



**PetroChina
Canada**

2020 Performance Presentation

MacKay River Commercial Project

AER Scheme Approval No. 11715

January – December 2020

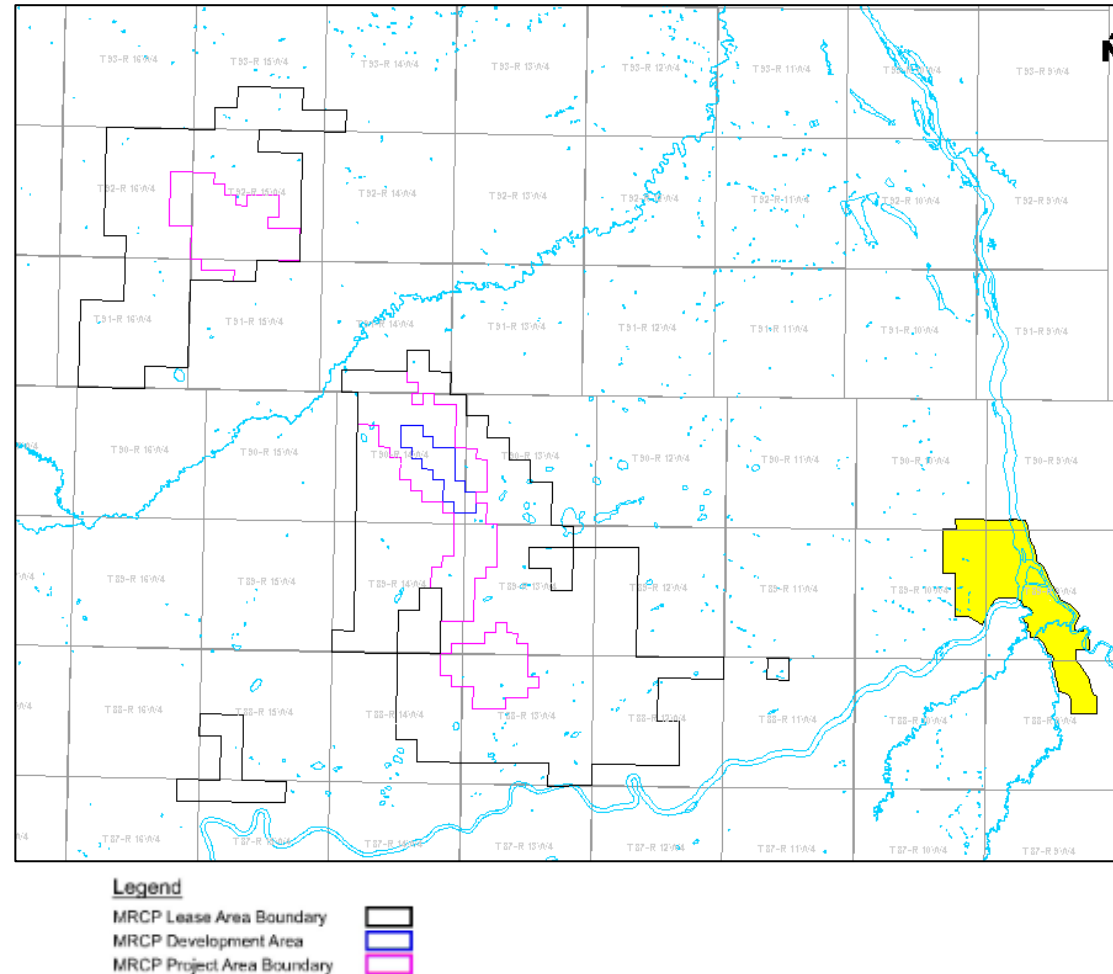
4.1 Introduction



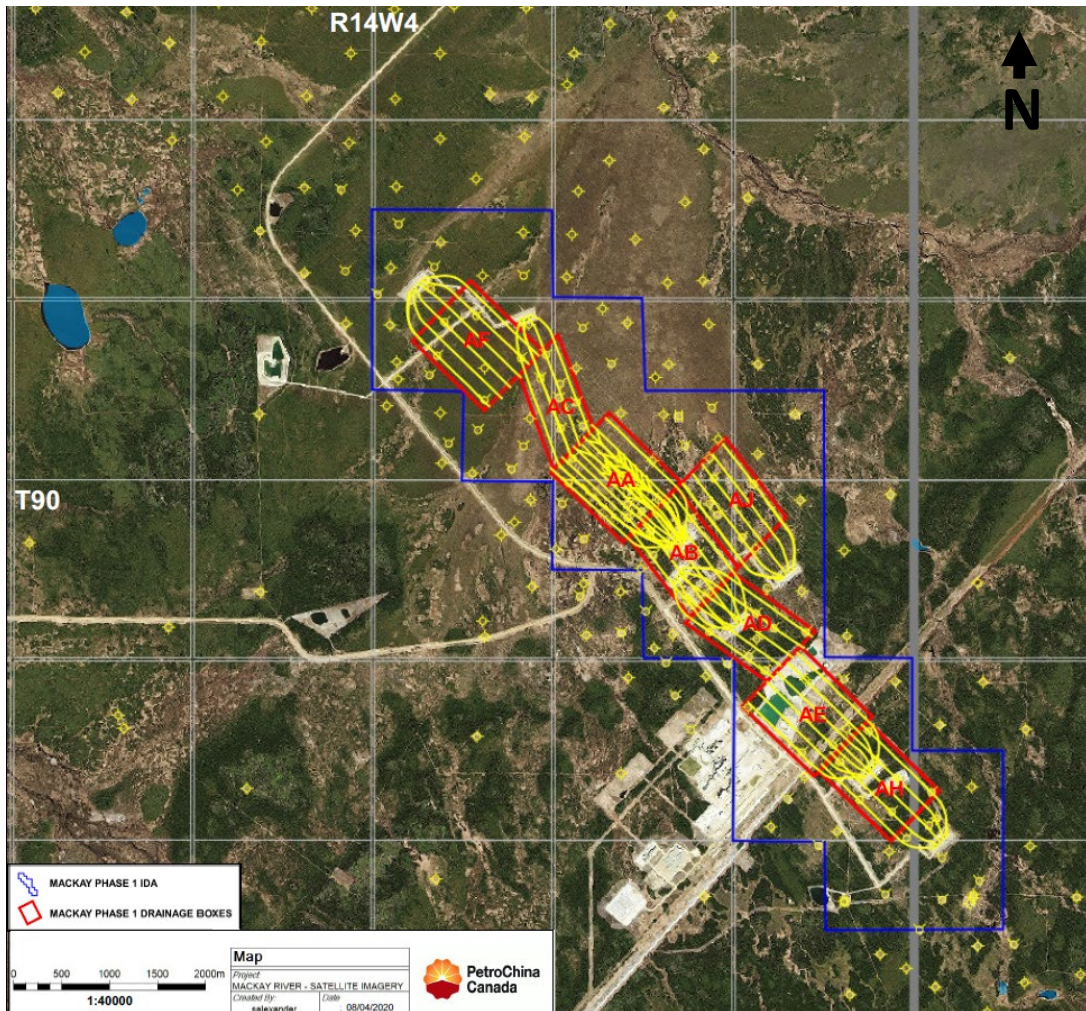
Project Background



- PetroChina Canada (“PCC”) owns and operates the MacKay River Commercial Project (“MRCP”)
- The MRCP is a bitumen recovery project located within the Regional Municipality of Wood Buffalo (“RMWB”) in northeast Alberta; approximately 30 km northwest of Fort McMurray
- The MRCP utilizes steam-assisted gravity drainage (SAGD) technology
- The MRCP is planned for phased development to peak capacity of 150,000bbl/d bitumen



MRCP Phase 1 Overview

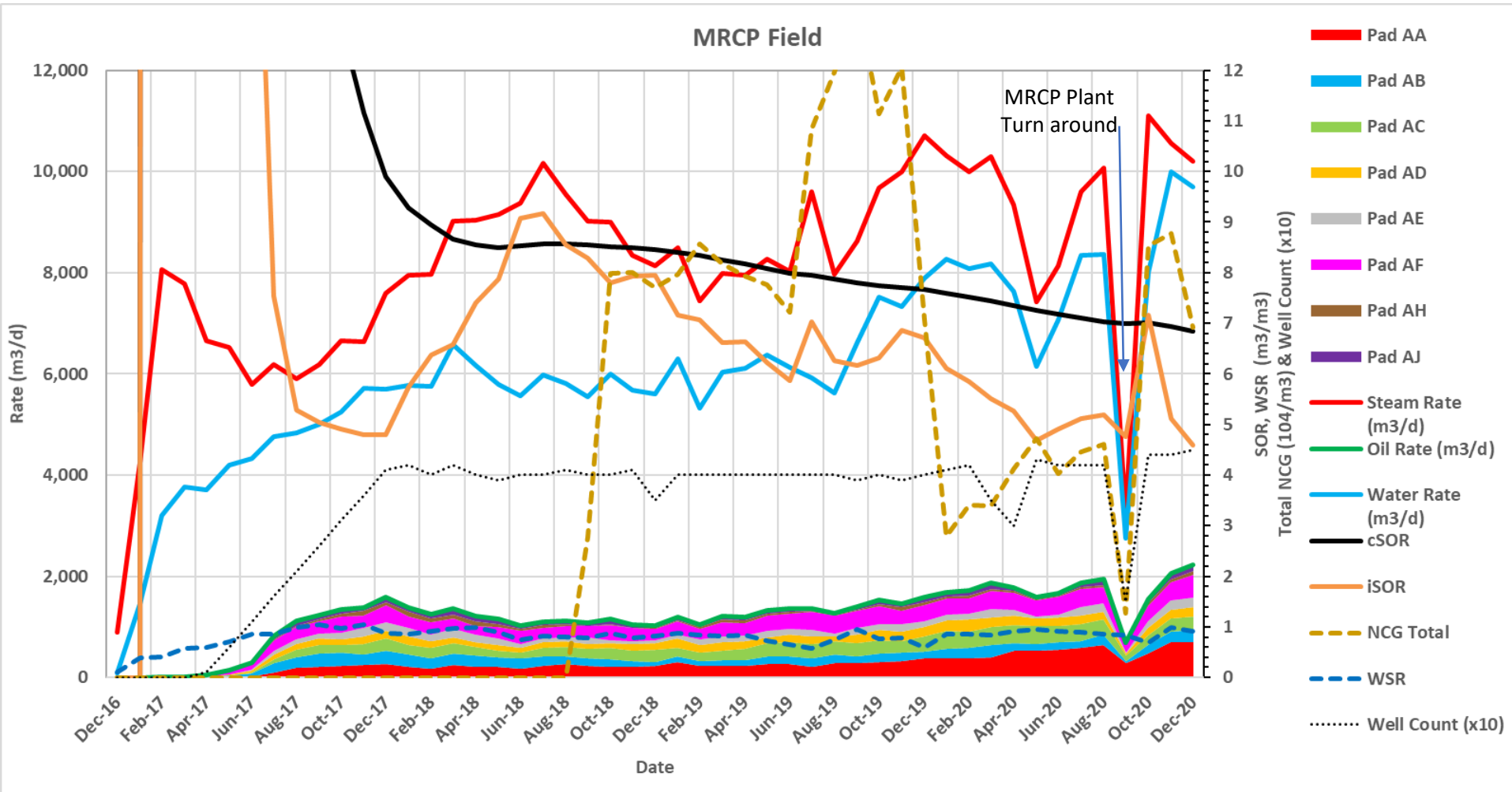


- Phase 1 has a bitumen capacity of 35,000 bpd
- The Phase 1 development area (DA) includes:
 - 8 SAGD surface well pads and associated subsurface drainage patterns
 - 42 SAGD Horizontal well pairs
 - 850m long horizontals
 - 125m well spacing
 - 4 Horizontal infill well pairs (PAD AA)
 - 850m long horizontals
 - Producer and/or injector uptracks
 - 62.5m well spacing
 - The Central Processing Facility (“CPF”)
 - Water source wells and associated pipelines
 - Observation wells
 - Borrow areas
 - Access roads
 - Camps

