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Thermal In-Situ Scheme Progress Report for 2019
Japan Canada Oil Sands Limited

Approval No. 11910 (Hangingstone Expansion Project)

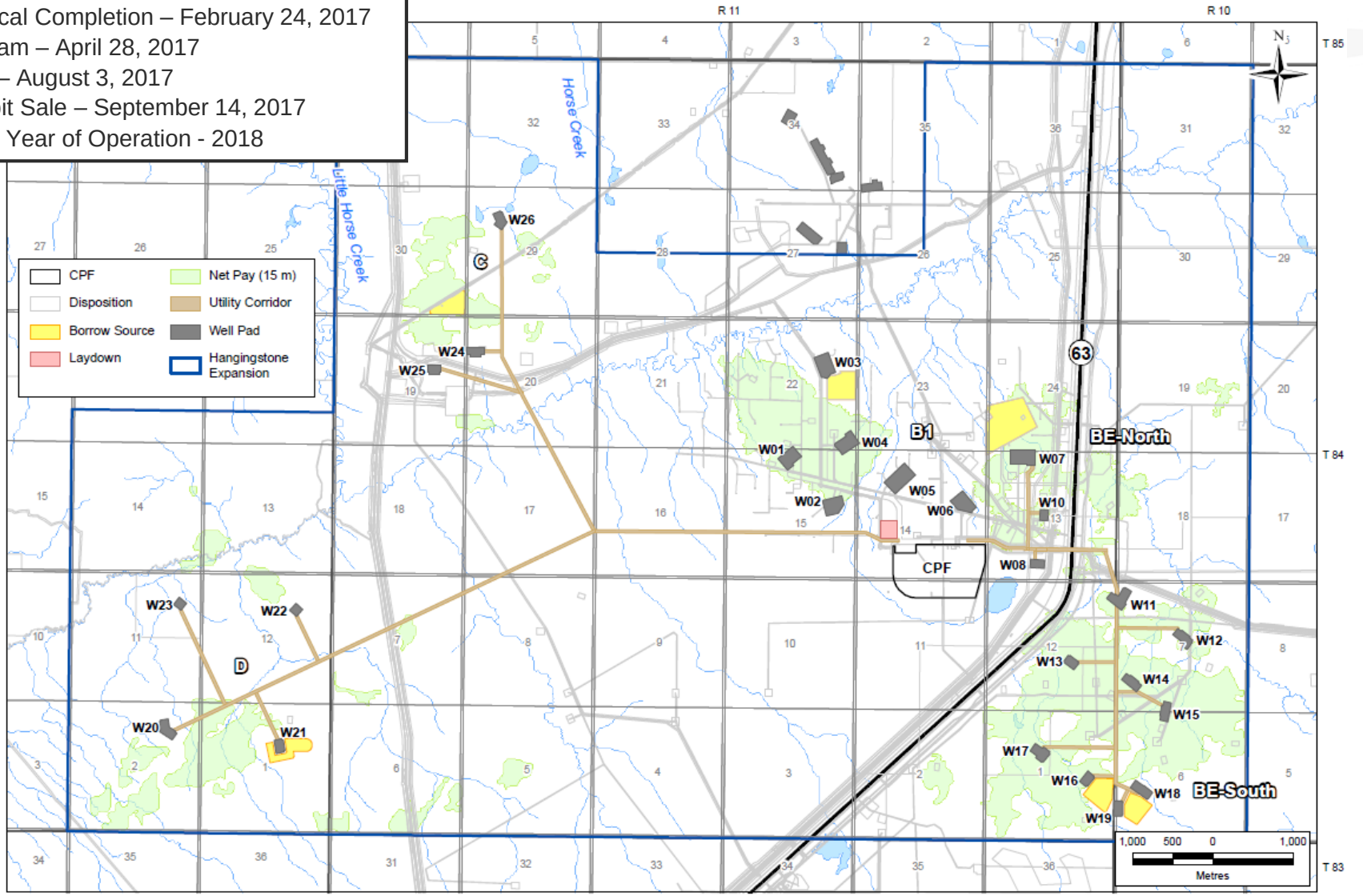
Submitted: February 19, 2020

Outline

1. Background – Hangingstone Expansion Project
2. Subsurface
   - Geosciences
   - Reservoir Performance
   - Well Design & Instrumentation
3. Surface Operations
   - Facility Design
   - Measurement & Reporting
   - Sulphur Emissions
   - Water
     - Source
     - Disposal
   - Other Wastes (not presented)
   - Environmental (not presented)
   - Compliance Statements & Approvals

Expansion Scheme No. 11910 Background

- Approved Capacity – 30 kbpd (4,770 m^3/d)
- Mechanical Completion – February 24, 2017
- First Steam – April 28, 2017
- First Oil – August 3, 2017
- First Dilbit Sale – September 14, 2017
- First Full Year of Operation - 2018



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Subsurface

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Geosciences

Net Pay

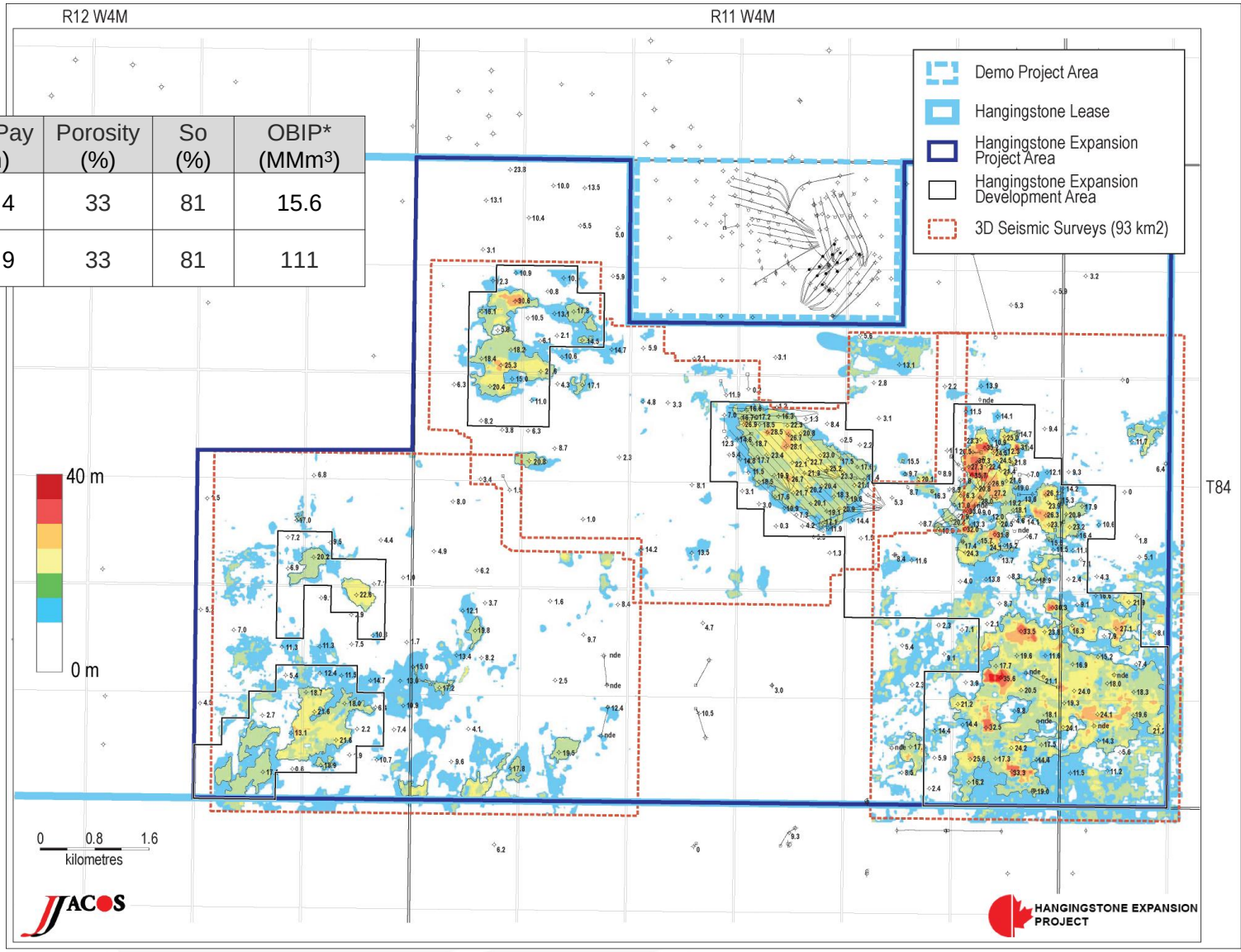
	Area (km^2)	Net Pay (m)	Porosity (%)	So (%)	OBIP* (MMm^3)
Operating Area	2.6	22.4	33	81	15.6
Approval Area	100.4	16.9	33	81	111

*10 m net pay cutoff

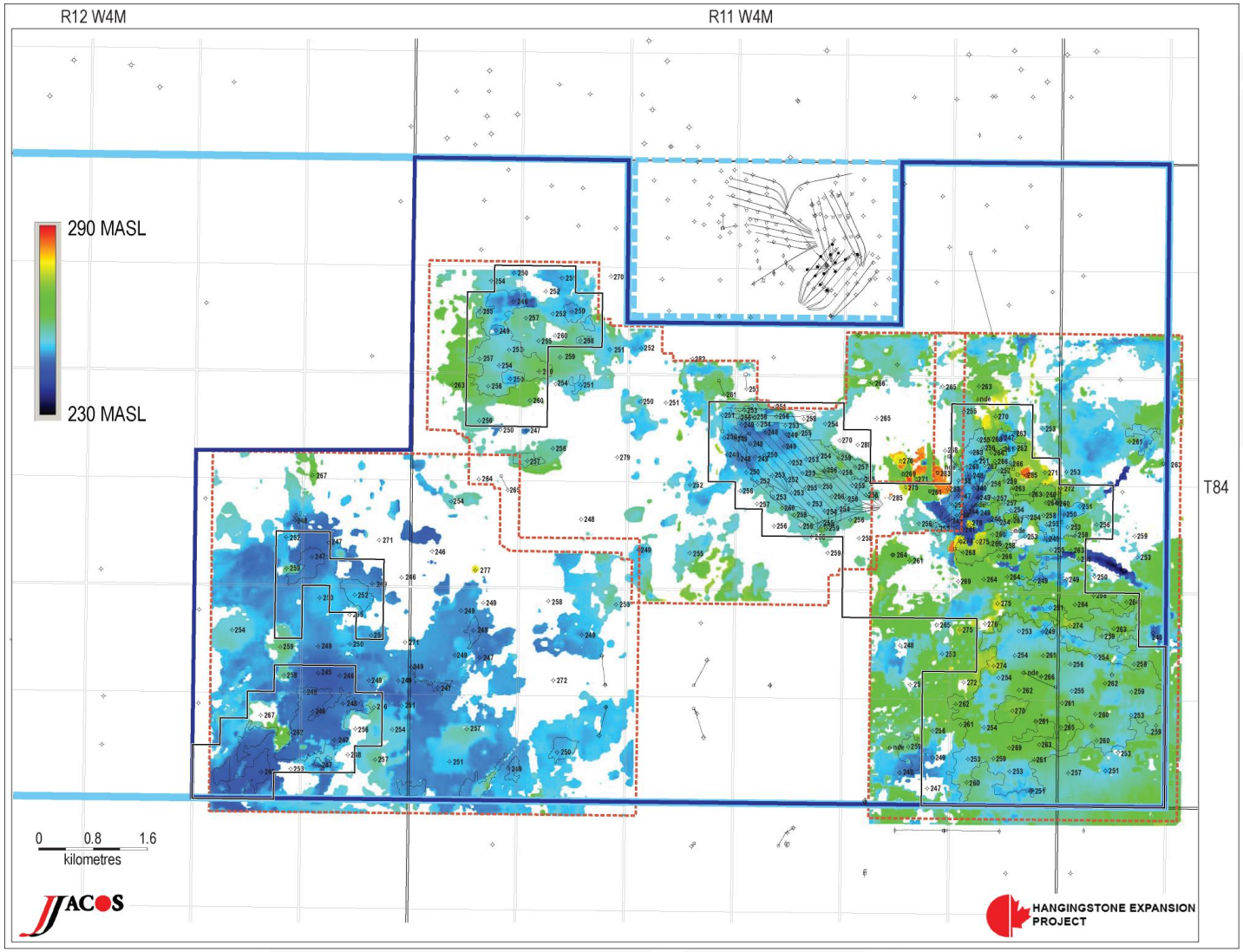
OBIP = RV * Por * So * FVF

where:
RV = Rock Volume
Por = Average Porosity
So = Average Oil Saturation
FVF = Formation Volume Factor (1.001)

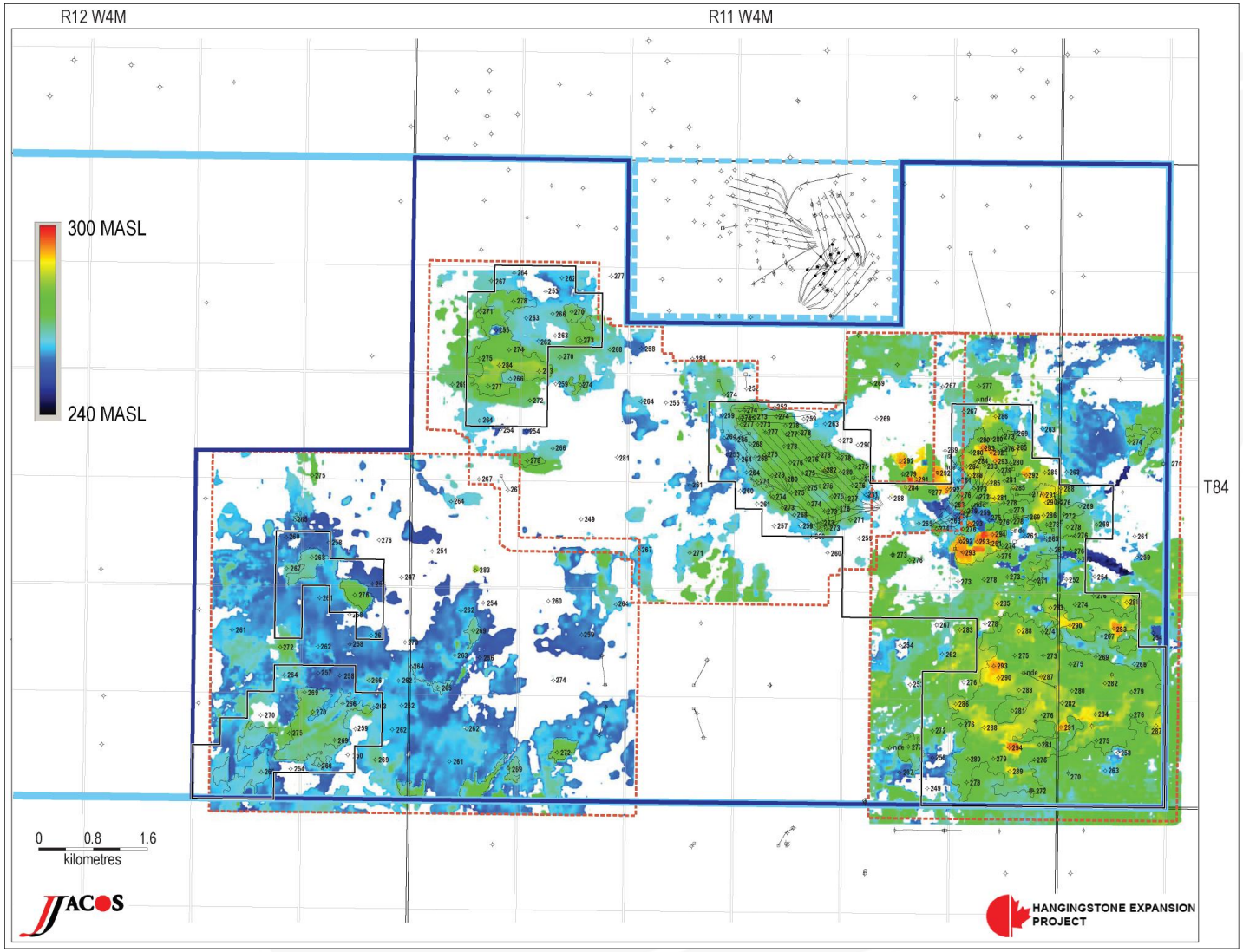
Avg. Kv: 4050 mD
Avg. Kh: 5800 mD
Avg. Depth: 340 m



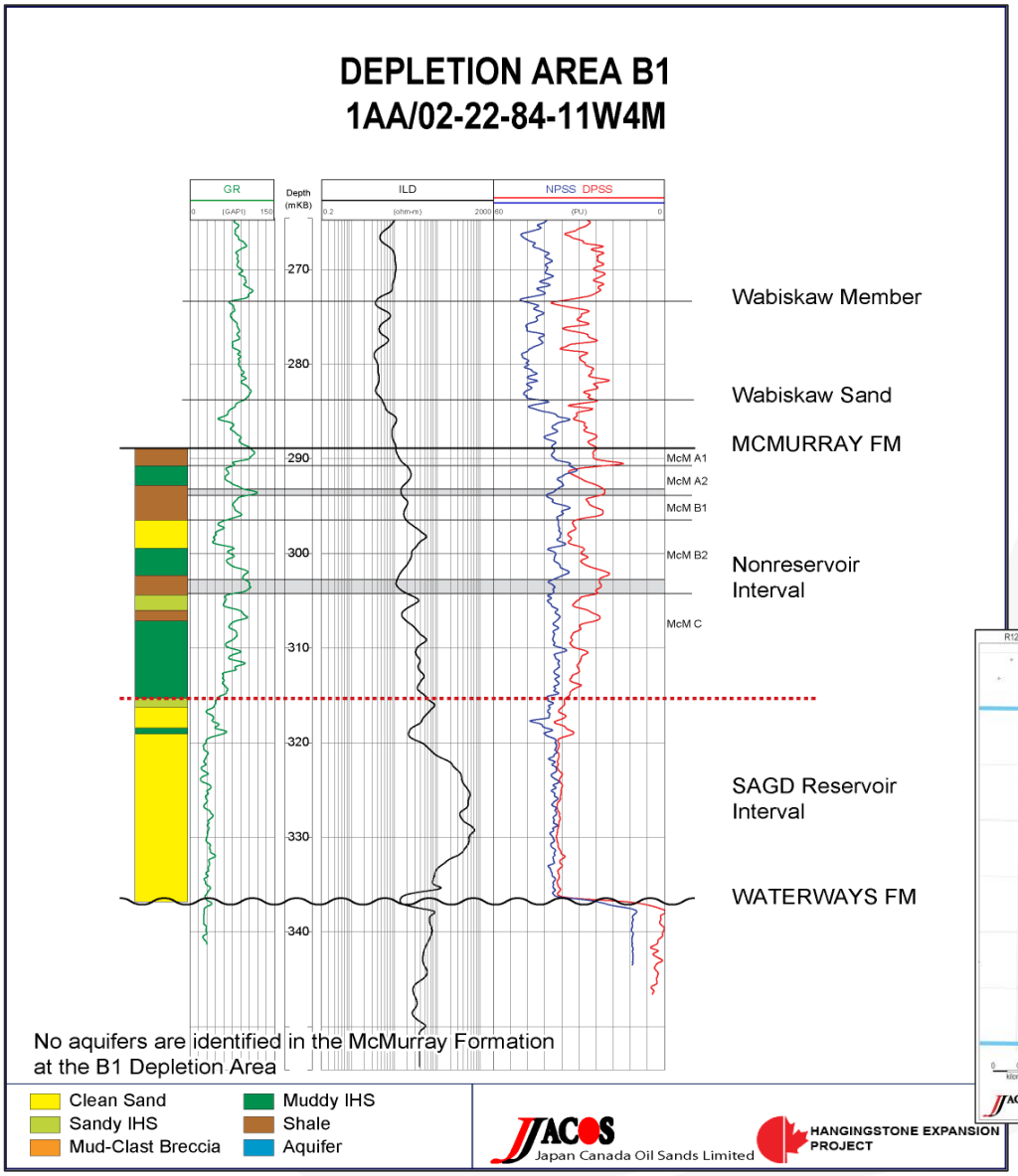
Base Reservoir Structure



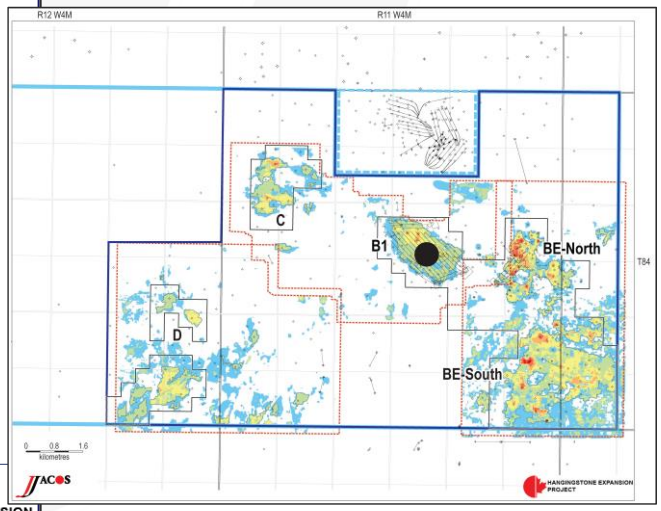
Top Reservoir Structure



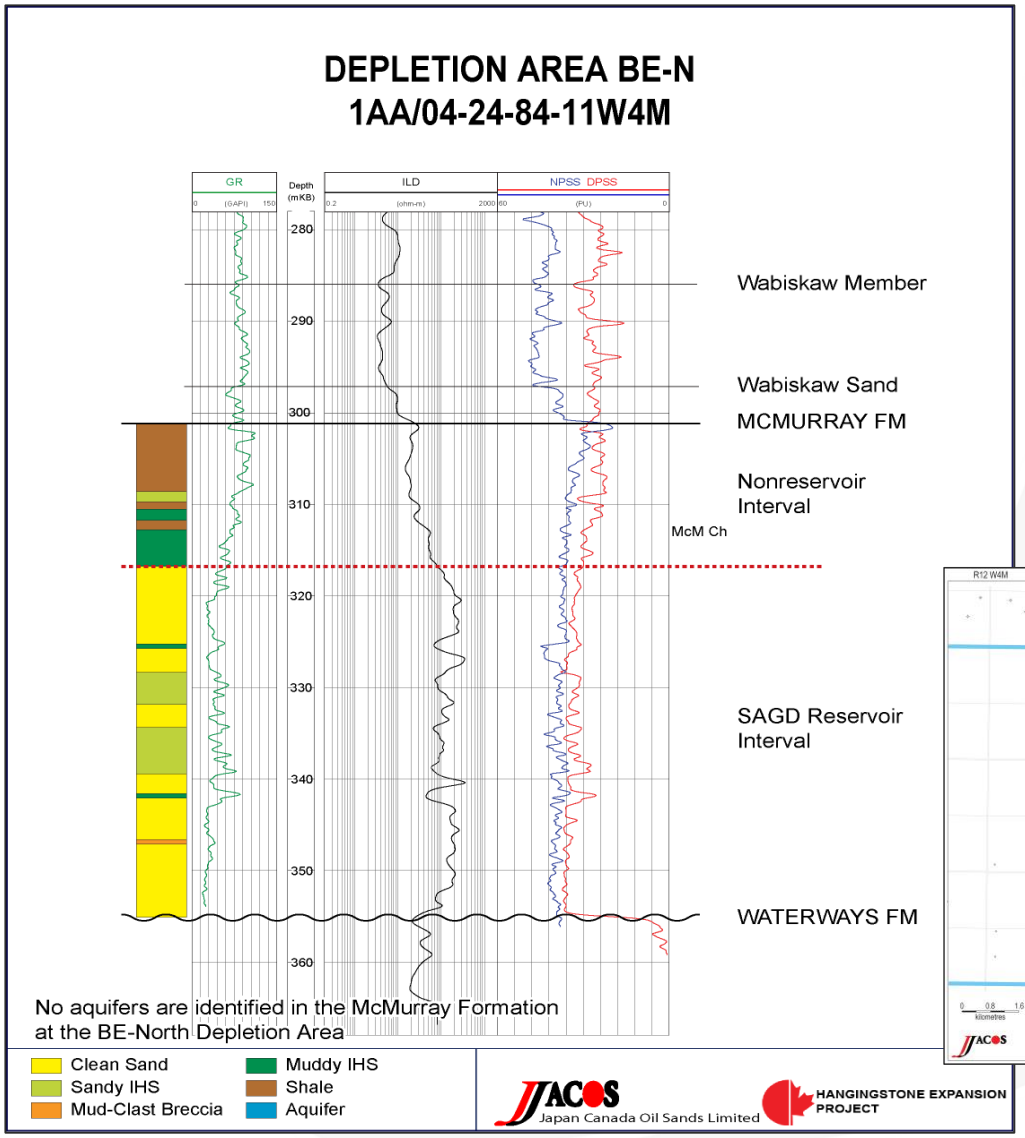
Hangingstone Expansion Composite Well B1 Area



