INTRODUCTION AND OVERVIEW

• Introduction

• Subsurface Issues Related to Resource Evaluation and Recovery
  – Directive 054, Section 3.1.1

• Surface Operations, Compliance, and Issues Not Related to Resource Evaluation and Recovery
  – Directive 054, Section 3.1.2
SUBSURFACE ISSUES: TABLE OF CONTENTS

1. Brief Background of the Scheme
2. Geology/Geoscience
3. Drilling and Completions
4. Artificial Lift
5. Instrumentation in Wells
6. Seismic
7. Scheme Performance
8. Future Plans
PROJECT LOCATION

[Project Location Map]

Legend:
- Indian Reservation
- Provincial Park

Lindbergh SAGD Pilot Project

Deferred SAGD Wellpairs
PROJECT OVERVIEW

- Pilot implemented to evaluate the SAGD recovery process in the Mannville Lloydminster Formation
- Two SAGD well pairs ~800 meters long with 100 meter spacing
  - Steam circulation commenced Feb 2012
- Contingent third pilot well pair approved but not drilled
- 12,500 bpd scheme approval received
  - Drilling and completions done and construction near completion
  - Commissioning and First steam – Q4, 2014
- Application 1784285 to increase production to 30,000 bpd submitted December 2013
LINDBERGH HISTORY

• Murphy piloted and then commercialized CSS production in Section 13 from 1972-1998

• Pengrowth acquired the Lindbergh lease from Murphy Canada in April, 2004

• All CSS wells have been abandoned

• Two pilot well pairs are on the western edge of the CSS area
  – Steam circulation commenced Feb 2012

• Construction of 12,500 bpd project near completion
  – New process facility and 20 new wellpairs
CSS IMPACT ON FUTURE DEVELOPMENT IN SEC 13

• Murphy produced a total of 2.3 MMbbls of oil and 7.6 MMbbls of water with 8.2 MMbbls (CWE) steam injection
• 71 vertical wells and 3 horizontal wells used in CSS operations
• The average recovery factor for the CSS area is 5-6% of the OOIP (up to 10% in various wells)
• CSS injection operations were at pressures over 10 MPa with injection at various depths within the target formation
• Pengrowth has submitted a D78 Category 2 Amendment Application to install 2 horizontal well pairs into this area to test SAGD production performance
• Potential impacts of the CSS operations are:
  – Channeling of steam, breakthrough to bottom water, increased SOR with decreased recovery, increased water production from residual CSS steam condensate
• Proposal is to drill and complete well pairs in Q4 2015 with circulation to commence in Q2 2016
# Lindbergh Application History

<table>
<thead>
<tr>
<th>Operator</th>
<th>Date</th>
<th>Event</th>
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<tbody>
<tr>
<td>Murphy</td>
<td>May 1991</td>
<td>ERCB Scheme Approval 6410 granted</td>
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<td></td>
<td>Aug 1993</td>
<td>ERCB Amended Scheme Approval 6410B granted</td>
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<td>Dec 1996</td>
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<td>Aug 1997</td>
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<td>Jun 1999</td>
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<td>Apr 2004</td>
<td>ERCB Amended Scheme Approval 6410F granted</td>
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<td>Apr 2008</td>
<td>Application to Amend for SAGD Production submitted</td>
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<td>Nov 2009</td>
<td>Commercial Scheme Amend 6410G Extension of App Expiry</td>
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<td>Dec 2010</td>
<td>SAGD Application Updated and Re-submitted</td>
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<td>D78 Cat 3 Amend - 6410I Expansion to 12,500 bopd</td>
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<td>Apr 2014</td>
<td>D78 Cat 2 Amend - 6410J Solvent Soak Trial</td>
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### LINDBERGH APPLICATION HISTORY (CONTINUED)

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<td>D78 Cat 3 Amend App #1784285</td>
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<td>Sep 2014</td>
<td>D78 Cat 2 Amend App #1808902</td>
<td>Debottleneck Oil Train</td>
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<td>Sep 2014</td>
<td>D78 Cat 2 Amend App #1809920</td>
<td>Add Sec 13 Well Pairs</td>
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<td>Expected Jan 2015</td>
<td>D56 Sales &amp; Diluent PL Application (PLA#141430, C&amp;R#001-356469)</td>
<td>Tie-in to Husky PL infrastructure</td>
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SAGD RECOVERY PROCESS

- Stacked horizontal wells
- Steam injected into top well and forms steam chamber
- Steam condenses on boundary of chamber and releases heat into the bitumen
- Bitumen and condensed water drain by gravity to the bottom well
- Bottom well produces liquid bitumen to surface
GEOLGY AND GEOSCIENCE
2014 & 2015 DRILLING

- 43 delineation wells drilled in 2014 (10 on Muriel Lake Lease).
- 44 delineation wells planned for 2015
BITUMEN VOLUMES & RESERVOIR PROPERTIES

- All values shown for $S_w$, $\Phi$ and bitumen volume are measured from the Petrel geology model.
- Boundaries defining the area and the top and bottom surfaces of the reservoir are used to confine the volume calculation.
- Bitumen volume extends below well pairs to the OWC.
- $S_w$, $\Phi$ are averages for the volume shown.
- Average horizontal permeability = 3500 md: $K_v / K_h = 0.86$
- Viscosity of the bitumen decreases upwards through the reservoir from approximately 600,000 cP at the base to 50,000 cP near the top.
- Mean reservoir thickness is 16.7 m. This includes all areas having a minimum thickness of 10 meters.
- Initial reservoir temperature = 20 Celcius, initial reservoir pressure 2800-3000 kPa
- Reservoir pressure in bottom water interval = 2850 kPa
- Reservoir depth ~ 500 mKB