4.2 SUBSURFACE

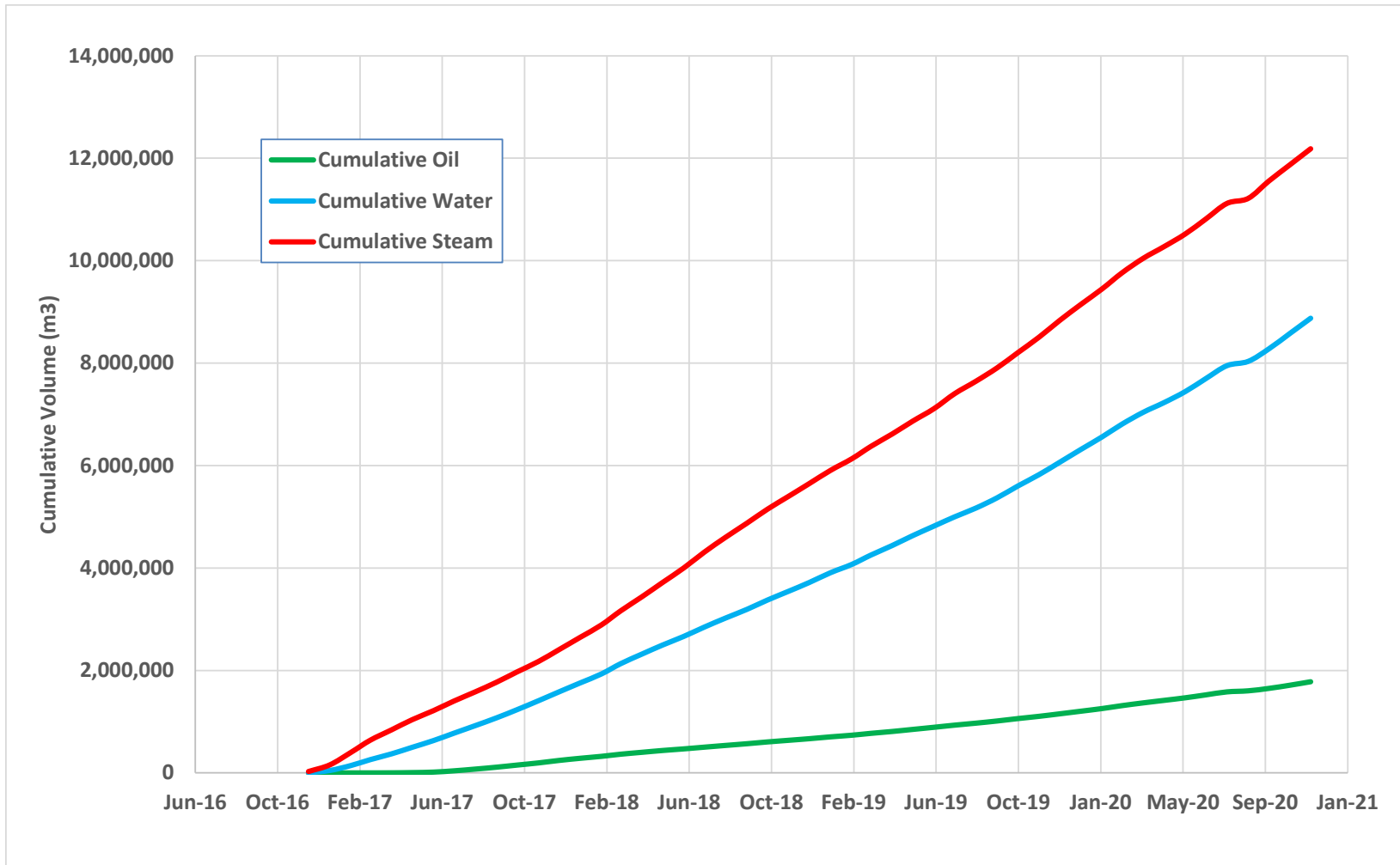


MRCP – Field Performance



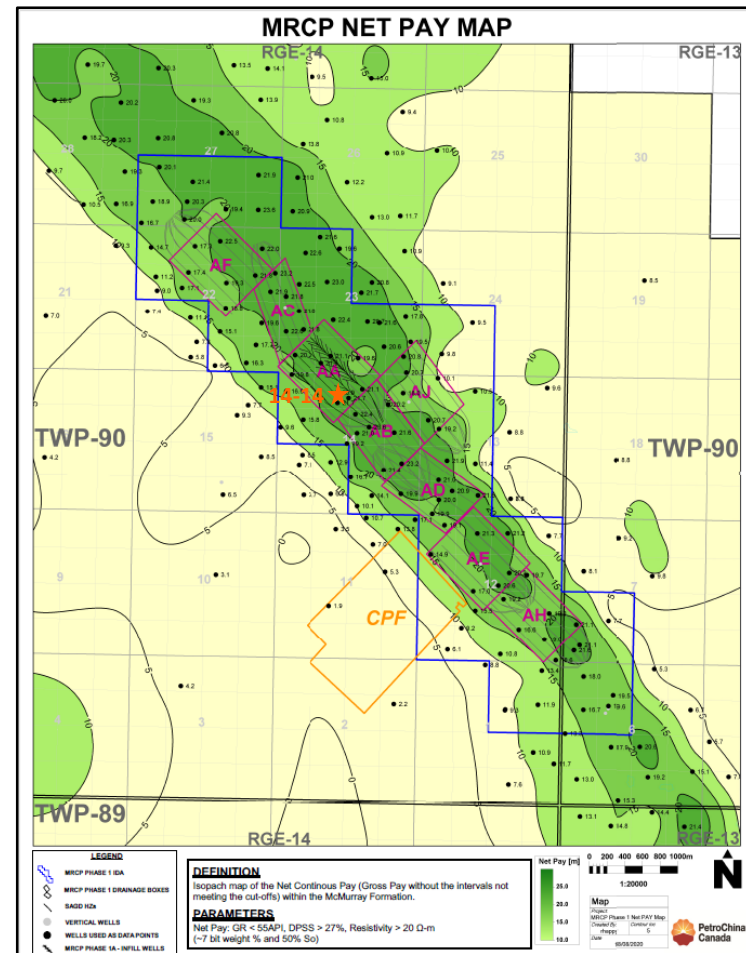
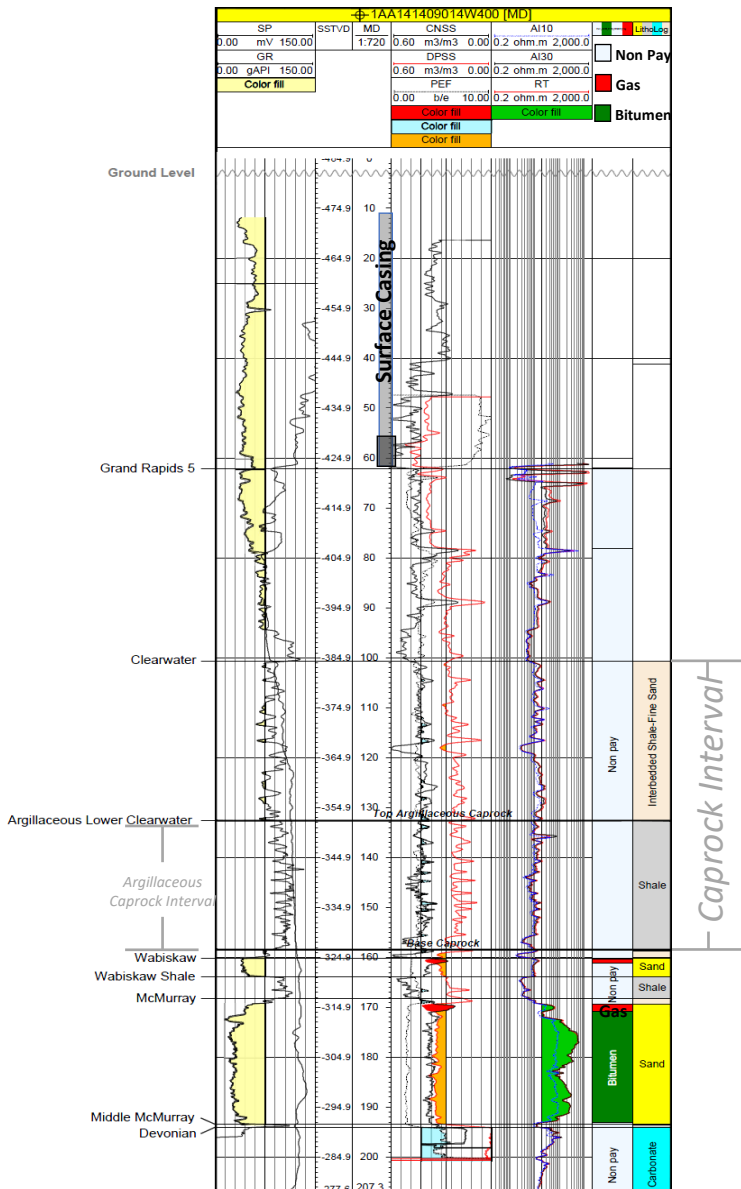
- Throughout 2020 MRCP continued to ramp up production. The 2020 monthly exit oil rate was 2,222 m3/d (13,976 bbl/d). SOR continued to improve.
- Operationally, production was affected in early 2020 by factors including reduced oil price and COVID-19.
- Continued field operation optimizations: Implementation of infill wells, tubing deployed inflow control devices (TDICD), ESP conversions
- MRCP Plant turn around conducted in September, 2020
- NCG: NCG co-injection in selected well pairs remained in 2020. PCC resumed NCG injection in Oct 2020 (vertical injection well).

MRCP – Cumulative Fluid Volumes



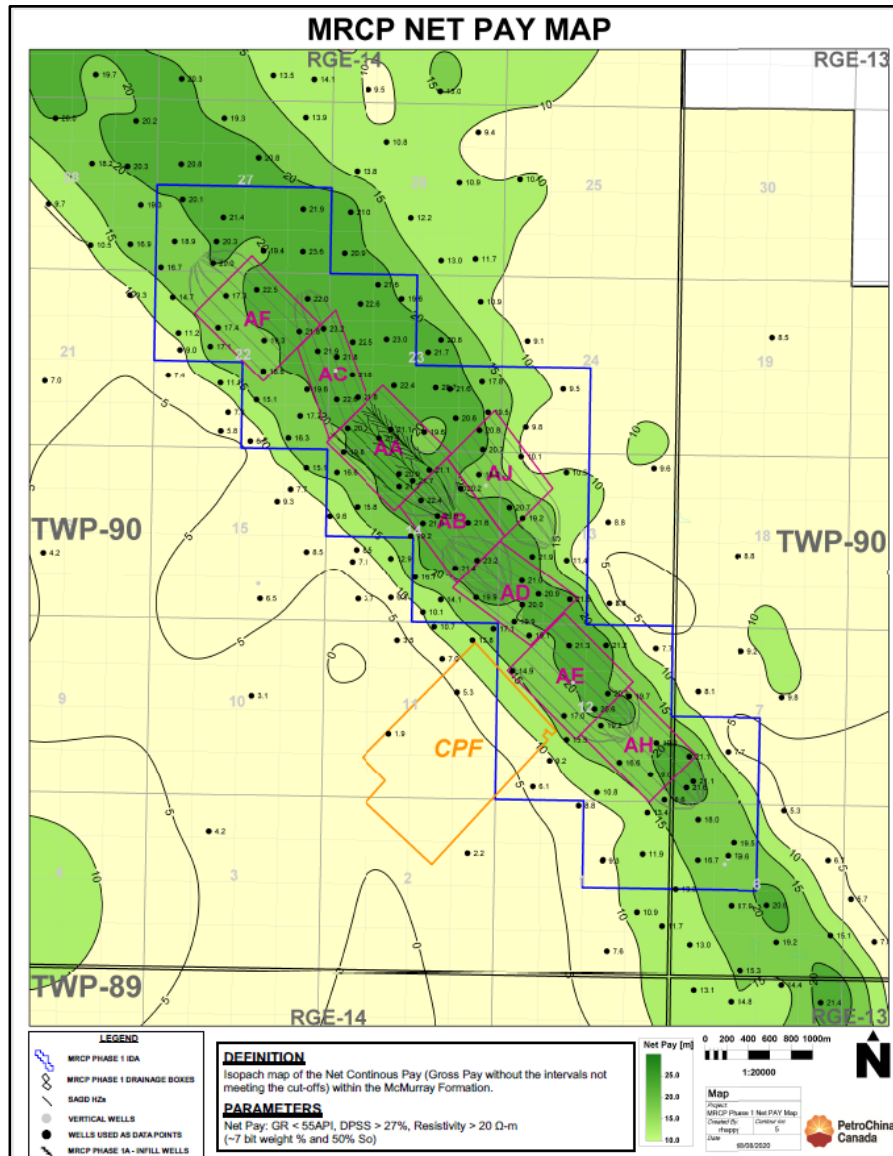
- Performance is impacted by the presence of top gas/top lean zones and areas of thicker lower transition zone and the presence of geological baffles (zones of higher mud bed frequency) impacting chamber growth
 - In a few areas, steam chamber interactions with top gas and losses to the lower transition zone has resulted in higher retention by the reservoir.
 - Mitigation strategies in execution include gas cap pressurization (NCG injection and co-injection), and balancing operating pressures with multiple thief zones. These strategies have significantly helped reduce water retention and steam losses