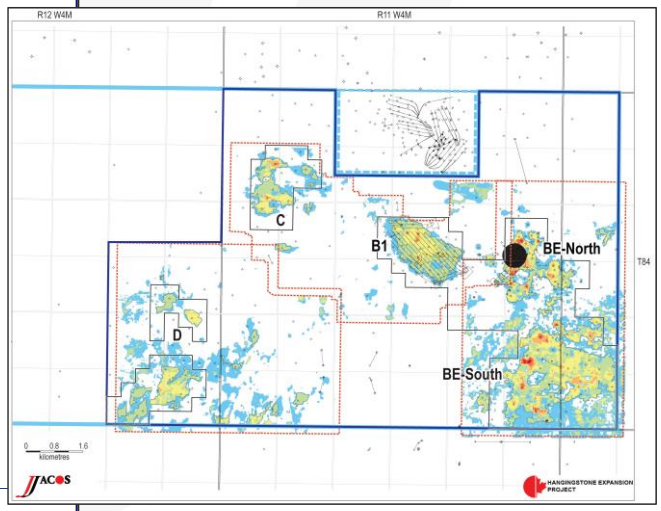
petrographic analysis identified trace chlorite and smectite



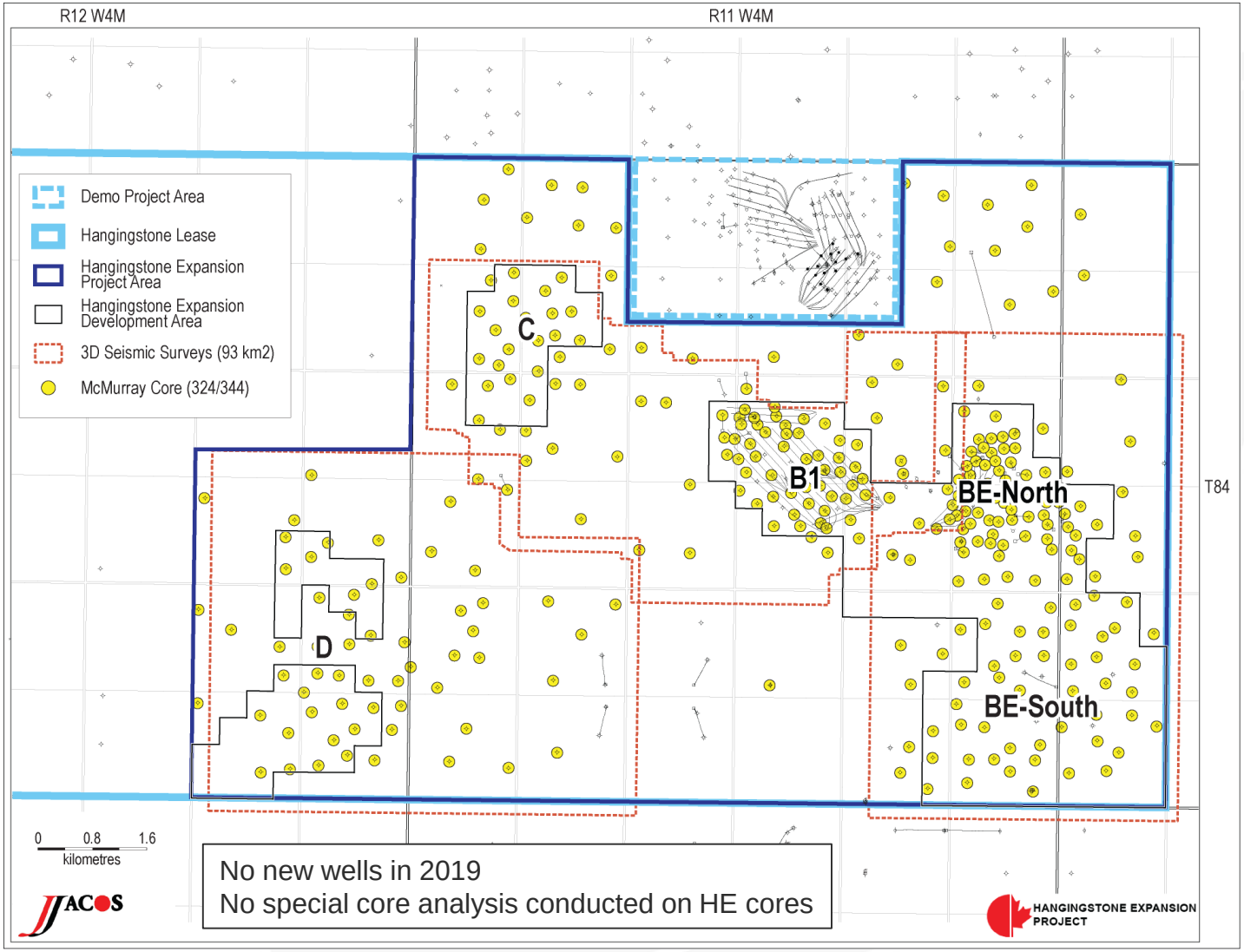
Hangingstone Expansion Composite Well BE-North Area



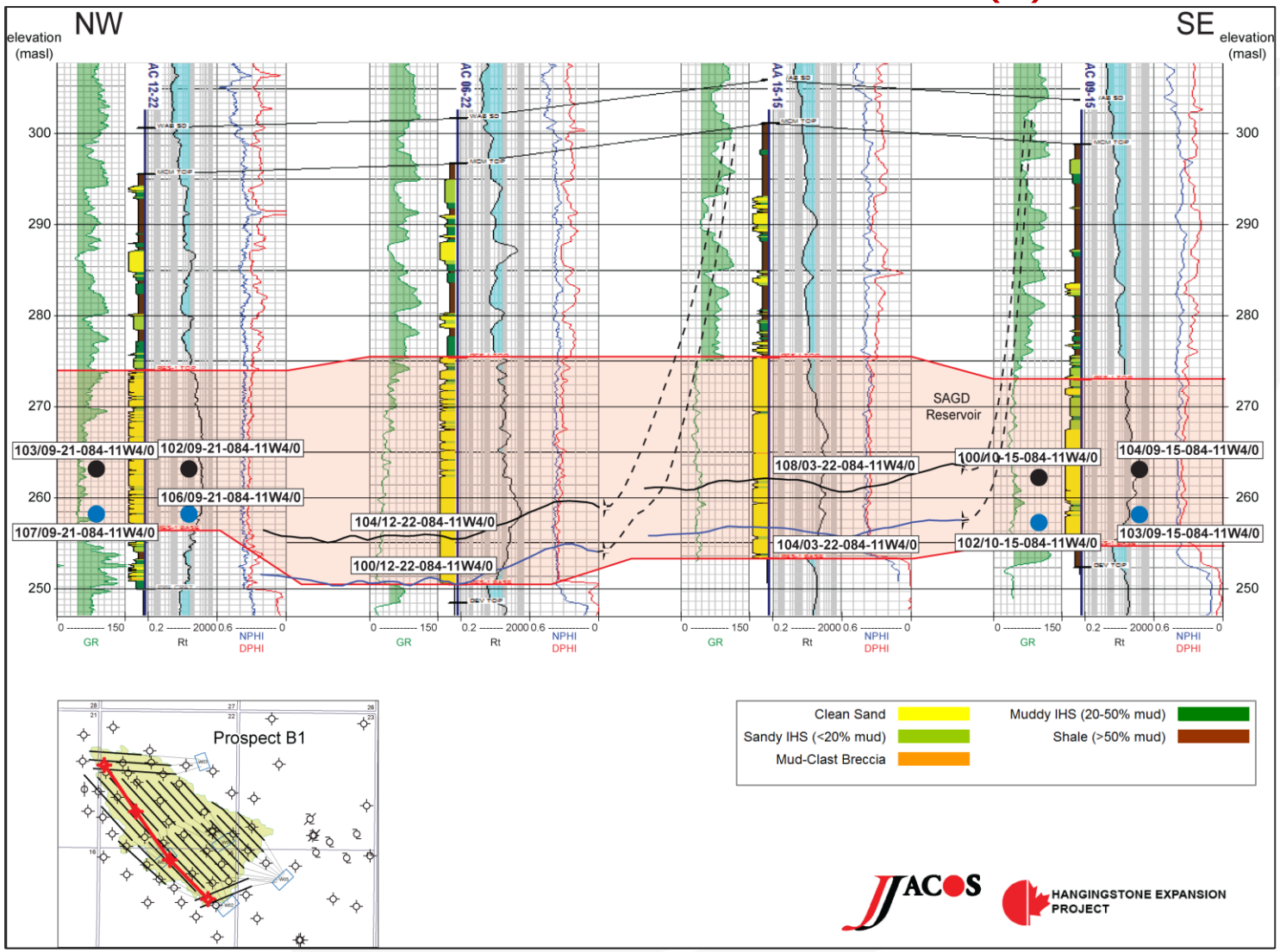
petrographic analysis identified trace chlorite and smectite



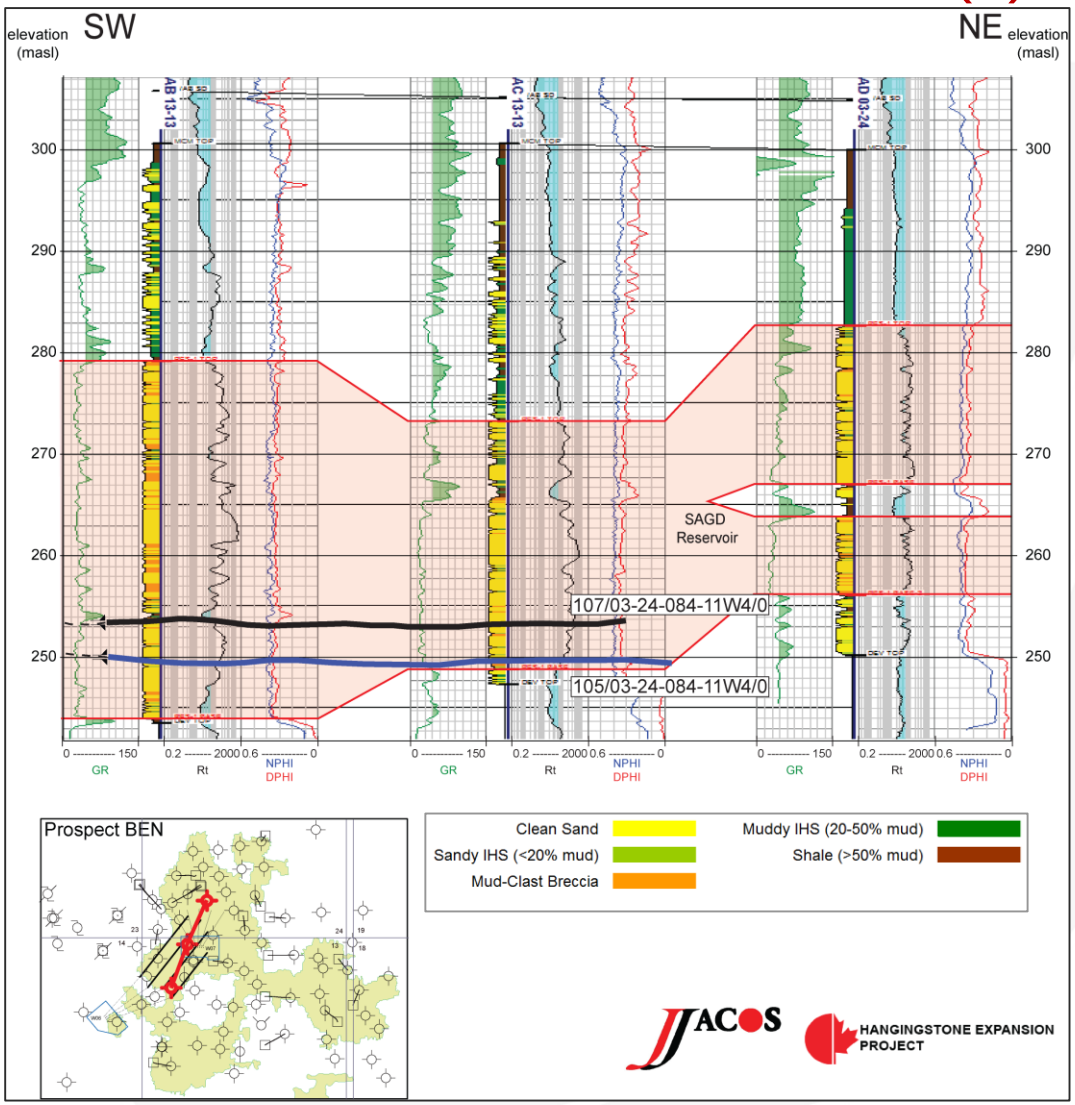
Database


R12 W4M
R11 W4M
Demo Project Area
Hangingstone Lease
Hangingstone Expansion Project Area
Hangingstone Expansion Development Area
3D Seismic Surveys (93 km2)
McMurray Core (324/344)
C
B1
BE-North
BE-South
D
T84
0 0.8 1.6
kilometres
No new wells in 2019
No special core analysis conducted on HE cores
HANGINGSTONE EXPANSION PROJECT

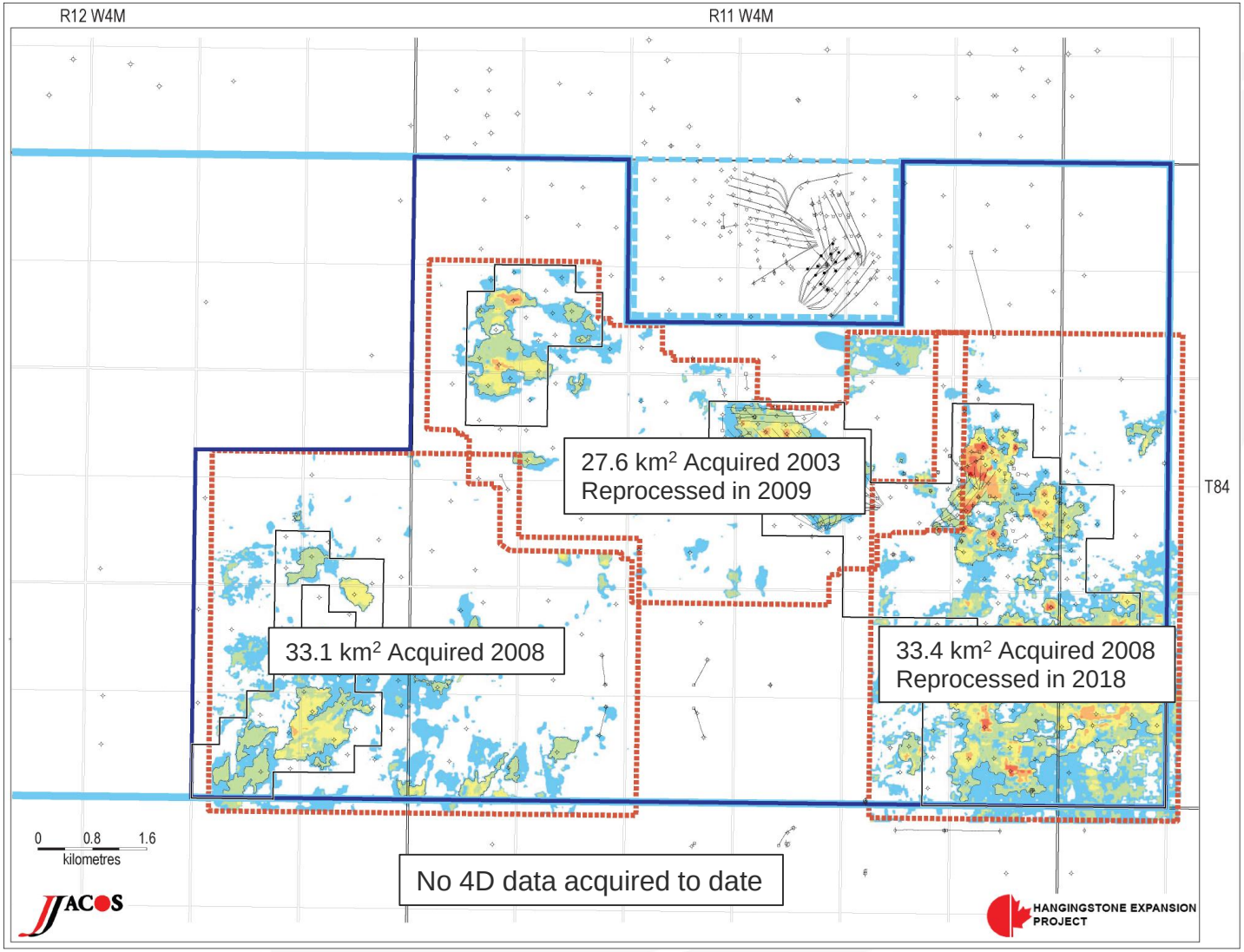
Hangingstone Expansion
Phase 1 Scheme Cross-Section (1)



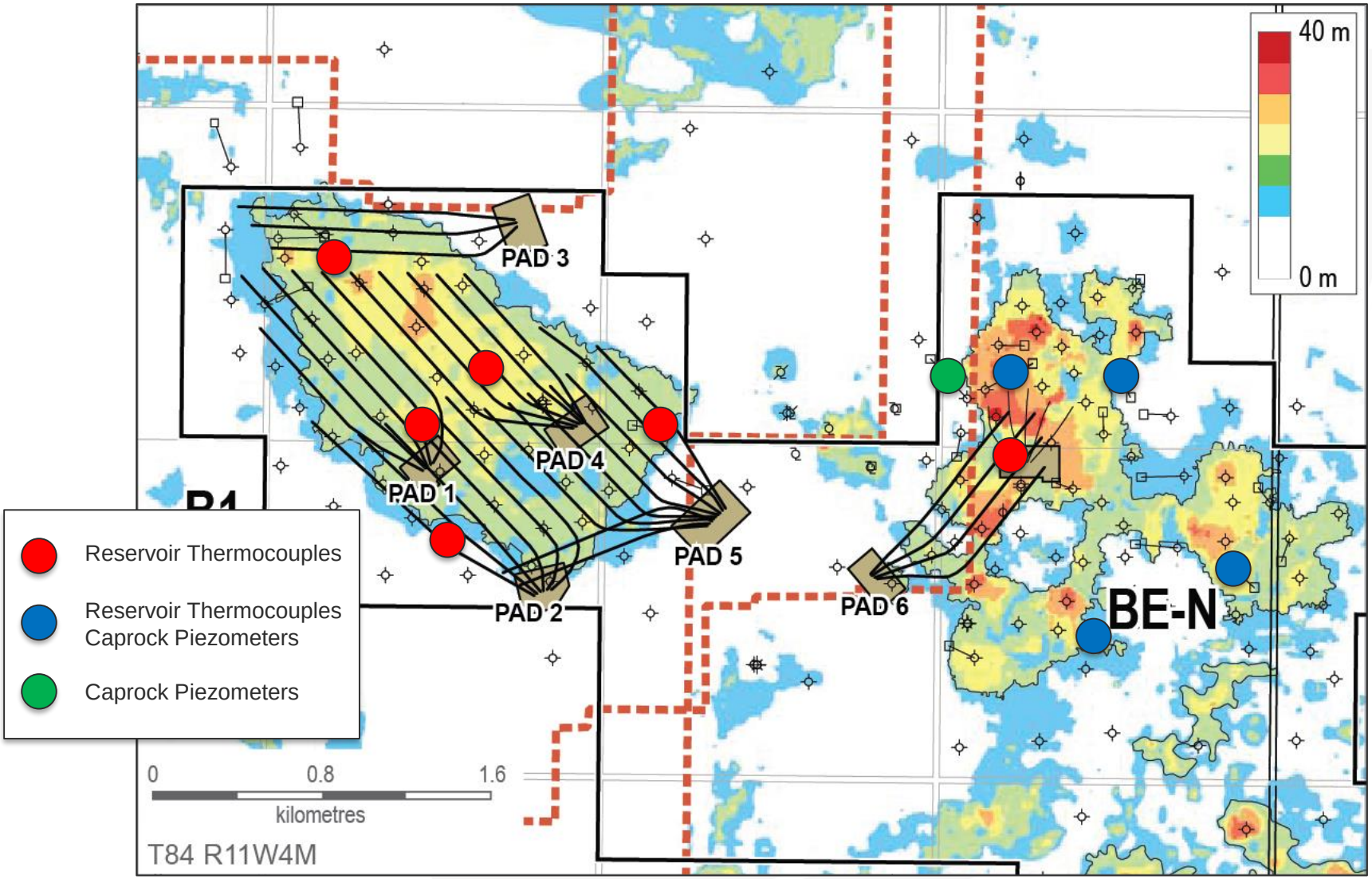
Hangingstone Expansion
Phase 1 Scheme Cross-Section (2)



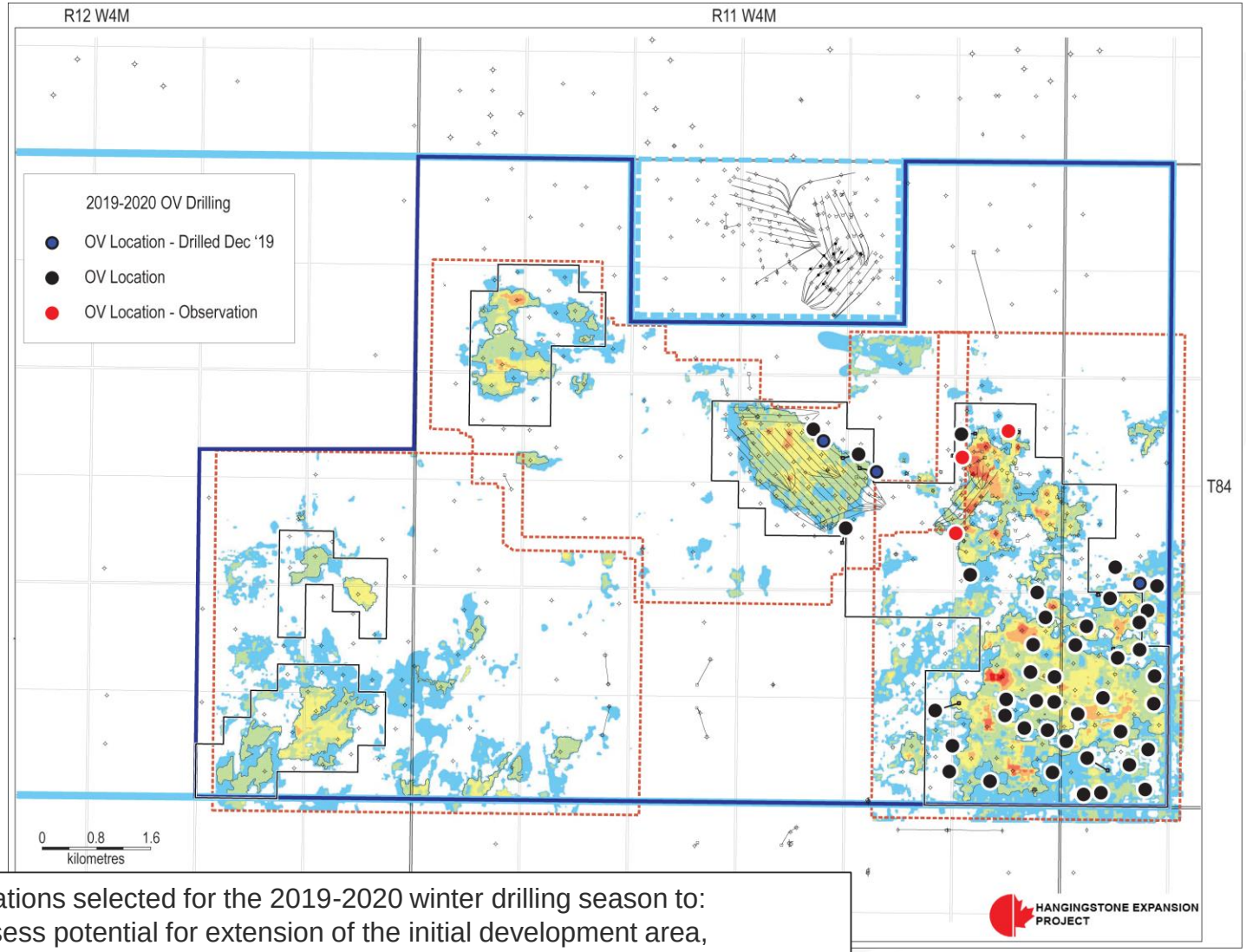
3D Seismic Data



Phase 1


40 m
0 m
PAD 3
PAD 4
PAD 1
PAD 5
PAD 2
PAD 6
BE-N
Reservoir Thermocouples
Reservoir Thermocouples
Caprock Piezometers
Caprock Piezometers
0
0.8
1.6
kilometres
T84 R11W4M

Future Plans
2019-2020 Appraisal Drilling



49 locations selected for the 2019-2020 winter drilling season to:
(1) assess potential for extension of the initial development area,
(2) optimize depletion planning for the first set of sustaining well pads, and
(3) delineate the future SE sustaining development area.