<table>
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<tr>
<th>Region</th>
<th>OBIP Volume (m$^3$)</th>
<th>Porosity (%)</th>
<th>$S_w$ (%)</th>
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<tr>
<td>Pilot</td>
<td>993,543</td>
<td>34.6</td>
<td>26</td>
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<td>Wellpad D02</td>
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<td>Wellpad D03</td>
<td>2,725,190</td>
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<td>Wellpad D05</td>
<td>3,003,181</td>
<td>35</td>
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</table>
Representative Composite Well Log

Cap Rock

Top Lloydminster Fm Reservoir

Oil/Water Contact Defined at 10 Ωm

Estimated Top Cummings Fm

Average Pay Thickness = 20 m
Average Producer to Injector Spacing = 5 m
Average O/W to Producer Distance = 3 m
NET BITUMEN PAY
STRUCTURAL TOP AND BOTTOM OF BITUMEN RESERVOIR
CORED WELLS AND SPECIAL CORE ANALYSIS

Core analysis typically consists of the following:

- Dean-Stark – 1762 samples
- Small plug $\Phi$, $K$, $Sw$ – 2000 samples
- Grain size – 37 wells sampled
- Petrographic, XRD – 25 samples from 12 wells
- Special core analysis – 36 samples from 5 wells
Lloydminster sands are continuous and contain rare shale interbeds. Typically the reservoir is composed of very fine grained sands throughout the interval.
PETROGRAPHIC ANALYSIS

- Some Petrographic analysis has been done on core samples in the Lloydminster Reservoir.
- Sands are typically classified as Feldspathic Litharenite to Sublitharenite on the Folk scale (Folk, 1974).
- The clay fraction is less than 10% of the bulk sample.
- Grain sizes range from coarse silt to lower medium grained sand.
- Critical velocity testing indicates that clays remain non-mobile during steam injection. The clays will not block pore throats.
• Producer planned to land 3 m above highest point on oil/water contact (OWC) surface.
• LWD measurements indicated OWC rising to the north.
• Needed to directionally control drilling to maintain offset from OWC.
HEAVE MONUMENTS

- Baseline readings were taken in March 2012.
- Most recent observations were taken in February and September of 2014.

<table>
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<tr>
<th>Point Differences vs Observation 1</th>
<th>∆N(m)</th>
<th>∆E(m)</th>
<th>∆Elev(m)</th>
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<tr>
<td><strong>Observation 6 (February 2014)</strong></td>
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<td>Control</td>
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<td>0</td>
<td>0</td>
</tr>
<tr>
<td>WP01</td>
<td>0.051</td>
<td>-0.05</td>
<td>0.019</td>
</tr>
<tr>
<td>WP02</td>
<td>0.022</td>
<td>-0.003</td>
<td>0.002</td>
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<tr>
<td><strong>Observation 7 (September 2014)</strong></td>
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<td>Control</td>
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<td>WP01</td>
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<td>0.019</td>
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<tr>
<td>WP02</td>
<td>0.046</td>
<td>-0.107</td>
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Heave Monitoring Map

In Situ Oil Development and Operations
**CAPROCK INTEGRITY AND RESERVOIR OPERATING PRESSURE**

  - All showed comparable results
  - Approved maximum ongoing operating pressure = 5500 kPa, less than 80% of minimum stress in caprock at reservoir depth

<table>
<thead>
<tr>
<th>Fracture No.</th>
<th>Formation</th>
<th>Fracture Type</th>
<th>Depth (m)</th>
<th>Dip (Degrees)</th>
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<tr>
<td>F1</td>
<td>GP</td>
<td>Small fracture</td>
<td>480.6</td>
<td>65</td>
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<tr>
<td>F2</td>
<td>GP</td>
<td>Small Fracture</td>
<td>480.9</td>
<td>70</td>
</tr>
<tr>
<td>F3</td>
<td>GP</td>
<td>Small Fracture</td>
<td>482.9</td>
<td>70</td>
</tr>
<tr>
<td>F4</td>
<td>GP</td>
<td>Hairline fracture</td>
<td>484.2</td>
<td>60</td>
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</table>
3D SEISMIC DATA COVERAGE

- New 3D seismic data acquired on Muriel Lake Lease in 2014
- New baseline 3D acquisition planned over well pads 2, 3 and 5 in 2015. Will be used for future 4D monitoring
- 3D data now exists on most of the lease with exploitable resource.
- Planning to acquire additional baseline data over PADs in early 2015
4D SEISMIC

• 1.32 sq km Baseline Survey acquired Feb 2012
  • Source, dynamite 0.25 kg @ 6m
  • Source line interval (E-W) 90m
  • Receiver line interval (N-S) 75m
  • Source and receiver interval 24m
  • Analog geophones 6 over 8m
  • First repeat survey in 2-3 years

• 1.32 sq km Monitor Survey acquired Dec 2013
  • Same acquisition parameters as baseline survey