Mackay River Stratigraphy



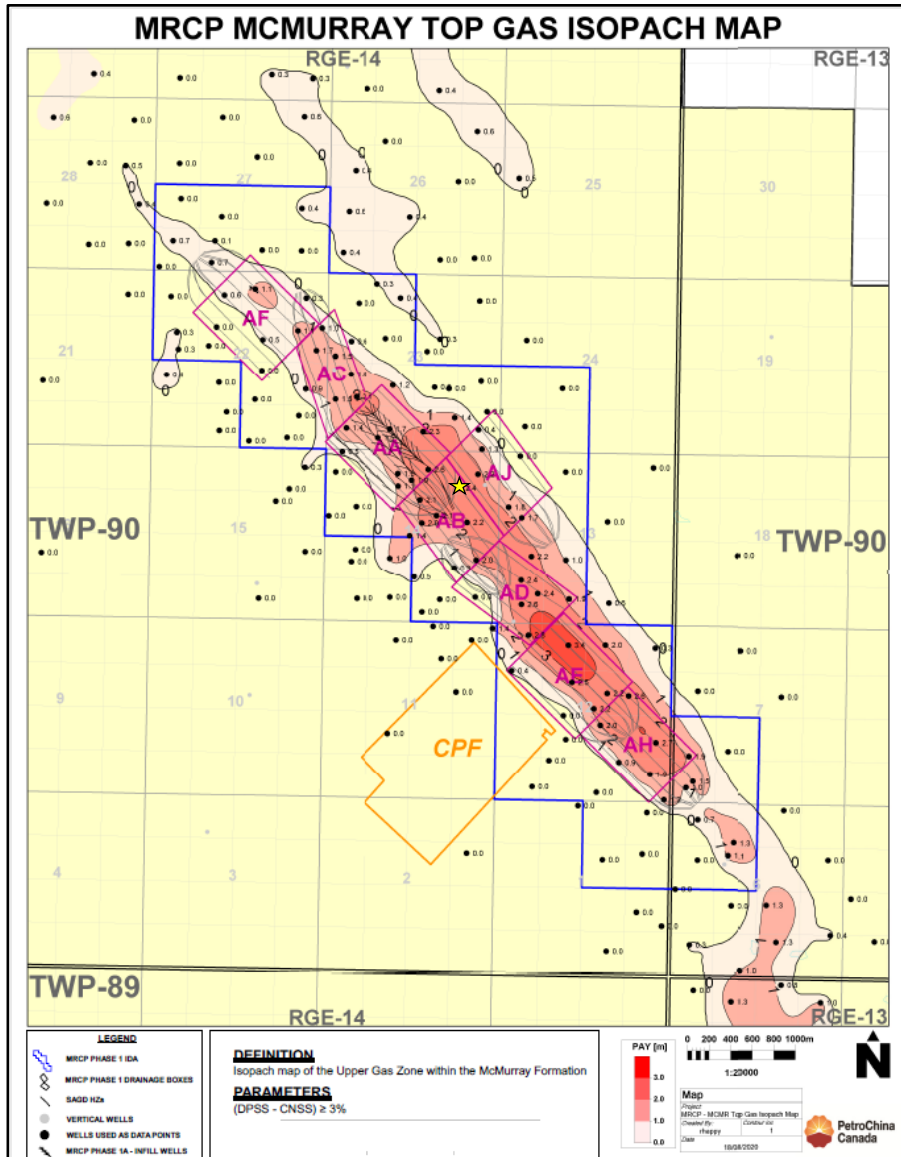
- Caprock is Argillaceous Lower Clearwater
- Wabiskaw sand above McMurray across DA
- Target reservoir is Upper McMurray

Bitumen Net Pay Map – Development Area

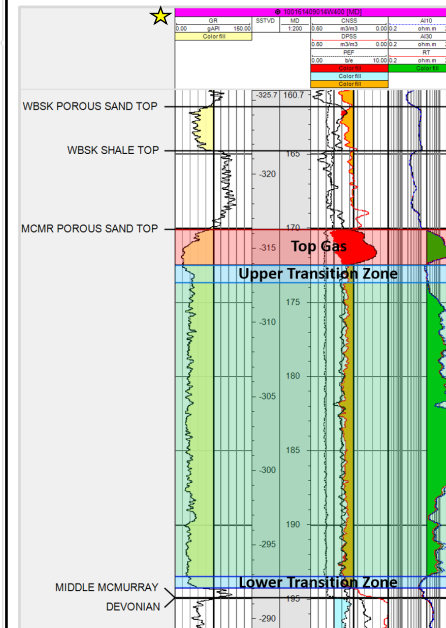


- Net pay cut-off at $\geq 10\text{m}$
- Thickness ranges from 10-25m in the DA
- Upper McMurray reservoir shows strong NW-SE trend
- Central processing facility located Southwest of development area
- Majority of 8 drainage boxes are in $>15\text{m}$ bitumen pay

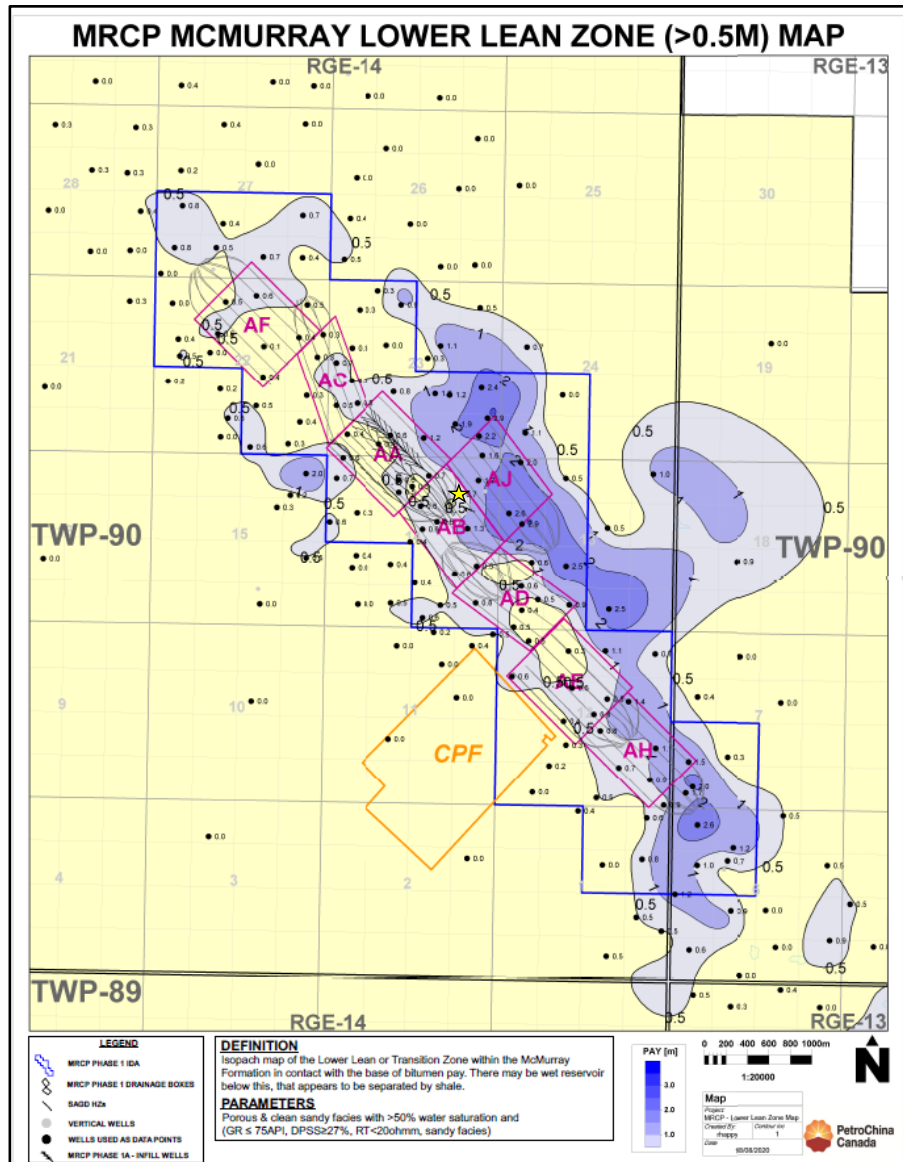
MCMR Top Gas Isopach Map



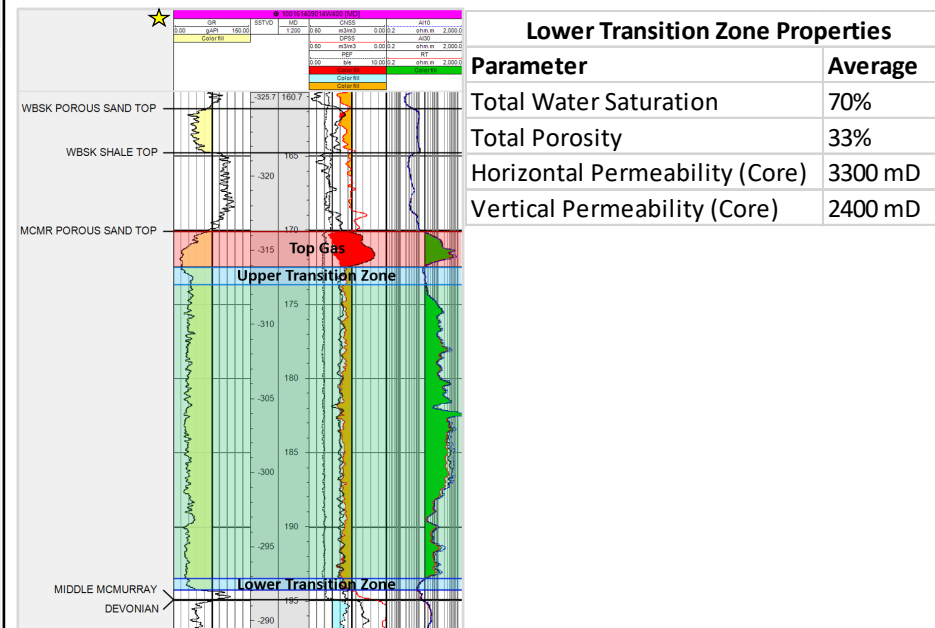
- Top gas zone present in the upper McMurray over the DA
- Ranges in thickness from approximately 0 to 3 meters



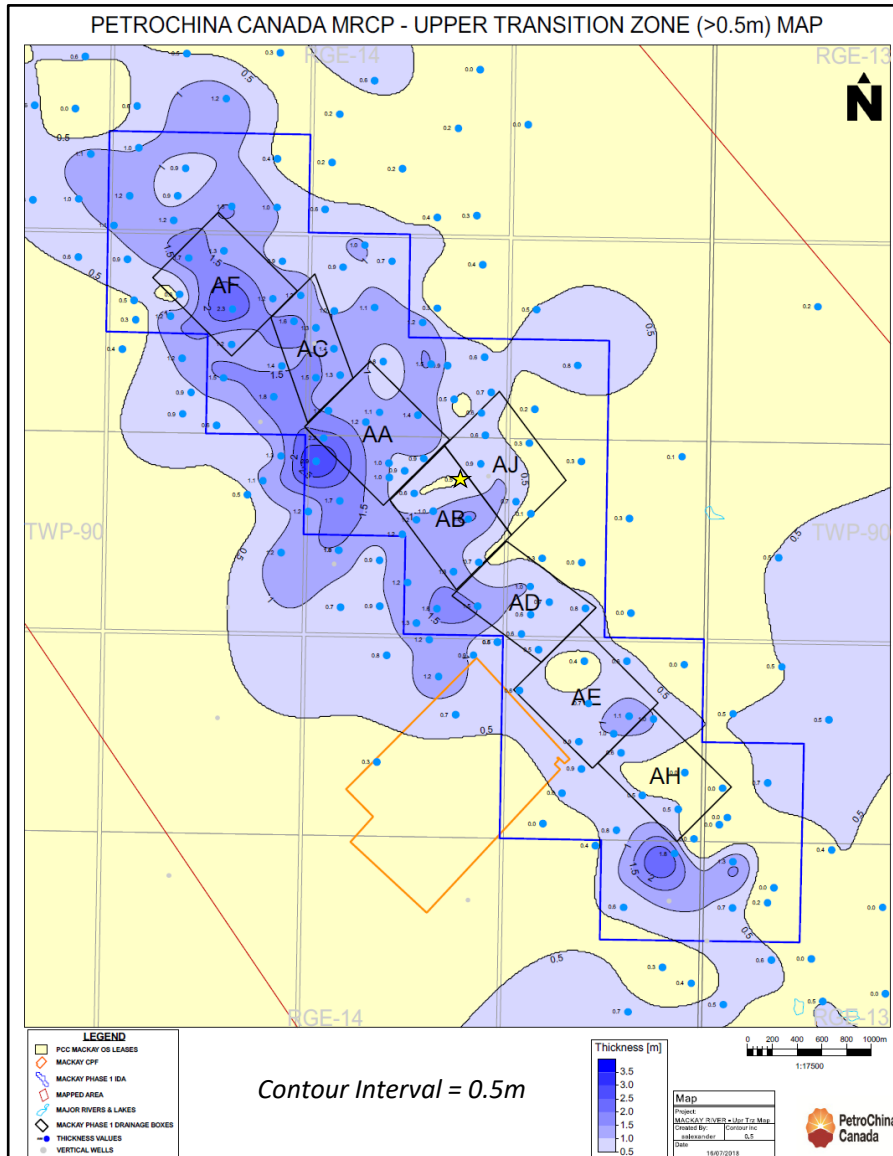
Lower Transition Zone Map



- Criteria:
 - Porous & clean sandy facies with >50% water saturation (GR ≤ 75API, DPSS≥27%, RT<20ohmm, sandy facies)
 - In communication with and below pay zone
- Characteristics:
 - Thin: <1.0m over most of the Phase 1 drainage boxes
 - Limited Lateral Extent



