2016 Performance Presentation

Devon Canada Corporation
Jackfish SAGD Project

Commercial Scheme Approval No. 10097 (as amended)

October 2016
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Subsurface Operations
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Subsurface Operations

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  Dermot O’Shea

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  Dermot O’Shea

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  Jim Anderson

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  Jim Anderson

• Instrumentation
  Jim Anderson

• Scheme Performance
  Devin Ollenberger & Anthony Nguyen

• Future Plans
  Devin Ollenberger
Project Background

Section 3.1.1-1
3.1.1-1

- Jackfish 1, 2 and 3 utilize steam-assisted gravity drainage (SAGD) to recover bitumen from the McMurray formation
- Located 150 km south of Fort McMurray
- Jackfish 1 Scheme approval granted in Aug 2006
- Jackfish 2 Scheme approval granted in Aug 2008
- Amalgamation of Jackfish approvals (including Jackfish 3) in Nov 2011
Brief Background of Scheme

Overall Scheme Map

Legend
- Development Area
- Project Area
- JF1_PDP Subsurface Patterns
- JF1_PUD Subsurface Patterns
- JF2_PDP Subsurface Patterns
- JF2_PUD Subsurface Patterns
- JF3_PDP Subsurface Patterns
- JF3_PUD Subsurface Patterns
## Brief Background of Scheme

**Jackfish**

3.1.1-1

<table>
<thead>
<tr>
<th>Asset</th>
<th>Number of Operating Pads</th>
<th>Number of Operating Well Pairs</th>
<th>Upcoming Pads</th>
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<tr>
<td>Jackfish 1</td>
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<td>65</td>
<td>O</td>
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<td>Jackfish 2</td>
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<tr>
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<td><strong>Total</strong></td>
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Geology

Section 3.1.1-2
## Geology

### Jackfish Approved Area OBIP

3.1.1-2a

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<tr>
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<th>Area (Ha)</th>
<th>OBIP (10^6 m³)</th>
<th>Avg. Net Pay (m)*</th>
<th>Avg. Oil Saturation (So)*</th>
<th>Avg. Porosity (%)*</th>
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*Average attributes derived from well control

---

![Map of Project and Development Areas](image-url)
Gross Rock Volume (GRV)

GRV Base (GRV1_B): picked as the maximum lower limit of continuous exploitable bitumen >50% $S_o$ and <40% $V_{sh}$

GRV Top GRV1_T: first barrier above GRV Base >3m true vertical thickness of $S_o$ < 50% and >40% $V_{sh}$ or base of gas cap

Gross Rock Volume (GRV): interval between GRV1_B and GRV1_T

GRV Net Pay is determined by removing estimated mud volumes from the GRV using a cutoff of 40% on the $V_{sh}$ curve

Average $S_o$ and porosity values are calculated from the GRV Net Pay interval for each well

$V_{sh}$ and $S_o$ are standard petrophysical curves calculated from gamma ray, resistivity, and porosity logs, and correlated to image logs and core data
Geology

Jackfish Approved Area OBIP Methodology

3.1.1-2a

Gross Rock Volume Height on Logs

Generate GRV P50

Calculate Ave Net/Gross (NTG)

Net GRV Pay Porosity ($\Phi$)

Net GRV Pay Oil Saturation ($S_o$)

OBIP = Gross Rock Volume * NTG * $\Phi$ * $S_o$

Original Bitumen in Place
## Geology
### Jackfish 1, 2 & 3 Average Reservoir Properties

3.1.1-2a

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<th>Property</th>
<th>Jackfish 1</th>
<th>Jackfish 2</th>
<th>Jackfish 3</th>
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<td>Avg Reservoir Depth mTVD</td>
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<td>Avg Reservoir Depth mASL</td>
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<td>Avg. Original Reservoir Pressure kPa</td>
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<td>Avg Phi %</td>
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<tr>
<td>Avg Bitumen Visc. Cp</td>
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<td>Original Bottom Water Pressure kPa</td>
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*Total for all producing, drilled, and planned pads utilizing GRV methodology (2015)*
Geology
Jackfish Total Net Pay Isopach

3.1.1-2b
Geology

Jackfish Structure On Base Gross Rock Volume (GRV_B)

3.1.1-2b
Geology

Jackfish Structure On Top Gross Rock Volume (GRV_T)

3.1.1-2b
Geology

Jackfish 1 Representative Well Log

3.1.1-2c
Geology

Jackfish 2 Representative Well Log

3.1.1-2c

Clearwater
Caprock
Wabiskaw
McMurray Fm

GRV_T
GRV_B

Paleozoic

Cap Rock

GRV
Net
Pay

GRV_B
Paleozoic
Geology

Jackfish 3 Representative Well Log

3.1.1-2c
No special core analysis conducted on core from the 2016 drilling program. Geomechanical testing complete on 2015 program.
Three steam evaluation cores obtained at Jackfish 2:
- AB/05-28 (Pad BB) encountered steam chamber
- AB/12-28 (Pad CC) & AB/14-28 (Pad KK) targeted low growth areas on 4D and did not encounter steam chamber

No new implications on ultimate recovery at this point in time
Geology

Jackfish 1 Representative Structural Cross-section

3.1.1-2g
Geology
Jackfish 3 Representative Structural Cross-section

3.1.1-2g
Interpretation complete on 2015 mini frac program:

- Lowest Wabiskaw shale fracture closure gradient of 14.1kPa/m at AA/10-31
- Fracture closure gradient of 18.6kPa/m from the 2011 mini frac program was utilized for the existing MOP approval
- Category 2 Amendment to adjust the Jackfish MOP submitted to the AER in Q3

\[ MOP = 0.80 \times \text{Caprock Fracture Closure Gradient} \times \text{Caprock Base Depth} \]
Seismic

Jackfish 3-D & 4-D - No 2016 4D Acquisition

3.1.1-2j

- Jackfish 2 4-D
  - 2013: 6.3 km²
  - 2015: 9.4 km²

- Jackfish 3-D
  - 2003-2008: 23 km²

- Jackfish 1 4-D
  - 2010: 8.4 km²
  - 2011: 8.4 km²
  - 2012: 8.7 km²
  - 2014: 11.6 km²