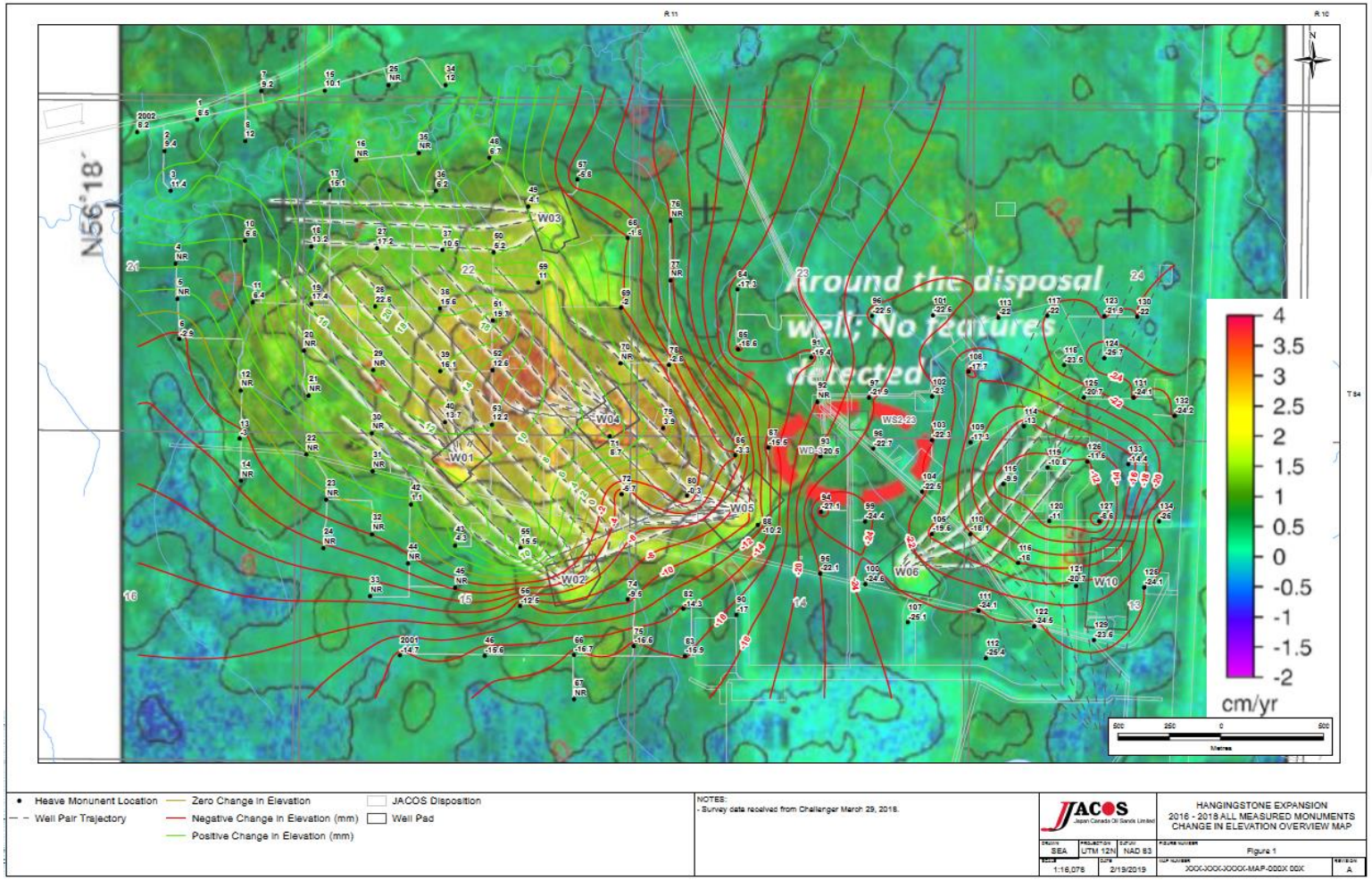
Cap Rock Integrity

- Initial determination of injection pressures was based on mini-frac tests in 1980s
- 2010 Mini-frac test for Hangingstone Expansion (HE) Project Cap Rock Integrity Study shows consistent results
- HE Project Cap Rock Study concluded 5 MPa to be a safe operating pressure (80% of fracture pressure)
- Monitoring of cap rock observation well pressures & temperatures showed no material anomalies in 2019

	Depth (m)	Min. Stress		Vert. Stress		Stress regime
		MPa	kPa/m	MPa	kPa/m	
McM Sands	327.0	5.59	17.09	6.91	21.13	V. frac
McM Shale	314.5	5.55	17.65	6.64	21.11	V. frac
WBSK Shale	297.0	6.17	20.77	6.26	21.08	H. frac
CWTR Shale	272.0	5.39	19.82	5.73	21.07	H. frac (?)

Surface Heave – 2018 Monument Survey vs. InSAR

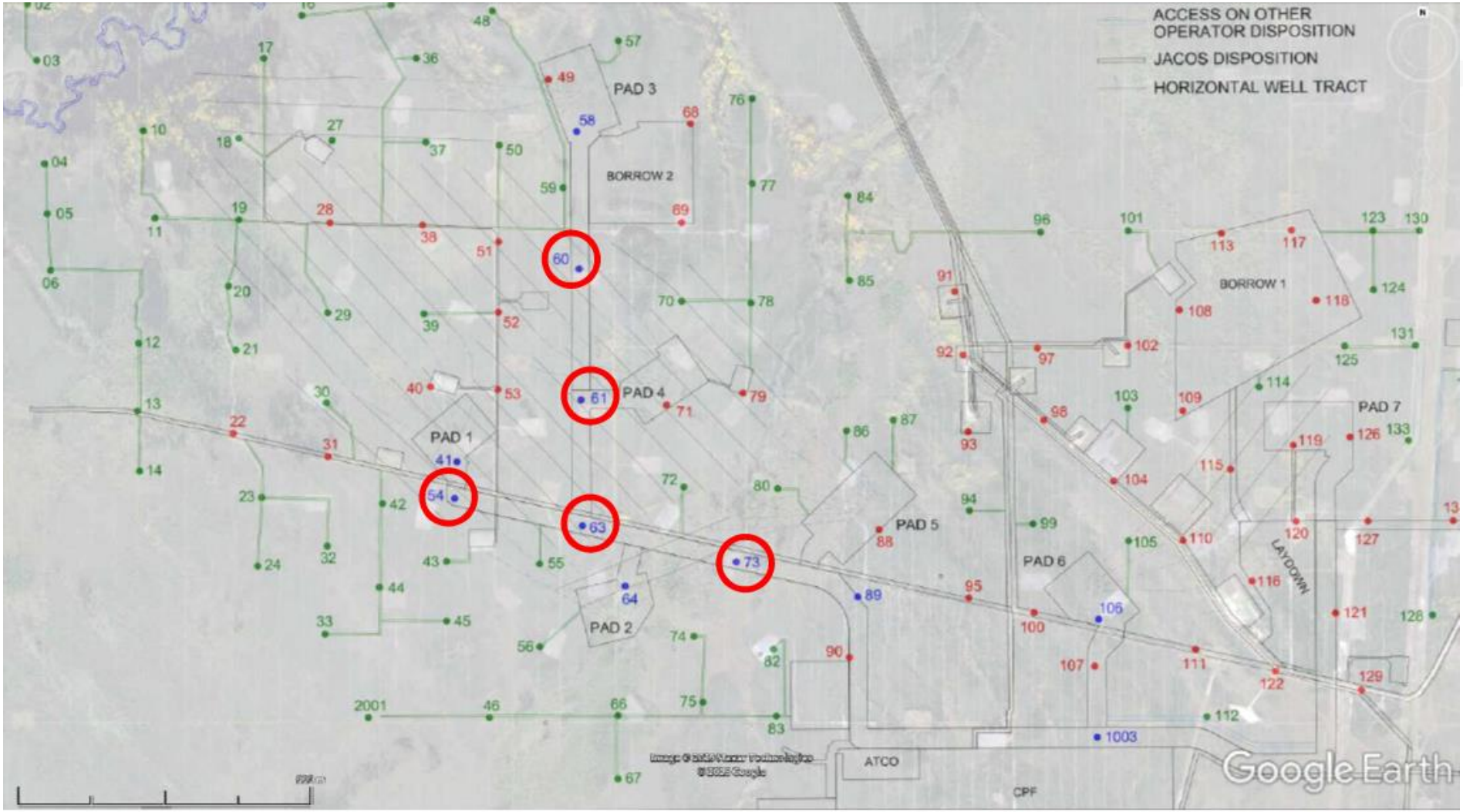
- Subsidence reported in 2018 monument survey has no physical basis and may have been due to defective monuments.
- InSAR data over similar interval did not indicate downward movement in eastern part of development area.
- Several monuments were found damaged in 2019 survey, therefore results were unreliable.



Surface Heave – 2019 Activity Summary

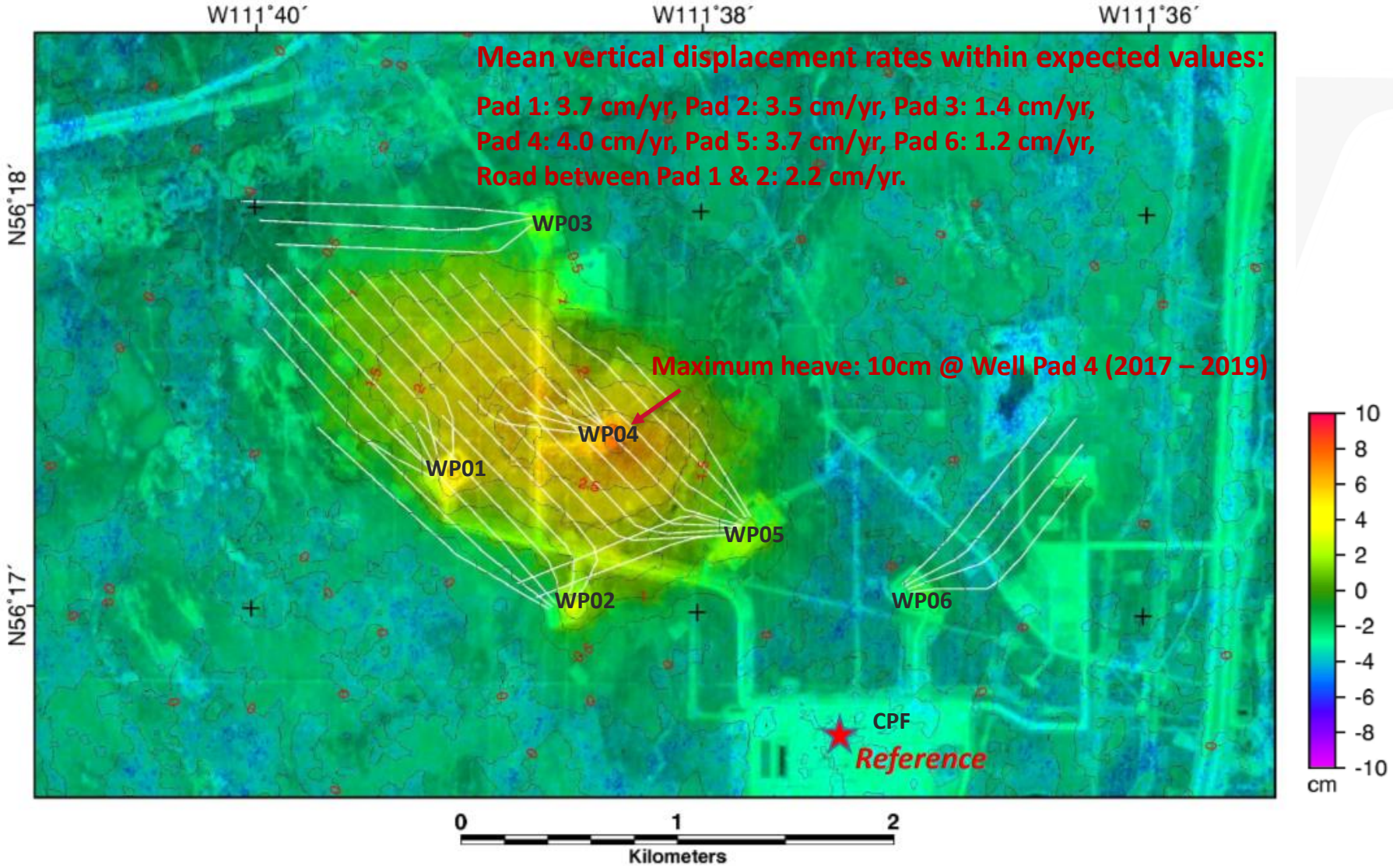
- JACOS continued to develop InSAR as an alternative to monument surveys because of their damage and unreliable results.
- Five corner reflectors (CRs) were installed in Oct 2019 to improve persistent scatterer (artificial structure) density for improved survey reliability.
- CR reflectance was validated and an InSAR survey completed in Nov 2019.
- Vertical displacements measured between Aug 2017 and Nov 2019 align with expected movements and InSAR appears to be a viable alternative heave monitoring method.

Surface Heave – Corner Reflector Installation



CR installed monument

Surface Heave – 2019 InSAR Survey



Vertical Displacement Rate 2017/8/7 – 2019/10/14 Background: Sentinel-2 MSI 2018/5/22

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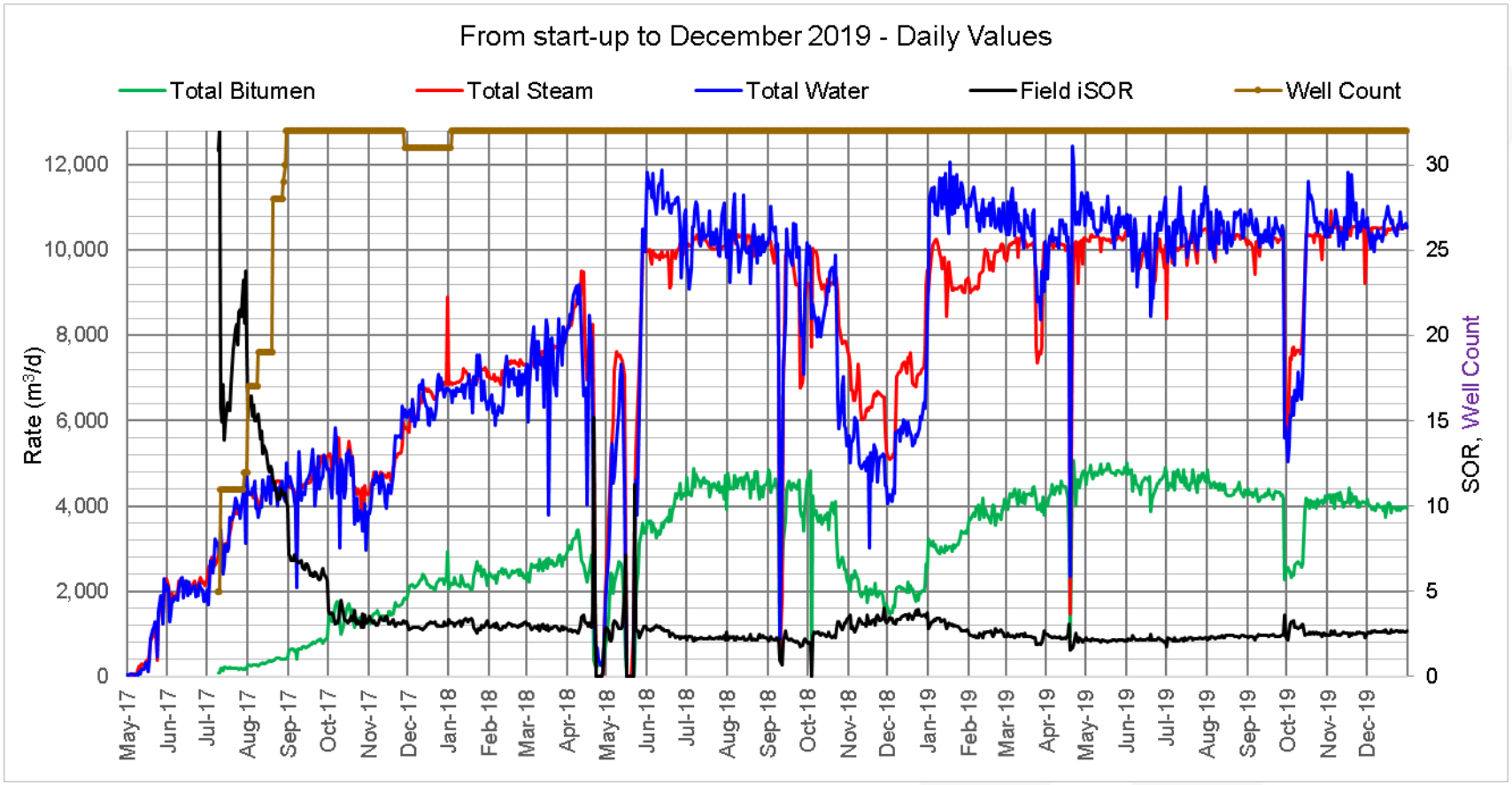
Reservoir

HE Phase 1 Reservoir Performance Summary

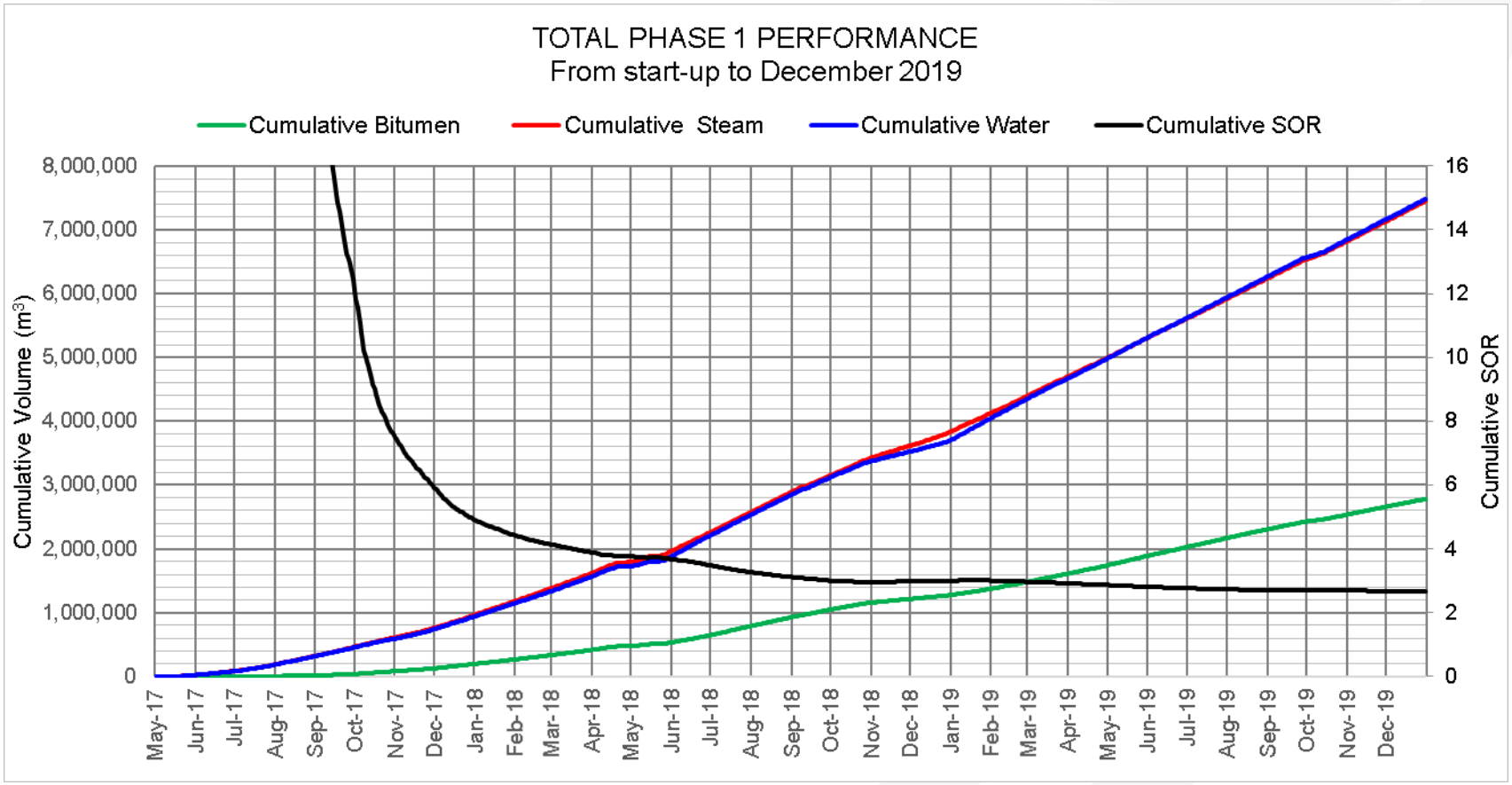
- SAGD mode achieved on all 32 Phase 1 well pairs by April 2018
- Successful ramp-up to monthly peak rate of 28.5 kbpd was achieved in August 2018
  - Secondary monthly peak rate of 30.2 kbpd in May 2019 was influenced by flush production
- 2019 average bitumen rate of 26.0 kbpd (4,130 m^3/day)
- Peak production rate of 31.9 kbpd on April 21, 2019
- Cumulative bitumen produced from project start-up to 12/31/2019 of 17.5 MMbbl (2.8 MMm^3)
- Cumulative SOR on 12/31/2019 = 2.7
- OBIP for the developed area is 98 MMbbl (15.6 MMm^3)
- Recoverable bitumen for Pads 1-6 is estimated at 60 MMbbl (9.5 MMm^3) and 61% Ultimate Recovery