Upper Transition Zone Map

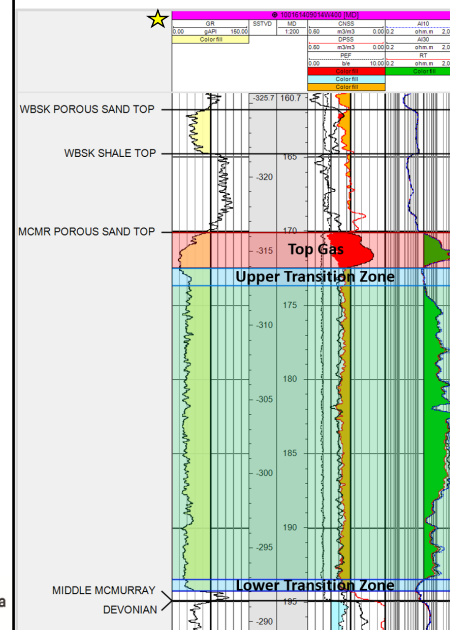


Criteria:

- Porous & clean sandy facies with >50% water saturation (GR ≤ 75API, DPSS ≥ 27%, RT < 20ohmm, sandy facies)
- In communication with and above pay zone

Characteristics:

- Thin: <1.5m over most of the Phase 1 drainage boxes
- Limited Lateral Extent



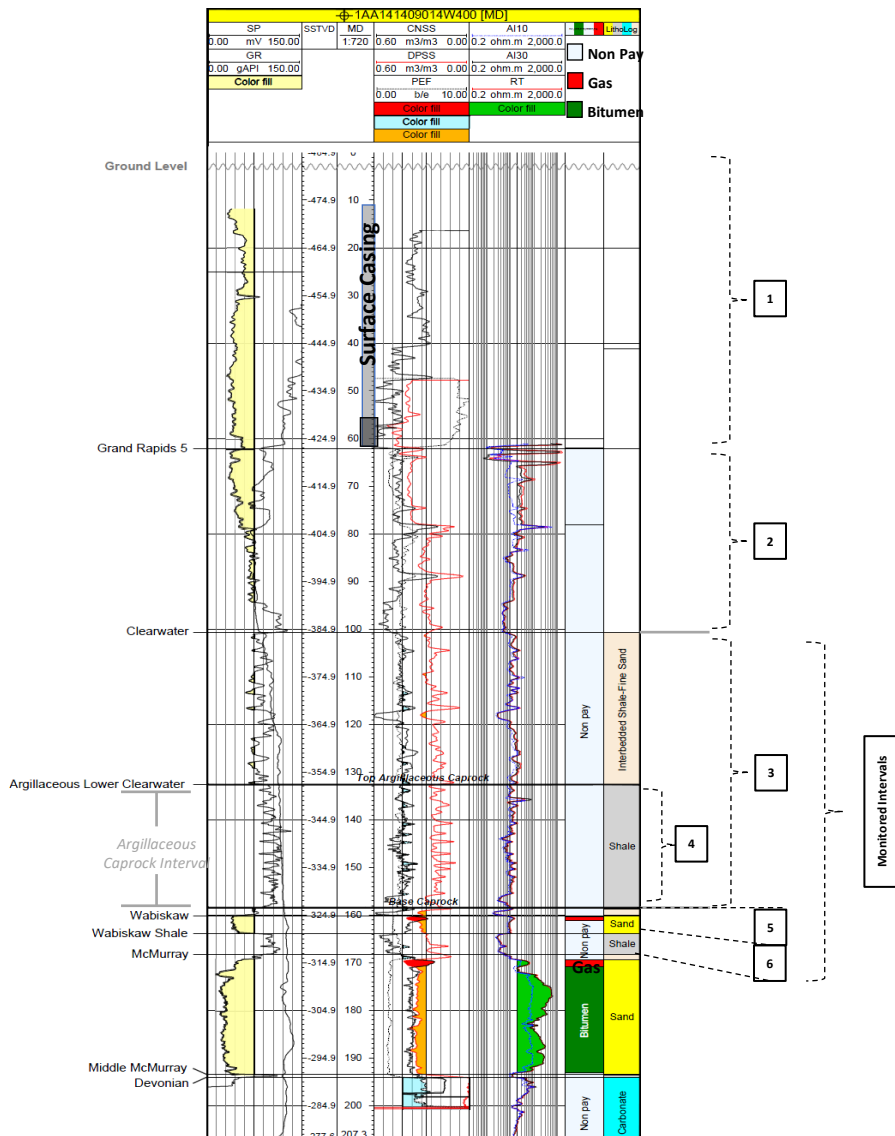
Caprock Monitoring: Overburden & Cap Rock Intervals

Overburden intervals:

1. Quaternary Sediments: from surface to the Grand Rapids
2. Grand Rapids, overlies Clearwater
3. Clearwater Formation, which is the gross caprock
4. Argillaceous interval of Clearwater is the primary caprock for MRCP. It is present across the MRCP DA, it's a thick (>21 m), and laterally continuous, consistent, clay-rich caprock, free of influence of any vertical pore pressure transmission pathways.

Some instrumentation is set outside the casing of observation wells to monitor the sandier Clearwater intervals above the Argillaceous caprock.

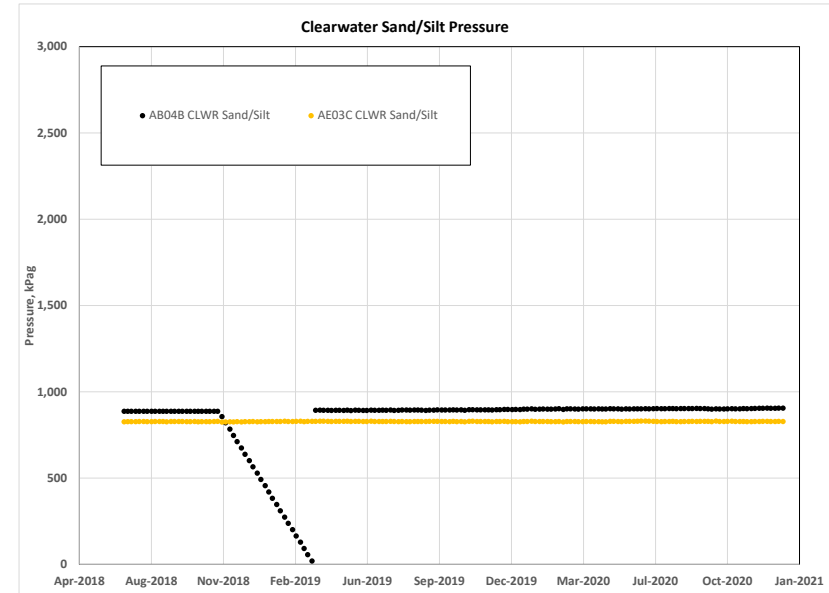
5. Wabiskaw sand is the first known horizontal pathway on top of the reservoir. It is the main target for reservoir containment assurance and/or caprock integrity monitoring, early warning for pressure buildup.
6. Wabiskaw shale lies above the McMurray reservoir, and is the lower-most interval included within the overburden monitoring strategy.



Caprock & Surface: Clearwater & Heave Monitoring

Overburden surveillance above MRCP caprock (Clearwater Argillaceous)

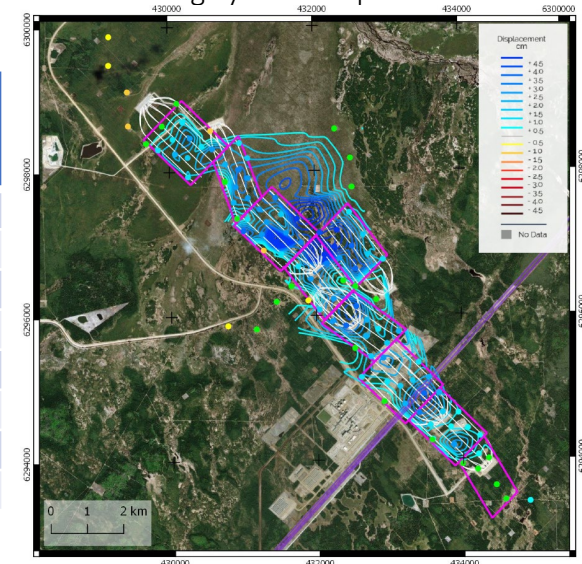
- Clearwater sand/silt is above the MRCP caprock
- Pressure: range 828 – 893 kPag (initial range: 826 - 896 kPag), Remains at virgin conditions, as expected
- Temperature: range 4 - 5 C (initial range: 4 - 5 C)
- Pressure and temperature expected to remain steady as this interval is immediately above the caprock



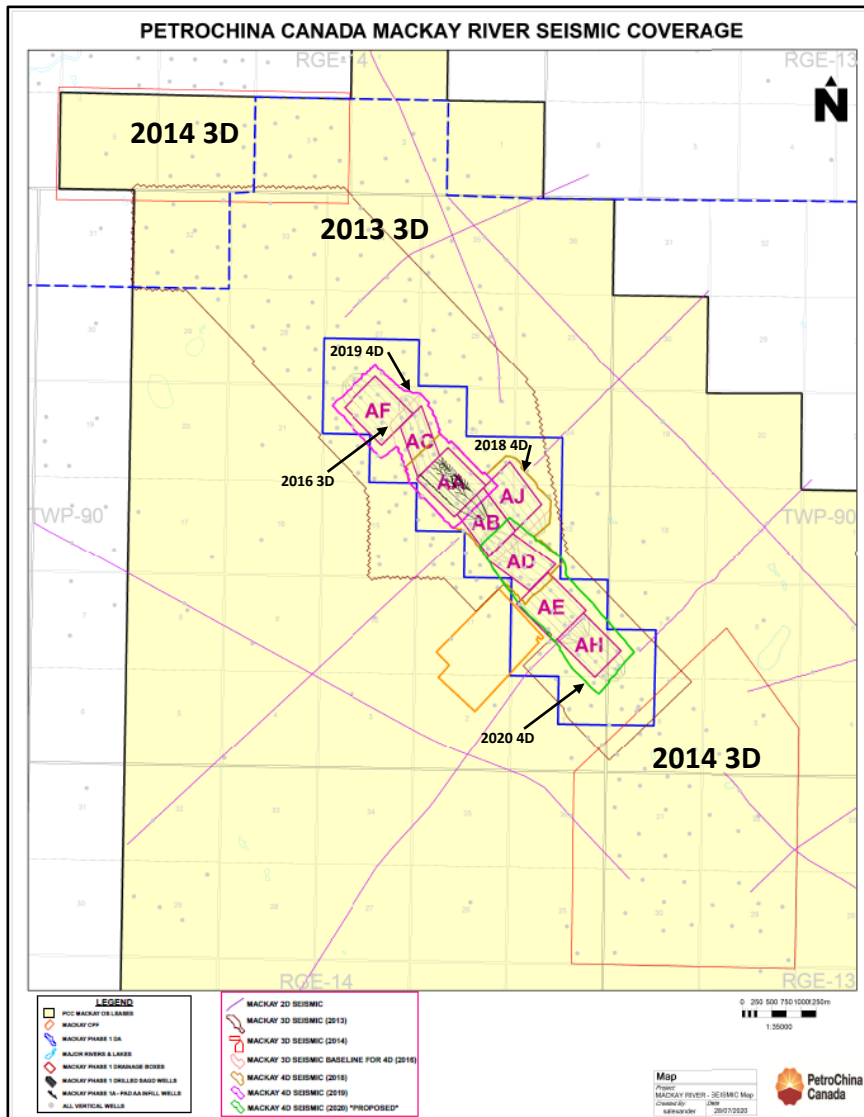
Surface Displacement Monitoring

- PCC implemented ground displacement monitoring using 104 corner reflectors over MRCP using Synthetic-aperture Radar Interferometry (InSAR) technology.
- Heave continues to be the dominant ground displacement effect registered in 2020
- Moderate heave up to 16.2 cm (as expected) has been recorded in all MRCP pads (MAX in pad AJ)
- Cumulative displacement per pad, Sep 2014 – Mar 2020 is shown in the adjacent table
- The displacement measured during the period 2019-2020 is shown in the map as isolines

Pad	Surface Displacement (cm)
AA	+10.9
AB	+10.7
AC	+6.6
AD	+11.4
AE	+9.6
AF	+5.9
AH	+8.6
AJ	+16.2



MRCP Seismic



Coverage Across MRCP includes:

- ~96 km of 2D
- ~58.4 km² of 3D
- ~3.9 km² of 3D baseline for 4D
- ~3.5 km² of 4D in 2018 - Interpreted
- ~3.0 km² of 4D in 2019 – Interpreted
- ~2.9 km² of 4D in 2020 – Interpreted

3D acquired in MRCP to help:

