



Canadian Natural

DIRECTIVE 54 PRESENTATION

06/05-11-084-17W5 DOWNHOLE HEATER

EXPERIMENTAL SCHEME APPROVAL 12582

May 23, 2019

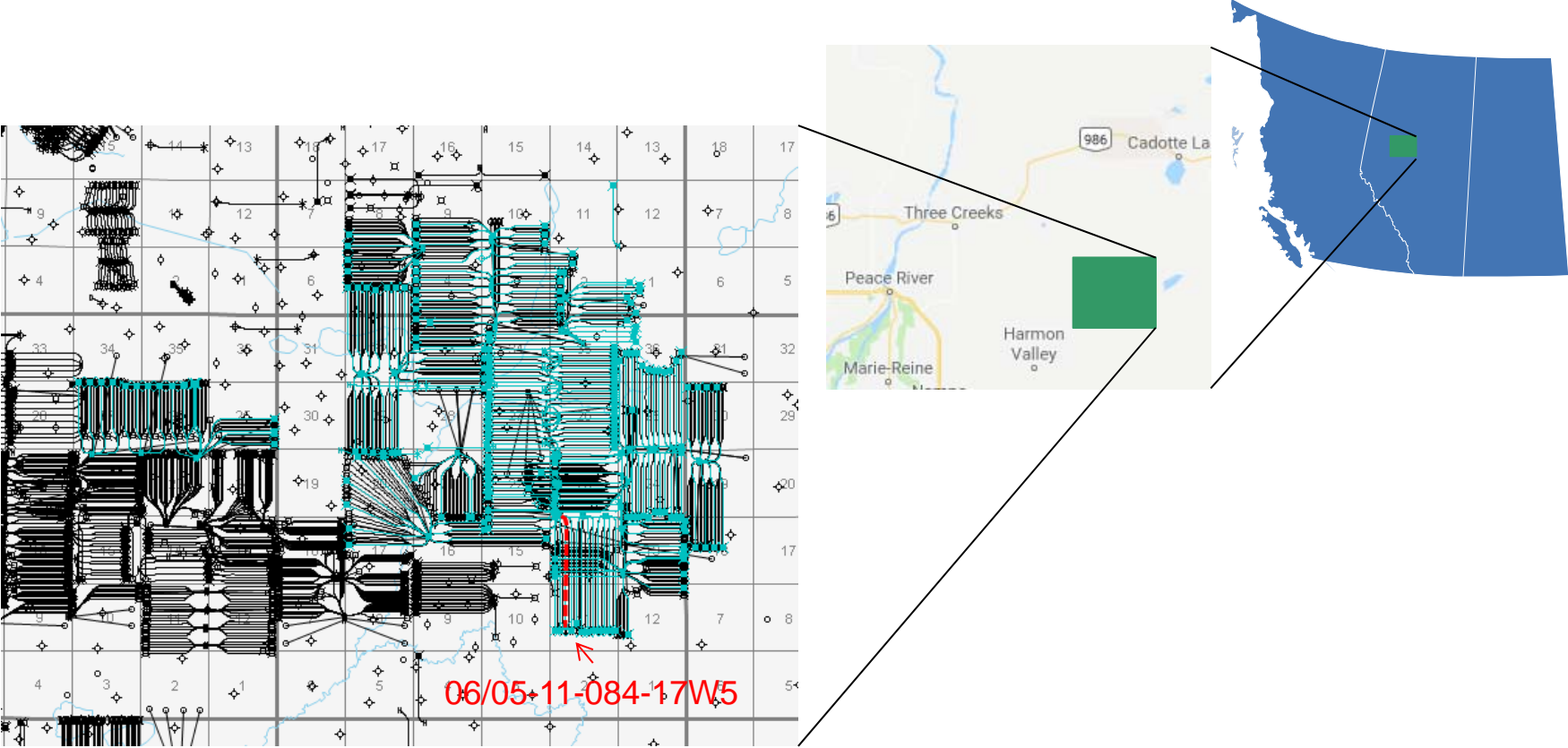
PREMIUM VALUE. DEFINED GROWTH. INDEPENDENT.

Agenda

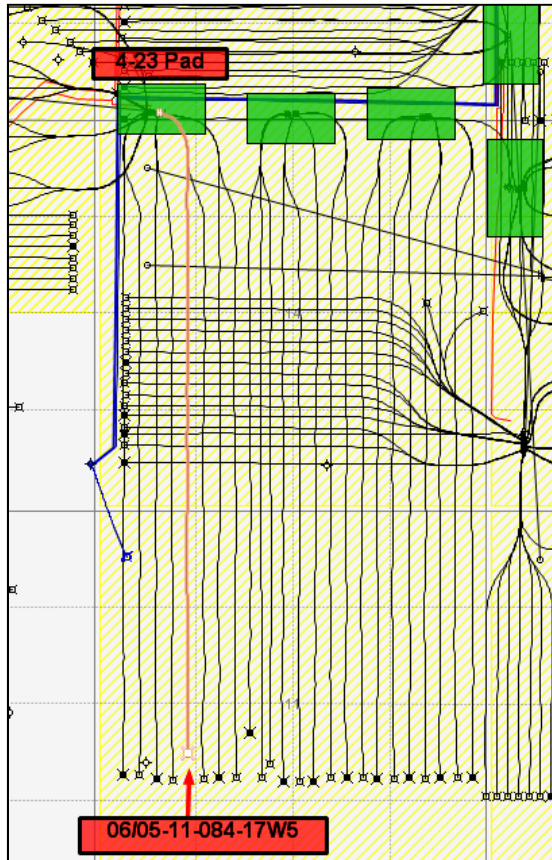
- Current Approval
- Geology Overview
- Completions, and Artificial Lift
- Performance and Surveillance
- Facilities
- Measurement and Reporting
- AER Compliance
- Conclusions