HE Phase 1 Field Performance



- Ramping production back up after rate reductions taken in response to poor market conditions in late 2018
- Rate reduction during Oct 2019 for plant turn-around activities

HE Phase 1 Cumulative Volumes



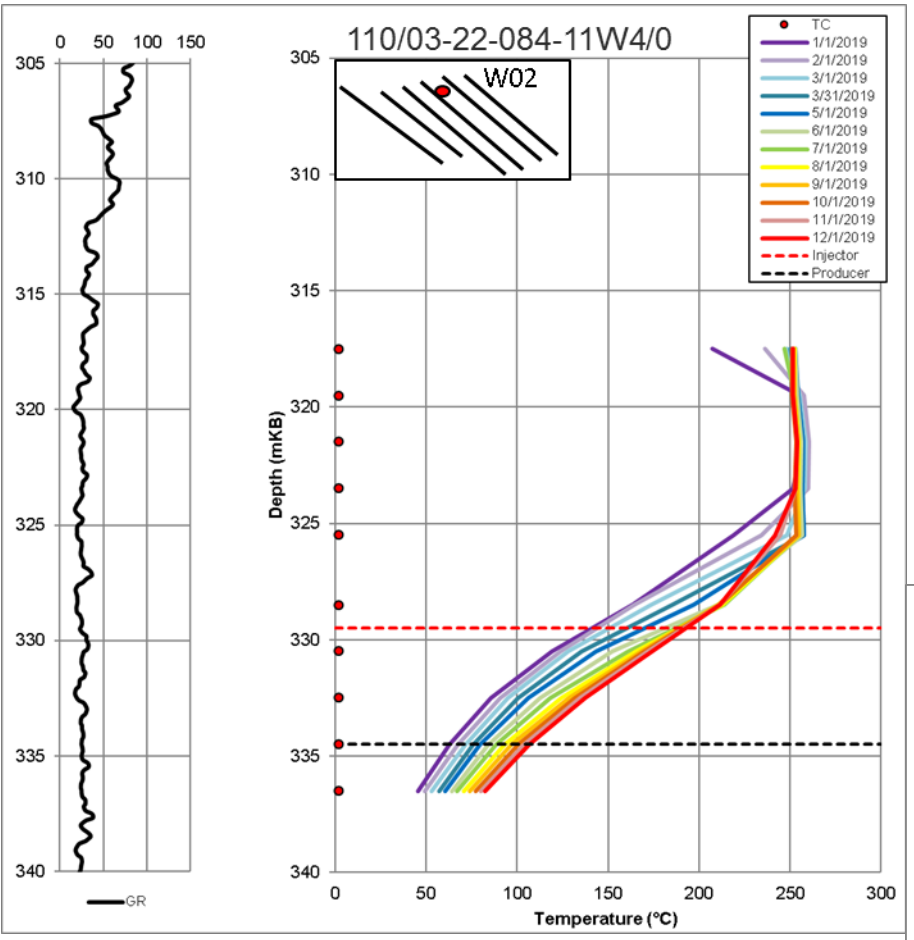
Injection Wellhead Pressures and Temperature

Well	Average 2019 Injection Pressure (kPa)	Average 2019 Injection temperature (°C)
W01-01	4,234	255
W01-02	4,222	255
W01-03	4,190	254
W01-04	4,260	255
W01-05	4,260	255
W02-01	4,214	253
W02-02	4,302	254
W02-03	4,309	255
W02-04	4,234	254
W02-05	4,302	254
W02-06	4,209	252
W03-01	4,251	255
W03-02	4,196	254
W03-03	4,074	241
W04-01	4,406	258
W04-02	4,313	256
W04-03	4,344	257
W04-04	4,304	256
W04-05	4,396	257
W05-01	4,355	257
W05-02	4,272	255
W05-03	4,334	256
W05-04	4,277	256
W05-05	4,312	256
W05-06	4,332	256
W05-07	4,310	255
W05-08	4,322	256
W05-09	4,285	256
W06-01	3,827	249
W06-02	3,733	248
W06-03	3,779	246
W06-04	3,788	248

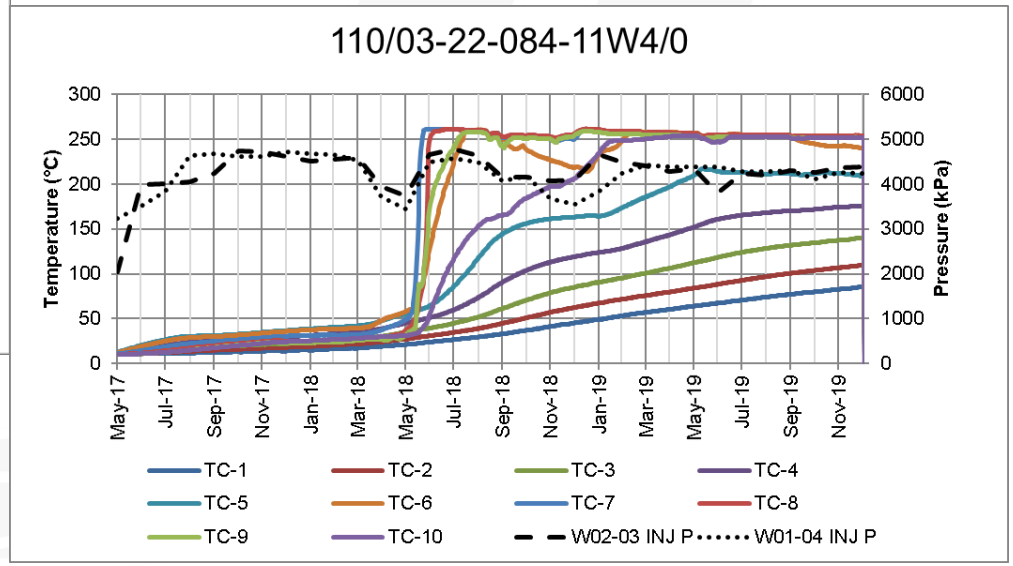
Assumption is 100% steam quality at the well head.

All well pads have steam traps at the inlet.

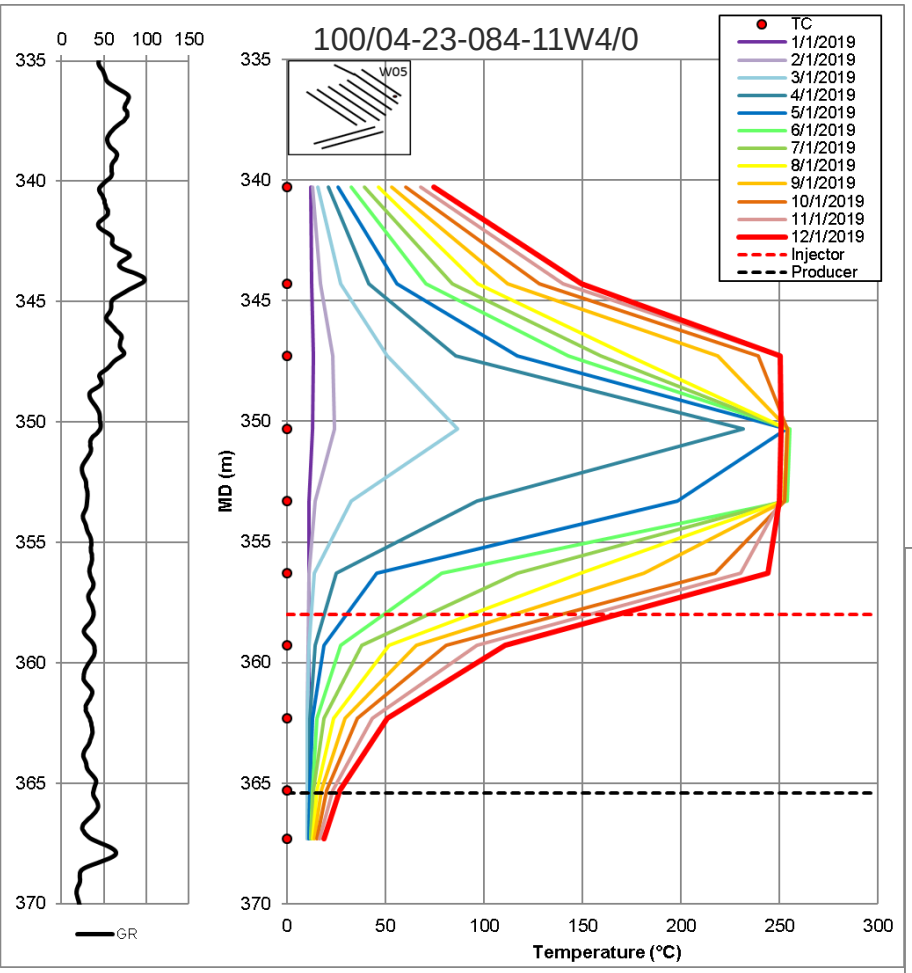
Steam Chamber - Observation Well (1)



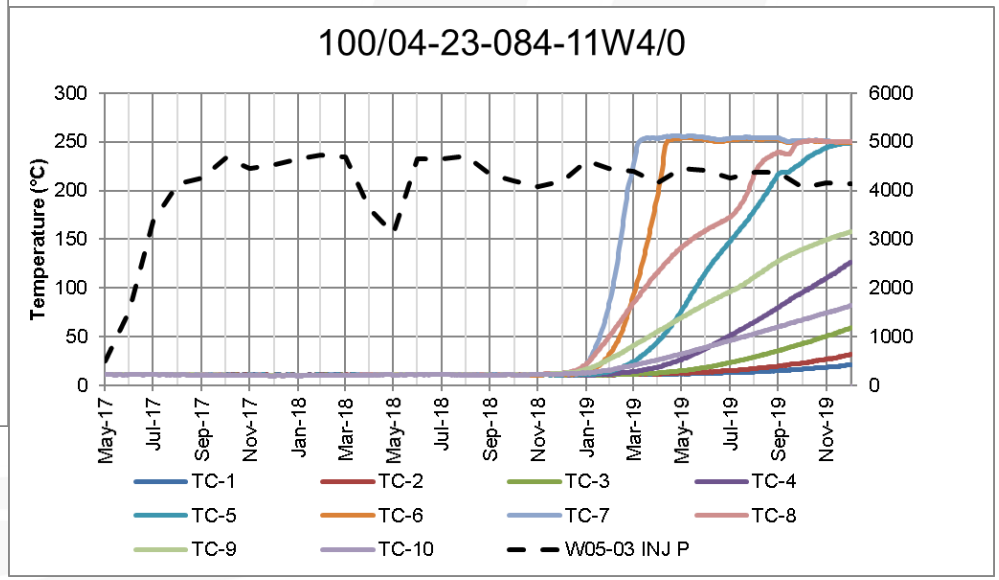
- As of December 31, two (2) observation wells out of six (6) are showing steam temperatures, indicating steam chamber development. The others do show some heating.
- This well is located 4.2 m away from the build section of well pair W01-04 and 18 m NE of the W02-03 well pair horizontal section.
- Temperature profile is shown to change as the injection pressures of W02-03 and W01-04 reduce in June 2019
- Cooling of temperature seen at bottom of steam chamber indicating fluid level buildup



Steam Chamber - Observation Well (2)



- As of December 31, two (2) observation wells out of six (6) are showing steam temperatures, indicating steam chamber development. The others do show some heating.
- This well is located 35m NE of the W05-08 well pair horizontal section.
- Temperature profile shows steam chamber starting to grow at this well from May 2019
- Temperature profile is shown to change as the injection pressures of W05-08 reduce after Sept 2019



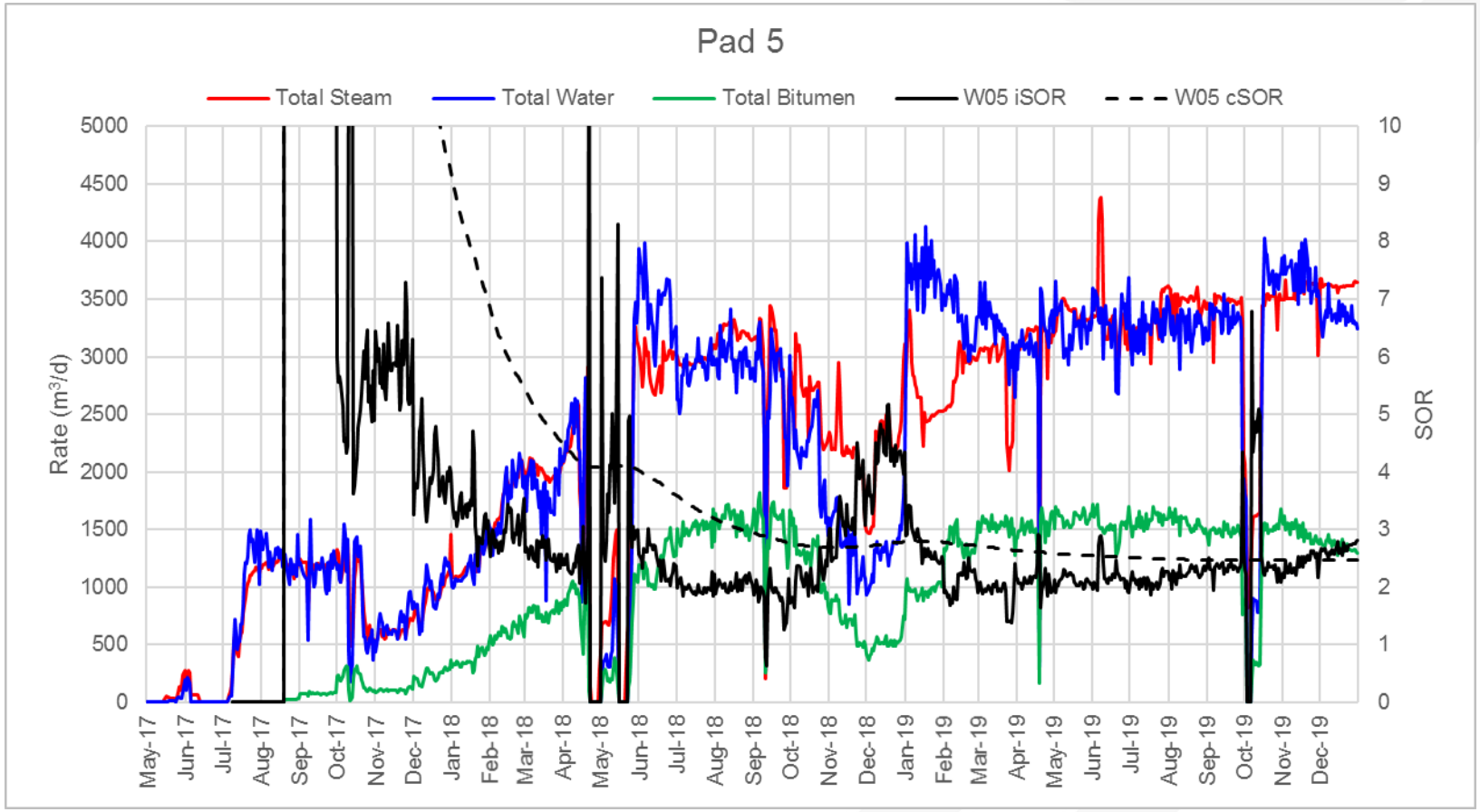
HE Phase I - 2019 Well Pad Recovery

Pad	Well	OBIP (MMm^3)	Cum Bitumen (Mm3)	Ultimate Recovery (%)	Current Recovery (%)
Pad 1	W01-01 W01-02 W01-03 W01-04 W01-05	2.62	555.6	61.3	21.2
Pad 2	W02-01 W02-02 W02-03 W02-04 W02-05 W02-06	3.14	521.8	61.4	16.6
Pad 3	W03-01 W03-02 W03-03	1.49	83.3	58.7	5.6
Pad 4	W04-01 W04-02 W04-03 W04-04 W04-05	2.72	516.8	62.8	19.0
Pad 5	W05-01 W05-02 W05-03 W05-04 W05-05 W05-06 W05-07 W05-08 W05-09	3.53	863.8	59.4	24.5
Pad 6	W06-01 W06-02 W06-03 W06-04	2.11	245.0	64.1	11.6
Total		15.6	2,786	61.3	17.9

PAD Performance – HIGH – Pad 5

- Two of nine well pairs have been on SAGD mode since 2017, seven of nine well pairs began SAGD mode in 2018
- cSOR: 2.5
- 2019 Average SOR: 2.3
- Average bitumen rate per well of 980 bpd (156 m^3/d)
- Six of the nine well pairs have better reservoir quality, with the three outer wells being more heterogenous toward the reservoir edge
- Pad 5 has the highest current recovery in HE at 24.5%
- Multiple wells have shown pressure communication with each other in 2019

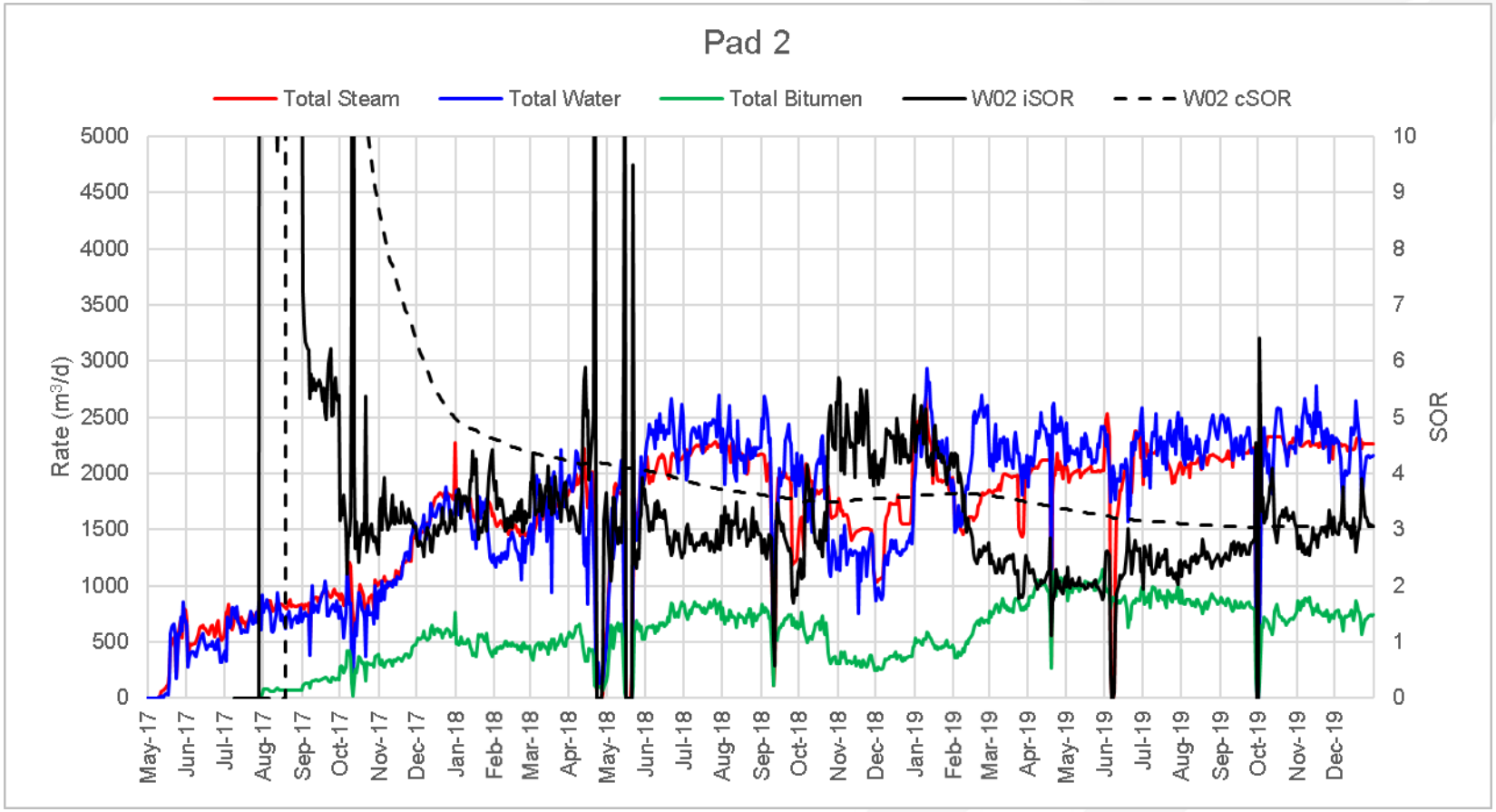
HIGH Performer Example – Pad 5



PAD Performance – MEDIUM – Pad 2

- Five of six well pairs have been on SAGD mode since 2017, one of six well pairs began SAGD mode in 2018
- cSOR: 3.1
- 2019 Average SOR: 2.7
- Average bitumen rate per well of 820 bpd (131 m^3/d)
- Three of the five well pairs have better reservoir quality, with the two outer wells being more heterogenous toward the reservoir edge
- Three of the wells with better reservoir quality have shown pressure communication

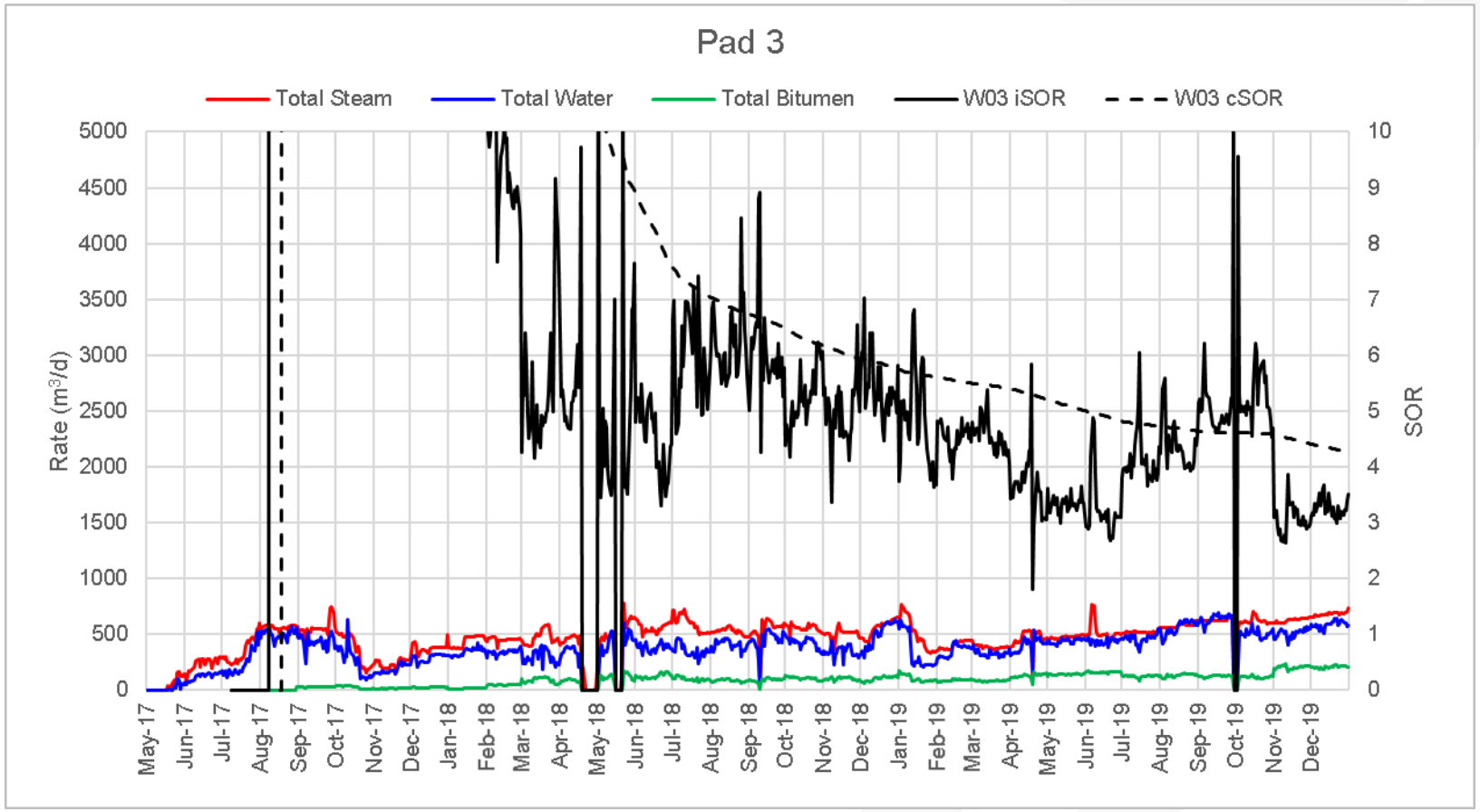
MEDIUM Performer Example – Pad 2



PAD Performance – LOW – Pad 3

- Three of three well pairs began SAGD mode in 2018
- cSOR: 4.3
- 2019 Average SOR: 4.1
- Average bitumen rate per well of 280 bpd (45 m^3/d)
- Due to heterogeneity encountered along the producer's wellbore, these well pairs have performed poorly and show limited temperature conformance along the horizontal section
- Based on well fluid and pressure balances, it is expected that steam chambers are not in communication

