovery
    - Differences in the productivity of the wells primarily due to geological variability
**PAD PERFORMANCE – HIGH PAD AB**

**HIGH PAD AB**
- Cumulative production: 338,560 m³
- cSOR: 3.4
- Highest reservoir quality
  - Mostly sandy reservoir
  - High oil saturation around well pairs
  - Thin low bitumen saturation zone
- Highest average effective wellbore (97%)
- Partially bounded
- Well 03-31 shows steam chamber development near toe of AB03
- Pressure increase at top of reservoir through IHS
PAD PERFORMANCE – MID PAD AD

**MID PAD AD**

- Cumulative production: 169,297 m³
- cSOR: 6.1
- Average reservoir quality
  - *IHS with high oil saturation in upper reservoir*
  - *Thick low bitumen saturation zone above injection well*
  - *Thickest net pay (26.2 m)*
- Shortest wells
- Most bounded pad
- High average effective wellbore (96%)
- Well 7-31 shows good steam chamber development at heel of AD02
  - *Temperature increase through IHS*
  - *Steam chamber advancing through LSZ*

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**AD02OA, 100/07-31-86-09W4 HEEL (0.7 m OFFSET)**

- Thermocouple

**Chart:**

- **Pad AD - Fluid Flow Rate, m³/d**
  - Oil (m³/d)
  - Steam (CWE m³/d)
  - Water (m³/d)
  - iSOR
  - cSOR

- **SOR:**
  - 0.0
  - 1.0
  - 2.0
  - 3.0
  - 4.0
  - 5.0
  - 6.0
  - 7.0
  - 8.0
  - 9.0
  - 10.0
  - 11.0
  - 12.0
  - 13.0
  - 14.0

- **Dates Range:**
  - Jan-2015
  - Apr-2015
  - Jul-2015
  - Oct-2015
  - Jan-2016
  - Apr-2016
  - Jul-2016
  - Oct-2016
  - Jan-2017
  - Apr-2017
  - Jul-2017
  - Oct-2017

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LOW PAD AE

- Cumulative production: 172,442 m³
- cSOR: 7.9
- Average reservoir quality
  - Breccia dominated
  - Thick low bitumen saturation zone above injection well
- Unbounded towards west
- Pad performance improved from last year after ESP conversions
- Well 12-31 shows good steam chamber development at heel of AE04
- Pressure increases at top of reservoir through IHS
- Temperature increasing above breccia
  - Fluid movement along bedding planes and through breccia
  - Steam chamber advancing through LSZ
FUTURE PLANS

- No new SAGD drills planned for next reporting period
- No abandonments planned in the next 5 years
- Production assurance wells to be brought online pending steam availability
- Expect to convert remaining active PCP wells to ESPs as required
- Evaluating opportunities for Flow Control Devices (FCDs) into one or more producer wells
SURFACE OPERATIONS

FACILITIES
FACILITY PERFORMANCE

SITE RELIABILITY > 95%
- Based on steam performance
- Integrity management program and predictive maintenance programs have been implemented to maintain higher site reliability

MAJOR ACTIVITIES
- Boiler Mechanical Cleaning
- Evaporator Mechanical Cleaning
- Enhanced Diluent Recovery System installation and commissioning
- Evaporator Eductor motive fluid electric heater installation and commissioning

MAJOR CHALLENGES
- De-oiling optimization
FACILITY PERFORMANCE

BITUMEN PRODUCTION

Bitumen Production

![Bitumen Production Chart]

- Bitumen Production (bpd)
- Plant Design (bpd)
- Bitumen Production (m3/d)
- Plant Design (m3/d)
Steam Generation

- Actual (m³/month)
- Plant Design (m³/month)

<table>
<thead>
<tr>
<th>Month</th>
<th>Actual (m³/month)</th>
<th>Plant Design (m³/month)</th>
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<tbody>
<tr>
<td>Nov-16</td>
<td>160,000</td>
<td>220,000</td>
</tr>
<tr>
<td>Dec-16</td>
<td>210,000</td>
<td>220,000</td>
</tr>
<tr>
<td>Jan-17</td>
<td>180,000</td>
<td>220,000</td>
</tr>
<tr>
<td>Feb-17</td>
<td>230,000</td>
<td>220,000</td>
</tr>
<tr>
<td>Mar-17</td>
<td>190,000</td>
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<tr>
<td>May-17</td>
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<td>220,000</td>
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<tr>
<td>Jun-17</td>
<td>200,000</td>
<td>220,000</td>
</tr>
<tr>
<td>Jul-17</td>
<td>190,000</td>
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<td>Aug-17</td>
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<tr>
<td>Sep-17</td>
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<td>220,000</td>
</tr>
<tr>
<td>Oct-17</td>
<td>230,000</td>
<td>220,000</td>
</tr>
</tbody>
</table>
FACILITY PERFORMANCE