• No seismic shot during reporting period
• InSAR data collection is ongoing, no heave data interpreted during reporting period
Drilling & Completions

Section 3.1.1-3
Operating SAGD Horizontal Wells
- **Jackfish 1**: 65 well pairs on 9 pads (Hz sections are 790 – 1,200m)
- **Jackfish 2**: 60 well pairs on 8 pads (Hz sections are 790 – 900m)
- **Jackfish 3**: 43 well pairs on 5 pads (Hz sections are 720 – 1,200m)

Observation Wells
- 59 active SAGD observation wells (2-3 per operating pad)
- 21 regional multi-zone monitoring wells equipped with piezometers

Service Wells
- 6 Grand Rapids brackish source water wells
- 2 McMurray brackish source water wells
- 13 water disposal wells (Class 1b)
Drilling & Completions

Jackfish 1 Overview – SAGD Wells

3.1.1-3a

Existing Pads

- Pad A, B, C, D, E, F, G, H & I: 7 well pairs per pad (9 on Pad F)
- Pad G started Q3 2015
- Pad F first steam Q2 2016
- 2 observation wells per pad (heel and toe)
Existing Pads

- Pad AA, BB, CC, DD & KK: 7 well pairs per pad
- Pad OO & PP (8 well pairs per pad) started in late 2015
- Pad FF: 9 well pairs
- 2 observation wells per pad (heel and toe), 3 wells at Pad FF
Drilling & Completions
Jackfish 3 Overview – SAGD Wells

3.1.1-3a

Existing Pads
- Pad J & EE: 7 well pairs per pad
- Pad VV & K: 10 well pairs per pad
- Pad RR: 9 well pairs
Drilling & Completions

Inter-well Spacing

• Standard lateral inter-well spacing at Jackfish is 80m
• Currently drilled pads that differ from the standard are:
  – Pad VV: Spacing of 60m
  – Pad F: 60m at the heels fanning to 90m at the toes
• Shift-able Steam Subs utilized on several injection wells
  – Majority of new wells have steam sub installed on long injection string to improve steam distribution

406.4 mm (16”) Surface Casing

298.5 mm (11 ¾”) Intermediate Casing

Short and long tubing are from 88.9 to 114.3 mm (3 ½” to 4 ½”)

25.4 mm (1”) coil tubing instrument string with thermocouples and a conduit to pump down fiber optics

219.1 mm (8 5/8”) Slotted Liner
3.1.1-3c

- Inflow Control Devices (ICDs) are trialed on select wells
  - Goal is to gain better understanding of technology in SAGD environment
  - Devices promote production through uniform inflow

- 25.4 mm (1") coil tubing instrument string with thermocouples and a conduit to pump down fiber optics

- 406.4 mm (16") Surface Casing
- 298.5 mm (11 ¾”) Intermediate Casing
- 31.8 mm (1 ¼”) Lift Gas Coils

- Short and long tubing are from 88.9 to 114.3 mm (3 ½” to 4 ½”)
- 219.1 mm (8 5/8”) Slotted Liner or Wire Wrap Screen

- 31.8 mm (1 ¼”) Lift Gas Coils
Drilling & Completions
Inflow Control Devices (ICDs)

3.1.1-3c

• Tubing Deployed systems on CC1P, DD2P, DD7P
  – Installed successfully via service rig
• Liner Deployed systems on RR2P, RR6P
  – Installed successfully via drilling rig
• Performance measured through sustained production uplift
  – Sustained uplift yet to be observed on tubing deployed systems
  – Early in trial of liner deployed systems, evaluation of performance ongoing
• Key Learnings
  – Actual pressure drops through ICDs different than designed
  – Additional testing needed to understand multiphase flow through ICDs
• No outflow control devices installed to date
Wire Wrapped Screens

3.1.1-3c

- Wire wrapped screens are currently considered the producer sand control liner standard for all future pads at Jackfish
- First implementation will be at Jackfish 1 - Pad F
  - First steam in Q2 2016
- Expected benefits of wire wrapped screens:
  - Reduced liner pressure drop
  - Increased open flow area
  - Mechanical strength
  - Sand control
Drilling & Completions

Liner Failures

3.1.1-3c

• CC2P was the only confirmed liner failure during the reporting period and was repaired by installing a secondary liner within the existing wellbore
• No re-drills or re-entries were completed during the reporting period
Artificial Lift

3.1.1-4a, b

- Gas lift is currently used for artificial lift at Jackfish District
- Gas lift continues to be an effective lift strategy for Jackfish operating conditions
  - Typical producer operating pressure above 1,800 kPag
  - Ability to handle over 1,000 m³/day emulsion flow
  - No operating temperature limitation
- One ESP installed in March 2015 (B3P)
  - B3P was selected due to lift issues caused by high pressure drop when operating on gas lift
  - Plan to continue to evaluate feasibility and deploy ESPs as deemed necessary
Instrumentation

Section 3.1.1-5
Instrumentation in Wells

SAGD Injection & Producer Wells

3.1.1-5b

- 25.4 mm (1”) coil tubing instrument string with 4 – 6 evenly spaced thermocouples and a conduit to pump down fiber optics
- Fiber optics currently in 39 wells on pads I, J, CC, DD, KK, FF, RR
Various methods are used simultaneously to monitor downhole pressure

**For Injector Wells:**

- Using thermocouples / fiber optics temperature data to convert downhole live steam temperature from $T_{\text{sat}}$ to $P_{\text{sat}}$.
- Conducting annulus blanket gas pressure survey on periodic basis.
- Calculate downhole pressure based on surface steam injection pressures on short and long tubing strings.
  - $\text{BHP} = \text{steam injection surface pressure} - \text{frictional losses}$.
- Conducting periodic near-zero steam injection rate test to estimate bottomhole pressure from surface injection pressure.