• Area will be resurveyed in 2015
4D SEISMIC

• Time Slice from the P Impedance Difference Volume at 150m asl, approximately at injector/producer level

• shows lower P impedance due to effects of steaming/methane
DRILLING AND COMPLETIONS
COMMERCIAL DRILLING

- Drilled 20 new SAGD wellpairs from 3 new PADs (D02, D03, D05)
  - Spud first well Sept 2013 and finished completions in October 2014
  - Minor changes to actual well designs as described in letter dated Oct 28, 2014

- New water disposal well drilled near CPF (basal Cambrian Sand)
  - To be completed and tied in Nov 2014

- Drilling deferred on 12 SAGD wellpairs until future when volumes required

- Plan to drill proposed Section 13 and D04 wellpairs commencing Oct 2015
TYPICAL CIRCULATION COMPLETION

Surface Casing
339.7 mm (13 3/8”)

Intermediate Casing
244.5 mm (9 5/8”)

Slotting details
Injector – 177.8 MM (7”) Slotted Liner
Producer – 177.8 MM (7”) Wire Wrapped Screen

Short string
88.9 mm (3 ½”)

Long string
88.9 mm (3 ½”)

Fiber Coil to the toe
31.8 mm Coil tubing

Injector – 177.8 MM (7”) Slotted Liner
Producer – 177.8 MM (7”) Wire Wrapped Screen
LINER DESIGN

• The relatively small grain size and the presence of fines in the reservoir combined laboratory flow testing indicated a liner slot width of 0.009” would be required

• This small slot width can lead to quality control problems in the manufacturing process

• The presence of fines with the small slot widths increased the potential for slot plugging. Therefore, Pengrowth chose to utilize wire wrap screens with a 0.009” wrap for the producer well liners
  • This increased the open flow area from about 2.5% to over 9%

• Straight cut slots were utilized in the injector wells

• Inflow Control Device
  – Liner deployed system installed across D05-P08 to test its performance with thinner pay and bottom water
TYPICAL ARTIFICIAL LIFT COMPLETION

Surface Casing
339.7 mm (13 3/8”)

Intermediate Casing
244.5 mm (9 5/8”)

Production Tubing
88.9 mm (3 1/2”)

Guide String
60.3 mm (2 3/8”)

Instr String (to toe or heel)

ESP

Scab Liner
COMPLETION CHANGES

• Scab Liner
  – Installed to reduce preferential steam chamber development at the heel
  – Reduce the potential of steam at the pump intake due to immediate installation of artificial lift following circulation

• Production Port
  – Allows for a more uniform development of the steam chamber due to uniform drainage and reduces short circuiting at the heel
  – Reduces the draw down or pressure drop required for fluid to get to the pump intake from the formation

• Steam Splitters
  – Installed in some cases to promote development in certain areas of the reservoir
ARTIFICIAL LIFT

• D01-P01
  – May 2012 - SAGD conversion – ESP install
  – April 2013 – ESP upsize
  – February 2014 – ESP upsize

• D01-P02
  – May 2012 – SAGD conversion – PCP install
  – April 2013 – PCP replacement (non failure)
  – December 2013 – PCP replacement (failure)
  – Jan 2014 – ESP conversion (PCP failure)
  – February 2014 – ESP upsize

• Commercial Artificial lift
  – Full field ESP installations upon conversions to SAGD
  – Utilize pilot well performance to better predict pump sizing requirements
<table>
<thead>
<tr>
<th>Drilling and Completions Plan</th>
<th>2014</th>
<th>2015</th>
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<tr>
<td></td>
<td>N</td>
<td>D</td>
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<tr>
<td>Complete and Tie DW5 (8-26)</td>
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<td>Drill and Tie in D01 Infill Well B01</td>
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<td>Complete B01 Well</td>
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<td>Core Steam Chamber</td>
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<td>Drill 6 Observation Wells (Sec 13 SAGD Monitor)</td>
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<tr>
<td>Move in rig to D04</td>
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<tr>
<td>Drill Sec 13 wellpairs (2 WP @ 14 days/wp)</td>
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<tr>
<td>Drill D04 wellpairs (8 WP @ 14 days/wp)</td>
<td></td>
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</table>
THERMALLY NON COMPATIBLE WELL REMEDIATION

- A total of 13 wells within the 300 meter buffer zone of the first 3 PAD drainage areas were deemed thermally non-compatible and repaired
  - Details in notification letter sent to AER on October 29
  - **All wells that will be impacted by thermal SAGD operations in Phase 1 are now compatible with thermal operations**

- 20 wells within 300 meters of the proposed Section 13 CSS SAGD wells may require repairs

- Additional thermal compatibility analysis of 26 wells within 300 meters of the drainage areas of the Phase 2 well pads is ongoing

- Repairs to Section 13 and Phase 2 non-compatible wells will be undertaken at appropriate time
INSTRUMENTATION
Observation Locations / Typical Completion

RTD combos
• 3 Sensor units
• Temp/Press

Temperature string
• 30 Thermocouples

BG
W
Overburden Caprock

Lloydminster Formation

Lloydminster OWC Underburden
SCHEME PERFORMANCE
SAGD SUMMARY

• Pilot wellpairs had first steam February 1, 2012
• ~28 Months of SAGD operation
• > 1.45 MM bbl total production to date
• Steam cutback in April 2014 (~10 days at half rates)
  – Associated with raw water softening issues