POWER USAGE YTD 106,447 MWh

POWER USAGE (MWh per month)
**FACILITY PERFORMANCE**

**TOTAL GAS USAGE YTD** 156,837 e³m³  
**SOLUTION GAS RECOVERY** 100%

<table>
<thead>
<tr>
<th>Month</th>
<th>TCPL Purchased gas (e³m³)</th>
<th>Produced Gas (e³m³)</th>
<th>Diluent Flash (e³m³)</th>
<th>Flare (e³m³)</th>
<th>Total Gas Usage (e³m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov-16</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dec-16</td>
<td></td>
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<tr>
<td>Jan-17</td>
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<td>Feb-17</td>
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<tr>
<td>Mar-17</td>
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<tr>
<td>Apr-17</td>
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<tr>
<td>May-17</td>
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<tr>
<td>Jun-17</td>
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<td>Jul-17</td>
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<td>Aug-17</td>
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<tr>
<td>Sep-17</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oct-17</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GAS USAGE (e³m³ per month)**

- TCPL Purchased gas (e³m³)
- Produced Gas (e³m³)
- Diluent Flash (e³m³)
- Flare (e³m³)
- Total Gas Usage (e³m³)
DIRECT GHG EMISSIONS FROM NOVEMBER 2016 – OCTOBER 2017: 333.3 KT CO₂e

- Sources: stationary combustion, flaring, venting and fugitives
- Calculated using quantification methodology submitted with 2016 SGER data
PRODUCED WATER RECYCLE (AVG. 96%)

Directive 081, Appendix H, Equation 6
FACILITY PERFORMANCE

- Disposal Limit % = \((FW \text{ In} \times Df \text{ (i.e. 0.03)} + PW \text{ In} \times Dp \text{ (i.e. 0.10)}/(FW \text{ In} + PW \text{ In})) \times 100\)
- Actual Disposal % = \((\text{Total Disposal})/(FW \text{ In} + PW \text{ In}) \times 100\)
WASTE DISPOSAL

- Waste streams are slop oil, evaporator blowdown and excess produced water

- Volumes reported via Petrinex
SURFACE MEASUREMENT, ACCOUNTING AND REPORTING PLAN (MARP)
MEASUREMENT, ACCOUNTING AND REPORTING PLAN (MARP) APPROVAL RECEIVED ON OCTOBER 5, 2012

- MARP variance was submitted to AER in February 2017 for changes in steam measurement meters, which was approval by AER and resulted in switching the names of primary and secondary meters
MEASUREMENT METHODOLOGY

WELL PRODUCTION AND INJECTION VOLUMES

- Each well pad has a dedicated test separator with liquid flow meter and water cut analyzer to determine well bitumen and water production.
- Wells are individually put on test for one valid testing hour for every 20 hours of operation. Valid well test criteria per approved MARP.
- Well gas production prorated from Battery Level GOR using a proration factor of 1. Battery Level GOR is updated monthly.
- Steam injection is metered at each individual wellhead. Primary and secondary steam production metering available at the central steam plant.

BATTERY SALES OIL

- Sales oil is shipped via pipeline from the Hangingstone Battery. Custody transfer metering is done at the receiving facility.

MEASUREMENT TECHNOLOGY

- Well testing uses standard method of test separators with microwave water cut analyzers. New technologies such as multiphase flow meters may be evaluated later.
STEAM VOLUMES

- Steam quality leaving the plant is approximately 98%
- A continuous blowdown (CBD) of approximately 2% is added to the steam of each boiler and is injected into the wells
- Intermittent blow down (IBD) flow is estimated at 0.02% of total water out of the facility using sound engineering practices

PRODUCED WATER VOLUMES

- Produced Water into the facility is calculated using the measured Water Disposition to the Injection Facility plus the Water Dispositions from the Plant plus and changes in Water Inventory less any Water Receipts
PRORATION OF BITUMEN AND WATER