LOW Performer Example – Pad 3



Summary of Key Learnings 2019

- HE production was considerably above expectations creating a steam shortage situation, so pressures on some pads were intentionally dropped to test lower pressure operations
  - Established that a bottom hole pressure of 3700 kPa or more is needed to maintain natural lift
- High production rate achieved in May 2019 was influenced by flush production after ramping back up from reduced production period late in 2018
- Water cut fluctuations were observed from the increased fluid levels after reduced production periods and turn-arounds
- Operating at pressures above 3500 kPa, coupled with higher than forecasted production rates, has driven SO_2 emissions above the expected 2 tonne/d
- Field SOR reached a minimum in 2019 and is now starting to increase

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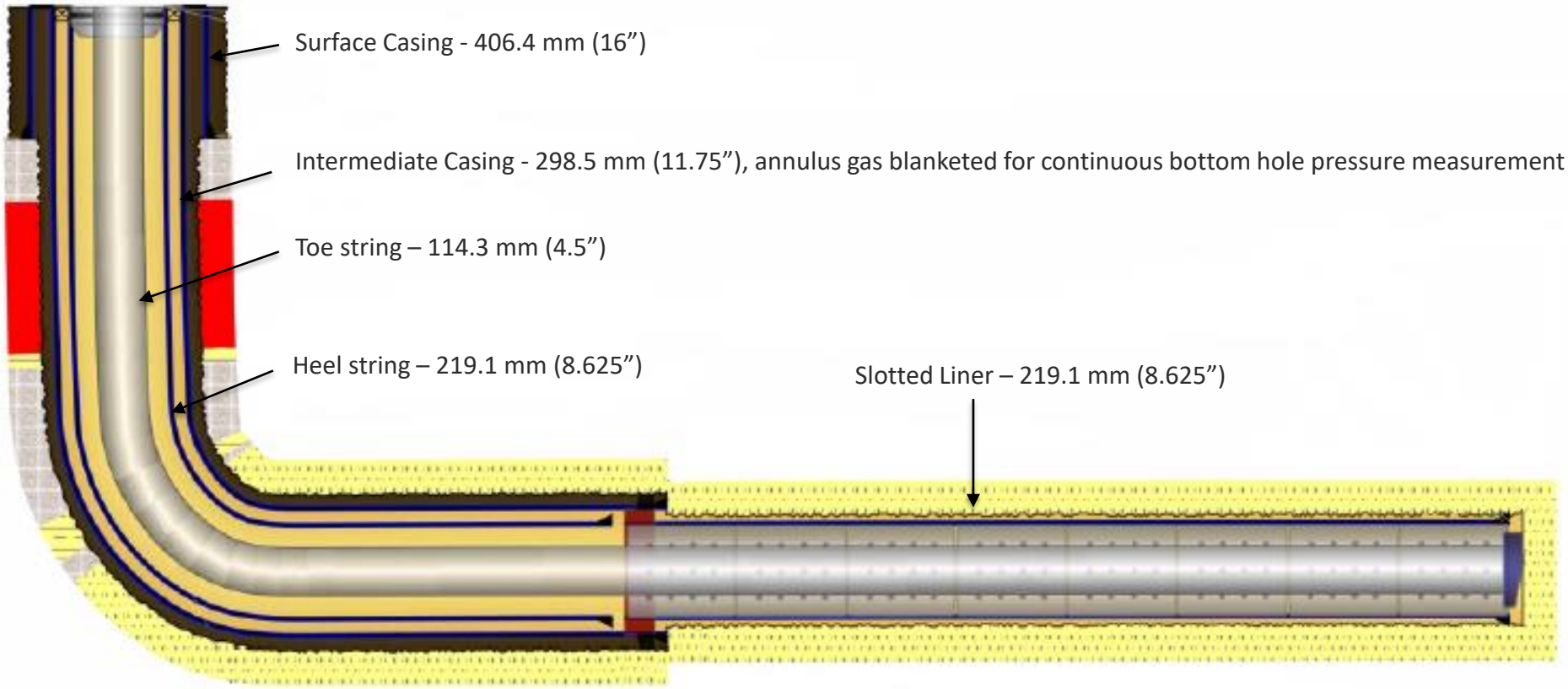
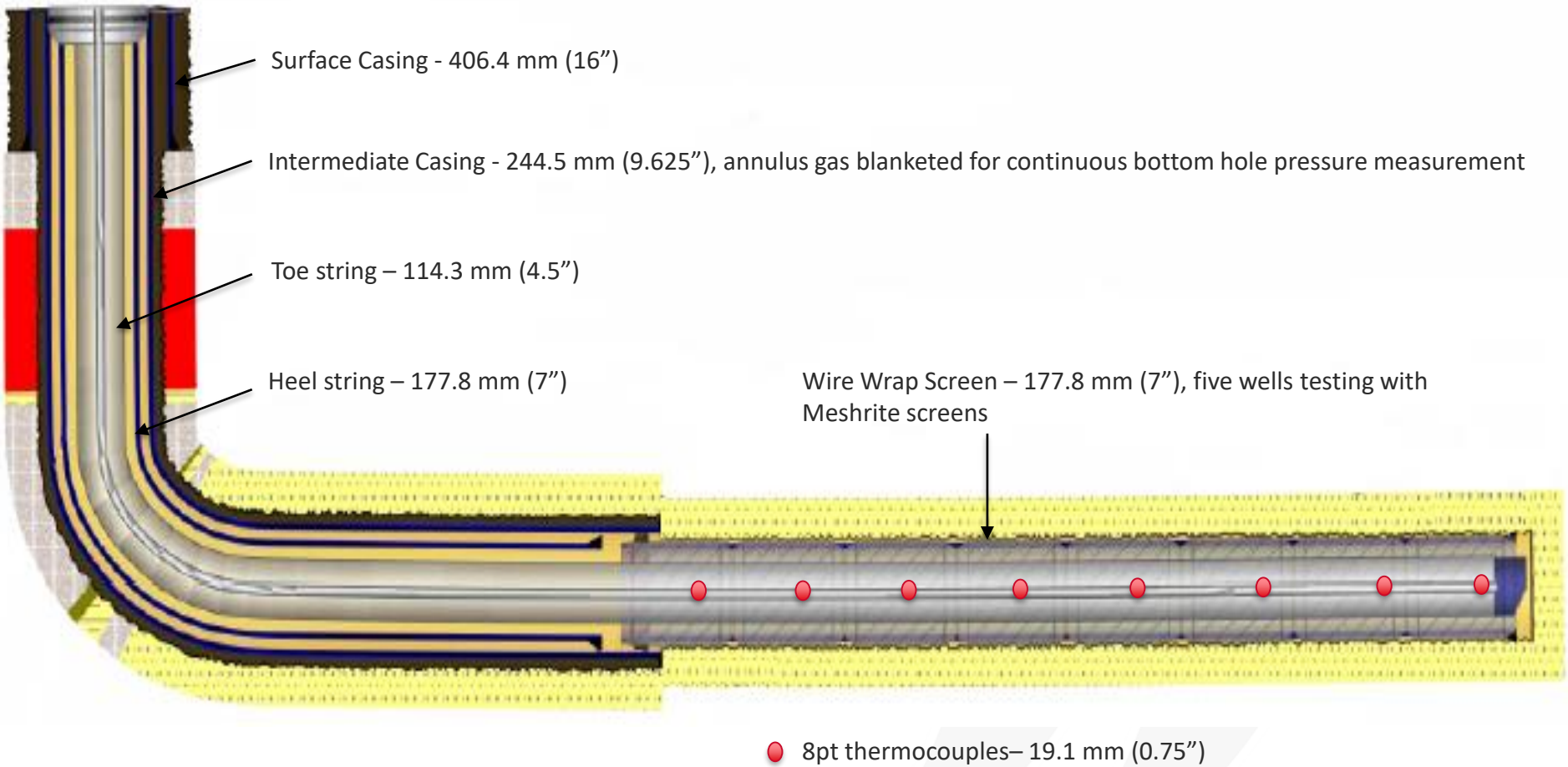
Well Design and Instrumentation

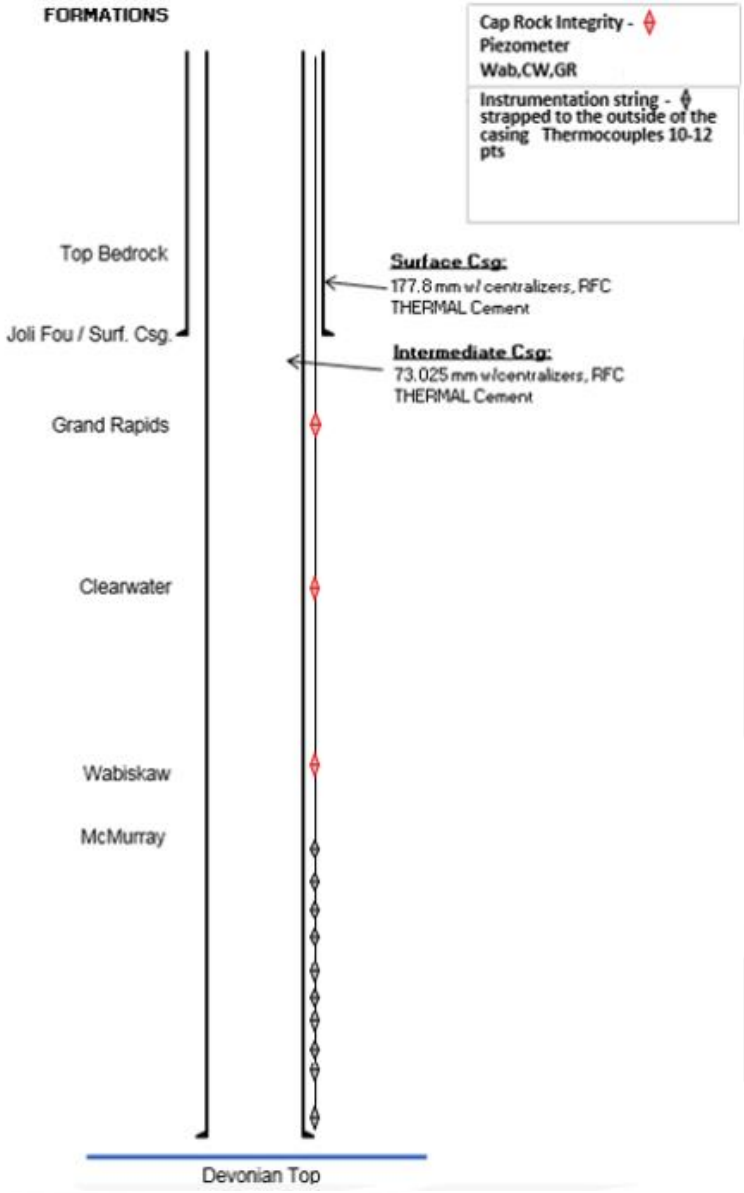
Typical HE SAGD Injector Well Schematic



Typical HE SAGD Producer Well Schematic



HE Observation Well Completion



SAGD Well Completions

- Hangingstone Expansion design – Slotted 8-5/8” liner on all injectors / Wire wrap 7” screens on producer wells with the exception of five producer wells with MeshRite screens (W01P01, W02P01, W02P06, W05P04, W06P03)
  - Excellent sand control from all producers
  - Low pressure differential drawdowns between injector and producer wells
- All 32 SAGD well pairs running, no well failures
- SCVF cold testing during planned outages (plant turnarounds), monitoring ongoing
- Three injector wells (W03I03, W06I02, W06I03) installed with two shiftable outflow devices per well
- Two producer wells (W05P05, W05P07) installed with shiftable inflow devices, two devices per well

Instrumentation

- SAGD steam injector
  - Blanket gas for pressure measurement on all wells
- SAGD producer
  - 8pt thermocouple string installed on all producer wells (32), inside 114.3 mm tubing toe string
  - DTS Fiber testing, strapped to outside 4.5” production tubing on three producers: W06P02/03 showing good results versus 8pt thermocouple (less temperature masking), W06P01 premature failure due to instrument cap line integrity (produce fluid ingress)
  - Blanket gas for pressure measurement on all wells
- Observations Wells
  - 10-12pt thermocouple strapped to outside 73-89 mm tubing
  - Caprock integrity- Piezometers monitoring Wab, CW, GR formations
  - Hanging piezometer design on one well, OV2R (04-24)

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Surface Operations

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Facility Design

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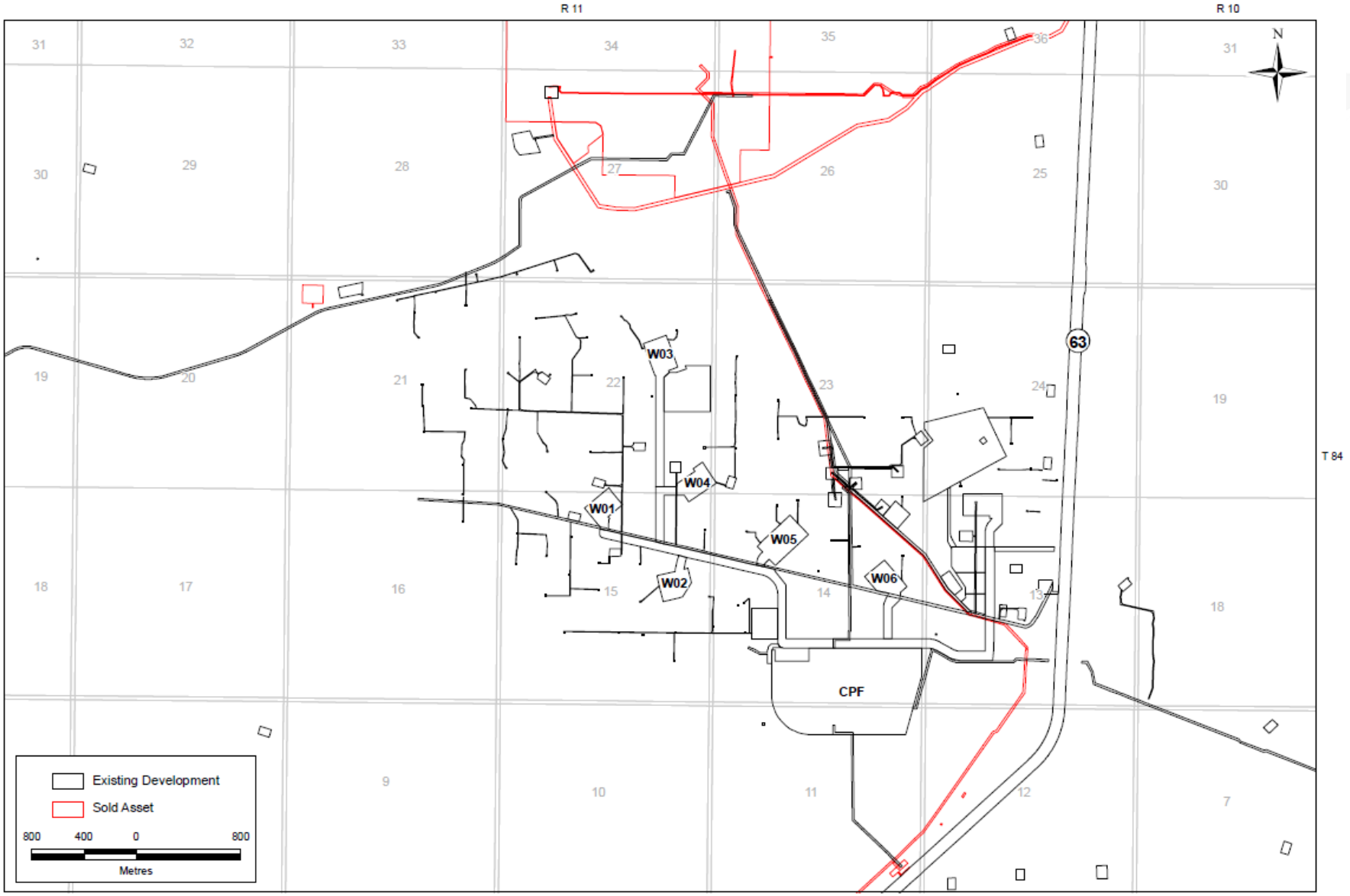
Site Plan



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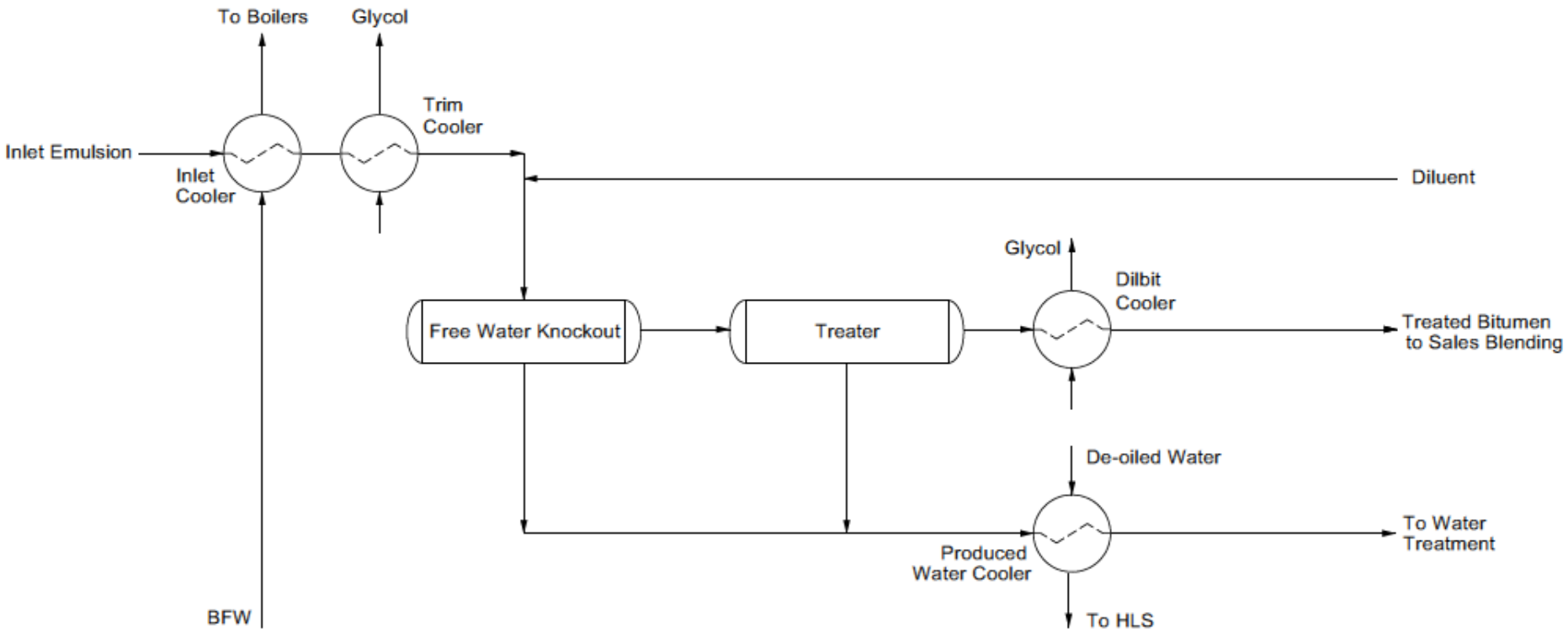
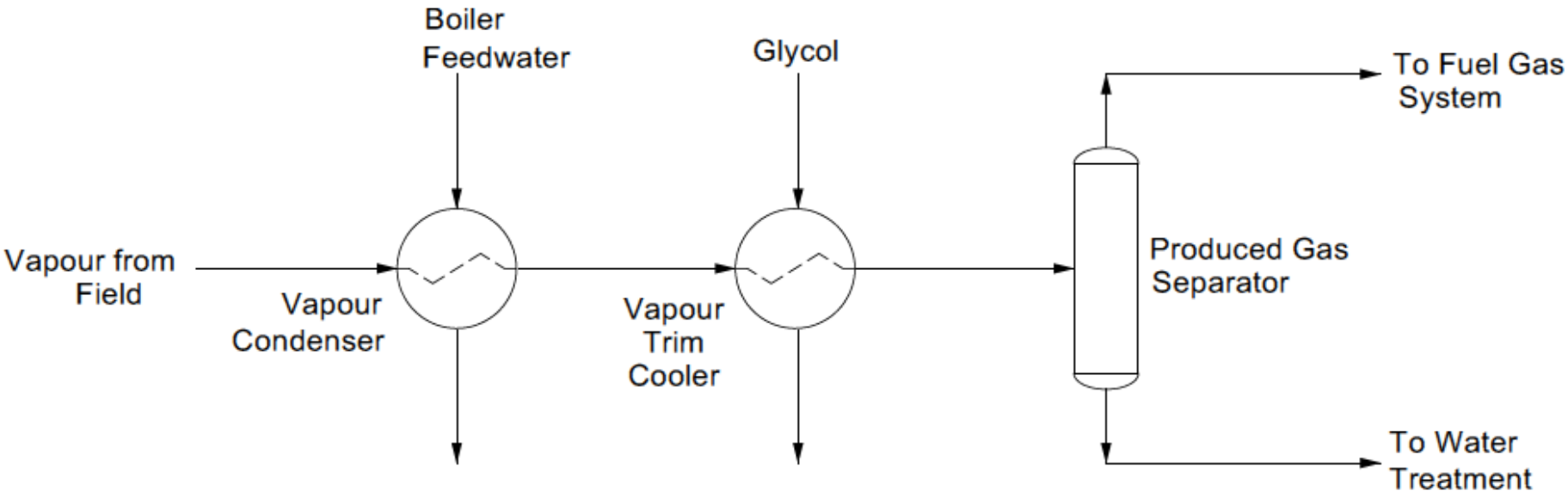
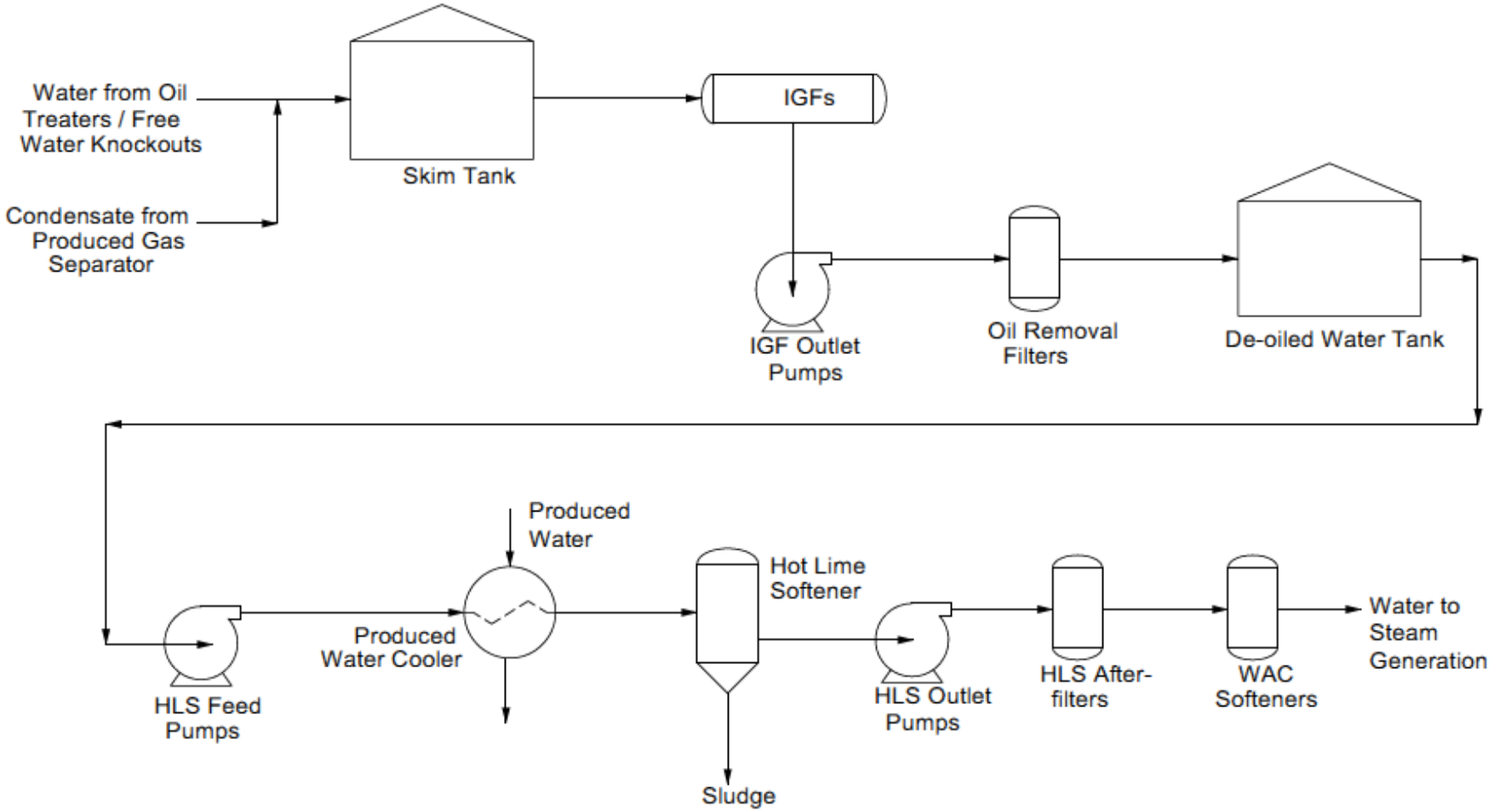
PFD – Bitumen Treating