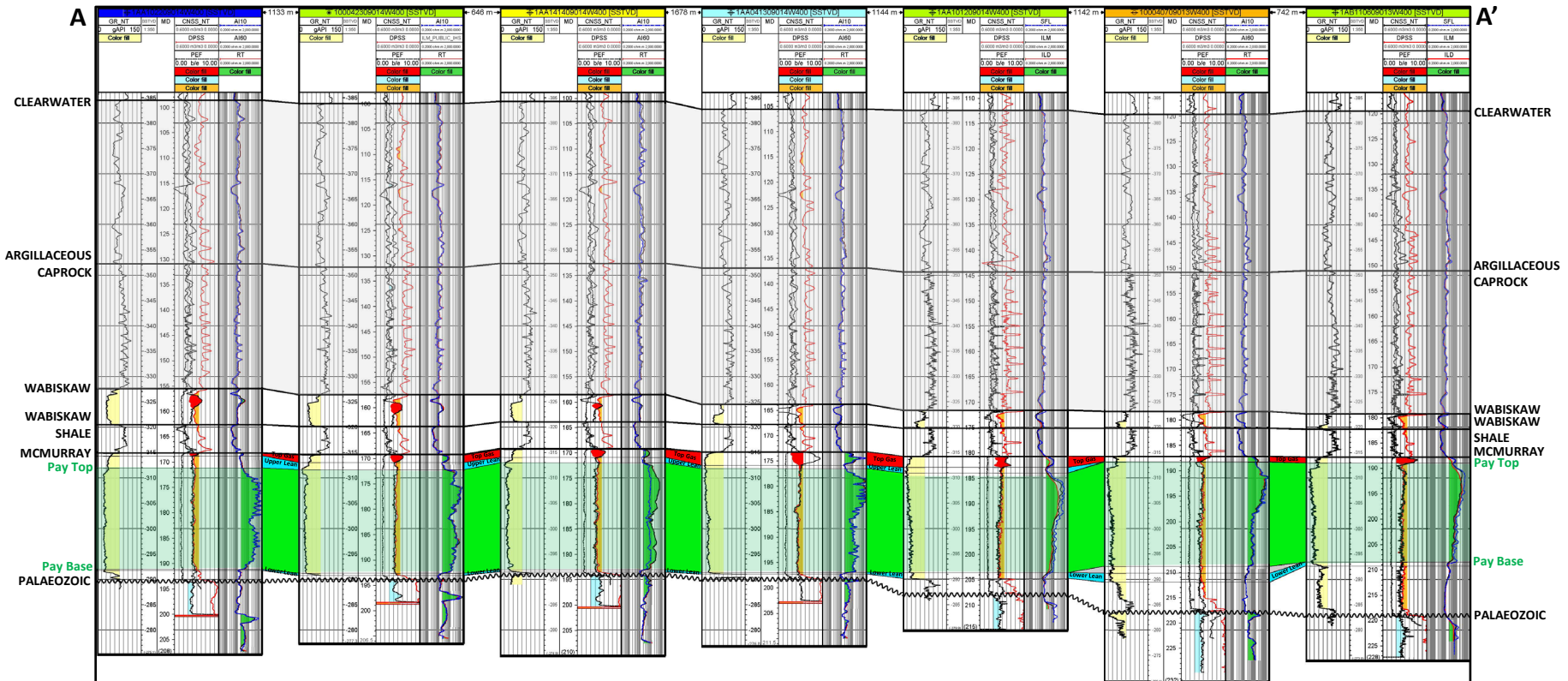
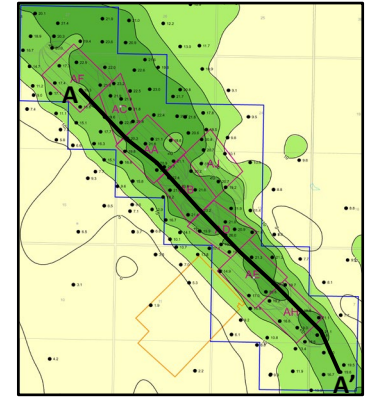
- Assess Caprock
- Plan/drill horizontal well trajectories
- Assess McMurray reservoir

4D seismic surveys acquired at MRCP in 2018, 2019 & 2020

- Used to monitor steam chamber growth
- 2018: Pads AA, AB, AJ, AD
- 2019: Pads AF, AC, AA
- 2020: Pads AD, AE, AH

Structural Cross-Section across MRCP

- Good reservoir quality with continuity along Development Area
- Minor structural variation at base of pay
- Thick and laterally continuous caprock with consistent lithology



Geologic and Reservoir Properties – OBIP FOR OPERATING AREA

Drainage Box	# Well Pairs	Drainage Box Area (m ²)	Average S _o (frac)	Average Φ (frac)	Average K _h (D)	Average K _v (D)	Average Bitumen Pay Thickness (m)	Drainage Box OBIP (m ³)	Estimated RF (%)	Estimated Drainage Box RBIP (m ³)
AA	10	698,200	0.83	0.34	2.7	1.1	21.3	4,197,138	54	2,273,450
AB	5	562,600	0.8	0.34	2.7	1.1	22.6	3,465,819	57	1,971,383
AC	4	418,700	0.85	0.34	2.6	1	21.9	2,655,008	63	1,669,316
AD	5	560,100	0.77	0.33	2.6	1	20.8	2,957,075	54	1,605,723
AE	6	674,700	0.76	0.33	2.2	0.9	20.8	3,513,514	53	1,860,095
AF	6	675,400	0.82	0.34	2.6	1	22	4,149,444	62	2,575,517
AH	5	594,300	0.77	0.34	2.6	1	20.4	3,179,650	48	1,526,232
AJ	5	562,300	0.75	0.34	2.5	0.9	20.5	2,941,176	57	1,669,316
Total	46	4,746,300	0.79	0.34	2.6	1	21.3	27,058,824	56	15,151,033

OBIP = Original Bitumen In-Place and measured in 10⁶m³ units and converted to 10⁶ barrels using conversion factor of 6.2898

NRV = Net Rock Volume in 10⁶m³ derived from deterministic mapping of SAGDable net pay, or from geomodel calculations

SO = Average bitumen saturation from the SAGD exploitable reservoir interval generated from 1-SWT (in fractions)

PORT = Average porosity from the SAGD exploitable reservoir interval generated from PORT (in fractions)

RBIP = Recoverable Bitumen in Place

$$OBIP = (NRV \times PORT \times SO)$$

Geologic and Reservoir Properties – OBIP

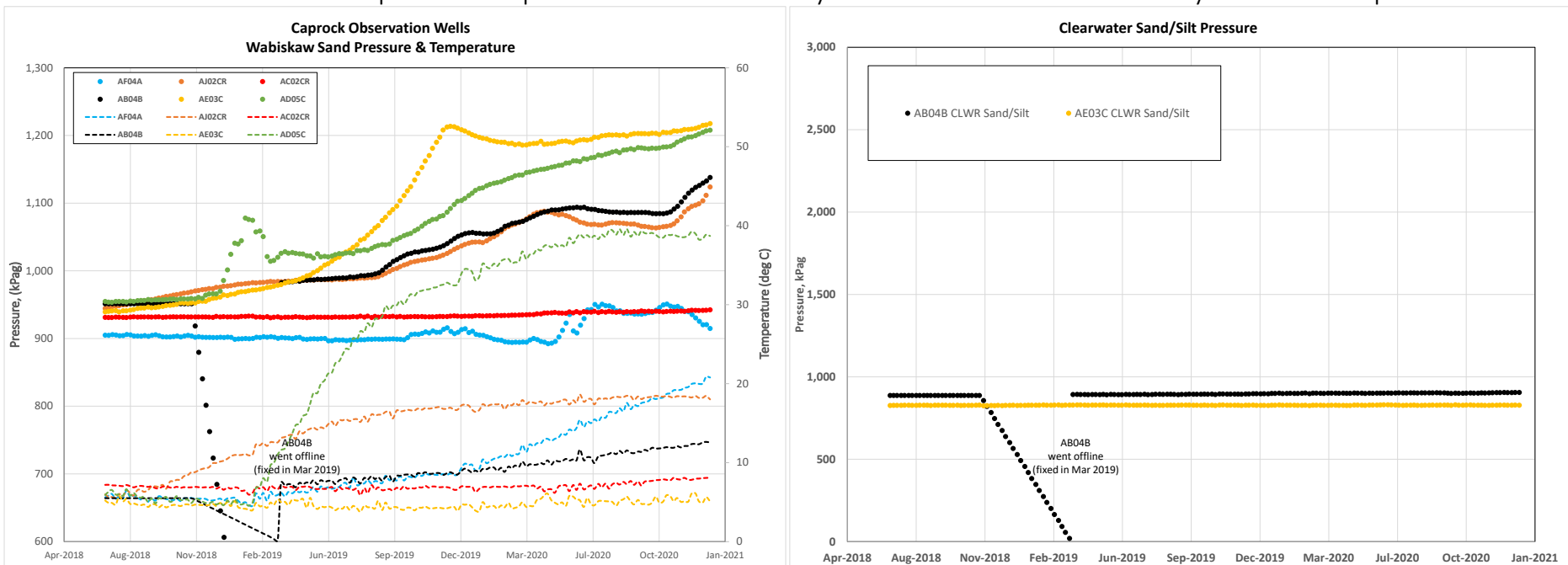
Parameters	Development Area	Project Area
Top of Reservoir Depth (mTVD)	176	175
Top of Reservoir Depth (TVD masl)	315	311
Base of Reservoir Depth (mTVD)	197	193
Base of Reservoir Depth (TVD masl)	294	293
Net Pay Thickness (m)	21.3	12.8
Porosity (frac)	0.34	0.33
Bitumen Saturation (frac)	0.79	0.75
OBIP (10 ⁶ bbl)	170.2	2890.8
OBIP (10 ⁶ m ³)	27.1	459.6
Initial Pressure (kPaa)	220 (top) – 400 (bottom)	220 (top) – 400 (bottom)*
Original Reservoir Temperature (°C)	6	6*

*Extrapolated from operating area

Caprock Monitoring: P & T Wabiskaw and Clearwater Sands

Overburden surveillance below and above MRCP caprock (Clearwater Argillaceous)

- **Wabiskaw Sand First line of defense (above reservoir, below caprock):**
 - Pressure: Average 993 kPag, range 900 – 1,218 kPag (initial range: 900 - 950 kPag)
 - Temperature: Average 10 °C, range 6 - 39 °C (initial range: 5-7 °C)
 - All pressure and temperature trends were considered normal in 2020 and attributed to thermal operations in the MCMR reservoir
- **Clearwater sand/silt is above of MRCP caprock**
 - Pressure: range 828 - 893 kPag (initial range: 826 - 896 kPag), Remains at virgin conditions as expected
 - Temperature: range 4 - 5 °C, (initial range: 4 - 5 °C)
 - Pressure and temperature expected to remain steady as this interval is immediately above the caprock



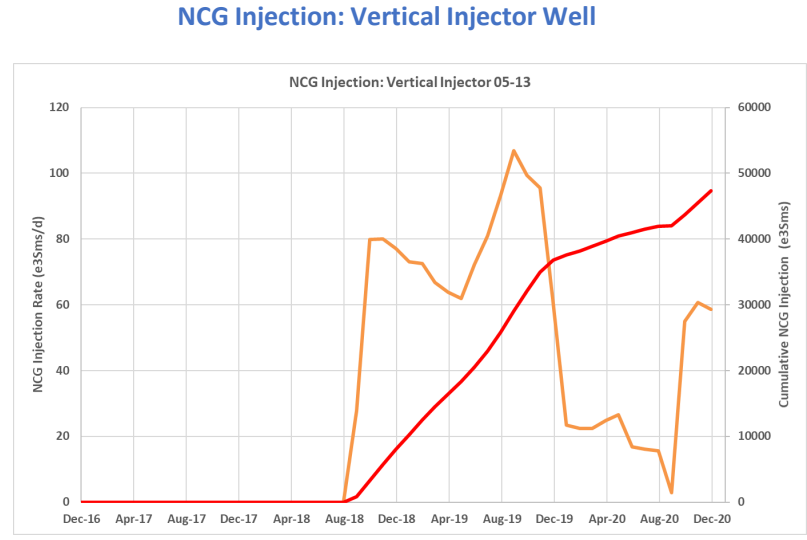
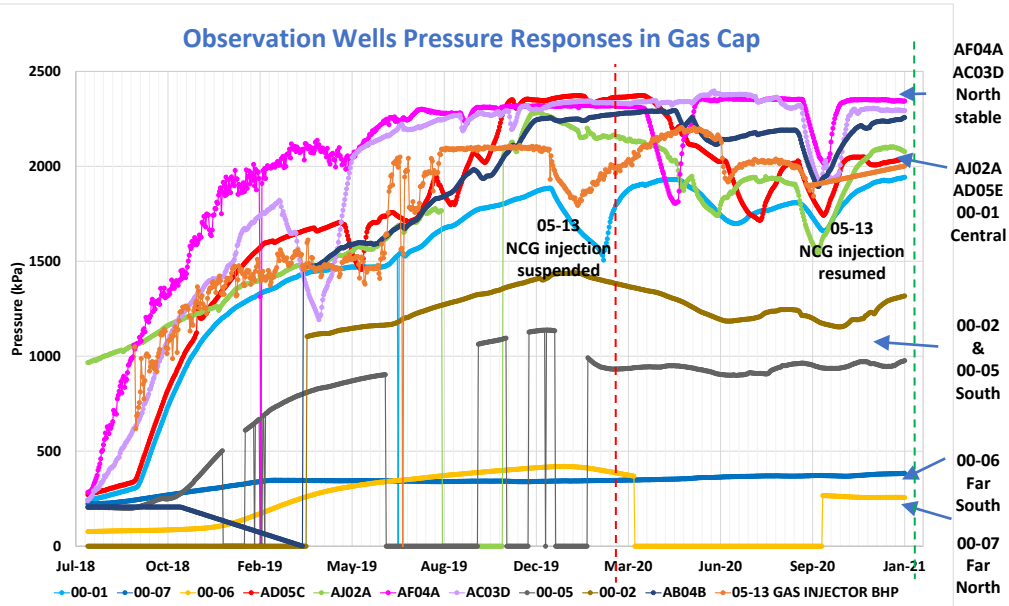
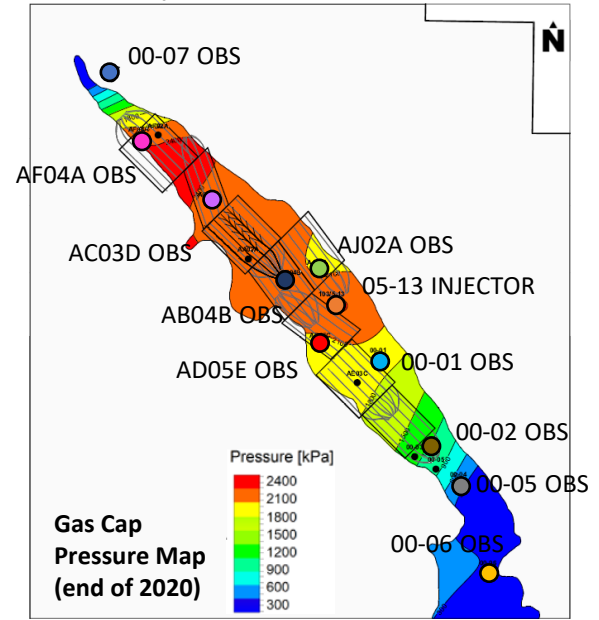
MRCP – Performance Indicators by Pad