• WP1
  – CSOR ~ 2.07
  – Cumulative Oil ~ 752,000 bbl

• WP2
  – CSOR ~ 2.11
  – Cumulative Oil ~ 711,000 bbl
  – Artificial lift issues in December 2013
    • Conversion from PCP to an ESP in late December
PREDICTING SCHEME PERFORMANCE

• Analogues
  – CNRL Wolf Lake

• Simulations
  – CSS historical match
  – SAGD modeling

• One of the purposes of the Lindbergh pilot was to establish a baseline for predicting commercial performance
Lindbergh Performance

Monthly Overview

- Fluid Rates (m³/d or T/d)
- SOR

Graph showing the monthly overview of fluid rates and SOR from 2/1/2012 to 8/1/2014.
### PAD RECOVERIES

**OBIP - Recovery and % recovery by pad**

<table>
<thead>
<tr>
<th>Pad</th>
<th>Thickness (m)</th>
<th>Length* (m)</th>
<th>Spacing (m)</th>
<th>Ave φ (%)</th>
<th>Ave So (%)</th>
<th>OBIP (e³m³)</th>
<th>Recovery** (%)</th>
<th>Recovery (%)</th>
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<td>993.5</td>
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<td>817</td>
<td>100</td>
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<td>D03</td>
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<td>3,366</td>
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**Developed BIP - Recovery and % recovery by pad**

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<th>Thickness (m)</th>
<th>Length* (m)</th>
<th>Spacing (m)</th>
<th>Ave φ (%)</th>
<th>Ave So (%)</th>
<th>DBIP (e³m³)</th>
<th>Recovery** (%)</th>
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*Length is average slotted length plus 25 meters per end (50 m total)

**Recovery to Oct 1 2014
LINDBERGH DEVELOPED RECOVERY

The graph shows the recovery percentage over time for two different categories, D01-P01 and D01-P02. The recovery percentage increases steadily from 0% in January 2012 to approximately 50% in August 2014. D01-P01 shows a slightly higher recovery rate compared to D01-P02.
D01-P01 PERFORMANCE

Wellpair 1 Monthly Overview

- Allocated Daily Steam (T/d)
- Allocated Daily Oil (m3/d)
- Allocated Daily Water (m3/d)
- Inst Steam/Oil Ratio
- Cum Steam/Oil Ratio

Fluid Rates (m3/d or T/d)

Date Range:
- 2/1/2012 to 8/1/2014
Wellpair 2 Monthly Overview

- Allocated Daily Steam (T/d)
- Allocated Daily Oil (m³/d)
- Allocated Daily Water (m³/d)
- Inst Steam/Oil Ratio
- Cum Steam/Oil Ratio
CUMULATIVE WATER/STEAM RATIO

The graph illustrates the cumulative water/steam ratio over time, comparing different intervals such as 2/1/2012 to 8/1/2014. The data shows a consistent ratio close to 1.0, with slight variations indicated by the lines for D01-P01, D01-P02, and Pilot.
WP2 OBSERVATION WELL EXAMPLE

~11 m offsetting WP 2

Injector

Producer
**BOTTOM HOLE PRESSURE**

Bubble gas blocked in (N\textsuperscript{2} line pressure)

Target Injector BHP = Bottom water + \(\sim\) 50-250 kPa

Plant turnaround

Bottom Water Pressure

Injector Bottom Hole Pressure (kPa)


D01 WP1, D01 WP2
LINDBERGH CSOR AND ISOR

![Graph showing the Steam/Oil Ratio from February 2012 to August 2014. The graph compares D01-P01 CSOR, D01-P02 CSOR, D01 P01 ISOR, and D01 P02 ISOR.]
WELLHEAD STEAM QUALITY

• Current steam quality injected at the well pad is ~99%
  – Close proximity to CPF
PAD ABANDONMENTS – 5 YEAR OUTLOOK

• No abandonments of SAGD wells or well pads are expected in the next 5 years
KEY LEARNINGS

• ESP is the preferred artificial lift technology
  – Operability, no surface maintenance and overall longevity

• Bottom hole pressure target changes over time
  – Will vary with oil/water contact changes and steam chamber size
  – Produced water has not shown significant impacts on wire wrap screen

• Scab liner design
  – Shorter scab liner preferred
  – Production port beneficial for uniform fluid level

• Casing gas compression
  – As producer temperature increases this is less of an issue as flashing steam supports gas movement up the casing
  – Investigating potential designs in case this is an issue at the commercial
FUTURE PLANS - SUBSURFACE

• Maintain steady state

• Commercial Wellpairs
  – Circulation of first well to commence in Q4, 2014
  – Conversion to SAGD and artificial lift (ESP) installations in Q1 2015
  – New well pairs drilled closer to OWC

• Pre Circulation Solvent Soak
  – Six month diluent soak in two injectors
  – Results TBD

• Future considerations
  – Infill well
  – Gas co-injection
  – Solvent co-injection into injection wells
  – Casing gas compression
FACILITIES
PILOT
LINDBERGH PILOT WELLPAD (D01) PLOT PLAN
LINDBERGH PILOT MODIFICATIONS