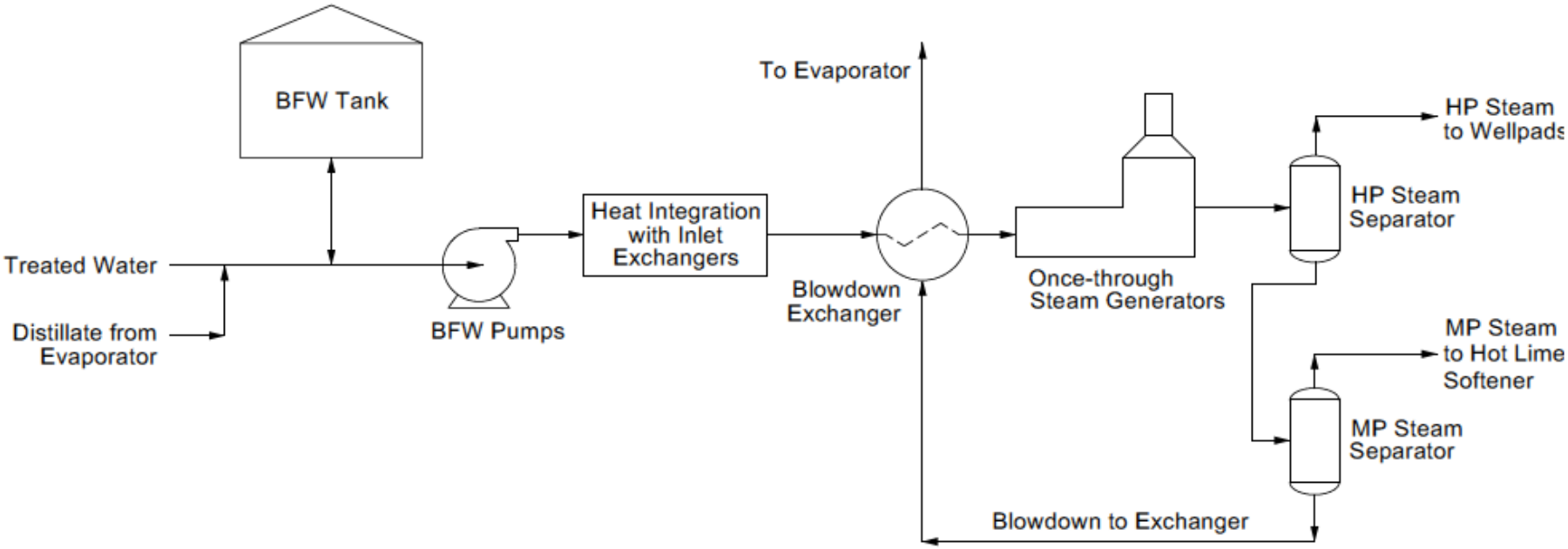
PFD – Produced Gas Recovery



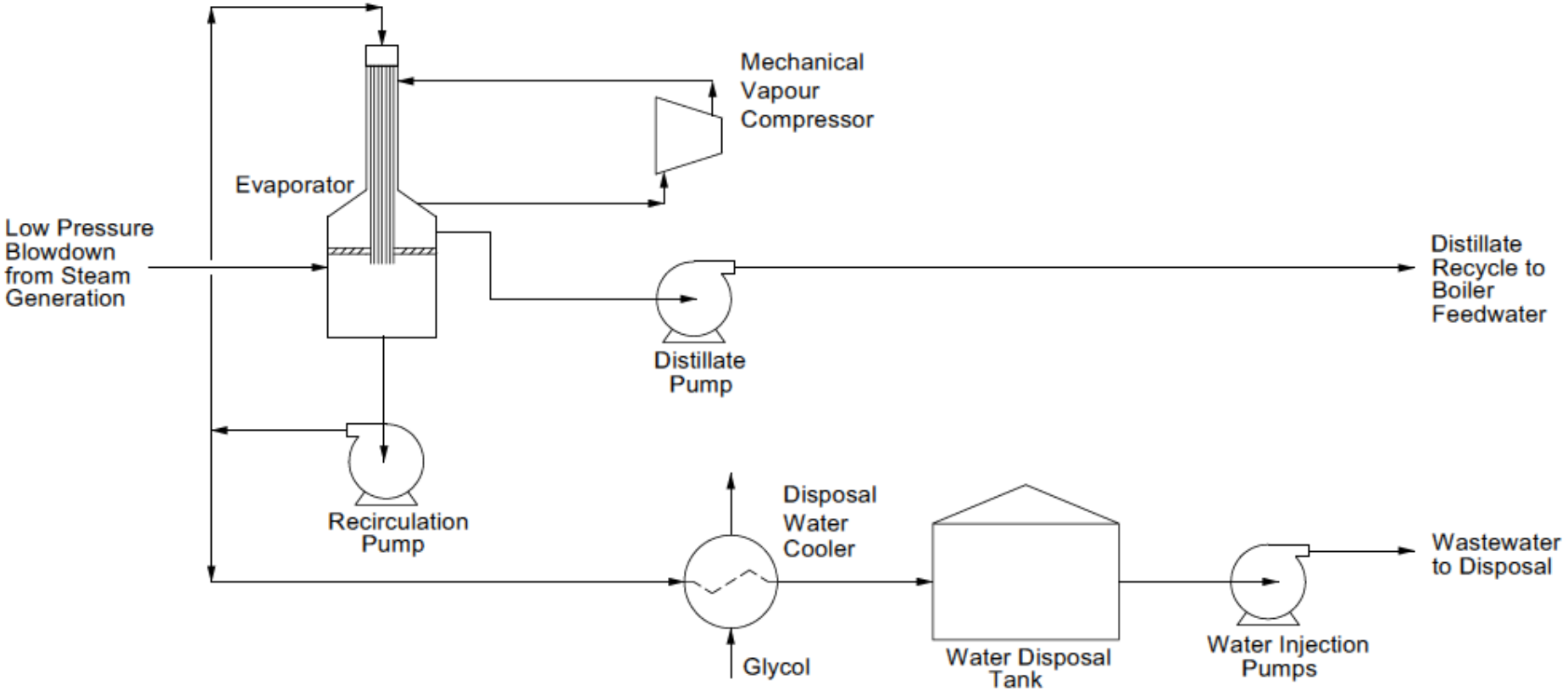
PFD – Produced Water Treatment



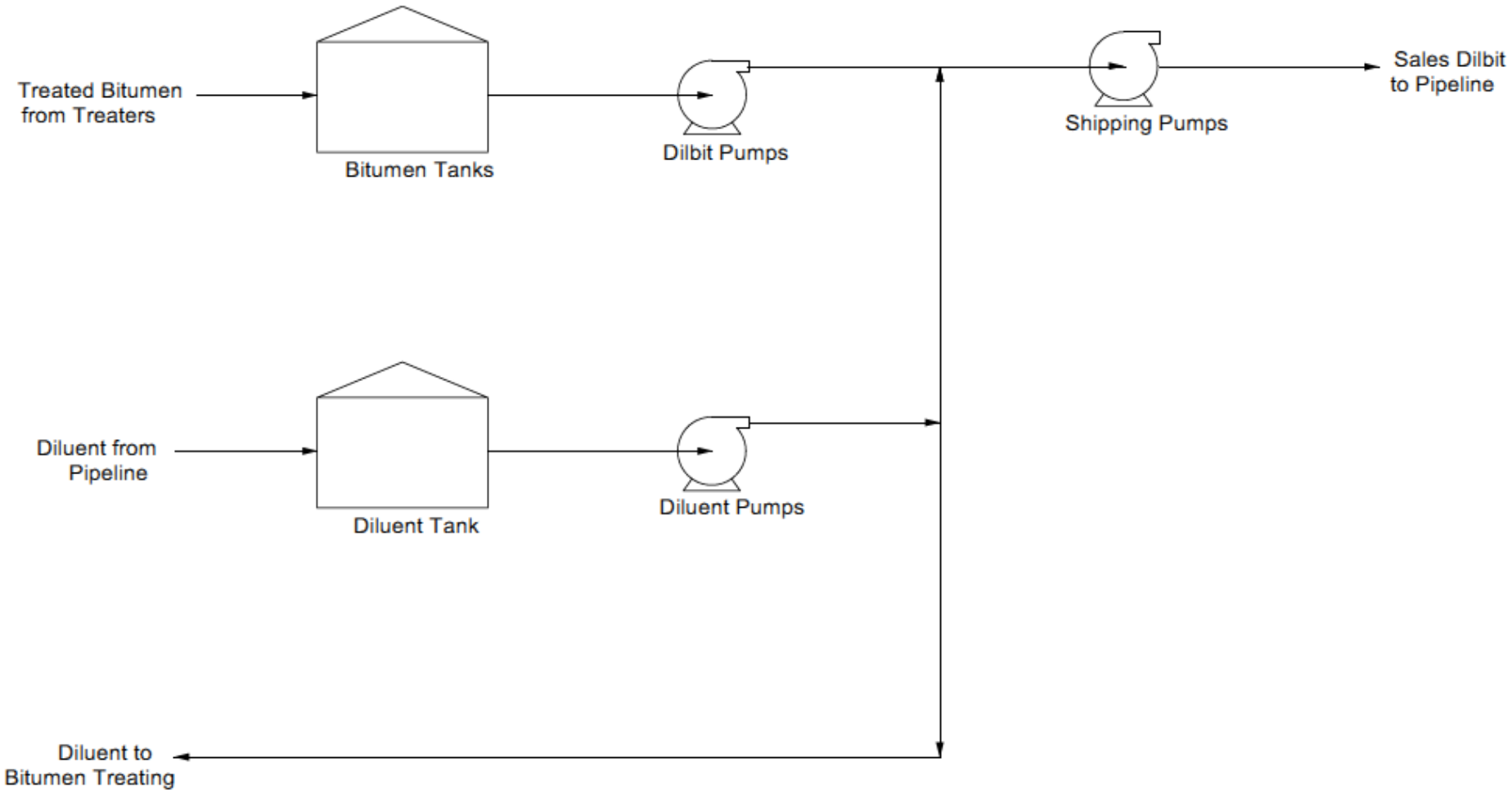
PFD – Steam Generation



PFD – Boiler Blowdown



PFD – Bitumen Blending & Sales



Operational Highlights – 2019

Second full year of operations

- Average annual production rate 26.0 kbpd (4100 m^3/d)
  - Maintained 30% higher than designed production rates
- Steadily increased production and rebalanced water through first half of year, following Q4 2018 production cutbacks (due to poor economics)
- Turn-around in October for two weeks
- Exceeded 2.0 tonne/d SO2, beginning April 27 – approved for 3.0 tonne/d to Dec 31/20
- Production declining at year end as steam chambers mature

Facility Performance - Bitumen Treatment

- Design
  - Bitumen handling = 30 kbpd (4800 m^3/d)
  - Bitumen density – 1011 kg/m^3 (Demo Project)
  - Dilbit viscosity spec. – 350 cSt
- 2019 Performance
  - Maximum Daily Volume: 32.1 kb (5100 m^3)
  - Maximum Monthly Average Rate (May): 30.2 kbpd (4800 m^3/d)
  - Maintained pipeline specifications throughout year

Facility Performance - Water Treatment

- Design
  - Designed water system for six 71.3 MW steam generators
  - Only four installed
  - Produced Water System: Surge Tank/Skim Tank/IGF/ORF/HLS/WAC
  - Blowdown to MP Steam & Evaporator; Brine Trucked Off-Site
- 2019 Performance
  - Overall system is working well
  - BFW targets
    - Silica (~50 ppm), O&G (<1 ppm) and Hardness (<0.1%)
  - Periodic oil carry over to the produced water system
    - Significant improvement following TA
  - Continued assessment of raw water system scale (high iron, phosphorous and calcium) and corrosion (microbiological induced corrosion)

Facilities Optimization Initiatives

- Diluent Flash Loss Reduction
  - Modified Sales Oil / Glycol exchanger (E 223 A/B) Tube bundle in Oct 2019 to improve Sales Oil Cooling and reduce flashing in the Sales Oil Tanks. Significant improvement observed in Sales Oil Temperature. Similar modifications are planned for E 222A/B Sales Oil / Glycol exchanger in Sep 2020.
  - With the above modifications Overall Diluent Losses is expected to reduced from 2.5% (year average) to <1.5% in 2021.
- Steam Quality Improvement
  - Steam quality has been increased from 73% to 77%. Fluctuations in control loops and online steam quality measurements will be addressed in 2020 to explore further improvement in Steam Quality.

Steam Generation

- B-510/515/520/525
  - 71.3 MW (240 MMBtu/h)

2019	Steam Volume (m^3)	Steam Quality (%)
January	317,643	73.5
February	291,158	74.0
March	309,805	73.8
April	299,524	73.2
May	325,111	73.6
June	305,898	73.9
July	320,534	73.7
August	326,819	74.1
September	306,867	73.6
October	289,310	74.1
November	322,095	75.4
December	334,325	75.5
Total	3,749,090	74.0
Daily Average	10,271	
Design Capacity	11,440	80

Power & Energy Intensity

2019	Power (kWh)	Power (MW)	Natural Gas* (e^3m^3)	Bitumen (m^3)	Intensity** (m^3/m^3 bitumen)	Nat gas heating value (GJ/e^3m^3)	Intensity** (GJ/m^3 bitumen)
January	8,695,502	11.7	22,423	96,839	232	40.8	9.5
February	7,761,569	11.5	20,258	107,627	188	41.0	7.7
March	9,003,725	12.1	20,822	129,308	161	40.9	6.6
April	8,399,160	11.7	18,899	129,703	146	40.9	6.0
May	9,417,360	12.7	19,688	148,958	132	41.1	5.4
June	9,482,708	13.2	17,899	136,826	131	40.9	5.4
July	9,655,227	13.0	18,619	142,810	130	40.9	5.3
August	9,771,569	13.1	19,383	136,564	142	41.0	5.8
September	9,401,616	13.1	18,549	124,264	149	41.1	6.1
October	9,316,100	12.5	19,099	106,636	179	41.0	7.3
November	9,416,664	13.1	21,128	124,330	170	41.0	7.0
December	9,700,089	13.0	22,349	123,028	182	41.1	7.5
Total	**110,021,289**	**12.6**	**239,116**	**1,506,893**	**159**	**41.0**	**6.5**

* - Total natural gas to plant

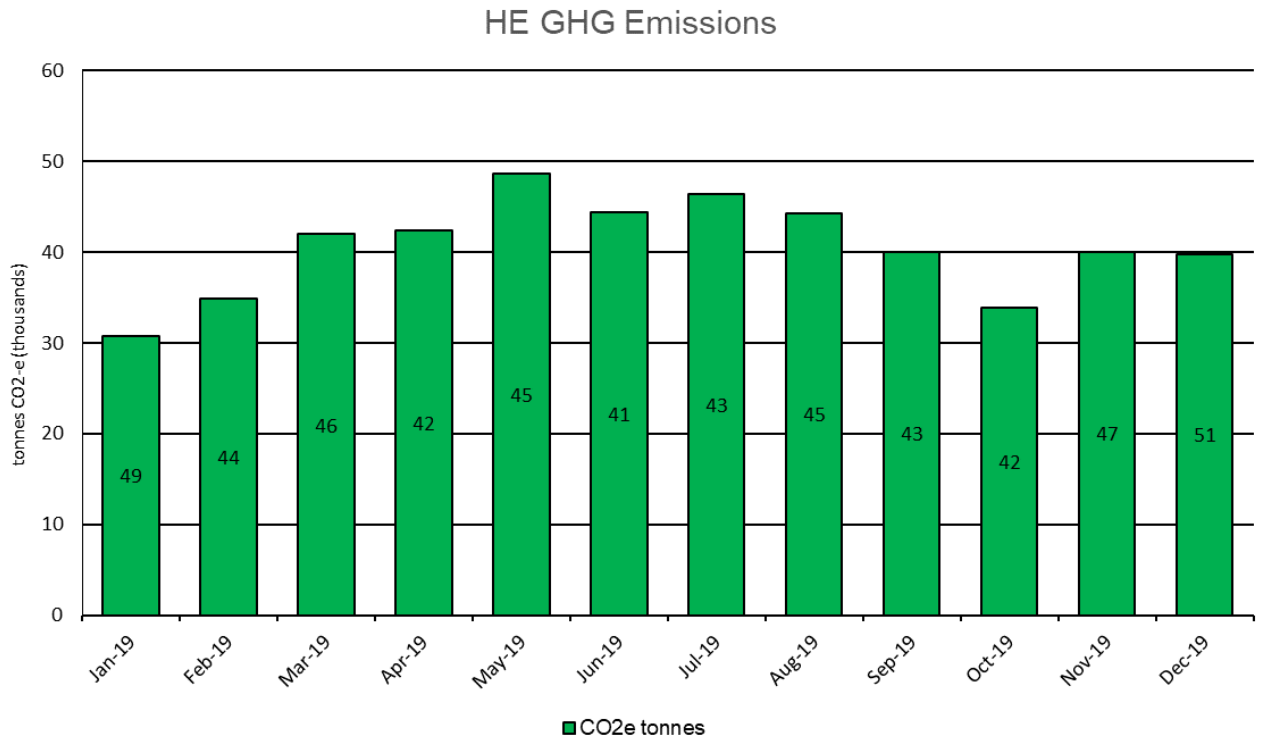
** - Using monthly natural gas values

Natural/Produced Gas Summary

2019	Purchased Gas (e^3m^3)	Produced Gas (e^3m^3)	Flared Gas (e^3m^3)	Produced Gas Recovery (%)
January	22,423	518.0	3.0	99.4
February	20,258	514.9	7.1	98.6
March	20,822	634.9	4.0	99.4
April	18,899	757.6	0.2	100.0
May	19,688	1140.1	0.0	100.0
June	17,899	1204.2	2.6	99.8
July	18,619	1316.7	0.0	100.0
August	19,383	1372.0	0.0	100.0
September	18,549	1279.3	3.1	99.8
October	19,099	813.6	3.3	99.6
November	21,128	1344.7	0.0	100.0
December	22,349	1525.3	0.4	100.0
Total	239,116	12,421	23.7	99.8

Greenhouse Gas Emissions

- 2019 GHG Emissions: 539,350 tonnes CO2e



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Measurement & Reporting

HE MARP

- Measurement, Accounting and Report Plan (MARP) originally approved in January 2013
- 2019 MARP revision completed
- 2020 MARP revision to be completed by February 28, 2020
  - Updates related to NCG Injection Application (new meters, allocation method)
  - Well test requirements aligned to D17 for more flexibility
  - Removed several non-accounting meters from the meter list

Optimization of Test Duration

- Optimization of test duration
  - Cycling through wells to achieve Directive 17 requirements
  - Excess testing time beyond the Directive 17 requirement is focused on dynamic/unstable wells
- Minimum test period: as per Directive 17
- BS&W tests:
  - Manual cuts are used with quality controlled procedure
  - Online meters are in place, unable to perform reliable accuracy at this time