Pad	OBIP (m ³)	Cum. Oil to December 2020 (m ³)	Recovery to December 2020 (%)	CSOR	ISOR	Ultimate Recovery (%)
AA	4,197,138	404,310	9.63%	5.1	3.8	54%
AB	3,465,819	222,767	6.43%	7.2	5.0	57%
AC	2,655,008	293,563	11.06%	4.1	3.8	63%
AD	2,957,075	185,359	6.27%	7.8	5.7	54%
AE	3,513,514	148,602	4.23%	10.2	6.3	53%
AF	4,149,444	366,101	8.82%	4.8	3.2	62%
AH	3,179,650	58,118	1.83%	19.8	8.9	48%
AJ	2,941,176	101,024	3.43%	14.1	8.6	57%
Total	27,058,824	1,779,843	6.58%	6.8	4.6	56%

- Higher SORs experienced on AE, AH, AJ and AD pads primarily due to gas cap contact and slightly larger lower transition zone leak off.
- Mitigations:
 - Operating pressure is balanced accordingly with the thief zones pressure
 - Gas cap pressurization with natural gas started in Sep 2018 in vertical well 05-13 (central DA), suspended in Dec 2019. Resumed in Oct 2020 after plant turn around
 - Gas co-injection started in well pairs of pads AH, AE, AD in Jan 2019 and it is expected to continue to support gas cap pressurization in the Southern DA during 2021

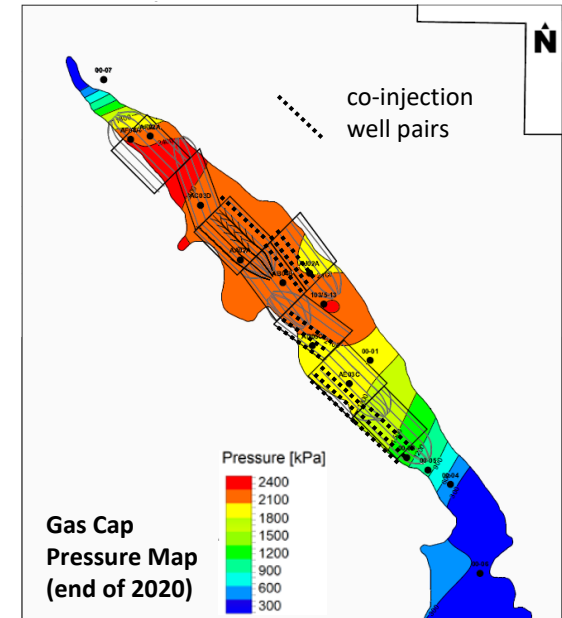
Gas Cap Pressurization: NCG Injection

- The purpose of gas cap pressurization at MRCP is to increase the pressure in the gas cap to operate at a more favourable pressure balance between steam chambers and top thief zones to minimize steam losses.
 - Initial gas cap pressure of 200 kPag, presented a challenge to SAGD operation pressure balance
 - Evidence of steam chamber communication to the gas cap since early 2018
 - The pressurization process started in Sep 2018. Natural gas was injected in the vertical well 103/05-13-090-14W4-00. By Q3, 2019 injection reached a maximum of 106,000 Sm³/d (max approved by AER is 120,000 Sm³/d per injector). In Dec 2019, injection was suspended in 05-13 as gas cap pressure was close to target value.
 - In Oct 2020, PCC resumed NCG injection at rate of ~50,000 Sm³/d to support field ramp up after the plant turnaround. By Dec 2020, cumulative NCG injection was ~47,000 e3Sm³ (as per chart below, right)
 - The gas cap pressurization process has helped reduced SOR and maintain stable operation and production of wells affected by gas cap contact

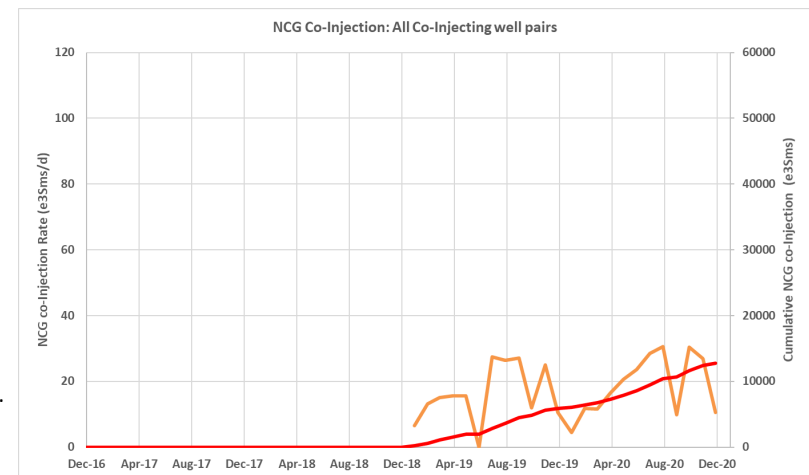


Gas Cap Pressurization: NCG Co-Injection

- NCG co-injection supports the gas cap pressurization at MRCP
 - Gas co-injection implemented since Jan 2019, to additionally support gas cap pressurization in areas distanced from vertical injector 05-13
 - Typical co-injection rates range from 2,400 to 4,200 Sm³/d per well (Max approved by AER is 5,000 Sm³/d per well). By Dec 2020, cumulative NCG co-injection was ~12,700 e3Sm³ (as per chart below, right)
 - Typical mole fractions (concentration) range between 0.5 and 2.0 %
 - NCG co-injection parameters are evaluated weekly: Co-Injection rates (within permitted range) are adjusted as per each well pair response. Wells could be on and off co-injection depending on SOR and TFSR evaluation.
 - Until Dec 2020, PCC has identified and used up to 13 well pairs (shown in map) for NCG co-injection.
 - AA06
 - AB05
 - AJ01, AJ02
 - AD03, AD04, AD05
 - AE01, AE02, AE03
 - AH01, AH02, AH03
 - NCG co-injection helps provide extra buoyancy to the steam chambers and support growth through tortuous and heterogeneous reservoir paths.
 - Pressure monitoring of the gas cap indicates that co-injected NCG reaches the top of the reservoir, effectively providing pressure support, preventing excessive steam losses and supporting effective SAGD operation.
 - No wellbore integrity issues identified
 - PCC continue to use gas co-injection to support pressurization of the gas cap.