**For Producer Wells:**

- Use concentric open-ended lift gas (LG) coiled tubing to calculate downhole pressure.
  - $\text{BHP} = \text{LG surface pressure} - \text{frictional losses} + \text{static head}$.
  - Frictional losses are correlated/calculated by performing numerous gas lift step rate tests.
- Validation of the above correlation is re-assured by periodic annulus blanket gas pressure surveys.

* Prior initial start up of circulation, well pairs would be purged to eliminate dead fluid column inside the wellbore. Historical data also showed such procedures improve warm up time in the horizontal wellbore section.
Instrumentation in Wells
SAGD Observation Wells

3.1.1-5b

Jackfish 1, 2, & 3 SAGD observation wells contain:

- 20 points thermocouples (25 points in more recently drilled wells), spaced above, below & within pay interval
- 2 pressure sensors*, one in the bitumen and the other in the basal water

*New Jackfish 3 wells have an additional pressure sensor near the top of the McMurray
Instrumentation in Wells
SAGD Observation Wells

3.1.1-5b
Monitoring wells cover areas of Jackfish 1, 2, and 3
Twenty-one wells
• 00/07-32-75-6W4 (5 piezometers)
• F1/08-28-75-6W4 (4 piezometers)
• F1/09-14-75-6W4 (4 piezometers)
• F1/12-31-75-6W4 (4 piezometers)
• F1/10-22-75-6W4 (5 piezometers)
• F1/04-26-75-7W4 (5 piezometers)
• F1/06-28-75-7W4 (5 piezometers)
• F1/15-19-75-6W4 (5 piezometers)
• F1/09-24-75-7W4 (5 piezometers)
• F1/14-25-75-6W4 (5 piezometers)
• F1/05-12-75-6W4 (5 piezometers)
• F1/09-22-75-7W4 (4 piezometers)
• 02/12-23-75-7W4 (4 piezometers) *
• 02/01-35-75-7W4 (3 piezometers)
• 00/15-07-75-5W4 (4 piezometers)
• 00/07-22-75-7W4 (2 piezometers)
• 00/03-15-75-6W4 (3 piezometers)**
• 02/09-33-75-6W4 (4 piezometers)
• 00/04-30-75-7W4 (3 piezometers)
• 00/01-19-75-6W4 (3 piezometers)**
• 00/11-30-75-6W4 (5 piezometers) **

* Perf with a Level Logger
** Perf for water sampling
Instrumentation
Regional Multi-zone Monitoring Wells
Scheme Performance

Section 3.1.1-7
Scheme Performance Prediction

*Jackfish*

3.1.1-7a

- Well pad performance forecasts generated using Jackfish & industry analogues and validated with numerical simulation and analytical methods

- Facility service factors based on historical data, future plans and quantified risks
Scheme Performance
Jackfish 1 Project Life Plot

3.1.1-7a
Scheme Performance

Jackfish 2 Project Life Plot

3.1.1-7a

The diagram shows the performance of the Jackfish 2 project over a period from May 2011 to August 2016. The x-axis represents time in months, while the y-axis represents flow rate in m³/d. Various events such as Pad FF startup, Pad KK startup, Pad OO, Pad PP startup, and Turn around are marked on the graph. The legend below the graph indicates different lines representing Daily Steam Injection, Daily Oil Production, Daily Water Production, ISOR, CSOR, Well Pairs, and Daily Gas Injection.
Scheme Performance
Jackfish 3 Project Life Plot

3.1.1-7a

Flow Rate (m³/d)

Pad RR startup

Pad K startup

SOR (m³/m³), Well Pairs

Daily Steam Injection

Daily Oil Production

Daily Water Production

ISOR

CSOR

Well Pairs
Devon manages injection pressures to maximize producing rates, manage leakoff and increase overall reservoir recovery. A reduction in operating pressure was implemented in 2013 and continued into 2016.
Scheme Performance

Jackfish 2 Bottom Hole Injector Pressures

3.1.1-7b

Pressure (kPa)

Turn around

Turn around


Pad AA  Pad BB  Pad CC  Pad DD  Pad KK  Pad FF  Pad DD  Pad PP
Scheme Performance
Jackfish 3 Bottom Hole Injector Pressures
## 2016 Scheme Performance
### 2016 Jackfish 1 Pad Recoveries

3.1.1-7c

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<tr>
<th>Pad</th>
<th>OBIP ($10^6m^3$)</th>
<th>Ult Rec ($10^6m^3$)</th>
<th>Cum Prod $^1$ ($10^6m^3$)</th>
<th>R.F. (%) to Date $^1$</th>
<th>Net GRV Pay $S_o$ (%)</th>
<th>Net GRV Pay Porosity (%)</th>
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$^1$ Effective August 31, 2016
# 2016 Scheme Performance
## 2016 Jackfish 2 Pad Recoveries

3.1.1-7c

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<th>Cum Prod $^1$ ($10^6$m$^3$)</th>
<th>R.F. (%) to Date $^1$</th>
<th>Net GRV Pay $S_o$ (%)</th>
<th>Net GRV Pay Porosity (%)</th>
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$^1$ Effective August 31, 2016
## 2016 Scheme Performance
### 2016 Jackfish 3 Pad Recoveries

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<th>Ult Rec $(10^6 m^3)$</th>
<th>Cum Prod $^1 (10^6 m^3)$</th>
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<td>86</td>
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$^1$ Effective August 31, 2016
3.1.1-7c

- First steam occurred in June 2011
- 7 well pairs in operation
- NCG injection as of March 2016 on DD1, DD3, DD5 and DD6
- Heterogeneous reservoir with low mid-heel ceiling of ~5m pay thickness
  - Limited vertical steam chamber growth
  - Regions of poor temperature conformance
- Inflow Control Device, installed Sept. 2013 (DD2), well achieved expected production with period of flush production
- Inflow Control Device, installed Nov. 2014 (DD7), under-performing pre-installation rates, likely due to dP higher than anticipated in design
- Potential fluid interaction with Pad AA due to chamber growth on DD1-DD3 wells
Pad DD Performance