HE Production / Injection

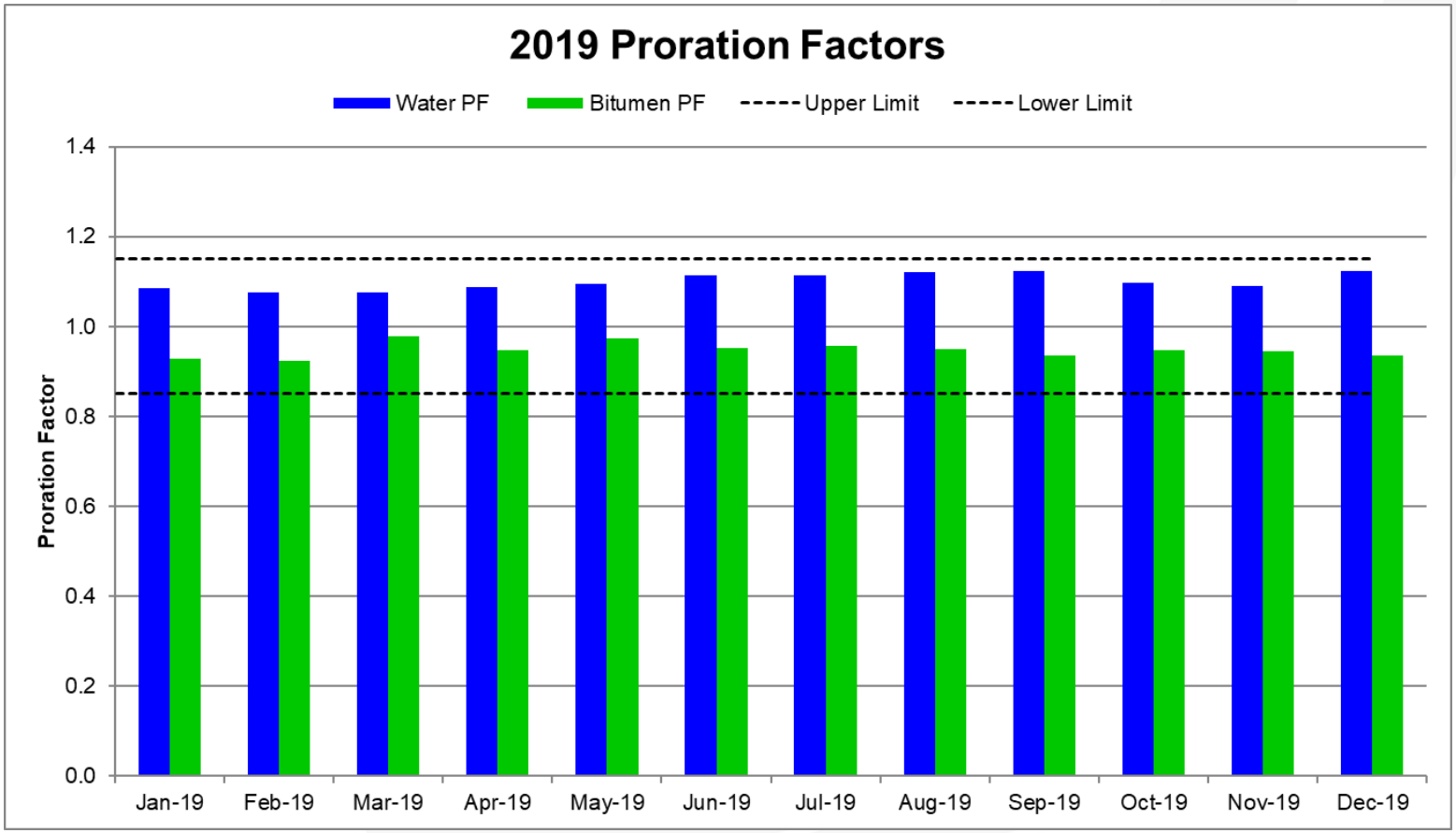
- 7 of 32 SAGD well pairs have individual metered wellhead separators, where produced fluid rates are continuously measured and recorded. The remaining wells use a group/test setup
- Group/test setup by phase
  - Pad 1: five wells; one group, one test
  - Pad 2: six wells; one group, one test
  - Pad 3: three wells; individual well head separators
  - Pad 4: five wells; one group, one test
  - Pad 5: nine wells; one group, two test
  - Pad 6: four wells; individual well head separators
- Manual bitumen cut sampling
- Steam injection rates are continuously measured at each wellhead

Reporting/Proration Method

- Produced Bitumen
  - Plant bitumen is calculated using metered dilbit minus diluent receipts compensated for flashing
  - ∑ Individual wellhead bitumen is calculated (produced fluid x bitumen cut) and prorated to the plant bitumen production
- Produced Water
  - Produced water from each well is calculated with the following formula
    - Produced Water = Produced Fluid – Bitumen
    - Produced water from all the wells is prorated to the total de-oiled produced water measured in the CPF
- Steam
  - Steam volumes are measured at the wellheads with individual vortex meters; steam traps exist at each well pad

Proration Factors

- The average 2019 proration factor
  - Bitumen: 0.948
  - Water: 1.100

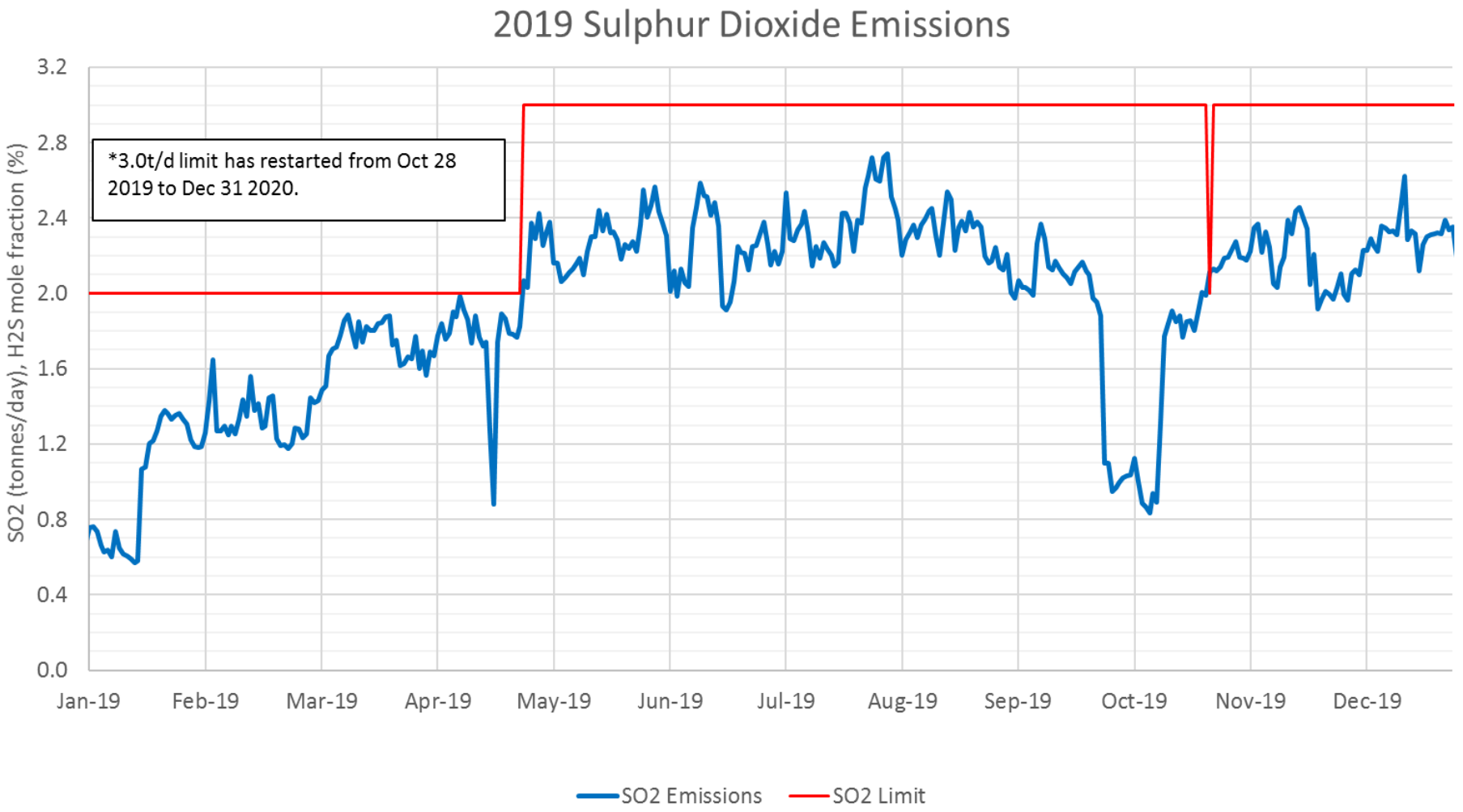


Water Balance at Injection Facility

2019	IN				OUT						(ABS) Δ(%)
	Produced Water (m^3)	Raw Water (m^3)	ΔINV (m^3)	Total (m^3)	Steam to Wells (m^3)	BFW Transfer (m^3)	Disposal to Truck out (m^3)	Evaporation (m^3)	ΔINV (m^3)	Total (m^3)	
January	346,219	16,265	76	362,407	293,477	0	3,060	49,504	13,659	359,699	0.7
February	304,905	9,476	-61	314,442	269,356	0	3,940	39,224	-121	312,399	0.6
March	318,628	9,921	-26	328,575	300,891	1,560	5,966	34,341	-7,870	334,887	1.9
April	309,070	22,150	-19	331,239	292,027	1,600	5,046	30,522	8,394	337,590	1.9
May	332,195	10,559	255	342,499	318,287	0	4,356	25,236	-7,106	340,773	0.5
June	305,150	14,178	-192	319,520	299,191	0	4,536	10,318	-1,526	312,519	2.2
July	324,636	10,798	-43	335,477	313,405	0	3,996	6,643	-1,566	322,478	3.9
August	325,526	16,468	215	341,779	319,827	0	3,924	5,803	-1,174	328,380	3.9
September	304,476	18,440	-8	322,923	299,381	0	3,708	6,561	1,941	311,592	3.5
October	275,057	30,922	62	305,917	280,937	0	3,168	9,151	-600	292,655	4.3
November	319,277	17,813	-96	337,187	313,348	0	3,846	9,017	-1,865	324,347	3.8
December	324,874	23,923	65	348,733	325,513	0	3,607	6,065	639	335,823	3.7
Total	3,790,013	200,914	229	3,990,698	3,625,640	3,160	49,153	232,385	2,804	3,913,143	1.9

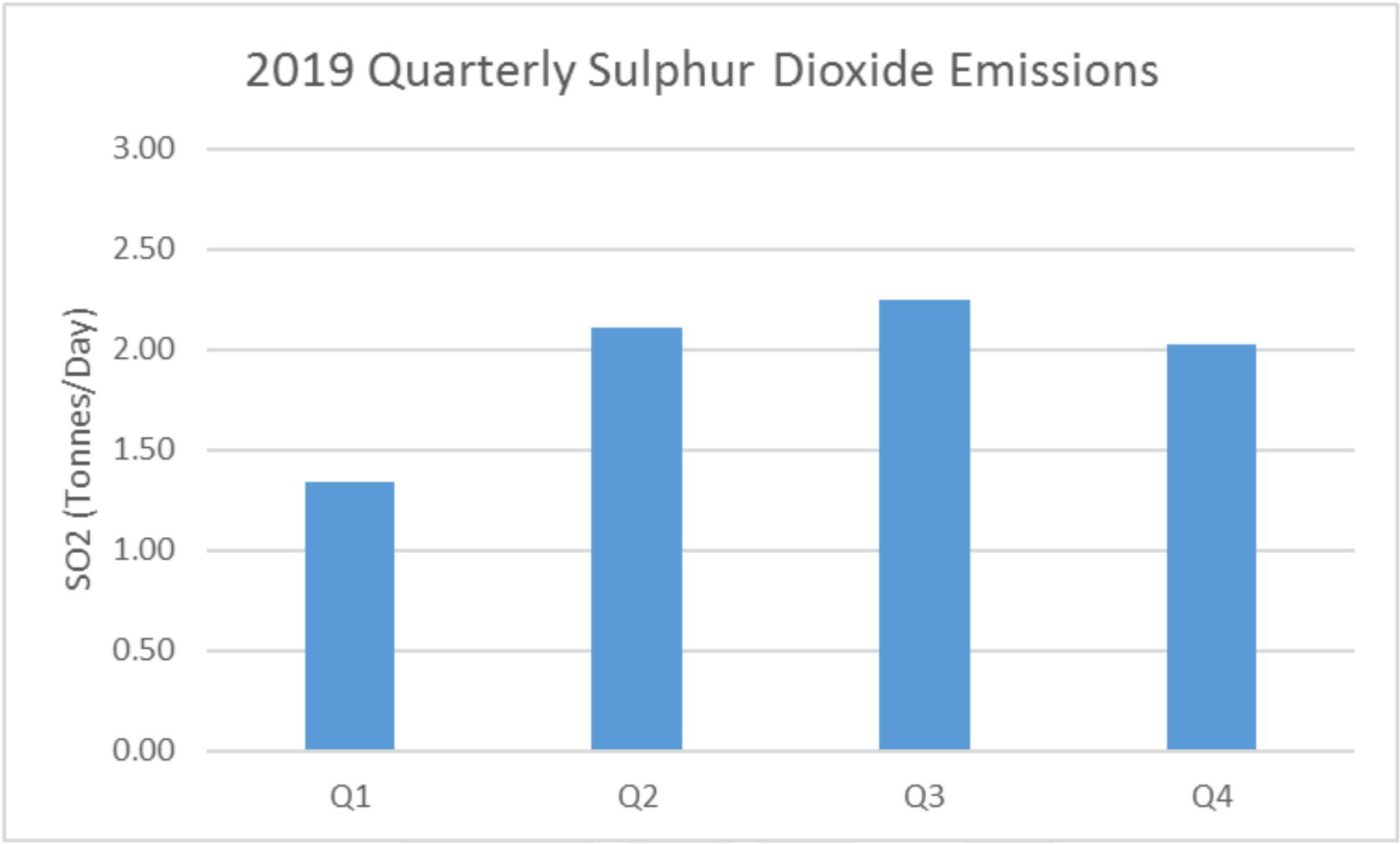
- High Produced Water / Steam Ratio for Jan and Feb as wells were going through banked production after cutbacks in Dec/Jan
- To manage high produced water rates, a large amount was evaporated from January to May
- BFW transfer volume is trucked-out boiler feed water to Greenfire plant

Sulphur Production



- Lapse in approval on October 27 resulted in exceeding 2.0 tonne/d limit, which was reported as an alleged contravention and resolved with the Bonnyville field centre.

Quarterly Sulphur Production



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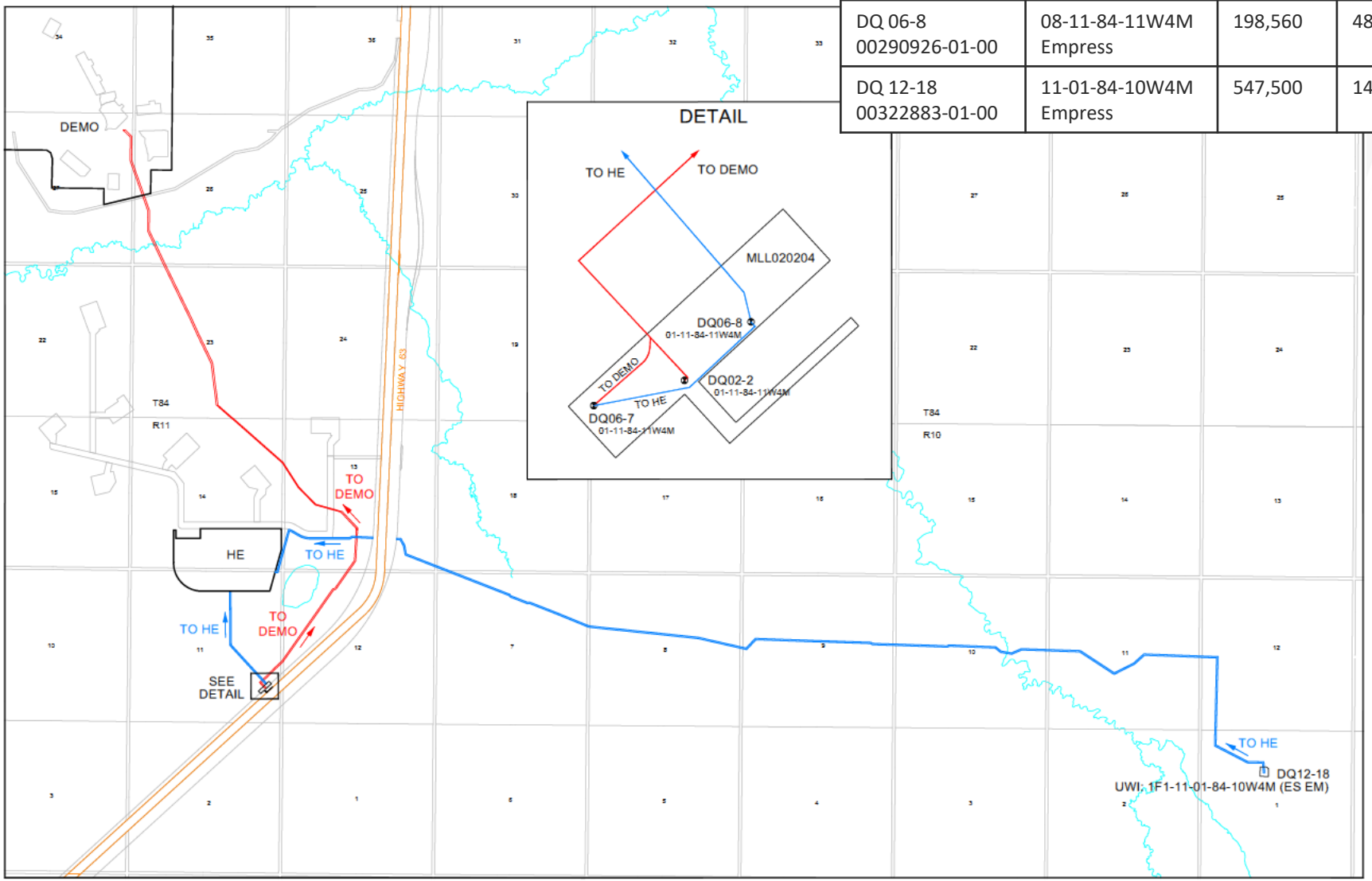
Water: Source, Produced, Injection, Disposal

Water Source Wells

Well Name WA License No.	Location Aquifer	Alloc. (m^3/yr)	Actual Used (m^3)
DQ 06-8 00290926-01-00	08-11-84-11W4M Empress	198,560	48,612
DQ 12-18 00322883-01-00	11-01-84-10W4M Empress	547,500	140,041



*DQ 02-2 and 06-7 wells, shown in the detail inset, are no longer licensed by JACOS.

2019 Fresh Water Usage

(m^3)	Fresh Water Sources (m3)			Total (m^3)
	DQ06-8	DQ12-18	Surface Runoff	
January	1,092	15,173	0	16,265
February	7,343	2,133	0	9,476
March	1,460	8,462	0	9,921
April	7,918	14,232	0	22,150
May	9,165	1,395	0	10,559
June	1,473	12,705	0	14,178
July	543	10,255	0	10,798
August	4,889	11,580	0	16,468
September	2,919	13,182	2,338	18,440
October	2,608	18,391	9,923	30,922
November	7,553	10,261	0	17,813
December	1,649	22,274	0	23,923
Total	**48,612**	**140,041**	**12,261**	**200,914**
Max Annual Diversion	198,560	547,500	15,000	

Directive 81: Disposal Limit vs. Actual

2019	Cumulative Alternative Type 3 (m^3)	Cumulative Alternative Type 1 (m^3)	Cumulative HQN (m^3)	Cumulative Disposal Water (m^3)	YTD Disposal Limit (%)	YTD Disposal Actual (%)
January	52,742	293,477	16,265	3,060	22.8	0.8
February	88,291	562,833	25,740	7,000	21.5	1.0
March	106,028	863,723	35,662	12,966	19.2	1.3
April	123,071	1,155,751	57,812	18,012	18.0	1.3
May	136,979	1,474,038	68,371	22,368	17.1	1.3
June	142,937	1,773,229	82,549	26,904	16.1	1.3
July	154,168	2,086,634	93,347	30,900	15.7	1.3
August	159,867	2,406,461	109,816	34,824	15.1	1.3
September	164,962	2,708,181	125,917	38,532	14.7	1.3
October	164,962	3,264,174	146,916	41,700	13.9	1.2
November	170,891	3,577,523	164,729	45,546	13.6	1.2
December	171,125	3,903,035	188,653	49,153	13.3	1.2

Calculated under New D81, issued Nov 5, 2019.

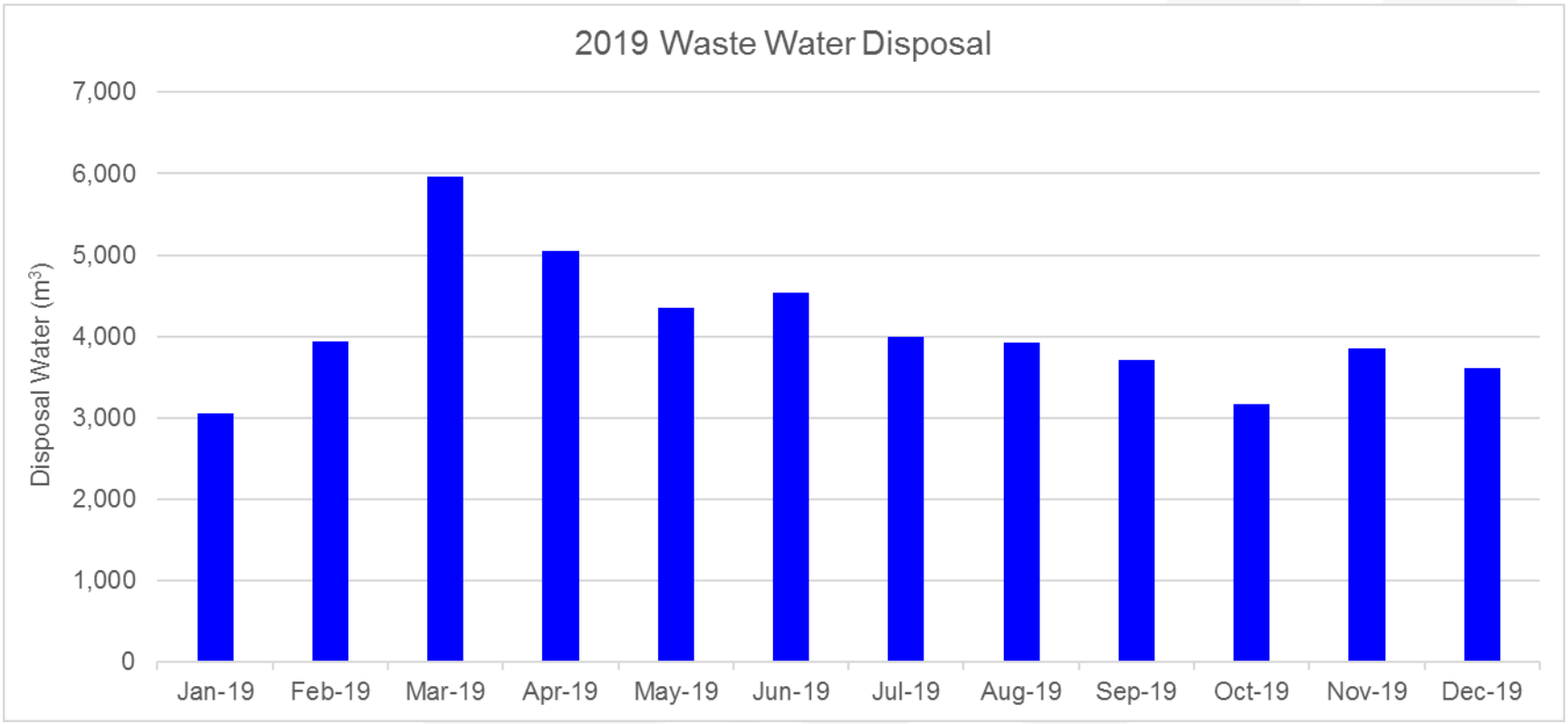
- Alternative Type 3: Produced Water greater than injected steam
- Alternative Type 1: Industrial Run off, produced water equal or less than injected steam
- High Quality Non-saline(HQN): Fresh water

$$Disposal\ Limit\ (\%) = \frac{(HQN \times D_{HQN}) + (A_1 \times D_{A1}) + (A_2 \times D_{A2}) + (A_3 \times D_{A3})}{HQN + A_1 + A_2 + A_3} \times 100$$

$$Actual\ Disposal\ (\%) = \frac{Total\ disposal}{Total\ inlet} \times 100$$

Waste Water Disposal Volumes

- Offsite disposal – White Swan Environmental Ltd.
- Total 49,153 m^3 disposal water in 2019



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Other Wastes

Oilfield Waste Management

Waste Receiver	Location	Waste Description	Quantity	Disposal Method
RMWB Municipal Landfill	RMWB (16-21-88-09 W4M)	Mixed Solids	147,510 kg	Landfilled
Stony Mountain	Sunset Recycle and Sale	Metals	170,720 kg	Processed and recycled
GFL Environmental	4208 84th AVE NW, Edmonton	GLYCOL	23,346 m^3	Processed and recycled
Tervita – Janvier Landfill	SE 1/4 03-081-06w4	SLGLIM	6,605.3 tonnes	Landfill
		SOILCO	58.6 tonnes	
		ASH/SOIL	292 tonnes	
White Swan Environmental Disposal Well	Atmore 11-23-67-18-W4M	BLBDWT	49,153 m^3	Disposed of at Disposal Well
		COEMUL	5,073 m^3	
		DRWSGC	696 m^3	
RBW Waste Management	3280-10 Street, Nisku	GLYCOL	1.6 m^3	Processed and Recycled
		FILSWT	1.0 m^3	
		EMTCON	0.4 m^3	
		WSTMTS	43.7 m^3	
		SOILCO	2.0 m^3	
		INCOHM	1.0 m^3	
		OILRAG	0.8 m^3	
		CWATER	1.0 m^3	
		TOTES (Empty)	34.0 m^3	
		SMETAL	4.3 m^3	

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Environmental Monitoring Programs

Environmental Monitoring Programs

Groundwater Monitoring Program

- Groundwater monitoring events are completed every spring and fall, interim reports (internal) in spring and a comprehensive, triennial report was filed with the AER in 2019
- Monitoring to meet the requirements for thermally mobilized constituents was initiated in 2019

Wetlands Monitoring Program

- Surface water monitoring events are completed every spring and fall, wetland vegetation monitoring, previously undertaken every summer was approved in spring 2019 to monitor every other year, no vegetation monitoring occurred this year

Rare Plant Monitoring

- There were no rare plant surveys in 2019. All populations are now healthy; these species are no longer tracked in the Alberta Conservation Information Management System.