• Commercial Water Transfer
  • Utilize existing pond and filters at Pilot CPF for source water handling
  • Addition of one new water tank, water transfer pump skid, pigging skid, and new pipeline from Pilot to Commercial CPF
  • Maintains water supply to Pilot while using water transfer for commissioning and make-up during Commercial operation

• Upsized Test Separator PSVs
  • Designed to handle blocked flow scenario with increased size of downhole pumps
LINDBERGH PILOT FACILITY

• 07-13-058-05 W4M Pilot Facility site
• Design Capacity
  • 1000 m³/d CWE for steam generation
  • 200 m³/d oil production (80% steam quality & SOR of 4.0)
• Pilot facility is not equipped to handle produced water recycle
  • Make-up volumes are below 500,000 m³/year
• Qualified and experienced SAGD operations team
• Pilot facility first steam February 2012
• Anticipate mothballing oil and steam trains of Pilot facility Q1/Q2 2015
• Will remain in service:
  • Source water filtration and instrument air for commercial water transfer
  • Glycol heaters for building heat
LINDBERGH PILOT FACILITY

• Bitumen Treatment
  • H2S scavenger added at truck loading station to meet rail shipping requirements

• Water Treatment
  • Higher organics content in produced water causing higher than expected HEX fouling

• Steam Generation
  • Carry through sediment into upfront SACs
    • Reduction in runtime on SACs, impact to BFW production
    • With commercial water transfer, change to use filtered water as backwash, rather than unfiltered pond water; prevent buildup of sediment under media filters during backwash
    • Anticipate longer run times once change implemented

• Power Consumption
  • Consistent consumption, increase over winter months
LINDBERGH PILOT – POWER CONSUMPTION

Lindbergh MWH Monthly Usage

<table>
<thead>
<tr>
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<tr>
<td>TOTAL</td>
<td>564.7</td>
<td>496.9</td>
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<td>494.7</td>
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<td>471.5</td>
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<td>SATELLITE WELL</td>
<td>59.3</td>
<td>58.4</td>
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<td>51.5</td>
<td>81.8</td>
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<td>WATER STATION</td>
<td>88.3</td>
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<td>417.1</td>
<td>362.7</td>
<td>394.9</td>
<td>340.8</td>
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<td>370.2</td>
<td>348.6</td>
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2014 YTD

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<td>WATER STATION</td>
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<td>SATELLITE WELL</td>
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<td>TOTAL</td>
<td>5521.0</td>
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LINDBERGH PILOT – GAS

Lindbergh SAGD Pilot Previous Calendar Year FG, PG, Flare

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<tr>
<th>Month</th>
<th>Total (e3m³)</th>
<th>Flare (e3m³)</th>
<th>PG (e3m³)</th>
<th>FG (e3m³)</th>
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<tr>
<td>Jan-2013</td>
<td>1231.8</td>
<td>3.6</td>
<td>108.1</td>
<td>1120.0</td>
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<td>Feb-2013</td>
<td>1169.8</td>
<td>2.4</td>
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<td>Mar-2013</td>
<td>1365.3</td>
<td>2.6</td>
<td>99.9</td>
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<td>Apr-2013</td>
<td>880.4</td>
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<td>70.5</td>
<td>803.0</td>
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<td>3.0</td>
<td>113.9</td>
<td>1268.8</td>
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<td>Jun-2013</td>
<td>1431.8</td>
<td>2.7</td>
<td>126.1</td>
<td>1303.0</td>
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<td>Jul-2013</td>
<td>1481.4</td>
<td>2.9</td>
<td>130.5</td>
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<td>Aug-2013</td>
<td>1550.0</td>
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<td>138.8</td>
<td>1408.5</td>
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<td>Sep-2013</td>
<td>1567.0</td>
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<td>Oct-2013</td>
<td>1614.4</td>
<td>3.5</td>
<td>126.7</td>
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<td>Nov-2013</td>
<td>1581.1</td>
<td>2.1</td>
<td>115.1</td>
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<td>Dec-2013</td>
<td>1457.4</td>
<td>2.2</td>
<td>110.5</td>
<td>1344.7</td>
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</table>

2014 YTD: FG – 13651e3m³, PG – 1118e3m³, Flare – 46e3m³, Total – 14815e3m³
LINDBERGH - SO2

• No sulphur recovery
• Average 2013 Month - 0.7444 tonnes, Average 2013 Day - 0.0248 tonnes

Total 2013 SO2 t/month

• 2014 YTD: Total SO2 – 16.452 tonnes, Flare – 0.179 tonnes, OTSG – 16.272 tonnes
• Average 2014 month – 1.8279 tonnes, Average 2014 day – 0.0609 tonnes
### Quarter Year Actuals

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<tr>
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<th>Flare Stack</th>
<th>OTSGs</th>
<th>Average</th>
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<tr>
<td>t</td>
<td>t</td>
<td>t</td>
<td>t</td>
<td>t/d</td>
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<tr>
<td>Q1 2013</td>
<td>1.402</td>
<td>0.002</td>
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<td>Q2 2013</td>
<td>1.572</td>
<td>0.010</td>
<td>1.563</td>
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<td>Q3 2013</td>
<td>2.224</td>
<td>0.004</td>
<td>2.221</td>
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<td>Q4 2013</td>
<td>3.734</td>
<td>0.009</td>
<td>3.725</td>
<td>0.041</td>
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<td>Q1 2014</td>
<td>5.137</td>
<td>0.022</td>
<td>5.115</td>
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<td>Q2 2014</td>
<td>6.059</td>
<td>0.097</td>
<td>5.962</td>
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<td>Q3 2014</td>
<td>5.256</td>
<td>0.061</td>
<td>5.195</td>
<td>0.058</td>
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### Monthly Sulphur