Jackfish 2 Pad DD Life Plot

3.1.1-7c

Flow Rate (m³/d)

SOR (m³/m³), Gas Injection (e3m³/d), Well Pairs

Daily Steam Injection  Daily Oil Production  Daily Water Production  Daily Gas Injection  ISOR  CSOR  Well Pairs
Pad DD Toe Observation Well Temp
(10.5m from DD3 well pair)

3.1.1-5d

- Lower temperature resulting from pressure reduction
Jackfish 3 – Pad EE Highlights
Medium Performer

3.1.1-7c

• First steam occurred in July 2014
• 7 well pairs in operation
• Production currently in the plateau phase, expected to decline around the end of 2017
• EE1 – EE5 have clean sand with uniform ceiling
• EE6 – EE7 have low ceiling at toe of wells
• Steam subs opened on EE1 – EE5 in 2015 to increase steam injection rates
• Pad SOR historical average around 2.2
Pad EE Performance

Jackfish 3 Pad EE Life Plot

3.1.1-7c
Pad EE Heel Observation Well Temp
(4.8m from EE5 well pair)

3.1.1-5d
Jackfish 3 - Pad K Highlights

*High Performer*

3.1.1-7c

- First steam occurred in February 2015
- 10 well pairs are in operation
- Best performing pad at Jackfish 3
- Clean sand throughout all 10 well pairs
- Historical SOR < 2
Pad K Performance

Jackfish 3 Pad K Life Plot

3.1.1-7c
Pad K Toe Observation Well Temp
(9.5m from K5 well pair)

3.1.1-5d
Five Year Outlook

Jackfish Pad Abandonments

3.1.1-7c

- No anticipated pad abandonments at Jackfish within the next five years
## Wellhead Steam Quality

### 3.1.1-7d

- Losses occur as steam is transported to the pads
- Utilize condensate traps at each pad to maximize wellhead steam quality

<table>
<thead>
<tr>
<th></th>
<th>Pressure (kPag)*</th>
<th>Temperature (°C)</th>
<th>Quality (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Plant Gate</td>
<td>9,600</td>
<td>311</td>
<td>100%</td>
</tr>
<tr>
<td>JF1 Wellhead</td>
<td>2,700-3,700</td>
<td>228-246</td>
<td>97%</td>
</tr>
<tr>
<td>JF2 Wellhead</td>
<td>3,000-4,400</td>
<td>247-256</td>
<td>97%</td>
</tr>
<tr>
<td>JF3 Wellhead</td>
<td>2,700-4,400</td>
<td>228-256</td>
<td>97%</td>
</tr>
</tbody>
</table>

*Pressures subject to change based on status of pending MOP application*
NCG Co-injection

3.1.1-7e, g

• NCG source is fuel gas, primarily composed of methane
• NCG co-injection pilot at Pad A was discontinued in late 2014
• NCG co-injection started on Pads DD, KK and FF in March 2016
• Learnings-to-date:
  – NCG injection rates within expected range (1 – 4 mole%, per pad)
  – NCG successful in maintaining chamber pressure with reduced steam injection
  – No negative impact to resource recovery observed
  – Improved SOR observed
• Continuing to monitor and evaluate NCG performance
• NCG injection as of Aug. 2016 on DD1, DD3, DD5 and DD6
NCG injection as of Aug. 2016 on FF1, FF2, FF3, FF4, FF5, FF6, FF8, and FF9
NCG Co-injection
Pad KK

3.1.1-7e, g

- NCG injection as of Aug. 2016 on KK2, KK3, KK5 and KK6
Jackfish Performance

Key Learnings

3.1.1-7f

- District SOR improvement tied to pressure reduction
- Produced water chlorides indicative of pressure balance with aquifer
- Successful use of NCG to enable steam transfer for new pad startup
Future Plans

Section 3.1.1-8
Future Plans
Well Operations, Drilling, Trials

3.1.1-8a, b

**Jackfish 1**
- SAGD drilling on Pad R in Q4 2017

**Jackfish 2**
- SAGD drilling on Pad QQ in Q3 2017
- One pre-SAGD observation well to be drilled on Pad QQ in Q1 2017

**Jackfish 3**
- SAGD drilling on Pad EEE in Q4 2016
Future Plans

Jackfish District Steam Strategy

3.1.1-8c

**Jackfish 1**
- Managing injection rates to balance chamber pressure with aquifer

**Jackfish 2**
- Utilizing steam capacity while managing SOR through steam allocation, pressure management, and leveraging NCG co-injection on Pads DD, KK, and FF

**Jackfish 3**
- Managing injection rates for SOR optimization through steam allocation and pressure management
- Injection meeting stable demand with all pads in early plateau stage
Surface Operations
Table of Contents

Surface Operations

• Facilities Overview  Ivan Morales
• Facilities Performance  Ivan Morales
• Measurement & Reporting  Jody Kutschera
• Water Production, Injection & Uses  Ivan Morales
• Sulphur Production & Air Emissions  Greg Rokosh
• Environment  Greg Rokosh
• Regulatory Compliance  Greg Rokosh
• Future Plans  Ivan Morales
Facilities
Section 3.1.2-1
Facilities
Plot Plan – Jackfish 1

3.1.2-1a
Facilities

Plot Plan – Jackfish 2

3.1.2-1a
Facilities Performance

Section 3.1.2-1
3.1.2-1a-c

**Turnarounds**
- Maintenance turnaround completed June 2016

**Bitumen Treatment**
- Stable operation maintained at higher blend densities and tight blend density ranges

**Water Treatment**
- Utilized brackish water wells with TDS ranging from 5,000-13,000 ppm for all make up water requirements
- Jackfish 1 - Installation of 4th LSF Unit to improve system reliability
- Jackfish 2 - Upgrades completed to Lime and MagOx systems and HLS to improve system reliability

**Steam Generation**
- Ongoing procedural refinement to manage water quality excursions
- 80% overall steam quality achieved to decrease blowdown disposal volumes and increase steam generation
• JF2 power consumption was low in June 2016 due to a planned maintenance turnaround.
Facilities Performance