Current Approval

Cliffdale Location



Experimental Scheme 12528A

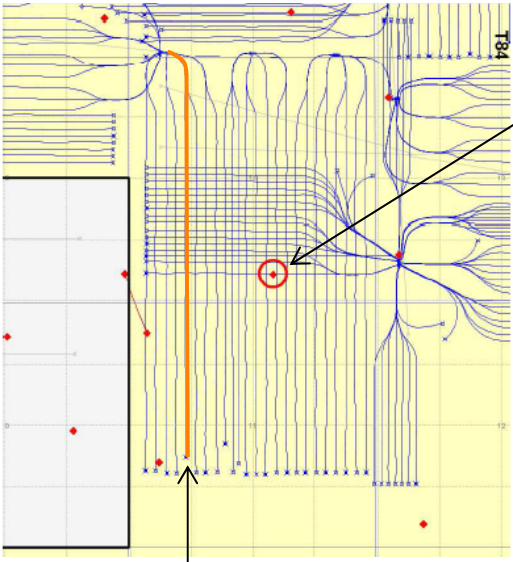
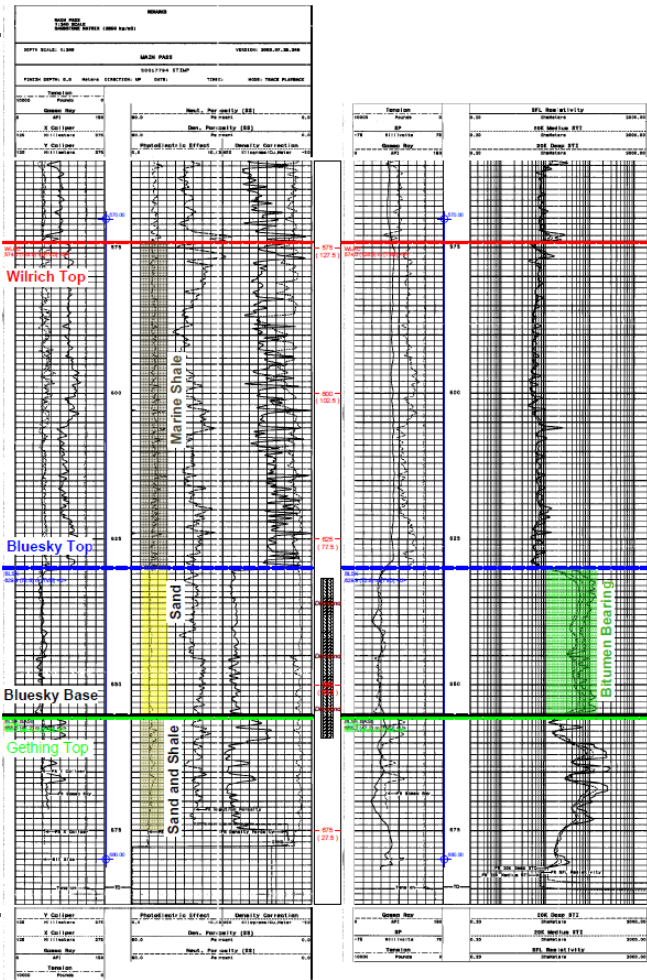


- Experimental scheme approved Feb 10, 2017
- Approval included single well in the Cliffdale heavy oil field.
- CNRL is current operator and 100% interest owner. Acquired from Shell Canada in 2017.
- Objective of experimental scheme was to enhance the production of a well by means of adding a downhole, electric, wellbore heater in the horizontal leg.
- Premise behind project was that insitu wellbore heating would reduce oil viscosity and thus reduce pressure differential inside the horizontal section of the wellbore resulting in higher production and increased reserves.