Proration Factor for Bitumen and Water

- Bitumen Proration
- Water Proration
- Lower Limit (-15%)
- Upper Limit (+15%)
SURFACE
WATER PRODUCTION, INJECTION AND USES
FRESH WATER WELLS

- Water Diversion License 00316166-01-00 amendment received on March 7, 2016 for 479,975 m³ annually
- During Nov. 1, 2016 to Oct. 31, 2017 AOC diverted 186,221 m³

**3 SOURCE WELLS**
- WSW 06-12-086-09 (ACTIVE)
- WSW 04-08-086-08 (ACTIVE)
- WSW 15-33-085-08 (CONTINGENT)

<table>
<thead>
<tr>
<th>Well ID</th>
<th>Location</th>
<th>Formation</th>
<th>TDS (mg/L)</th>
<th>Maximum Rate of Diversion (m³/d)</th>
</tr>
</thead>
<tbody>
<tr>
<td>WSW153308508W400</td>
<td>15-33-085-08-W4</td>
<td>Quaternary</td>
<td>286</td>
<td>3,000</td>
</tr>
<tr>
<td>WSW061208609W400</td>
<td>06-12-086-09-W4</td>
<td>Quaternary</td>
<td>303</td>
<td>3,000</td>
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<tr>
<td>WSW040808608W400</td>
<td>04-08-086-08-W4</td>
<td>Quaternary</td>
<td>287</td>
<td>3,000</td>
</tr>
</tbody>
</table>

Wells are less than 150 m in depth and not licenced with the AER. Well IDs are AOC internal identifiers, not UWIs.
GROUNDWATER MONITORING

WATER SOURCE AND OBSERVATION WELL DRAWDOWN IS STABLE SINCE JUNE 2016 (AFTER THE FIRE), THIS INDICATES THAT DIVERSION IS SUSTAINABLE
### RESULTS OF CHEMICAL ANALYSES OF WATER

<table>
<thead>
<tr>
<th></th>
<th>UNITS</th>
<th>PRODUCED WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calculated Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardness (CaCO3)</td>
<td>mg/L</td>
<td>37</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>2635</td>
</tr>
<tr>
<td><strong>Elements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Calcium (Ca)</td>
<td>mg/L</td>
<td>10.8</td>
</tr>
<tr>
<td>Dissolved Iron (Fe)</td>
<td>mg/L</td>
<td>0.7</td>
</tr>
<tr>
<td>Dissolved Magnesium (Mg)</td>
<td>mg/L</td>
<td>2.5</td>
</tr>
<tr>
<td>Dissolved Manganese (Mn)</td>
<td>mg/L</td>
<td>0.1</td>
</tr>
<tr>
<td>Dissolved Potassium (K)</td>
<td>mg/L</td>
<td>18.8</td>
</tr>
<tr>
<td>Dissolved Sodium (Na)</td>
<td>mg/L</td>
<td>922</td>
</tr>
<tr>
<td><strong>Anions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Chloride (Cl)</td>
<td>mg/L</td>
<td>1081.5</td>
</tr>
<tr>
<td>Dissolved Sulphate (SO4)</td>
<td>mg/L</td>
<td>6.8</td>
</tr>
<tr>
<td><strong>Physical Properties</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conductivity</td>
<td>uS/cm</td>
<td>4325</td>
</tr>
<tr>
<td>pH</td>
<td>pH</td>
<td>8.6</td>
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<tr>
<td>Alkalinity (Total as CaCO3)</td>
<td>mg/L</td>
<td>407</td>
</tr>
<tr>
<td>Alkalinity (PP as CaCO3)</td>
<td>mg/L</td>
<td>236</td>
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<tr>
<td>Bicarbonate (HCO3)</td>
<td>mg/L</td>
<td>209.5</td>
</tr>
<tr>
<td>Carbonate (CO3)</td>
<td>mg/L</td>
<td>141.8</td>
</tr>
<tr>
<td>Hydroxide (OH)</td>
<td>mg/L</td>
<td>0.5</td>
</tr>
</tbody>
</table>
# WATER ANALYSES – SOURCE WATER (YEARLY AVERAGE)