Flared Gas Volume

3.1.2-1e

- Flare volumes are produced gas only, volumes are aligned with MARP reporting requirements for Jackfish
- JF1: Multiple plant trips in April
- JF2: Higher flare volumes in May & June from Turn Around Ramp Down/Ramp Up and August power outage
- JF3: Higher flare volume in August for power outage
Facilities Performance
Vented Gas Volume

3.1.2-1e

- J1 G pad start-up resulted in plant process instability
- J2 pad trips in November, VRU issues in June
- J3 Access pumps tripped in October, chemical trials in June
Facilities Performance
Solution Gas Recovery

3.1.2-1e

Solution Gas Recovery

Monthly Percentage

- J1
- J2
- J3

- Sep-15
- Oct-15
- Nov-15
- Dec-15
- Jan-16
- Feb-16
- Mar-16
- Apr-16
- May-16
- Jun-16
- Jul-16
- Aug-16
Facilities Performance
Fuel Gas Consumption

3.1.2-1e

Fuel Gas Consumption J1

- Produced Gas
- Purchased Gas

Monthly Volume (e3m3)

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<thead>
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<td>22,000</td>
<td>20,500</td>
<td>19,000</td>
<td>17,500</td>
<td>16,000</td>
<td>14,500</td>
<td>13,000</td>
<td>11,500</td>
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</table>
• JF2 Fuel Gas Consumption was low in June 2016 due to a planned maintenance turnaround
Facilities Performance

Fuel Gas Consumption

Fuel Gas Consumption J3

<table>
<thead>
<tr>
<th>Month</th>
<th>Produced Gas</th>
<th>Purchased Gas</th>
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<td>Nov-15</td>
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<td>Dec-15</td>
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<td>Jan-16</td>
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<td>Feb-16</td>
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<td>Mar-16</td>
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<td>Apr-16</td>
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<td>May-16</td>
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<td>Jun-16</td>
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<td>Jul-16</td>
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</tr>
<tr>
<td>Aug-16</td>
<td></td>
<td></td>
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</tbody>
</table>
Facilities Performance

Greenhouse Gas Emissions

3.1.2-1f

Direct Jackfish GHG Emission By Month

- JF1 12-month total: 696,776 tonnes CO₂E
- JF2 12-month total: 623,314 tonnes CO₂E
- JF3 12-month total: 761,434 tonnes CO₂E
Well Bitumen / Water Production

- The total battery production is allocated to each SAGD producing well based on individual well tests.

- Battery Bitumen Production = Dispositions – Receipts + ΔInventory + Blending Shrinkage

- Battery Water Production = Inlet Produced Water + ΔInventory + Truck Out – Truck in – Desand Water to Treater & FWKO

- Individual well test:
  - Each pad equipped with test separator along with coriolis meter and watercut analyzer on liquid leg
  - Vortex meter for gas measurement / water vapor calculation
  - Tested water volume includes the calculated water vapor (from $P_{sat}/P_{measured}$)
  - Typical well test duration is 9 hours
Well Gas Production

- Well estimated test gas production = GOR x test bitumen production
- Battery Gas Production = Fuel + Fuel to IF + Flare – TCPL Purchase – Receipt Gas – Diluent Flash
- Battery gas is allocated to each well based on well test

Steam Injection

- Total steam to field measured downstream of HP separators minus the steam condensate
- Vortex meters at each wellhead are used to allocate the total steam
Measurement & Reporting

Proration factors

3.1.2-2a, b

Bitumen / Water Proration Factor

- Within AER target tolerances on an ongoing basis
- Jackfish 2 full facility outage June 2016
- Jackfish 3 oil production ramped up by 9% from Feb to July.

Steam Proration Factor

- 12 months avg was 1.025 for Jackfish 1, 1.024 for Jackfish 2 & 0.987 for Jackfish 3
- Trends for all facilities highly stable
### Facility Reporting Codes

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<tr>
<th>FACILITY CODE</th>
<th>FACILITY SUB-TYPE</th>
<th>DESCRIPTION</th>
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<tr>
<td>ABBT 0094366</td>
<td>344 In-Situ Oil Sands</td>
<td>Jackfish 1 CPF</td>
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<tr>
<td>ABIF 0094395</td>
<td>506 In-Situ Oil Sands</td>
<td>Jackfish 1 IF</td>
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<tr>
<td>ABBT 0114300</td>
<td>344 In-Situ Oil Sands</td>
<td>Jackfish 2 CPF</td>
</tr>
<tr>
<td>ABIF 0114303</td>
<td>506 In-Situ Oil Sands</td>
<td>Jackfish 2 IF</td>
</tr>
<tr>
<td>ABBT 0130642</td>
<td>344 In-Situ Oil Sands</td>
<td>Jackfish 3 CPF</td>
</tr>
<tr>
<td>ABIF 0130641</td>
<td>506 In-Situ Oil Sands</td>
<td>Jackfish 3 IF</td>
</tr>
<tr>
<td>ABIF 0115392</td>
<td>506 In-Situ Oil Sands</td>
<td>Source / Disposal Facility</td>
</tr>
<tr>
<td>ABGS 0131346</td>
<td>621 Gas Gathering System</td>
<td>Purchase Fuel Distribution</td>
</tr>
</tbody>
</table>
3.1.2-2d

**Primary Steam Metering with Bypass**

- Installation of replacement CPF steam meters completed in Q1-2015 for JF2 and JF3 and Q3-2015 at JF1
- JF3 meter ceased to indicate steam volumes in July 2016, none of the new meters presently in service
- AER notified and authorization granted for alternate steam determination for JF2 and JF3, JF1 returned to using previous MARP meter
- Currently investigating for root cause of failure, destructive testing of JF3 meter components underway by independent lab
Water Production, Injection & Uses

Section 3.1.2-3
Water Disposal and Source Water
Well Locations
Water Disposal Geology

Basal McMurray Aquifer

3.1.2-3a

[Map of the area showing various locations and markers related to water disposal and geology.]
Water Disposal Operations