NCG co-Injection: Several Well Pairs

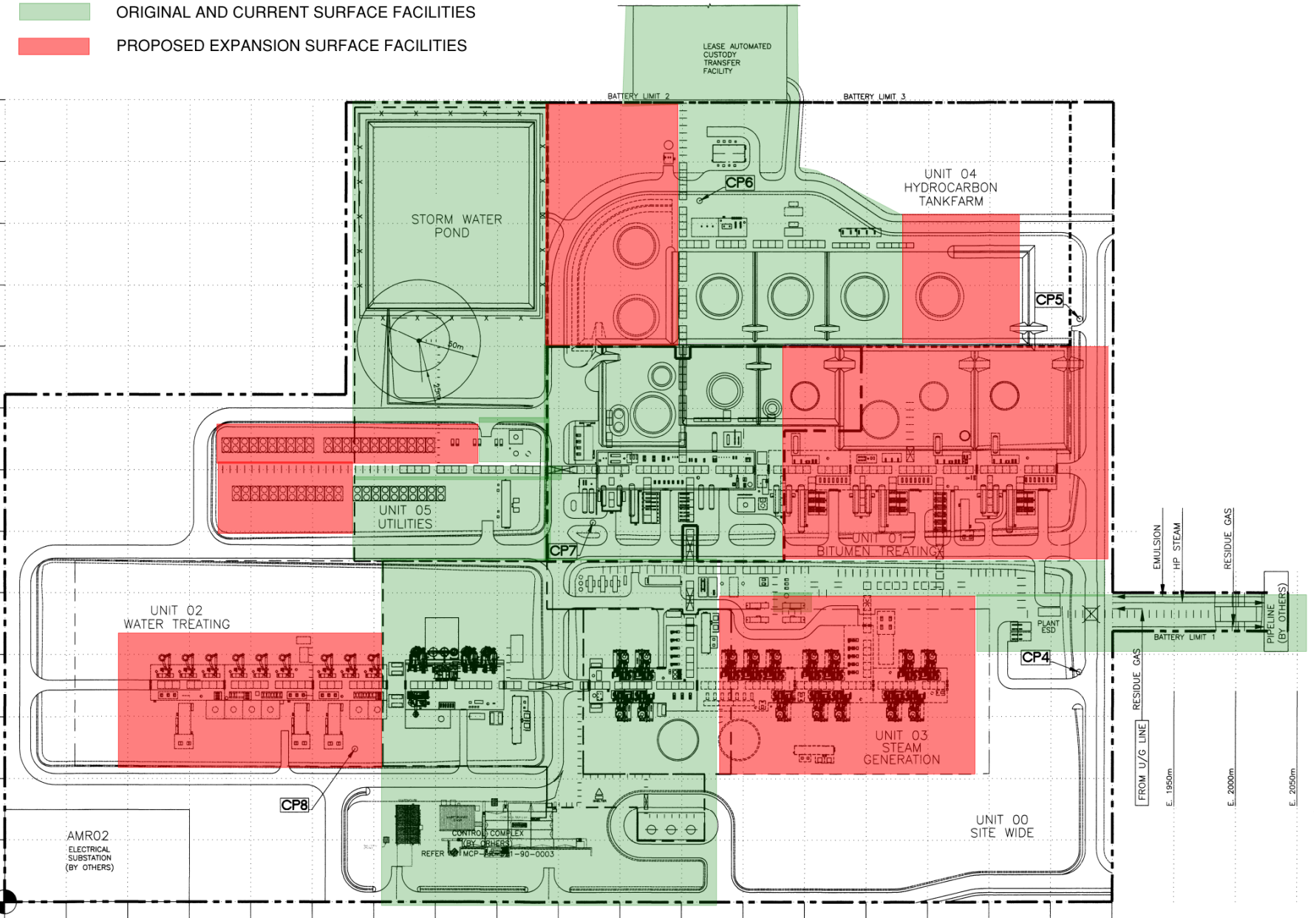


4.3 SURFACE



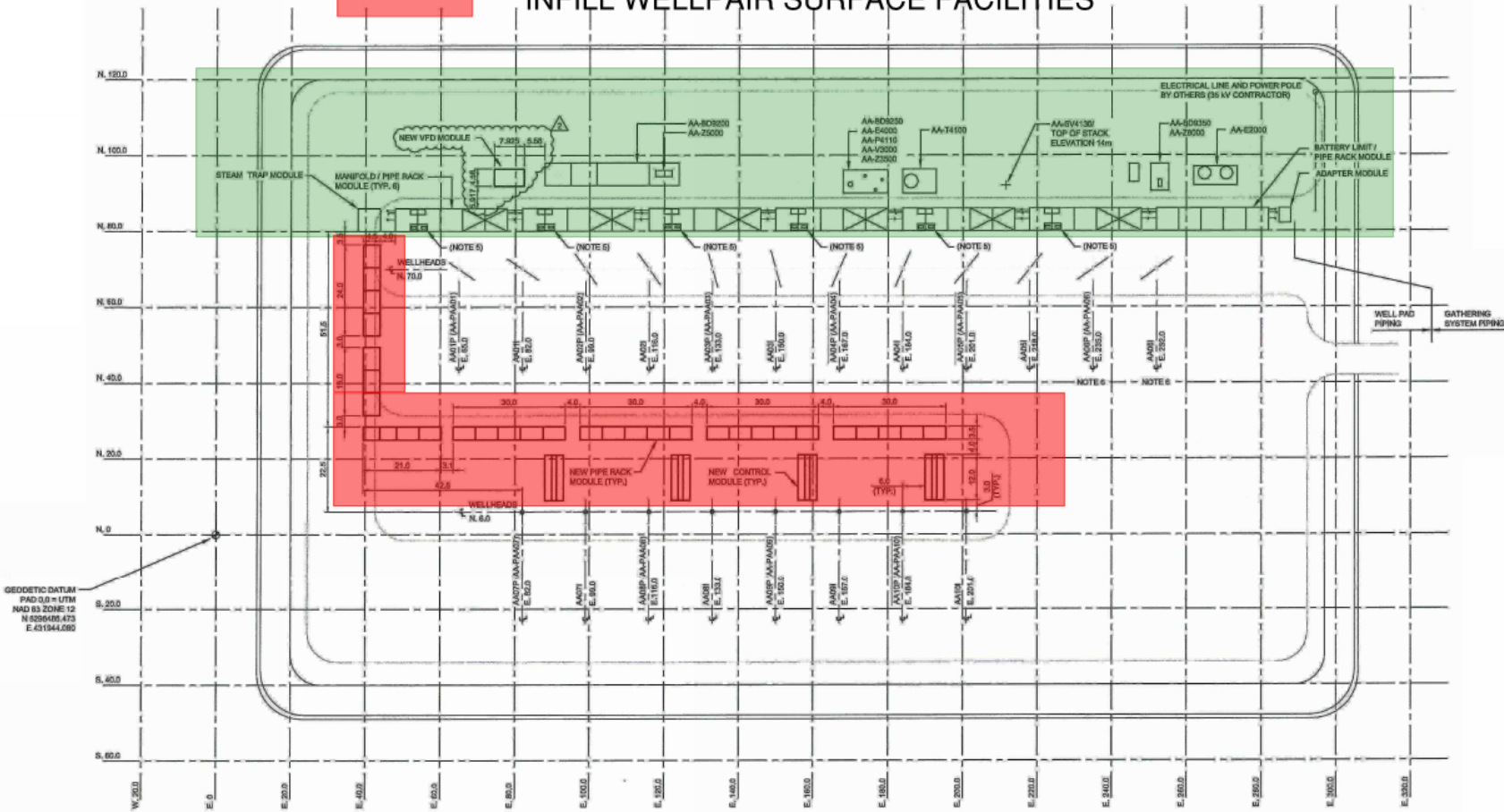
Central Plant Facility Development

- ORIGINAL AND CURRENT SURFACE FACILITIES
- PROPOSED EXPANSION SURFACE FACILITIES



Pad Surface Facility Development

ORIGINAL PAD SURFACE FACILITIES
 INFILL WELLPAIR SURFACE FACILITIES

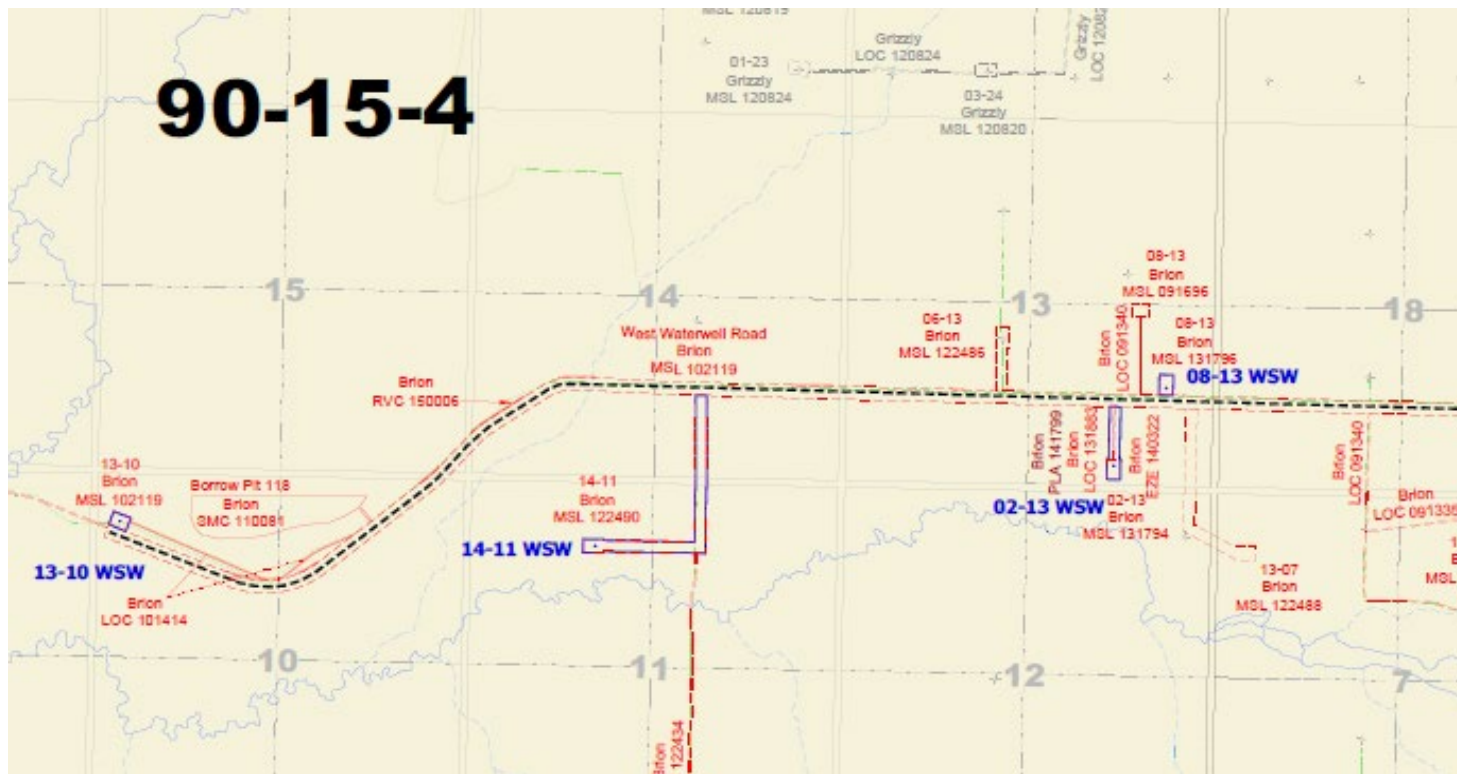


EQUIPMENT LIST											
AA01	INJECTION WELL	AA8P	PRODUCTION WELL	AA-PA03	DOWNHOLE PUMP	AA01	INJECTION WELL (NEW)	AA-PA07	DOWNHOLE PUMP (NEW)		
AA02	INJECTION WELL	AA6P	PRODUCTION WELL	AA-PA04	DOWNHOLE PUMP	AA02	INJECTION WELL (NEW)	AA-PA08	DOWNHOLE PUMP (NEW)		
AA03	INJECTION WELL	AA-B0200	MCC / AIR COMPRESSOR BUILDING	AA-PA05	DOWNHOLE PUMP	AA03	INJECTION WELL (NEW)	AA-PA09	DOWNHOLE PUMP (NEW)		
AA04	INJECTION WELL	AA-B0250	TEST SEPARATOR BUILDING	AA-PA06	DOWNHOLE PUMP	AA10	INJECTION WELL (NEW)	AA-PA10	DOWNHOLE PUMP (NEW)		
AA05	INJECTION WELL	AA-B0350	START-UP PRODUCTION / ANNULUS GAS PUMP BUILDING	AA-T4100	POP TANK						
AA06	INJECTION WELL	AA-E3000	START-UP PRODUCTION AIR/WL COOLER	AA-V3000	TEST SEPARATOR	AA07P	PRODUCTION WELL (NEW)				
AA01P	PRODUCTION WELL	AA-E4000	PAD RESIDUE GAS HEATER	AA-Z3000	SAMPLE PACKAGE	AA08P	PRODUCTION WELL (NEW)				
AA02P	PRODUCTION WELL	AA-P4110	POP TANK PUMP	AA-Z5000	PAD INSTRUMENT AIR PACKAGE	AA09P	PRODUCTION WELL (NEW)				
AA03P	PRODUCTION WELL	AA-PA01	DOWNHOLE PUMP	AA-Z6000	START UP / ANNULUS GAS PUMP PACKAGE	AA10P	PRODUCTION WELL (NEW)				
AA04P	PRODUCTION WELL	AA-PA02	DOWNHOLE PUMP	AA-SW4130	VENT STACK						

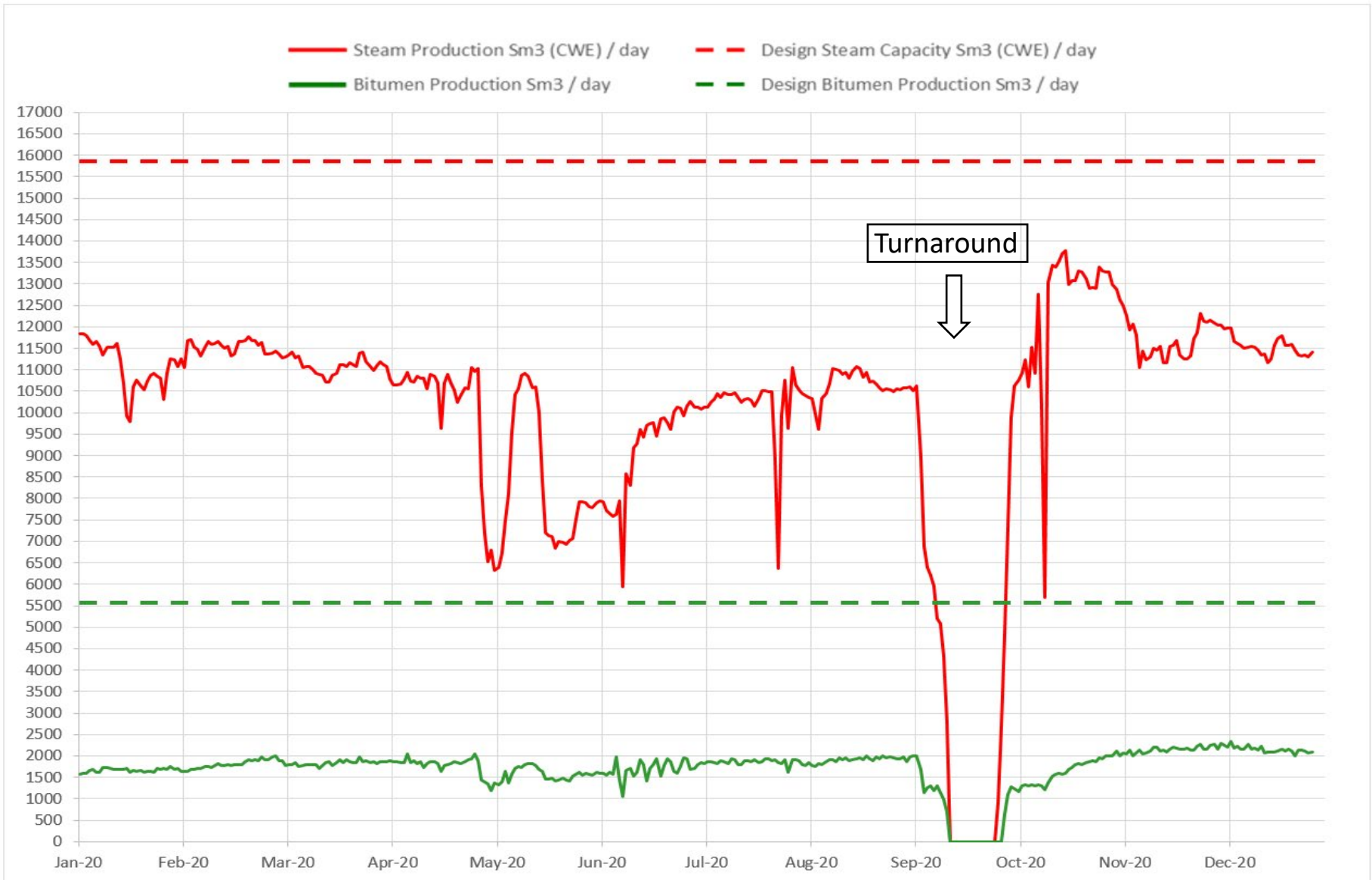
Built and Planned Water Infrastructure

Water Act Licence No. 00266369-01-03:

- Approved Annual Withdrawal Volume = 2,116,964 m³/year from the Empress Channel Aquifer
 - 13-10-90-15W4, max rate 2,930 m³/d
 - 14-11-90-15W4M, max rate 3,000 m³/d
 - 02-13-90-15W4M, max rate 2,900 m³/d
 - 08-13-90-15W4M, max rate 3,100 m³/d



Operational Comparison to Design Throughputs



4.4 Historical and Upcoming Activity



Historical and Upcoming Activity

Summary of suspension and abandonment activity within 2020:

There were no suspension or abandonment activities in 2020

2020 Regulatory and Operational Changes

There were no regulatory or operational changes made throughout 2020

There were no modifications to the Central Processing Facility throughout 2020 that required AER approval.