Geology

Type Log

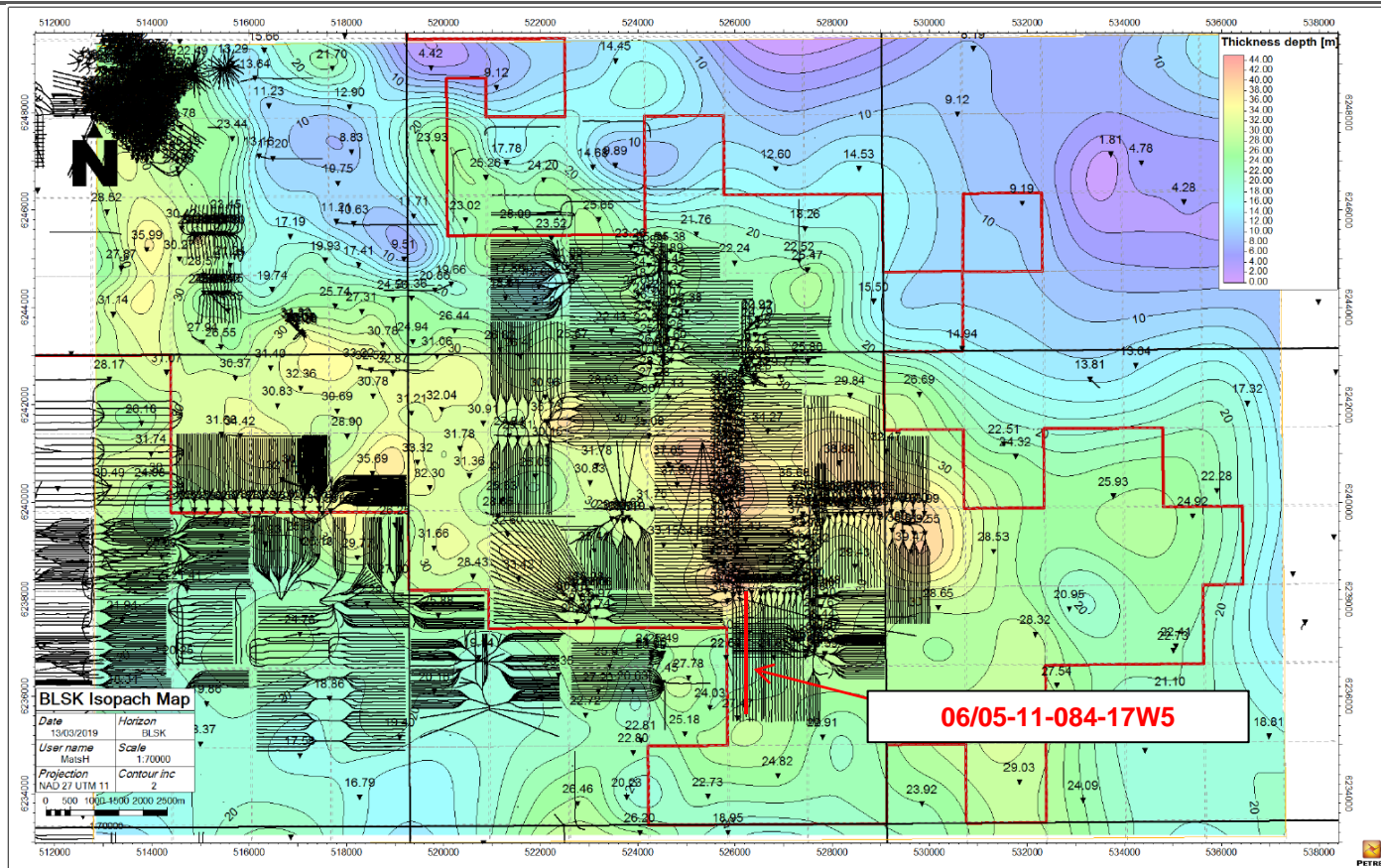
00/02-14-084-17W5/0
 KB: 702.5 m RR: 3004-02-04
 TD: 685.0 m [TVD] FormID: PLZC
 Mode: Aband Fluid: N/A
 ONUL CLIFFD 2-14-84-17