Basal McMurray Pressure in 75-6W4, 75-7W4

3.1.2-3a
3.1.2-3a

• Brackish source water produced from the Grand Rapids ‘C’ and McMurray zones
• Available for Jackfish 1, Jackfish 2 and Jackfish 3
• Two McMurray Wells:
  - F1/07-30-075-06W4
  - F1/03-15-075-06W4
• Six Grand Rapid Wells:
  - F1/12-15-075-06W4
  - F1/15-15-075-06W4
  - F1/03-10-075-06W4
  - F1/03-11-075-06W4
  - F1/04-16-075-06W4
  - F1/05-17-075-06W4
• Brackish water production from the Grand Rapids ‘C’ commenced on July 12, 2007 and McMurray commenced on October 2, 2014
• Brackish water quality analyzed 1-2 times per year
JF2 produced water was low in June 2016 due to a planned maintenance turnaround.
• JF2 steam injection was low in June 2016 due to a planned maintenance turnaround
Produced Water Recycle

3.1.2-3e

- Only brackish water is used for required makeup volumes
- Jackfish Disposal Limit = 12 - 14%
  - Jackfish 1 2015/16 Disposal Rate 6.8%
  - Jackfish 2 2015/16 Disposal Rate 8.3%
  - Jackfish 3 2015/16 Disposal Rate 6.0%

Disposal Limit = \( \frac{(\text{Brackish Water} \times D_f) + (\text{Produced Water} \times D_p)}{(\text{Brackish Water} + \text{Produced Water})} \times 100\% \)
Disposal System is shared between Jackfish 1, Jackfish 2 and Jackfish 3

Two disposal streams:
- blowdown & regen waste

Thirteen Class 1b disposal wells in total

Approved MWIP of 6,000 kPa (July 2009)

Jackfish 1 disposal wells:
- 00, 02 & 03/09-14-075-06W4 (blowdown)
- 00 & 02/12-14-075-06W4 (regen)

Jackfish 2 disposal wells:
- 02 & 03/07-13-075-06W4 (blowdown)
- 02 & 04/12-15-075-06W4 (regen)

Jackfish 3 disposal wells:
- 00 & 02/05-12-075-06W4 (blowdown)
- 00 & 02/03-22-075-06W4 (regen)
Water Disposal – Approval No. 10790
Volume Summary

3.1.2-5b

Blowdown Water Volumes

Regen Water Volumes
Water Disposal – Approval No. 10790
00/09-14-075-06W4

3.1.2-5b

00/09-14-075-06W4 BD Disposal Well
MWIP 6,000 kPag

Monthly Volumes [m³]
Average Injection Pressure [kPa]

Axis Title

Monthly Volume (m³)

Average Wellhead Pressure (kPag)
Water Disposal – Approval No. 10790
02/09-14-075-06W4

3.1.2-5b

02/09-14-075-06W4 BD Disposal Well
MWIP 6,000 kPag

Monthly Volumes [m³]
Average Injection Pressure [kPa]
Water Disposal – Approval No. 10790
03/09-14-075-06W4

03/09-14-075-06W4 BD Disposal Well
MWIP 6,000 kPag

Average Wellhead Pressure (kPag)

Monthly Volume (m³)

Average Injection Pressure [kPa]
02/07-13-075-06W4 BD Disposal Well
MWIP 6,000 kPag

Monthly Volumes [m³]
Average Injection Pressure [kPa]
Water Disposal – Approval No. 10790
03/07-13-075-06W4

3.1.2-5b

03/07-13-075-06W4 BD Disposal Well
MWIP 6,000 kPag

Monthly Volumes [m³]
Average Injection Pressure [kPa]


Water Disposal – Approval No. 10790
03/07-13-075-06W4

3.1.2-5b

03/07-13-075-06W4 BD Disposal Well
MWIP 6,000 kPag

Monthly Volumes [m³]
Average Injection Pressure [kPa]

Water Disposal – Approval No. 10790
00/12-14-075-06W4

3.1.2-5b

00/12-14-075-06W4 Regen Disposal Well
MWIP 6,000 kPag
Water Disposal – Approval No. 10790
02/12-14-075-06W4

3.1.2-5b

02/12-14-075-06W4 Regen Disposal Well
MWIP 6,000 kPag

- Monthly Volumes [m³]
- Average Injection Pressure [kPa]
Water Disposal – Approval No. 10790
02/12-15-075-06W4

3.1.2-5b

02/12-15-075-06W4 Regen Disposal Well
MWIP 6,000 kPag

Monthly Volumes [m3]
Average Injection Pressure [kPa]
04/12-15-075-06W4 Regen Disposal Well
MWIP 6,000 kPag

Monthly Volumes [m3]
Average Injection Pressure [kPa]
Water Disposal – Approval No. 10790
00/05-12-075-06W4

3.1.2-5b

00/05-12-075-06W4 BD Disposal Well
MWIP 6,00 kPag

Monthly Volumes [m³]
Average Injection Pressure [kPa]
Water Disposal – Approval No. 10790
02/05-12-075-06W4

3.1.2-5b

02/05-12-075-06W4 BD Disposal Well
MWIP 6,000 kPag

- Monthly Volumes [m³]
- Average Injection Pressure [kPa]
Water Disposal – Approval No. 10790
00/03-22-075-06W4

00/03-22-075-06W4 Regen Disposal Well
MWIP 6,000 kPag

Average Injection Pressure [kPa]
Monthly Volumes [m3]
Water Disposal – Approval No. 10790  
02/03-22-075-06W4

3.1.2-5b

02/03-22-075-06W4 Regen Disposal Well  
MWIP 6,000 kPag

- Monthly Volumes [m³]
- Average Injection Pressure [kPa]
### Off-site Water Disposal Volumes