There were no phase expansions, change in injection strategy, or infrastructure changes throughout 2020 that materially affected scheme performance or energy material balances

Key Learnings To-Date

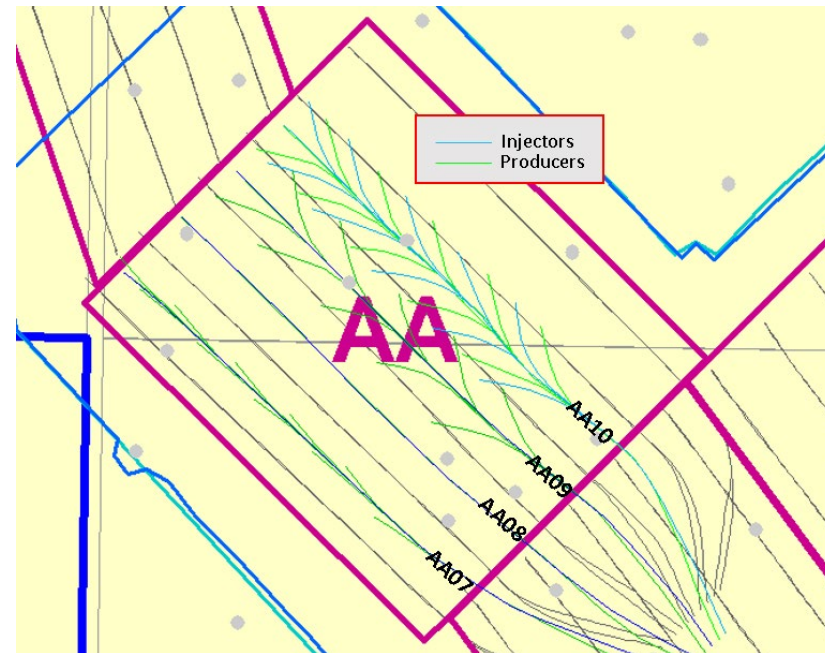
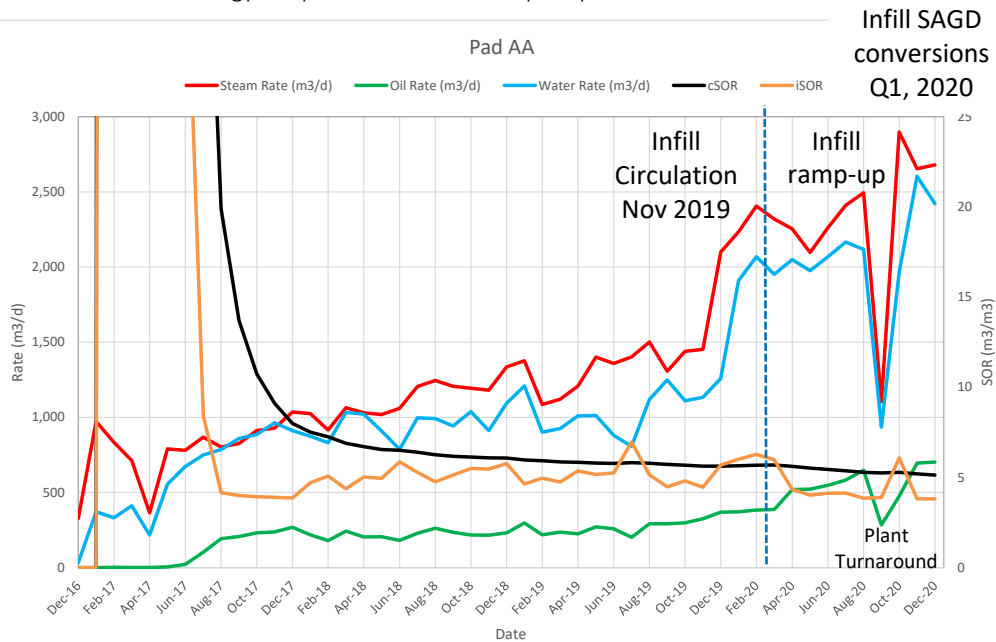
- SAGD
 - Continuing to ramp-up production through optimization efforts and mitigating the effects of:
 - Top gas and thicker lower transition zones
 - Operational pressure strategies tied to “thief” zones
 - Effects of baffles and barriers
 - Fines migration
 - The implementation of infill wells in pad AA has resulted in a positive experience. Key learnings in well/facilities planning, drilling, completion and operation are considered for future developments at MRCP
 - Electrical Submersible Pump (ESP) conversions continue to meet run-life expectations and are in-line with industry averages.
 - The use of fiber optic temperature coils has proven to be a valuable tool to diagnose downhole issues and survey the conformance along the horizontal section.
 - For wells that have been worked over with Tubing Deployed Inflow Control Devices (TDICD), continuous fiber optic temperature coils have left out of the completion to minimize pressure drop inside the liner, however some requirement for surveys or installation of coils have presented to further assess TDICD performance.

Well Pad AA Infill Wells

Key Learnings for Future MRCP Developments

- Steam circulation began late Nov 2019
- SAGD conversion between Mar-Apr 2020
- Infill wells performance to-date represents a clear improvement over their parent (original) wells
- Multilaterals showing communication with adjacent steam chambers. PCC continues to develop strategies to promote steam chamber development in heterogeneous reservoir
- Reservoir Conditions (heterogeneities, quality) variable along the pad. Generally improving in the NE-SW direction. No direct comparison of infills performance is possible as each infill (as well as original wells) deals with different reservoir qualities.
- Main learnings:
 - Conventional infill well pair (no multilateral) with completion enhancements in cleaner reservoir outperforms parent wells
 - Multilateral wells more adequate to lower quality reservoir to help promote steam chamber growth and reaching out to interbedded sands. They also outperform parent wells
 - Technology adaptation to reservoir quality

- **AA07:**
 - Casing Inflow Control Device in producer, PPS liner
 - Uptrack laterals
 - Vacuum Insulated Tubing
- **AA08:**
 - Casing Inflow Control Device in producer
 - Base Pair (conventional well pair, enhanced design with learning from first 42 well pairs), PPS liner.
- **AA09:**
 - Casing Inflow Control Device in producer,
 - Producer multilaterals to adjacent steam chamber
- **AA10:**
 - Casing Inflow Control Device in producer,
 - Producer and injector multilaterals to adjacent steam chamber



2020 Compliance Summary

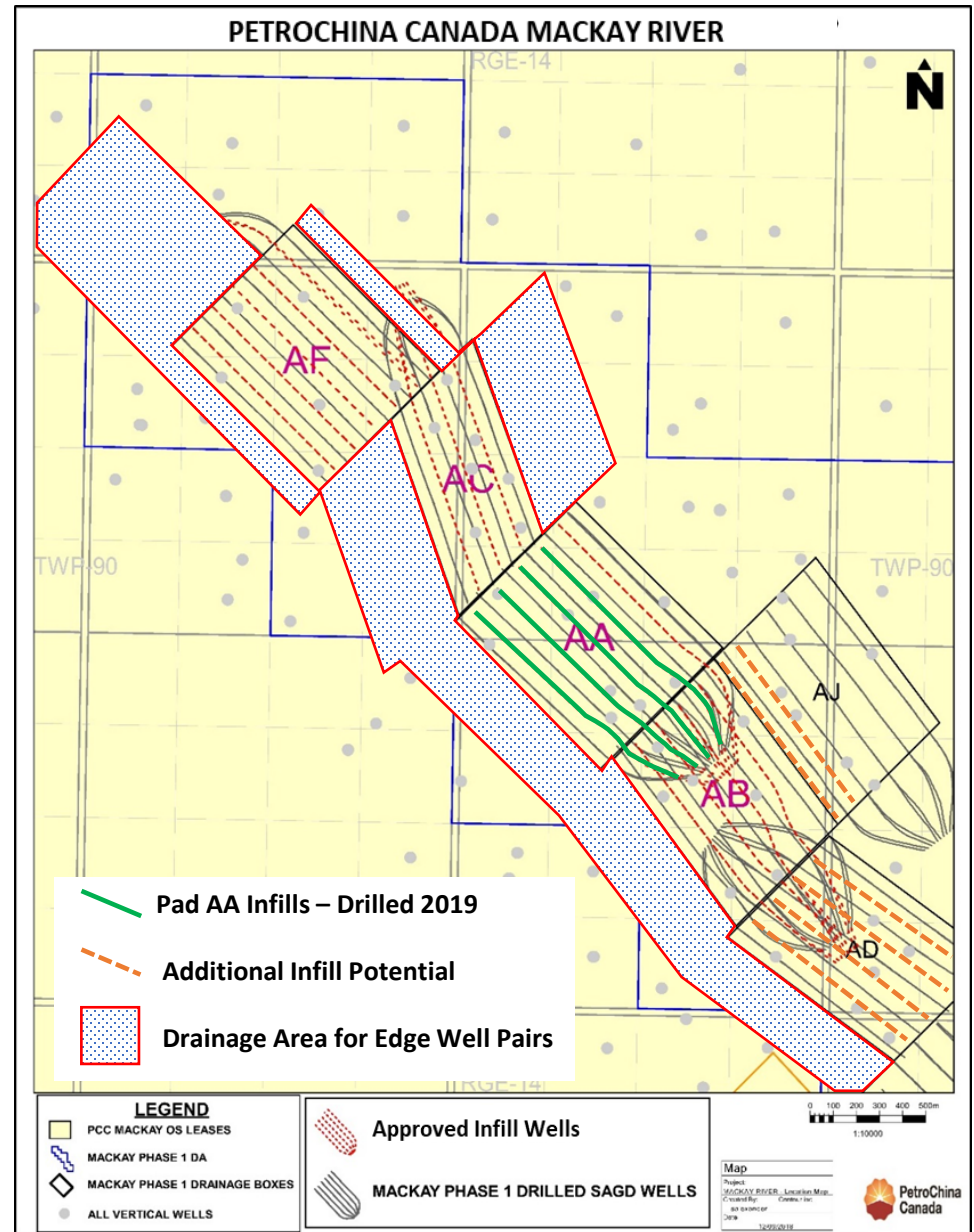
Event Description and AER Reference Number (if applicable)	Event Details	Event Reason (if applicable)	Plan to Resolution
Missing Drilling Waste Information	Required post-disposal information was not submitted within 24 months of rig release.	Insufficient follow up with contractor	Contractor completed upload of the required data and AER verified that the data was satisfactory.
Emulsion Leak (367788)	Approximately 0.001m ³ of emulsion leaked from the pipeline between the CPF and PAD AD. The spill was identified and cleaned up immediately. AER was notified on the date of the spill.	Bolts on the Pipeline coffin became loose over the course of the year causing the leak. The bolts were re-torqued after the spill was cleaned up.	Spill was cleaned up and reported to AER immediately. Follow up report was issued on June 23, 2020.
Steam Leak (0368691)	Approximately 1m ³ of steam was released from a HP steam valve. The incident was immediately reported to AER and a release report was submitted on July 15, 2020.	There was a packing failure on the valve.	The incident was immediately reported to AER and a release report was submitted on July 15, 2020. Valve will be evaluated during next shutdown. Additional information was provided on August 18, 2020.
Pop Tank Release (372283)	Approximately 1.5m ³ of Steam condensate, 0.3m ³ of Bitumen, and 10m ³ of gas was released from the pop tank vent stack at Pad AB.	Operations left a valve open during warm up operations, leading to the release.	The incident was reported to AER and a follow-up report was issued on September 30, 2020. approximately 15m ³ of soils and 2m ³ of water was removed as part of clean up.
Steam Leak	Operator on rounds identified what was thought to be a packing leak at the Bly Sky Skid on the CPF. Further investigation discovered a pin hole leak in the body casting of a 3" gate valve. Inspection was then sent out to review and the pin hole is larger than when first found. Valve is flanged, plan being implemented to take down the header and replace this valve.	There was a pinhole leak in the valve. Initial review indicates it may have been caused by steam erosion of the valve.	The leak was reported to ABSA on October 9, 2020. plan is being developed to replace this valve.
Missing Packer Isolation Test (VSD ID 11126)	Packer Isolation Test on gas injection well was missed for 2020.	No previous corporate requirement for PITs so the list was not monitored	The issue was disclosed to the AER December 21, 2020. Test has since been completed.

Future Initiatives - 2021

- Winter Appraisal Program:
 - No new delineation wells
 - No seismic survey planned
- Potential Commercial Amendment Applications:
 - Pressure maintenance in bottom transition zone continue to be investigated
 - Use of polymers to mitigate bottom transition zone to be investigated
- New Developments:
 - Infill wells approved by AER
- Other initiatives:
 - Producer sidetrack in selected wells pairs
 - Continue improving technology implementations (tubing deployed inflow control devices and other remedial pilot technologies for casing/liner improvement)

Future Initiatives

- PCC long range planning is ongoing and subject to change
 - No new delineation wells are planned
 - Sufficient delineation exist in near term, ~5 years
 - 4D seismic will be acquired throughout MRCP
 - As needed basis to monitor and manage reservoir
 - Opportunistically cycle through the drainage areas
 - ~2 to 3 drainage boxes annually
- Potential Amendment Applications:
 - Application for additional future sustaining well pairs
- Future Sustaining Development Potential
 - Development of the approved 13 infills well pairs
 - PCC is currently reviewing opportunity for:
 - Additional infills
 - Edge well pairs
 - Development extends from current drainage boxes
 - Use existing footprint and pad facilities wherever possible
 - Incorporate learning from Pad AA Infill well pairs





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