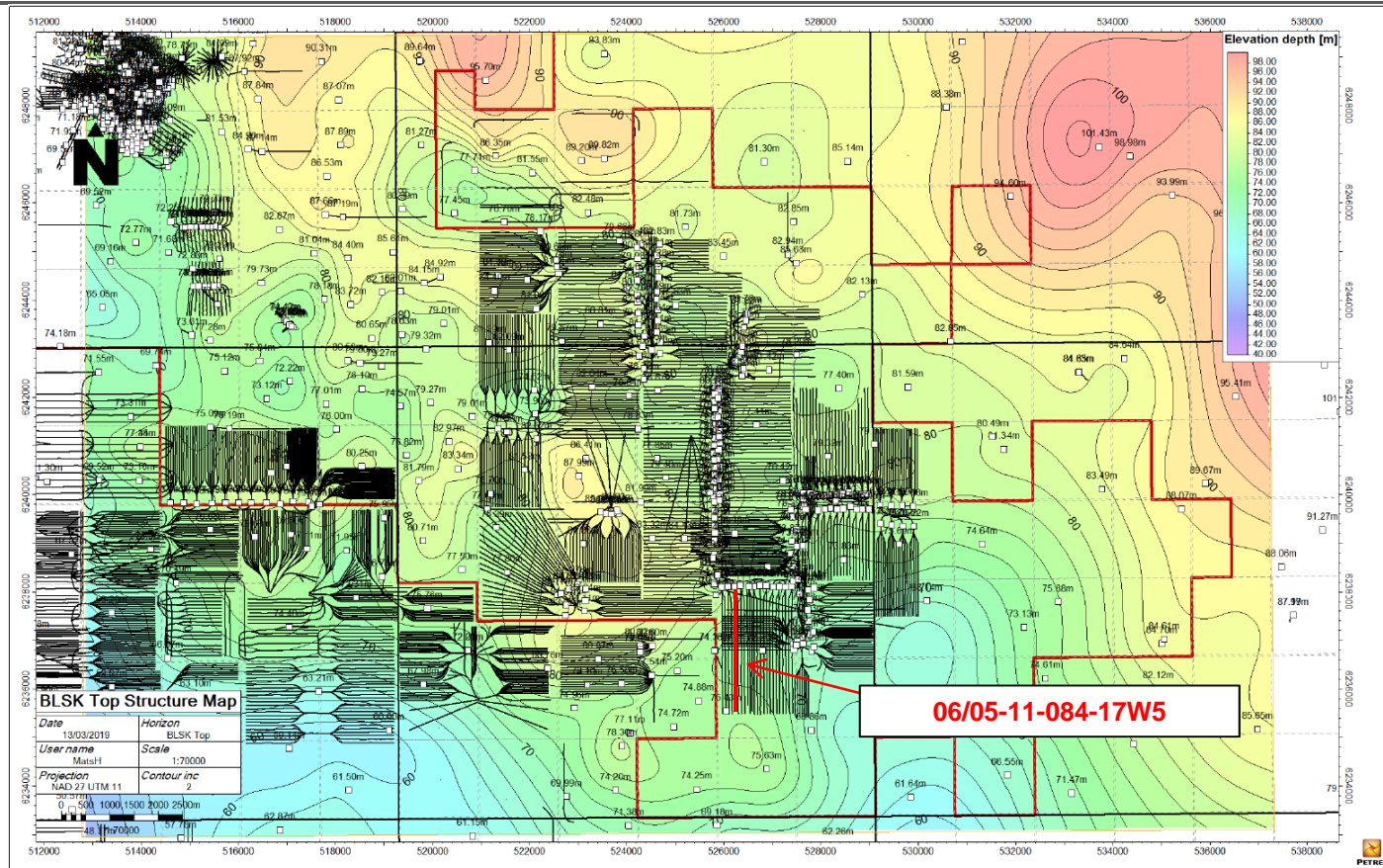
Type Log Location

06/05-11-084-17W5

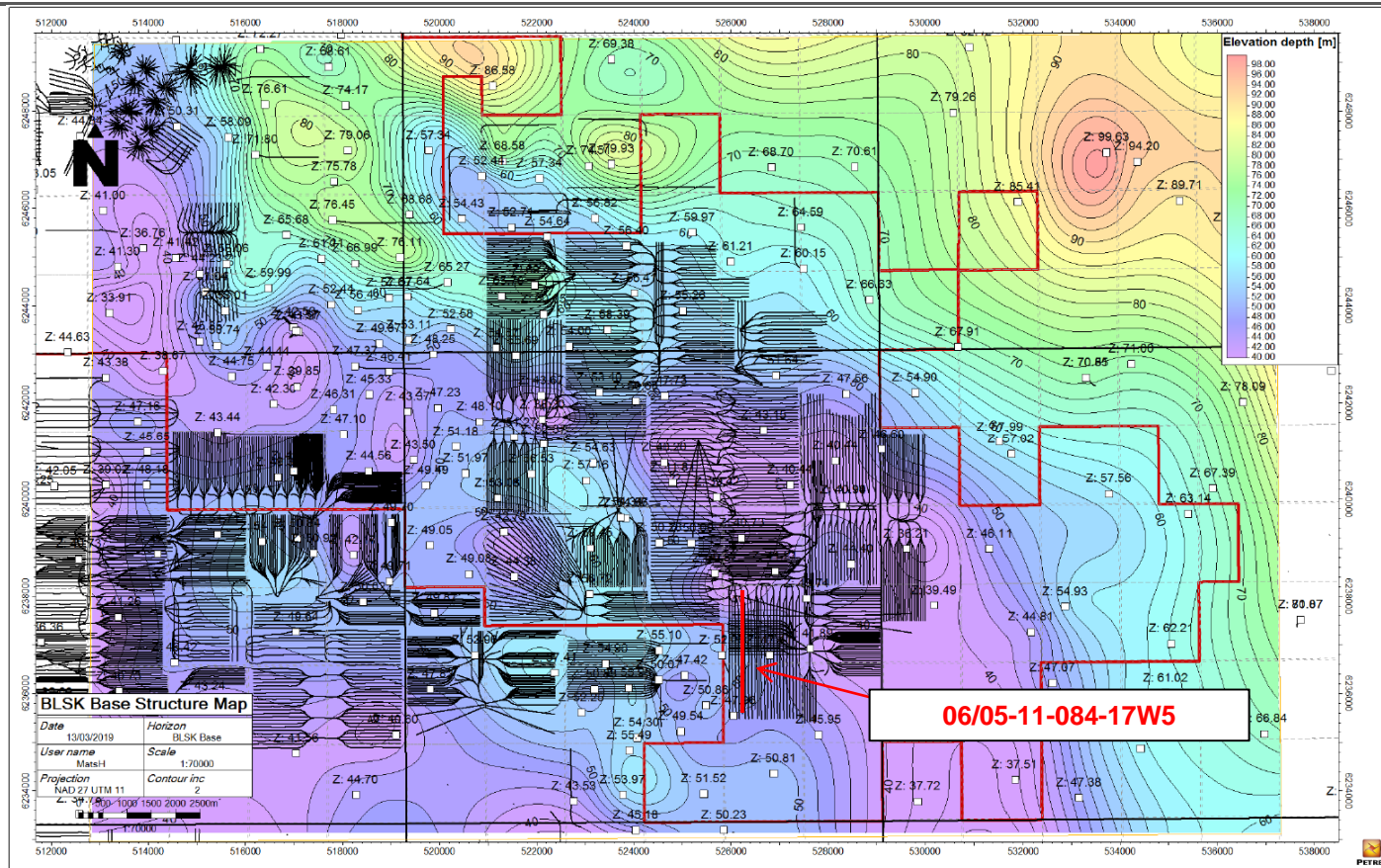
Bluesky Gross Thickness Map



Bluesky Top Structure Map



Bluesky Base Structure Map

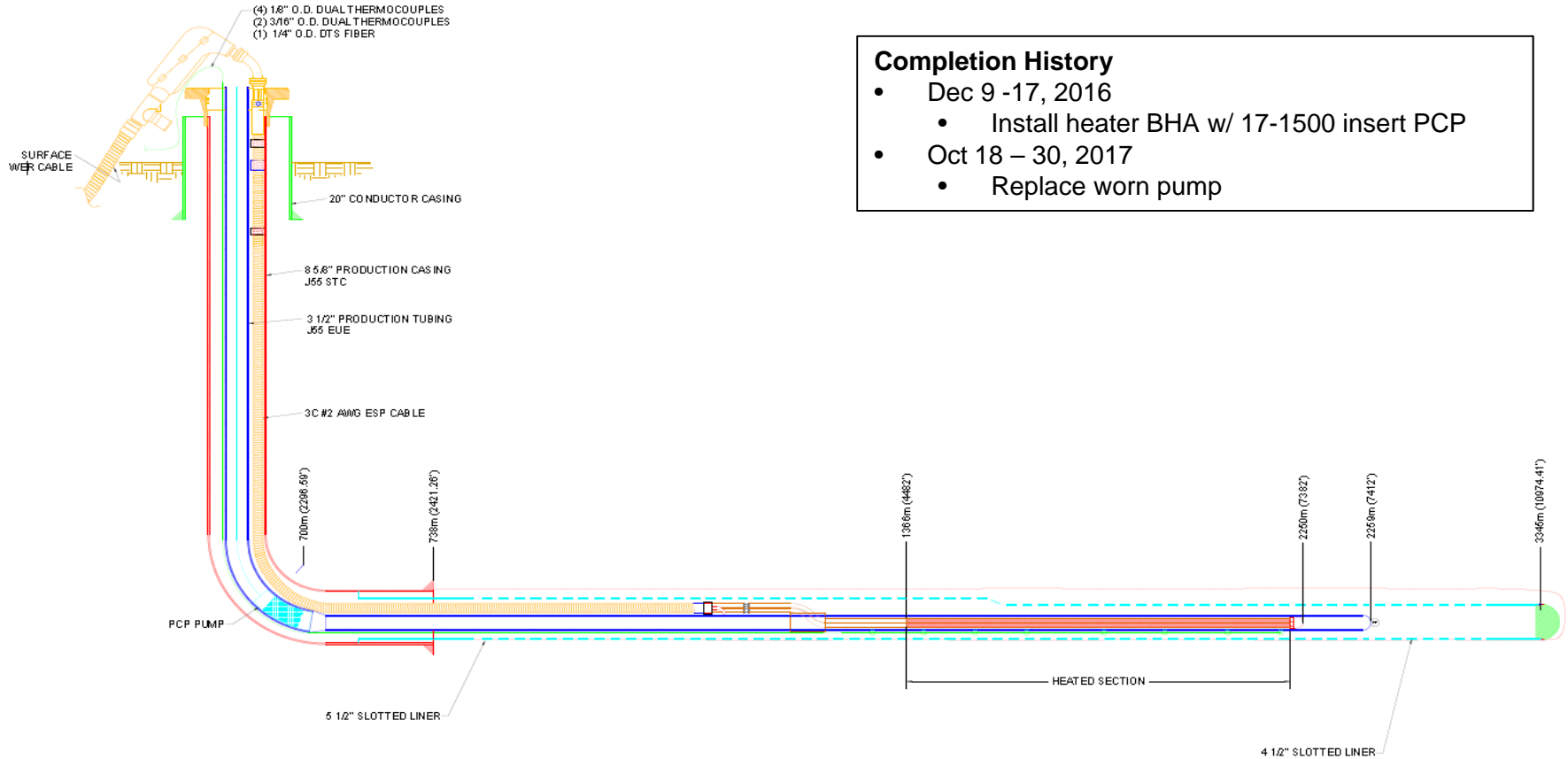


Cliffdale Reservoir Properties (From 02-14 Type Log and Core)

- Bluesky Sand
 - Thickness: 25.0m
 - Depth: 630 – 655m TVD
 - Net Pay: ~18.0m
 - Average Core Porosity: ~28%
 - Average Core Permeability: 463mD
 - Temperature: 18°C
 - Water Saturation 20 – 35%
 - Core Oil Viscosity Range: 8,200 – 120,000cP @20°C
 - Initial Reservoir Pressure: 3 800kpa