#### 3.1.2-5c

<table>
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<tr>
<th>Facility</th>
<th>Volume (m³)</th>
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<tbody>
<tr>
<td>Access pipeline</td>
<td>5,939</td>
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<tr>
<td>Newalta Elk Point WP</td>
<td>783</td>
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<tr>
<td>Newalta Fort McMurray</td>
<td>129</td>
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<tr>
<td>Newalta Hughenden</td>
<td>21</td>
</tr>
<tr>
<td>Tervita Lindberg WP</td>
<td>1,302</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>8,174</strong></td>
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</table>
Sulphur Production & Air Emissions
Section 3.1.2-6
Sulphur Production

Operations with Sulphur Recovery

3.1.2-6a (i) and (ii)

Jackfish 1 Sulphur Recovery

Inlet Sulphur content <1t/d
No Sulphur Recovery Required
Sulphur Production
Operations with Sulphur Recovery

3.1.2-6a (i) and (ii)

Jackfish 2 Sulphur Recovery

- Plant Outage
- Turnaround

Legend:
- Daily Recovery
- Quarterly Average Recovery
- Required Recovery
Sulphur Production

Peak Daily and Rolling Averages – SO$_2$ Emissions

(30 day rolling average of the J1, J2 & J3 daily SO2 emissions)

- District 30-day Rolling Avg.
- Jackish 1 Daily Avg.
- Jackfish 2 Daily Avg.
- Jackfish 3 Daily Avg.
- EPEA Approval Limit
Ambient Air Quality Monitoring

3.1.2-6d

Passive air monitoring

• At least four passive stations located at each Jackfish site to monitor sulphur dioxide and hydrogen sulphide

Continuous ambient monitoring

• Monitored parameters: sulphur dioxide, hydrogen sulphide, nitrogen dioxide, total hydrocarbons, wind speed and direction

2015-2016 monitoring and reporting requirements were satisfactorily met.
Ambient Air Quality Monitoring

3.1.2-6d

[Map showing air monitoring stations and locations]
### Ambient Air Quality Monitoring

**Results**

#### 3.1.2-6d

**Jackfish 1 Ambient Monitoring - Hourly Maximum**

- **NO₂ (ppb)**
- **SO₂ (ppb)**
- **H₂S (ppb)**
- **THC (ppm)

**Alberta AAQO (1-hr)**
- NO₂ : 159 ppb
- SO₂ : 172 ppb
- H₂S : 10 ppb

- Marginal increase in NO₂ concentrations due to nearby construction activities

**Jackfish 2/3 Ambient Monitoring - Hourly Maximum**

- **NO₂ (ppb)**
- **SO₂ (ppb)**
- **H₂S (ppb)**
- **THC (ppm)

**Alberta AAQO (1-hr)**
- NO₂ : 159 ppb
- SO₂ : 172 ppb
- H₂S : 10 ppb
Environmental Issues

Section 3.1.2-7
# Environmental Issues

## Environmental Non-Compliances

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<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Corrective Action</th>
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<tbody>
<tr>
<td>Sep 2015</td>
<td>Jackfish 1 domestic wastewater treatment plant TSS exceedance</td>
<td>• Maintenance procedures reviewed and updated to ensure proper cleaning of membrane filters</td>
</tr>
</tbody>
</table>
| Oct 2015 | H$_2$S exceedance detected at Jackfish 1 ambient air monitoring trailer | • Investigation has found no upset or operating condition that would result in an H$_2$S exceedance  
• Cause suspected to be naturogenic (natural source of H$_2$S) in combination with poor meteorological conditions |
| Nov 2015 | Jackfish 3 CEMS Downtime                                             | • New probe installed  
• Probe material compatibility is under review |
| Apr 2016 | Jackfish CEMS Data Acquisition System failure                        | • System memory card replaced and issue resolved |
| Jun 2016 | Significant rainfall resulted in an uncontrolled release of surface water collected on a source water pad | • Water tested and met surface water discharge criteria  
• Berm was repaired and a dedicated pump is on-site |
| Jul 2016 | Jackfish 2 SRU compressor upset resulted in SO$_2$ emissions above daily limit | • Sulphur recovery unit operating procedure altered across Jackfish CPF’s |
### D78 Amendments – September 2015 to August 2016

* Indicates current approval as of August 31, 2016

<table>
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<th>Amendment</th>
<th>Date</th>
<th>Category</th>
<th>Category Code</th>
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<td>Jackfish Pad EEE and Development Area Request</td>
<td>September 10, 2015</td>
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<td>10097CC</td>
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<tr>
<td>Jackfish 1 NCG Injection and Wind-down</td>
<td>September 16, 2015</td>
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<td>10097DD</td>
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<tr>
<td>Jackfish 2 NCG Injection</td>
<td>September 16, 2015</td>
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<td>10097DD</td>
<td>2</td>
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<tr>
<td>Pad O Revised Well Trajectories</td>
<td>December 9, 2015</td>
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<td>10097EE</td>
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<td>Pad R Revised Well Trajectories</td>
<td>January 5, 2016</td>
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<td>Jackfish 1 Sulphur Recovery</td>
<td>April 15, 2016</td>
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<td>Letter</td>
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<td>Pad QQ Proposal</td>
<td>April 29, 2016</td>
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<td>10097GG*</td>
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</table>
D56 Facilities Licences

- Jackfish 1 F33125 Licence Amendments – Changes to H₂S content of inlet gas, continuous sulphur emissions, sulphur inlet rate and facility category
- Jackfish 2 F39950 Licence Amendments – Changes to H₂S content of inlet gas, continuous sulphur emissions, inlet rates and compressors
- Jackfish 3 F44113 Licence Amendment - Changes to H₂S content of inlet gas, continuous sulphur emissions, inlet rates and facility category