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<th>Flare Stack</th>
<th>OTSGs</th>
<th>Peak day</th>
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<td>t/month</td>
<td>t/month</td>
<td>t/month</td>
<td>t/d</td>
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<tr>
<td>Jan-13</td>
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<td>0.002</td>
<td>0.446</td>
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<td>0.340</td>
<td>0.000</td>
<td>0.340</td>
<td>0.017</td>
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<td>Mar-13</td>
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<td>0.510</td>
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<td>0.038</td>
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<td>1.397</td>
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<td>0.008</td>
<td>1.961</td>
<td>0.069</td>
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<td>Apr-14</td>
<td>1.920</td>
<td>0.008</td>
<td>1.912</td>
<td>0.077</td>
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<td>May-14</td>
<td>2.147</td>
<td>0.060</td>
<td>2.087</td>
<td>0.086</td>
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<td>Jun-14</td>
<td>1.991</td>
<td>0.028</td>
<td>1.963</td>
<td>0.073</td>
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<td>Jul-14</td>
<td>1.946</td>
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<td>1.921</td>
<td>0.075</td>
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<td>Aug-14</td>
<td>1.570</td>
<td>0.034</td>
<td>1.536</td>
<td>0.098</td>
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<td>Sep-14</td>
<td>1.739</td>
<td>0.002</td>
<td>1.738</td>
<td>0.073</td>
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</table>

**Graph:**
- Linear (t/month) with data points indicating a steady increase in total SO2 and Flare Stack emissions from January to September 2013 and 2014.
COMMERCIAL
LINDBERGH COMMERCIAL TYPICAL WELLPAD PLOT PLAN

D02 – 5 Wellpairs   D03 – 7 Wellpairs   D05 – 8 Wellpairs
Steam and assist gas from Commercial facility. Emulsion and produced gas production to wellpad D05 test and group separators prior to being sent to the Commercial CPF for processing.
LINDBERGH COMMERCIAL SCHEMATIC
LINDBERG SAGD COMMERCIAL FACILITY

• SW-25-058-05 W4M CPF site
• Maximum Daily Design Capacity
  • 8000 m³/d (50,000 bwpd) CWE for steam generation
  • 2208 m³/d (13,888 bopd) bitumen production
  • SOR 3.61
• Commercial facility equipped with water recycle
  • Falling film mechanical vapour compression
  • Expect >90% water recycle rate
• Qualified and experienced SAGD operations team
• Commercial facility first steam expected by end of 2014
MEASUREMENT AND REPORTING
MARP SUMMARY

• Testing
  – Individual test separator for each well
  – 24 hour tests
    • Within +/- 10% of previous results to be accepted
  – Individual well gas allocated a function of facility GOR and monthly allocated production

• Commercial MARP approved
  – Single test separator per wellpad
  – No change in testing strategy
## PRORATION FACTOR

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<tr>
<th></th>
<th>Oct-13</th>
<th>Nov-13</th>
<th>Dec-13</th>
<th>Jan-14</th>
<th>Feb-14</th>
<th>Mar-14</th>
<th>Apr-14</th>
<th>May-14</th>
<th>Jun-14</th>
<th>Jul-14</th>
<th>Aug-14</th>
<th>Sep-14</th>
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<tr>
<td>Oil</td>
<td>0.93</td>
<td>0.94</td>
<td>0.83</td>
<td>0.90</td>
<td>0.92</td>
<td>0.99</td>
<td>0.92</td>
<td>0.93</td>
<td>0.98</td>
<td>1.00</td>
<td>0.89</td>
<td>0.96</td>
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<td>Water</td>
<td>0.93</td>
<td>0.96</td>
<td>0.96</td>
<td>0.95</td>
<td>0.84</td>
<td>0.91</td>
<td>0.83</td>
<td>1.00</td>
<td>0.94</td>
<td>0.88</td>
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**OIL PRORATION**

**H2O PRORATION**

![Graph showing proration factor trends from Oct-13 to Sep-14 for oil and water][1]

1. [Graph showing proration factor trends from Oct-13 to Sep-14 for oil and water](#)
WATER
LINDBERGH PILOT WATER SOURCES

• 10-23-056-05 W4M River Water Station
  • Fresh water source from the North Saskatchewan River
  • AENV License No.13844

• Pilot
  – Actual usage ~800 m3/d for steam injection
  – Pilot to be partially mothballed in 2015
    • All water usage will then be associated with the commercial

• Commercial
  – Anticipate ~260m3/d make-up water usage at 12,500 bopd commercial facility
  – Pilot wellpad to be tied into commercial CPF Q2, 2015

• No brackish water sources
LINDBERGH PILOT SOURCE WATER VOLUMES

2013 Monthly Source Water (m3)

2014 YTD – 226795 m³
2014 YTD: Fresh Water – 226795m3, BFW – 229972m3
Filter backwash is returned to the pond; softener backwash is trucked offsite