<table>
<thead>
<tr>
<th>RESULTS OF CHEMICAL ANALYSES OF WATER</th>
<th>UNITS</th>
<th>SOURCE WATER</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calculated Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardness (CaCO3)</td>
<td>mg/L</td>
<td>199</td>
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<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>300</td>
</tr>
<tr>
<td><strong>Elements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Calcium (Ca)</td>
<td>mg/L</td>
<td>56.3</td>
</tr>
<tr>
<td>Dissolved Iron (Fe)</td>
<td>mg/L</td>
<td>0.3</td>
</tr>
<tr>
<td>Dissolved Magnesium (Mg)</td>
<td>mg/L</td>
<td>14.2</td>
</tr>
<tr>
<td>Dissolved Manganese (Mn)</td>
<td>mg/L</td>
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<tr>
<td>Dissolved Potassium (K)</td>
<td>mg/L</td>
<td>2.85</td>
</tr>
<tr>
<td>Dissolved Sodium (Na)</td>
<td>mg/L</td>
<td>38.75</td>
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<tr>
<td><strong>Anions</strong></td>
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<tr>
<td>Dissolved Chloride (Cl)</td>
<td>mg/L</td>
<td>3.05</td>
</tr>
<tr>
<td>Dissolved Sulphate (SO4)</td>
<td>mg/L</td>
<td>26.0</td>
</tr>
<tr>
<td><strong>Physical Properties</strong></td>
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<td></td>
</tr>
<tr>
<td>Conductivity</td>
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<tr>
<td>pH</td>
<td>pH</td>
<td>7.7</td>
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<tr>
<td>Alkalinity (Total as CaCO3)</td>
<td>mg/L</td>
<td>261.5</td>
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<tr>
<td>Alkalinity (PP as CaCO3)</td>
<td>mg/L</td>
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<tr>
<td>Bicarbonate (HCO3)</td>
<td>mg/L</td>
<td>319.0</td>
</tr>
<tr>
<td>Carbonate (CO3)</td>
<td>mg/L</td>
<td>0.5</td>
</tr>
<tr>
<td>Hydroxide (OH)</td>
<td>mg/L</td>
<td>0.5</td>
</tr>
</tbody>
</table>
### RESULTS OF CHEMICAL ANALYSES OF WATER

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>EVAP 1 SUMP B</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Calculated Parameters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Hardness (CaCO₃)</td>
<td>mg/L</td>
<td>107</td>
</tr>
<tr>
<td>Total Dissolved Solids</td>
<td>mg/L</td>
<td>100000</td>
</tr>
<tr>
<td><strong>Elements</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Calcium (Ca)</td>
<td>mg/L</td>
<td>37.2</td>
</tr>
<tr>
<td>Dissolved Iron (Fe)</td>
<td>mg/L</td>
<td>21.2</td>
</tr>
<tr>
<td>Dissolved Magnesium (Mg)</td>
<td>mg/L</td>
<td>3.55</td>
</tr>
<tr>
<td>Dissolved Manganese (Mn)</td>
<td>mg/L</td>
<td>0.2345</td>
</tr>
<tr>
<td>Dissolved Potassium (K)</td>
<td>mg/L</td>
<td>917.5</td>
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<tr>
<td>Dissolved Sodium (Na)</td>
<td>mg/L</td>
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</tr>
<tr>
<td><strong>Anions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dissolved Chloride (Cl)</td>
<td>mg/L</td>
<td>61500</td>
</tr>
<tr>
<td>Dissolved Sulphate (SO₄)</td>
<td>mg/L</td>
<td>335.0</td>
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<tr>
<td><strong>Physical Properties</strong></td>
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<tr>
<td>Conductivity</td>
<td>uS/cm</td>
<td>130000</td>
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<tr>
<td>pH</td>
<td>pH</td>
<td>10.8</td>
</tr>
<tr>
<td>Alkalinity (Total as CaCO₃)</td>
<td>mg/L</td>
<td>27400</td>
</tr>
<tr>
<td>Alkalinity (PP as CaCO₃)</td>
<td>mg/L</td>
<td>16150</td>
</tr>
<tr>
<td>Bicarbonate (HCO₃)</td>
<td>mg/L</td>
<td>5.3</td>
</tr>
<tr>
<td>Carbonate (CO₃)</td>
<td>mg/L</td>
<td>13550.0</td>
</tr>
<tr>
<td>Hydroxide (OH)</td>
<td>mg/L</td>
<td>1655</td>
</tr>
</tbody>
</table>
Currently there are no sulphur recovery facilities at the Hangingstone Project.