Completions and Artificial Lift

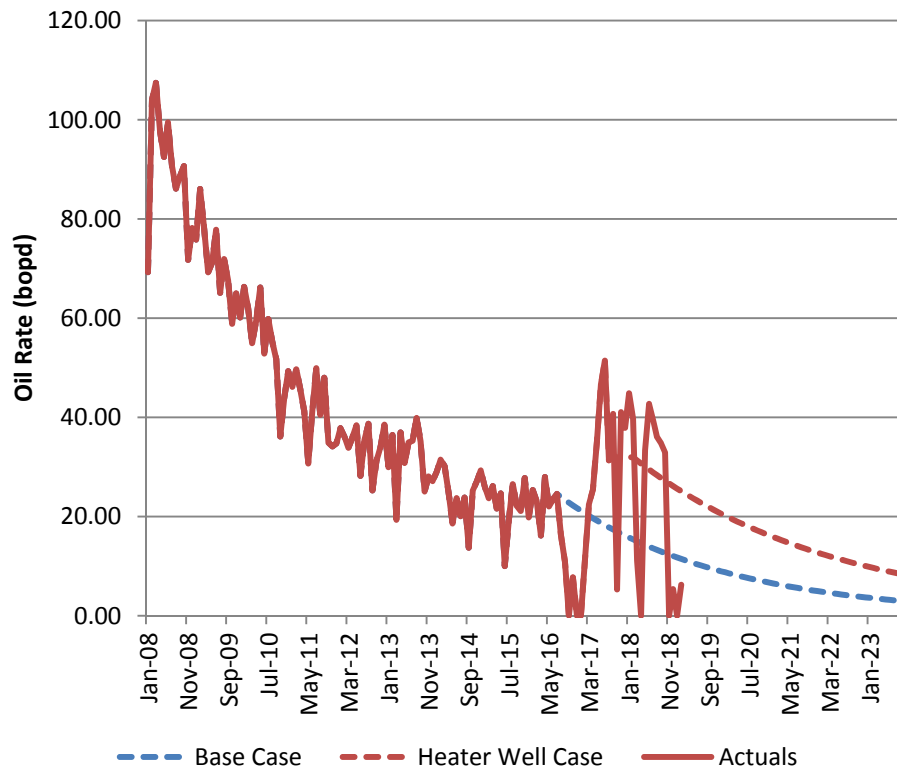
Completions and Artificial Lift



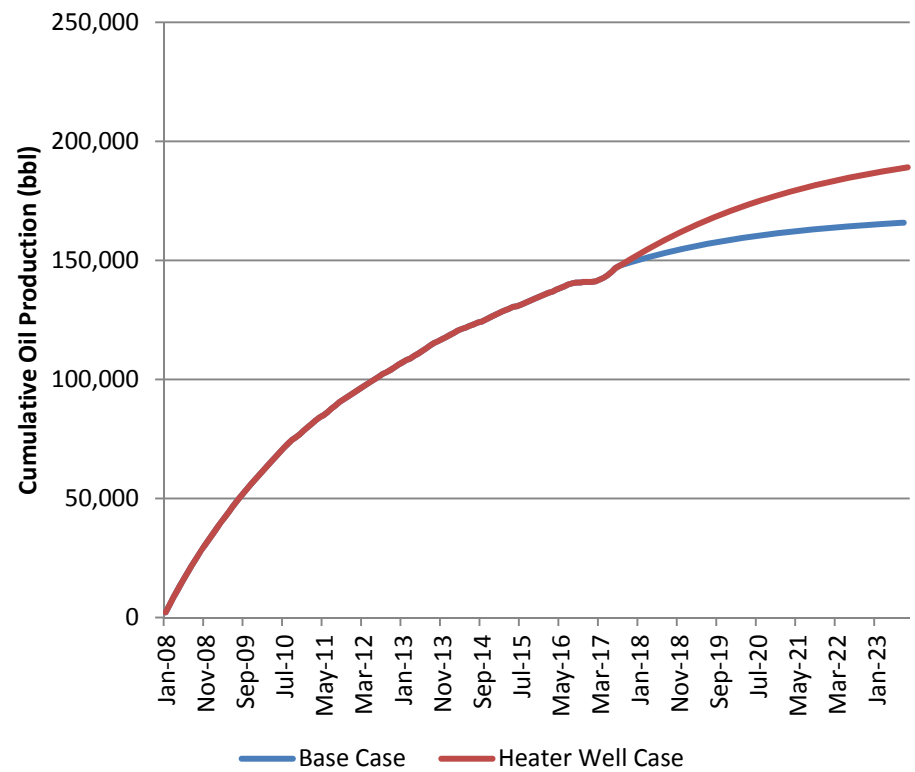
Performance And Surveillance

Production History – 06/05-11

Base Case vs. Incremental - Oil Rate

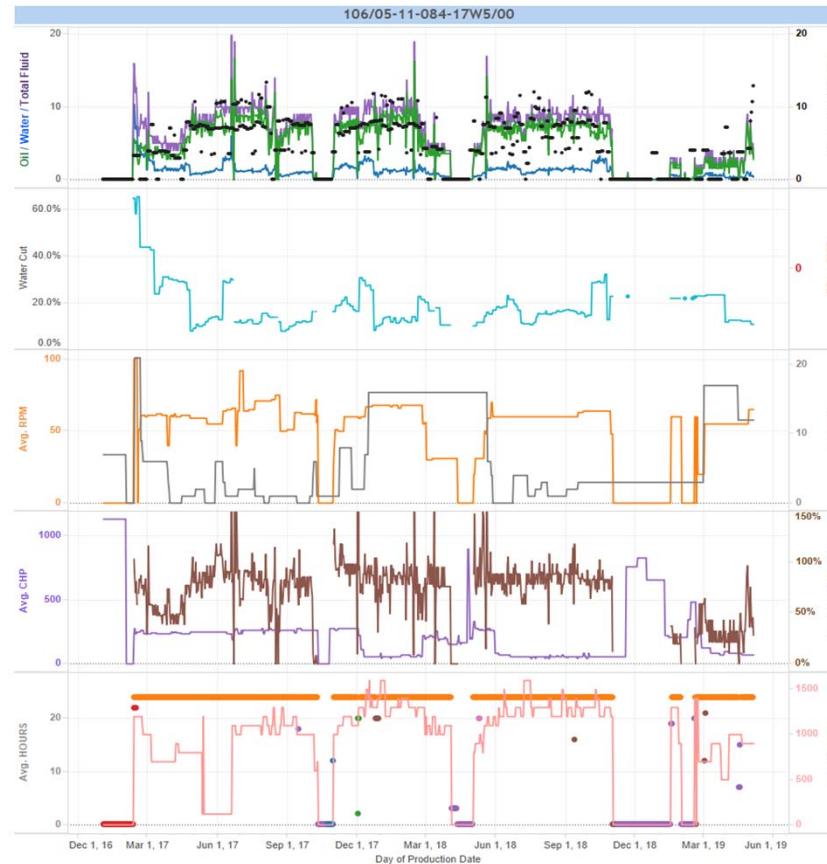


Base Case vs. Incremental – Cum Production



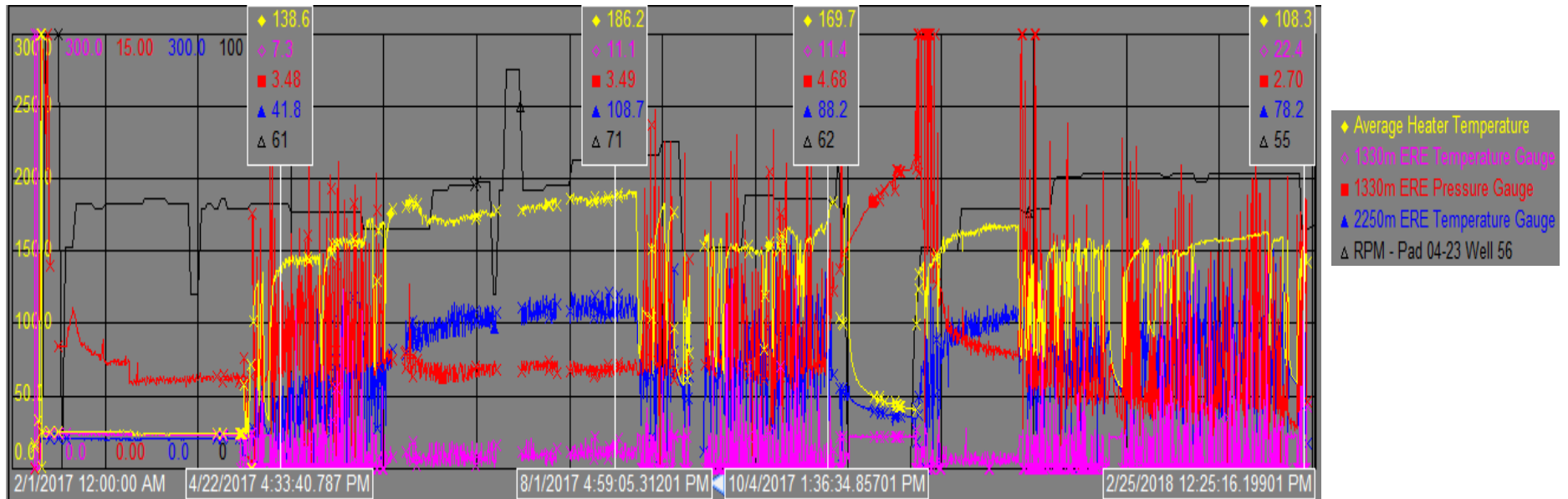
Production History Details

- Heater online April 14, 2017
- Well down time events