2014 YTD: Filter BW – 14394m3, Softener BW – 6534m3
No PW recycle, no blowdown recycle, ~75% steam quality leaving OTSGs

2014 YTD: PW – 167948m³, Steam – 168934t
LINDBERGH WATER BALANCE

Same performance expected for commercial

Cumulative Water/Steam Ratio

0.90 - 1.10
0.93 - 1.00
0.96 - 1.03
0.99 - 1.06
1.02 - 1.10
1.05 - 1.13
1.08 - 1.16
1.11 - 1.19
1.14 - 1.22
1.17 - 1.25
1.20 - 1.28
1.23 - 1.30
1.26 - 1.32
1.29 - 1.35
1.32 - 1.38
1.35 - 1.40

# LINDBERGH PILOT WATER QUALITY

Source: Source Water

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<th>Analyte</th>
<th>Value</th>
<th>DL</th>
<th>Units</th>
<th>Analyte</th>
<th>Value</th>
<th>DL</th>
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<tbody>
<tr>
<td>Cond. (Lab)</td>
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<td>uS/cm</td>
<td>Mo by ICP</td>
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<td>ppm as Mo</td>
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<tr>
<td>m-Alk by titration</td>
<td>128</td>
<td>0.5</td>
<td>ppm as CaCO3</td>
<td>MoO4 from Mo by ICP</td>
<td>&lt;0.012</td>
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<td>ppm as MoO4</td>
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<td>p-Alk by titration</td>
<td>&lt;0.5</td>
<td>0.5</td>
<td>ppm as CaCO3</td>
<td>Ni by ICP</td>
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<td>pH by Meter</td>
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<td>SU</td>
<td>Zn by ICP</td>
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<td>Br by IC</td>
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<td>F by IC</td>
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<td>NO2 by IC</td>
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<td>NO3 by IC</td>
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<td>Cl-PO4 by IC</td>
<td>&lt;0.005</td>
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<td>ppm as PO4</td>
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<td>TCO (NPOC)</td>
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<td>Fe by ICP</td>
<td>0.038</td>
<td>0.001</td>
<td>ppm</td>
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<td>Mn by ICP</td>
<td>&lt;0.001</td>
<td>0.001</td>
<td>ppm</td>
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## Chemical Analysis

<table>
<thead>
<tr>
<th>Chemical</th>
<th>Analysis</th>
<th>Value (mg/L)</th>
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<tbody>
<tr>
<td>Calcium (Ca)</td>
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<td>30</td>
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<tr>
<td>Magnesium (Mg)</td>
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<tr>
<td>Barium (Ba)</td>
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<tr>
<td>Strontium (Sr)</td>
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<tr>
<td>Sodium (Na)</td>
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<td>856</td>
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<tr>
<td>H2S</td>
<td></td>
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<tr>
<td>Iron (Fe)</td>
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<tr>
<td>Manganese (Mn)</td>
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<td>0.07</td>
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<tr>
<td>Chlorides (Cl)</td>
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<td>Sulfates (SO4)</td>
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<td>20</td>
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<tr>
<td>Bicarbonates (HCO3)</td>
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<tr>
<td>Carbonate (CO3)</td>
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</tr>
<tr>
<td>Carbon Dioxide (CO2)</td>
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<td>182</td>
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</table>

## Other Measurements

<table>
<thead>
<tr>
<th>Measurement</th>
<th>Value</th>
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<tbody>
<tr>
<td>pH</td>
<td>7.3</td>
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<tr>
<td>Specific Gravity</td>
<td>1.000</td>
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<tr>
<td>Temperature (°C)</td>
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</tr>
<tr>
<td>Pressure (kPa)</td>
<td>100</td>
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<tr>
<td>Total Dissolved Solids</td>
<td>2425</td>
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<tr>
<td>Total Hardness</td>
<td>96</td>
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<tr>
<td>Ionic Strength</td>
<td>0.04</td>
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</table>
DISPOSAL WELLS
DISPOSAL WELLS

• 111/15-13-58-5W4
  – Well license number – 0126796
  – Disposal approval number – 5565
    • Completed in Basal Cambrian sands
    • No rate limit
    • Max WHP – 10.9 MPa
  – Re-classified as 1B

• 104/05-13-58-5W4 (DW4)
  – Well license number – 0454598
  – Disposal approval number – 12088
    • Completed in Basal Cambrian sands
    • No rate limit
    • Max WHP – 13 MPa
  – Produced water disposal

• 100/08-26-58-5W4 (DW5)
  – Well license number – 0469115
  – Disposal approval number – TBD
    • Drilled Sept 2014
    • To be completed in Basal Cambrian sands
    • Screened completion
  – SAC regen and/or produced water disposal
DISPOSAL WELLS

- Three water disposal wells (Basal Cambrian Sand) at ~1600 meters depth
- 11/15-13 and 04/05-13 are disposing of produced water and boiler blowdown from the pilot
  - Pilot to be shut down in Q2, 2015 and all volumes processed at new CPF
- 00/08-26 is new well (completion planned for November)
- All 3 wells are tied into the commercial CPF
  - 2 disposal streams into these wells are softener regeneration backwash and excess produced water
## Offsite Disposal Volumes and Locations – YTD 2014