SO$_2$ emissions are calculated based on analytical results of produced gas samples.
MONTHLY FLARING AND VENTING

Monthly Flaring and Venting

- Monthly Flaring volume
- Monthly Venting Volume
ATHABASCA OIL CORPORATION HANGINGSTONE PROJECT IS IN COMPLIANCE WITH AER APPROVALS AND REGULATORY REQUIREMENTS

- For the period of November 1, 2016 to October 31, 2017, AOC has no unaddressed non-compliant events
# Approvals and Amendments

<table>
<thead>
<tr>
<th>Date</th>
<th>Approval Summary</th>
</tr>
</thead>
<tbody>
<tr>
<td>November 11, 2016</td>
<td>MOP increase from 1,900 kPa to 2,100 kPa approved (11888E)</td>
</tr>
<tr>
<td>December 13, 2016</td>
<td>Three existing and two additional truck load-out stacks added as approved emission sources to EPEA Approval (000289664-00-01)</td>
</tr>
<tr>
<td>May 17, 2017</td>
<td>D56 amendment approved to install an Enhanced Diluent Recovery Unit (EDRU)</td>
</tr>
</tbody>
</table>
COMPLIANCE – MONITORING PROGRAMS

AIR MONITORING

- Monthly air contaminant concentrations for SO2 and NO2 summarized monthly and submitted in accordance with EPEA approval requirements
- Passive air monitoring around the facility for SO2, NO2 and H2S
- Performance testing including Cylinder Gas Audits (CGA), Relative Accuracy Test Audits (RATA) and manual stack survey
- The 2017 fugitive emissions survey notes 33 leaks – 2 repaired on the spot, 31 repairs planned for next shutdown

SURFACE WATER MONITORING

- Industrial wastewater and runoff monitored and tested prior to release and reported annually
- Water use reporting for dust control, winter road construction, OSE, drilling and completion activities, Temporary Diversion License (TDL) and Term Water License
NO$_x$ MONTHLY AVERAGE

NO$_x$ Monthly Average

kg/hr
EPEA GROUNDWATER AND SOURCE WATER MONITORING
- Semi-annual groundwater and source water monitoring ongoing
- Groundwater quality results are consistent with previous years
- No new wells added to the program in the past 12 months

SOIL MONITORING
- First soil monitoring event did not identify any significant soil impacts
- Soil management program not required

CARIBOU MONITORING
- Wildlife cameras on above ground pipeline crossings
- Employee wildlife sighting cards

WILDFIRE CLEARING MONITORING
- Update provided September 14, 2017
**AUDITS**

- MARP site visit and audit conducted on October 6, 2016 and follow up submission provided by AOC on November 9, 2016
- Pipeline Safety and Loss Management System Self-Assessment and Declaration submitted June 14, 2017
- Injection Pressure audit conducted September 15, 2017
- Compliance Assessment regarding Aboveground Pipeline Wildlife Crossing Directive was submitted November 30, 2017

**INSPECTIONS**

- Satisfactory Pipeline Detailed Operations Inspection conducted on January 16, 2017
- Satisfactory Inspection conducted on March 28, 2017 in response to an on-lease release within secondary containment inside the Evaporator building
The following list summarizes non-compliance events for the period of November 1, 2016 to October 31, 2017:

- For all events, corrective actions were identified and tracked to completion.