 - Pump Change October 2017
 - Curtailment April 2018
 - Curtailment November 2018 to January 2019
- Heater down time events
 - Feb 2018 – May 2018
 - Jan 2019 – April 2019



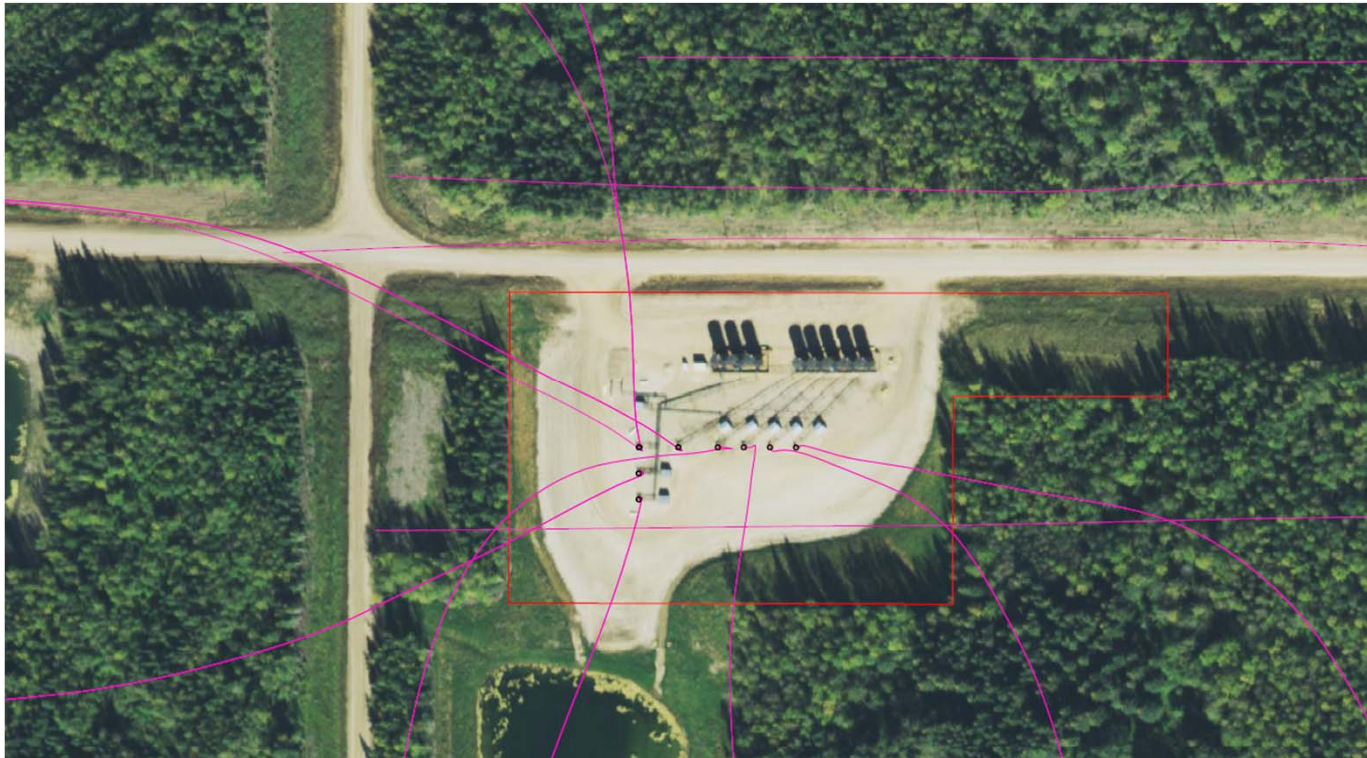
Surveillance –Temperature Profile

- Temperatures of heated section continuously monitored using thermocouples and optical fiber
- Temperature profile along heater shown below
- Average heater temperature of 170 – 186° C observed during steady-state production