<table>
<thead>
<tr>
<th>Date</th>
<th>Absolute Edmonton (m³)</th>
<th>Cen-Alta Kitscoty (m³)</th>
<th>NewAlta Elk Point (m³)</th>
<th>NewAlta Hughenden (m³)</th>
<th>Tervita Lindbergh (m³)</th>
<th>Total Offsite (m³)</th>
<th>05-13 Prod Water (m³)</th>
<th>15-13 Blowdown (m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jan-14</td>
<td>2735.50</td>
<td>4055.00</td>
<td>746.00</td>
<td>1023.10</td>
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<td>8559.60</td>
<td>9758.91</td>
<td>5693.79</td>
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<td>Feb-14</td>
<td>2536.50</td>
<td>1327.10</td>
<td>3719.00</td>
<td>142.50</td>
<td>320.60</td>
<td>8247.70</td>
<td>8441.66</td>
<td>4734.63</td>
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<td>Mar-14</td>
<td></td>
<td>884.80</td>
<td>116.50</td>
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<td>56.30</td>
<td>1057.60</td>
<td>20626.90</td>
<td>5366.56</td>
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<td>Apr-14</td>
<td>1043.90</td>
<td>73.00</td>
<td></td>
<td>235.00</td>
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<td>1351.90</td>
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<td>May-14</td>
<td>480.00</td>
<td>723.80</td>
<td>300.50</td>
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<td>376.40</td>
<td>1880.70</td>
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<td>Jun-14</td>
<td>401.50</td>
<td>713.33</td>
<td>178.50</td>
<td>86.00</td>
<td>110.00</td>
<td>1489.33</td>
<td>20394.38</td>
<td>7162.31</td>
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<tr>
<td>Jul-14</td>
<td>42.00</td>
<td>697.70</td>
<td>293.00</td>
<td>164.50</td>
<td>182.00</td>
<td>1379.20</td>
<td>19377.64</td>
<td>7059.60</td>
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<td>Aug-14</td>
<td>1656.16</td>
<td>463.00</td>
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<td>1446.70</td>
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<td>3823.86</td>
<td>17779.63</td>
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<td>Sep-14</td>
<td>293.00</td>
<td>708.70</td>
<td>441.00</td>
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<td>245.00</td>
<td>1687.70</td>
<td>18586.73</td>
<td>5489.65</td>
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<td>Oct-14</td>
<td>461.00</td>
<td>2121.20</td>
<td>627.00</td>
<td>200.50</td>
<td>693.70</td>
<td>4103.40</td>
<td>17175.86</td>
<td>5176.76</td>
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AMBIENT AIR QUALITY
AMBIENT AIR QUALITY

• Continue to actively participate in LICA and the Air Quality Monitoring Program Network as per the Lindbergh Pilot SAGD EPEA approval and Lindbergh SAGD Expansion approval.

• Will be addressing JOSM requirements
ENVIRONMENTAL ISSUES
ENVIRONMENTAL ISSUES

• In 2014, 7 sites have been assessed as a Phase 2 ESA, with one other site scheduled for assessment before 2015.

• Four sites (Pad B, C, D and E) have undergone remediation around cut and capped well casings. Closure samples have indicated that these sites were remediated to within Tier 1 guidelines. Of these four sites, three of them require additional remediation within the former Drilling Waste Disposal Area (DWDA) which will be completed in Q4 of 2014.

• Reclamation was carried out on Pad J, Pad 5526 and the 111/8-13-058-05 W4M well site. This also includes the borrow pit area on the 111/8-13 well site.

• Pad G and Pad H have both been seeded and fenced for reclamation.
DECOMMISSIONING AND RECLAMATION

• Budgeted and spent $1,100K on site decommissioning and reclamation in 2014

• Located, excavated and abandoned pipelines and risers from old CSS facilities

• Conducted soils testing in various areas in preparation for reclamation work

• Carried out contaminated soil removal for disposal at approved landfill
COMPLIANCE
COMPLIANCE

• Self disclosure submitted December 2012 for increase in licensed H2S to 10 mol/kmol
  • ABSA approval received September 16, 2014.
  • D56 amendment submitted September 26, 2014, waiting on AER review

• Self disclosure in August 2014 of missing sulphur analysis in monthly report


• Pengrowth believes that the Lindbergh project is in full compliance with AER regulatory approvals and regulatory requirements
FUTURE PLANS
FUTURE PLANS – PILOT FACILITIES

• Tie D01 into commercial CPF and partial mothball of Pilot
  • Maintain source water filtration and instrument air for commercial water transfer
  • Maintain glycol heaters for building heat
  • D01 well pad to be connected to commercial facilities
  • Anticipated to occur Q1/Q2 2015
FUTURE PLANS – 12,500 BOPD FACILITIES

• Commission and start up 12,500 bopd project – Q4, 2014
• Debottleneck oil treating train (application submitted) – installation Q3, 2015
• Drill 2 Section 13 SAGD wellpairs into old CSS area from Pad D04 – application submitted – commence Q4, 2015
• Drill and tie in infill well on Pad D01 in Q3, 2015 – application to be submitted
• Obtain core from steam chamber near heel of D01-P02 well – Q3, 2015
FUTURE PLANS

• Drill 8 SAGD well pairs (excluding 2 Sec 13 well pairs) from Pad D04 – Commence drilling in Q4, 2015

• Drill 3 SAGD well pairs into pay zone less than 13 meters thick with significant bottom water interval – application to be submitted

• Begin construction and drilling for project expansion to 30,000 bopd – application submitted