D65 Disposal Approval No. 10790

- No Amendments
AER Regulatory Approval Summary

Jackfish Class II Landfill

D58 Approval WM105

<table>
<thead>
<tr>
<th>Date Issued</th>
<th>Approval To:</th>
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<tbody>
<tr>
<td>Nov 24, 2015</td>
<td>• One time approval to accept additional waste from Devon OSE programs</td>
</tr>
<tr>
<td>Nov 27, 2015</td>
<td>• One time approval to accept additional waste from the Devon Pike Project Area</td>
</tr>
<tr>
<td>Dec 10, 2015</td>
<td>• Amendment Approval WM105E for expansion of the landfill lease boundary</td>
</tr>
<tr>
<td>Dec 16, 2016</td>
<td>• One time approval to accept additional waste from Devon Northeast Gas sites</td>
</tr>
<tr>
<td>Jul 8, 2016</td>
<td>• One time approval to accept additional waste from Devon OSE programs</td>
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</tbody>
</table>

Water Act Approval No. 383956-00-00 - Issued August 19, 2016

• For the operation of underdrains below Landfill Cell 2 and Leachate Pond
AER Regulatory Approval Summary

Jackfish District

3.1.2-7b

EPEA Operating Approval No. 224816-00-04
  • No Amendments

Water Diversion Licence No. 337687-00-00
  • No Amendments

Water Diversion Licence No. 336307-00-00 & 336307-00-01
  • No Amendments

Water Diversion Licence No. 336306-00-00
  • No Amendments
AER Regulatory Reporting Requirements

3.1.2-7c

- Industrial Wastewater and Industrial Runoff Report
- Groundwater Monitoring Report
- Wetland Monitoring Report
- Potable Water Monitoring Report
- Air Monitoring Report
- Soil Management Report
- Soil Monitoring Report
- Conservation and Reclamation Annual Report
- Wildlife Mitigation and Monitoring Program
- Caribou Mitigation and Monitoring Program
Water Management

Jackfish 1, 2 and 3

Groundwater

- Jackfish 1, 2 & 3 groundwater monitoring twice yearly at CPF, well pads and Tank Farm as per EPEA approval
- Minor issues to date include slightly elevated chlorides due to road safety and rebalancing of water table below Jackfish 1 CPF
- Monitoring ongoing

Wetlands

- Wetland monitoring program amendment approved by AER (Sept, 2016)
- Wetland monitoring sites were surveyed in Q2 & Q3 2016
- No significant impacts observed to date
Soil Monitoring & Soil Management

**Jackfish 1, 2 and 3**

3.1.2-7c

- Jackfish 1 soil monitoring report submitted in 2011

- Ongoing monitoring of Jackfish 2 operational areas (CPF and wells pads)

- The next soil monitoring proposal for Jackfish 1, 2 and 3 is due November 2016

- The next soil monitoring report for Jackfish 2 is due in 2017
As per EPEA Approval Condition, Devon’s Jackfish Wildlife Monitoring Program was authorized in July 2012.


Long term monitoring ongoing.

No significant project related impacts observed to date.
3.1.2-7d

- Christina Lake Regional Water Management Agreement (CLRWMA)
- Canada’s Oil Sands Innovation Alliance (COSIA)
- Alberta Biodiversity Monitoring Institute (ABMI)
- Regional Aquatics Monitoring Program (RAMP)
- Monitoring Avian Productivity and Survivorship (MAPS Program)
- Regional Industry Caribou Collaboration (RICC)
- Clean Air Strategic Alliance (CASA)
- Wood Buffalo Environmental Association (WBEA)
**Other Environmental Initiatives**

3.1.2-7d

**COSIA (Canada’s Oil Sands Innovation Alliance)**

- Devon is an active participant of the Water, Land and GHG Environmental Priority Areas (EPAs) and the COSIA Monitoring Working Group
- Aspirations for each EPA have been developed and Devon is striving to:
  - GHG: Produce oil with lower greenhouse gas emissions than other sources of oil
  - Land: Be world leaders in land management, restoring the land and preserving biodiversity of plants and animals
  - Water: Be world leaders in water management, producing Canadian energy with no adverse impact on water
- Devon is a participant and, in some cases leading, Joint Industry Projects in each of the EPAs
Other Environmental Initiatives

3.1.2-7d

MAPS Program (Monitoring Avian Productivity and Survivorship)
• Continued annual support (technical, financial) of the MAPS Program
• This program analyzes the influence of industry throughout NE Alberta

RICC (Regional Industry Caribou Collaboration)
• Devon is leading a consortium of organizations in implementing a collaborative caribou conservation program for the Cold Lake Range, which comprises the JF and Pike district
• This program focuses on:
  – Managing and reducing industry’s current and future footprint
  – Identifying effective techniques to reduce wolf and bear movements throughout the caribou habitat
Regulatory Compliance
Section 3.1.2-8, -9
Devon Canada Corporation believes the Jackfish Project is in compliance with AER approvals and regulatory requirements. As of August 31, 2016, Devon has no unaddressed non-compliant events.
AER Summary of Noncompliance

3.1.2-9

The following list summarizes non-compliant events in the reporting period. For all events corrective actions were identified and tracked to completion.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Corrective Actions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oct 2015</td>
<td>Notice of Noncompliance re: Outstanding Serious SCVF/GM Repairs</td>
<td>• SCVFs have been reclassified to non-serious</td>
</tr>
<tr>
<td></td>
<td></td>
<td>• Authorization also received for deferral of repair</td>
</tr>
<tr>
<td>May - Jul 2016</td>
<td>Notice to Submit Well Logs, 5 wells</td>
<td>• Devon submitted required information</td>
</tr>
<tr>
<td>Sept 2016</td>
<td>Notice of Noncompliance re: J1 injection facility water imbalance 2015-2016</td>
<td>• DCS programming error found to be main contributing factor and has been corrected.</td>
</tr>
</tbody>
</table>

### AER Spill Reporting

<table>
<thead>
<tr>
<th>Site</th>
<th>No. of Reportable Spills</th>
<th>Volume Released (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jackfish 1</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>Jackfish 2</td>
<td>6</td>
<td>34</td>
</tr>
<tr>
<td>Jackfish 3</td>
<td>4</td>
<td>63</td>
</tr>
</tbody>
</table>
Future Plans

Section 3.1.2-10

Surface Operations

3.1.2-10a, b, c, d

Jackfish 3
• Plant Maintenance Turnaround planned for 2017
Thank you.