<table>
<thead>
<tr>
<th>Event</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>December 19, 2016 – Unapproved venting from Well Pad AE Start-Up Production Cooler tube leak</td>
<td>Well Pad AE Start-Up Production Cooler has two bays which are isolatable. AOC positively isolated the bay with the tube leak and continued operation of the Start-Up Production Cooler with remaining single bay</td>
</tr>
<tr>
<td>December 21, 2016 – Failure to sign off on submitted CEMS data</td>
<td>The monthly CEMS reporting process was modified</td>
</tr>
<tr>
<td>January 27, 2017 – Uncontrolled release of slop oil into tank farm from failed valve on a sample point</td>
<td>Evaluate current valves, piping, temporary hoses and sample tubing to ensure proper freeze protection</td>
</tr>
<tr>
<td>March 2, 2017 – Controlled release from evaporator recirculation pump seal failure</td>
<td>The evaporator was safety taken out of service and the failing seal was replaced</td>
</tr>
<tr>
<td>Event</td>
<td>Corrective Action</td>
</tr>
<tr>
<td>----------------------------------------------------------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>April 4, 2017 – Erosion channel created by uncontrolled release of contained surface water on Pad AA</td>
<td>An assessment of all lease berms was completed to ensure no other overflow conditions were present. The AOC lease berm integrity and AOC contained surface water release instruction was reviewed with field operations</td>
</tr>
<tr>
<td>May 3, 2017 – Unapproved venting when produced water transfer pumps tripped</td>
<td>The system operated as designed and a rate of change limit was added to the transmitter signal to prevent the controller from tripping the pumps. Cooling feed water will continue to be fed to the evaporator system, preventing a foul vent collection system trip</td>
</tr>
<tr>
<td>May 9, 2017 – Uncontrolled release of the CPF surface water pond from seepage through spillway rock layer</td>
<td>Visual inspection of the pond has been added to the AOC Operator round sheet with guidance provided to operate the pond with low levels of water and to pump off the pond more frequently to avoid repeat occurrence</td>
</tr>
<tr>
<td>June 6, 2017 – Unapproved venting while manually lowering level on PW tank</td>
<td>The produced water tank emptying procedure was updated to ensure a plug is installed on the overflow piping outside of the tank prior to the level inside the tank getting below the lower end of detection by the level transmitter and Operations has installed a 12&quot; plumbers plug to seal the vent while the level is lowered below the siphon</td>
</tr>
</tbody>
</table>
## COMPLIANCE – SUMMARY OF NON-COMPLIANCE

<table>
<thead>
<tr>
<th>Event</th>
<th>Corrective Action</th>
</tr>
</thead>
<tbody>
<tr>
<td>August 6, 2017</td>
<td>Electric motive fluid heaters were installed on the eductors to prevent future hydrate issues on September 8, 2017</td>
</tr>
<tr>
<td>August 10, 2017</td>
<td></td>
</tr>
<tr>
<td>August 31, 2017</td>
<td></td>
</tr>
<tr>
<td>September 8, 2017 (planned)</td>
<td></td>
</tr>
<tr>
<td>– Unapproved venting through the evaporator foul vent condenser caused by hydrate formation</td>
<td></td>
</tr>
<tr>
<td>September 15, 2017 – Second CEMS pressure differential test not performed in 2016</td>
<td>All CEMS related compliance activities have been set to Regulatory Priority (high) in the AOC enterprise asset management software for maintenance scheduling. The contravention was also discussed with site leadership</td>
</tr>
<tr>
<td>September 23, 2017 – Unapproved venting from eductor trip due to process upset</td>
<td>This is how the system is designed and could happen again during a process upset condition</td>
</tr>
</tbody>
</table>
### COMPLIANCE – RELEASE REPORTING

<table>
<thead>
<tr>
<th>No. of Reportable Spills</th>
<th>Volume Released (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>9</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Flaring Notifications</th>
<th>Volume Flared (e³m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>57.3</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No. of Reportable Venting Events</th>
<th>Volume Vented (e³m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>9.95</td>
</tr>
</tbody>
</table>

- All spills were cleaned up and have been remediated to eliminate any potential for adverse effect
- AOC tracks all release incidents within the Corporate Compliance and Incident Tracking System
AOC IS A FUNDING MEMBER OF:
- Wood Buffalo Environmental Association (WBEA)
- Joint Oil Sands Monitoring Program
- Oil Sands Black Bear Partnership

AOC PARTICIPATES IN:
- Various regional CAPP Committees
  - NE Alberta Caribou Working Group
  - Lower Athabasca Regional Planning
OSE ASSESSMENT AND RECLAMATION WORK IS ONGOING

- Reclamation Certifications applied for OSE programs 120026 and 130006
FUTURE PLANS
FUTURE PLANS

HANGINGSTONE EXPANSION PROJECT TECHNICALLY COMPLETE

- Aboriginal Consultation Office (ACO) making final decision on consultation adequacy
  - *Expect decision in Q1 2018*

The expansion includes:

- Increased bitumen recovery capacity from the existing approved 1,908 m³/d (12,000 bbl/d) to 13,037 m³/d (82,000 bbl/d) to be developed in two phases:
  - *Project 2A and 2B to add incremental 6,360 m³/d (40,000 bbl/d)*
  - *Project 3 to add incremental 4,770 m³/d (30,000 bbl/d)*

- Production life extension from 10 to 40 years

- CPF expansion from 35 ha to 76 ha (no additional site clearing required)