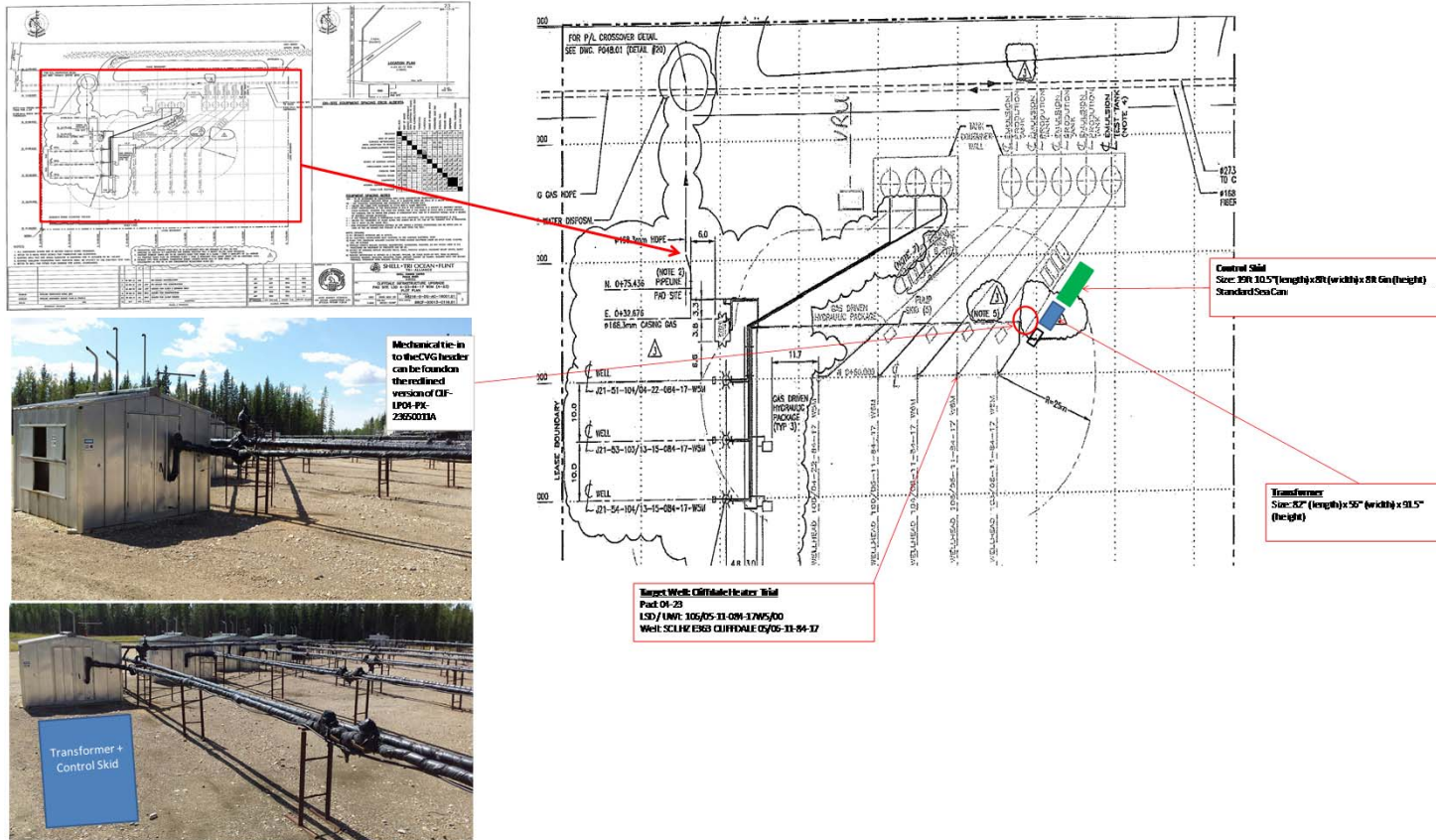


Facilities

Wellsite 106/05-11-084-17W5/00



Plot Plan



Facility Modifications

- Original facility modifications completed in 2017 and included:
 - Control skid
 - Transformer
- Since start-up, no additional facility modifications were carried out



Facilities Summary

- Wellsite Facilities (106/05-11):
 - Production goes to a 1000 bbl tank
 - Fluids are heated to ~70°C
 - Oil and water are trucked separately to the Cliffdale Battery
 - All produced gas is collected in a combined VRU/gas header and also sent to the Cliffdale Battery
 - Power consumption:
 - Average / Maximum – 300 kW / 482 kW

- Cliffdale Battery (03-25-084-17W5):
 - Produced water is de-oiled and discharged to a disposal well
 - Oil is further treated before sales
 - Produced gas from pads is scavenged for H₂S, compressed and conveyed to Peace River Complex for either use as fuel for steam generation or storage

AER Compliance

AER Directive 84

- CNRL's Cliffdale field lies with-in the AER defined Peace River area that is subject to AER Directive 84
- Directive 84 states operators in the Peace River area must conserve at least 95 percent of all solution gas produced.
- All solution gas associated with the operation of the 06/05-11-084-17W5 well is conserved and then utilized in field operations or injected and stored at CNRL's Three Creeks gas storage pool.

Conclusions

Project Summary

- Oil production pre-startup of the downhole heater was ~25bbls/d oil.
- Post startup of heater, oil production increased to an average of 37bbls/d oil, an increase of ~12bbls/d oil. During periods of heater downtime, oil production decreased by this same volume.
- Increased oil production observed during operation of downhole electric heater provided evidence that the downhole electric heater experimental trial was successful in validating original theory.
- Increased oil rates have proven economics of continuing the operation of the down hole electric heater and CNRL will be applying to continue the enhanced oil recovery process.



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