Environmental Monitoring Programs (cont.)

Soil Monitoring Program

- The soil monitoring proposal was started in 2019, when approved by GOA the requirements for the 2020 will be established

Wildlife and Caribou Programs

- Wildlife camera data is downloaded every spring and fall, one caribou was photographed east of the highway this spring. The 2019 monitoring program was modified to reduce the number of Auditory Recording Units, and to monitor borrow pit recovery.

Regional Monitoring Programs

- Involved through the Alberta Oil Sands Monitoring (OSM) programs
- Active member of CAPP and participation in the Caribou Working Group, the Species At Risk Working Group, as well as Air Emissions and Climate working groups.
- JACOS is a member of the Monitoring Participation Group of the Canadian Oil Sands Innovation Alliance (COSIA)

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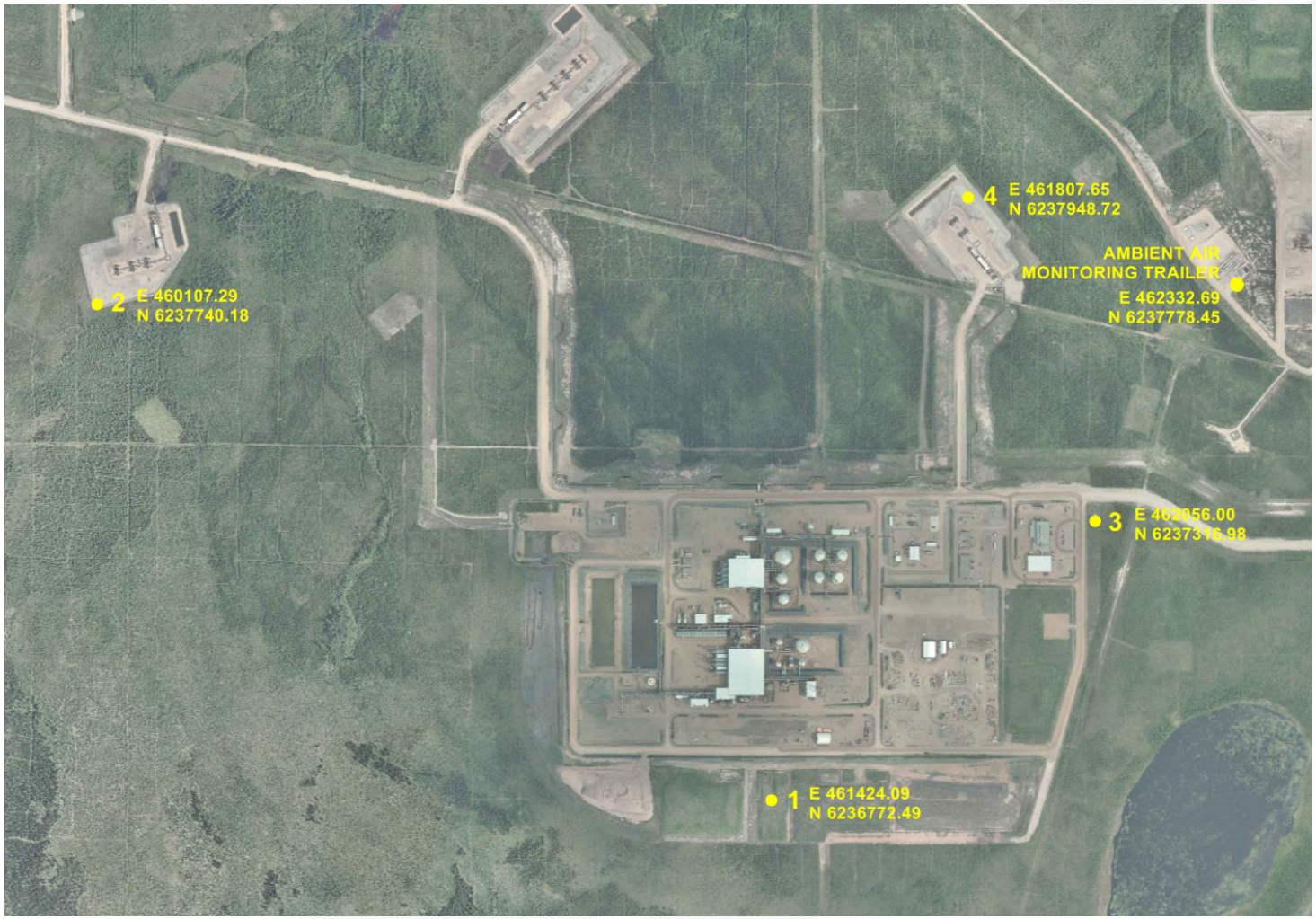
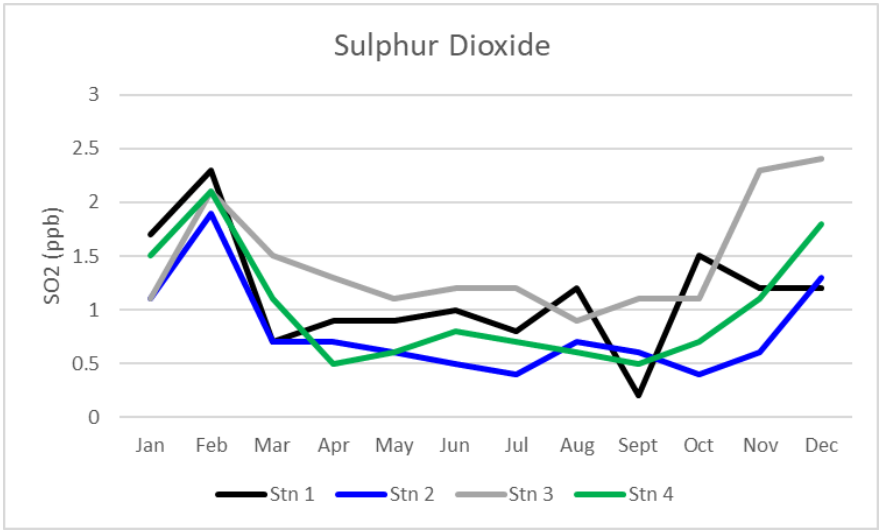
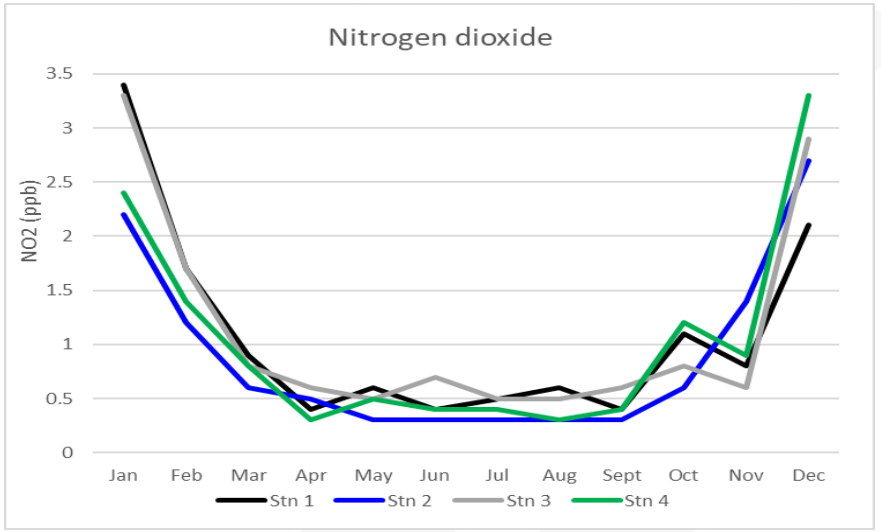
Environmental Monitoring – Air Quality

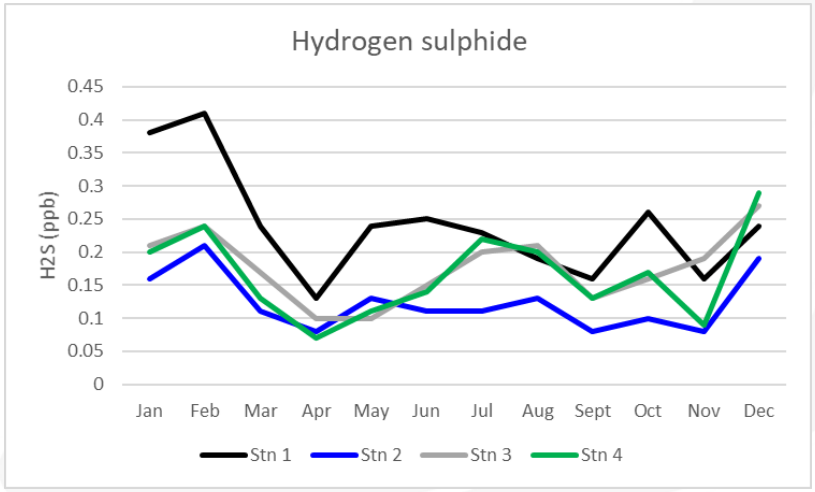
Air Monitoring Station Locations



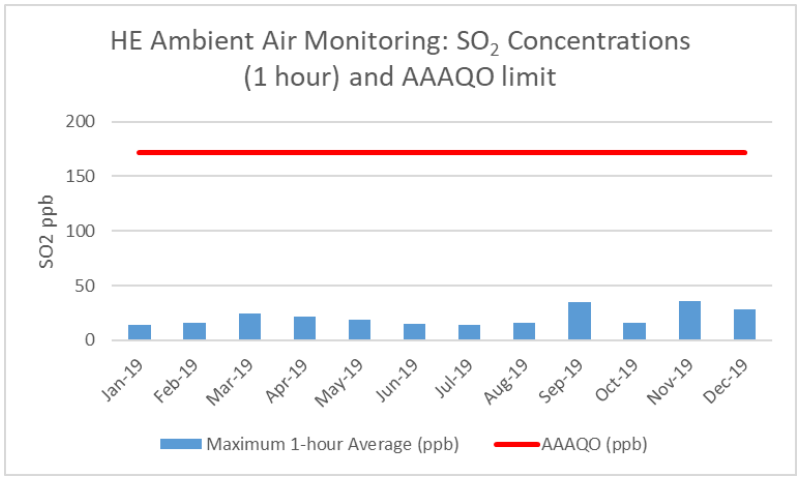
Passive Exposure Stations Results 2019

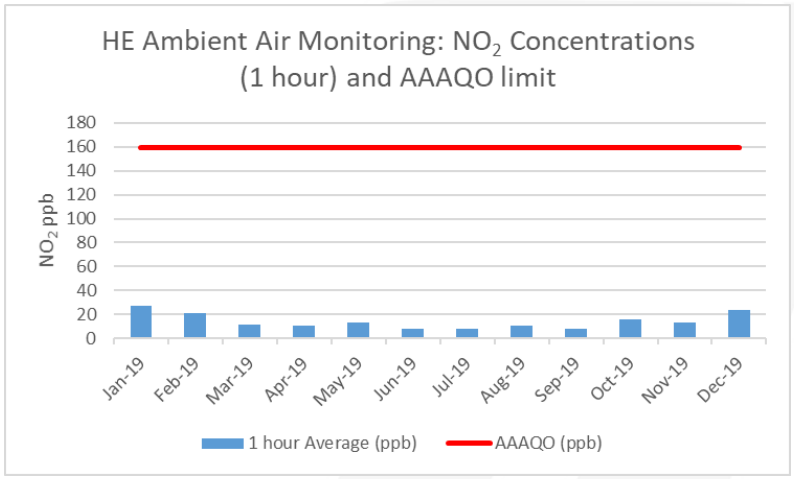


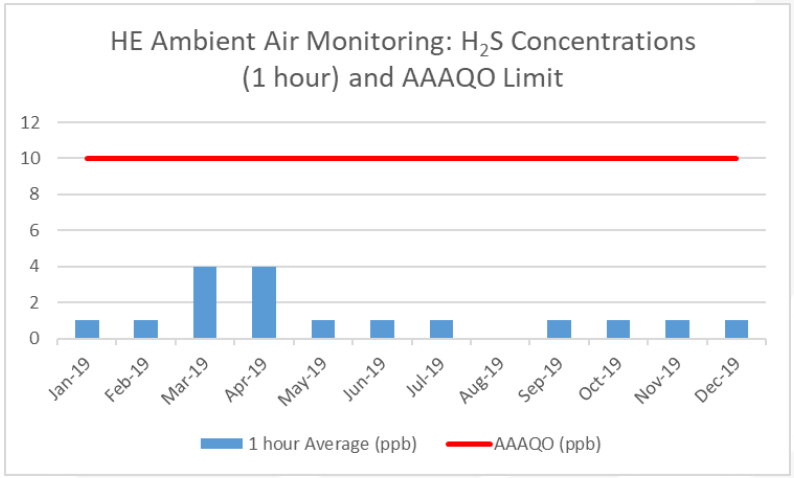




Continuous Ambient Air Monitoring Results 2019







Source Air Emissions Monitoring

- JACOS completed all the source air emissions monitoring and testing required during 2019. Manual stack surveys confirmed that all combustion equipment requiring testing was performing below the limits specified in the HE EPEA Approval.
- 2019 average CEMS Availability was greater than 90% for both systems.

Remediation and Reclamation Progress

- In Q3 of 2019 JACOS undertook Phase I ESAs on a former water source well (05-34-83-11 W4M) and a former gas well (01-22-84-11 W4M).
- Vegetation management continued throughout the site.
- Throughout 2019, JACOS maintained its involvement in iFROG (COSIA-JIP) and undertook Wetland Reclamation Research work on a JACOS disposition.
- JACOS supported an upland reclamation research project (on existing JACOS dispositions) with the University of Waterloo.
- Detailed site assessments (DSAs) were undertaken on select former surface dispositions.



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Environmental Issues, Compliance Statement, and Approvals

2019 Compliance Statement

- JACOS is in compliance with all conditions of their approvals and regulatory requirements.
- JACOS has achieved full compliance with the Inactive Well Compliance Program (IWCP).

2019 Applications and Approvals

- Application No. 005-153105 requesting an amendment to the temporary SO_2 emission limit approval to emit up to 3.0 tonnes/day SO2 for a 6-month period starting the first day SO2 emissions exceeded 2.0 tonne/day filed February 9, 2019. Approval No. 153105-00-04 issued March 8, 2019.
- Application No. 006-153105 requesting an increase in the approved duty of two glycol heaters from 10 MW to 13 MW was filed August 29, 2019. Approval No. 153105-00-05 issued October 28, 2019.
- Application No. 007-153105 requesting a second extension to the temporary SO_2 emission limit amendment from 2.0 to 3.0 tonnes/day, to December 31, 2020 filed September 4, 2019. Approval No. 153105-00-05 received October 28, 2019 with condition to submit sulphur recovery study by March 31, 2020.
- Application No. 1923993 requesting waiver under *ID2001-03*, 2019 filed September 4, 2019. Approval No. 11910D issued November 5, 2019.
- Application No. 1925256 requesting field-wide approval for NCG co-injection filed October 30, 2019. Approval No. 11910E issued on November 12, 2019.
- Application No. 1924925 - D78 sustaining well pad application for WPs 7,8,10 filed October 17, 2019. SIR#1 received November 6, 2019. Application open as at December 31, 2019.
- Application No. 003-290926 – Water Act renewal for DQ06-8 (GIC ID: 10016000)

Future Plans – Compliance & Approvals

- Commence NCG co-injection
- Resubmit sustaining well pad D78 application for WPs 7, 8, and 10, including SIR#1 response (application was withdrawn on January 24, 2020).
- Application for Highway Crossing (development east of Highway 63) – next few years
- Application for SA-SAGD Pilot

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Appendices

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Appendix 5.d.(v)

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Average Injection Wellhead Pressure

Well	HE Phase 1 Average Injection Wellhead Pressures (kPa)											
	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
W01-01	3,851	4,360	4,441	4,347	4,341	4,454	4,164	4,230	4,188	4,214	4,134	4,084
W01-02	3,776	4,203	4,464	4,391	4,403	4,346	4,130	4,123	4,174	4,149	4,282	4,223
W01-03	3,907	4,200	4,445	4,368	4,328	4,301	4,187	4,233	4,239	3,857	4,101	4,117
W01-04	3,840	4,232	4,429	4,380	4,387	4,376	4,286	4,279	4,309	4,111	4,254	4,236
W01-05	3,801	4,357	4,465	4,344	4,369	4,302	4,248	4,260	4,326	4,146	4,260	4,241
W02-01	4,662	4,483	4,403	4,268	4,318	3,787	4,179	4,113	4,127	4,046	4,081	4,096
W02-02	4,664	4,539	4,469	4,344	4,426	3,997	4,318	4,275	4,333	3,897	4,169	4,187
W02-03	4,661	4,489	4,414	4,276	4,340	3,806	4,232	4,196	4,302	4,257	4,359	4,377
W02-04	4,640	4,472	4,400	4,259	4,320	3,757	4,196	4,178	4,136	4,123	4,177	4,151
W02-05	4,683	4,486	4,418	4,268	4,333	3,650	4,340	4,338	4,232	4,282	4,316	4,274
W02-06	4,093	4,442	4,463	4,136	4,160	3,784	4,282	3,963	3,980	4,149	4,543	4,507
W03-01	4,617	4,636	4,635	4,544	4,499	4,456	4,139	3,986	3,950	3,854	3,869	3,820
W03-02	4,581	4,593	4,590	4,466	4,444	4,522	4,181	4,006	3,797	3,598	3,769	3,798
W03-03	4,120	4,072	4,080	4,001	3,813	3,953	4,100	3,981	3,762	3,980	4,514	4,516
W04-01	4,639	4,547	4,552	4,425	4,476	4,416	4,303	4,411	4,384	4,270	4,218	4,232
W04-02	4,581	4,579	4,548	4,458	4,512	4,398	4,252	4,244	4,155	4,119	4,013	3,897
W04-03	4,553	4,559	4,551	4,407	4,501	4,407	4,323	4,274	4,224	4,223	4,103	4,008
W04-04	4,477	4,420	4,477	4,426	4,488	4,399	4,324	4,247	4,127	4,132	4,106	4,029
W04-05	4,601	4,512	4,621	4,372	4,466	4,437	4,287	4,339	4,394	4,345	4,250	4,129
W05-01	4,655	4,524	4,418	4,289	4,426	4,352	4,357	4,322	4,301	4,083	4,235	4,298
W05-02	4,564	4,562	4,505	4,295	4,286	4,315	4,261	4,123	4,078	3,849	4,203	4,222
W05-03	4,650	4,600	4,489	4,317	4,403	4,406	4,254	4,228	4,202	3,918	4,253	4,285
W05-04	4,573	4,470	4,423	4,318	4,377	4,328	4,202	4,129	4,120	4,040	4,190	4,151
W05-05	4,548	4,426	4,346	4,221	4,382	4,331	4,263	4,321	4,373	4,056	4,237	4,235
W05-06	4,573	4,396	4,358	4,184	4,385	4,439	4,276	4,277	4,383	4,146	4,322	4,243
W05-07	4,609	4,551	4,445	4,228	4,336	4,385	4,275	4,233	4,207	4,063	4,190	4,194
W05-08	4,616	4,446	4,396	4,166	4,460	4,407	4,252	4,377	4,365	4,063	4,167	4,145
W05-09	4,627	4,423	4,400	4,100	4,333	4,422	4,293	4,185	4,184	4,132	4,121	4,195
W06-01	4,043	3,910	4,074	4,077	4,133	4,112	4,040	3,857	3,540	3,305	3,380	3,455
W06-02	3,273	3,858	4,042	3,991	4,038	4,088	4,016	3,832	3,528	3,213	3,360	3,556
W06-03	3,520	3,848	4,061	4,107	4,160	4,111	4,034	3,857	3,559	3,374	3,449	3,271
W06-04	4,057	3,876	4,036	4,041	4,140	4,095	4,015	3,846	3,545	3,257	3,279	3,266

Assumption is 100% Steam Quality for Pads 1 through 6 * Steam Traps in all pads

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Average Injection Wellhead Temperature

Well	HE Phase 1 Average Injection Temperatures (°C)											
	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
W01-01	250	257	258	253	257	258	254	255	253	255	254	253
W01-02	249	255	259	254	258	257	254	254	255	254	256	255
W01-03	251	255	258	254	257	256	255	255	255	243	254	254
W01-04	250	255	258	254	258	257	256	256	256	254	256	255
W01-05	249	257	258	254	257	256	255	256	256	254	256	255
W02-01	261	258	257	253	256	231	254	253	254	252	253	253
W02-02	262	260	259	254	258	233	257	256	257	246	255	255
W02-03	261	259	258	253	257	232	255	255	256	256	257	257
W02-04	261	259	258	253	257	231	255	255	254	254	255	254
W02-05	261	259	258	253	257	228	257	257	255	256	256	256
W02-06	254	259	256	249	255	226	256	252	252	254	260	256
W03-01	261	261	261	257	259	259	254	252	252	250	250	250
W03-02	260	260	260	255	258	259	255	252	249	246	249	249
W03-03	250	248	251	239	224	231	225	226	225	251	259	259
W04-01	261	260	260	255	259	258	256	258	257	256	255	255
W04-02	261	260	260	255	260	257	256	256	255	254	253	251
W04-03	260	260	260	255	259	258	257	256	256	256	254	253
W04-04	259	258	259	255	259	258	257	256	254	254	254	253
W04-05	260	259	261	255	258	258	256	257	257	257	256	254
W05-01	261	259	258	252	258	257	257	257	256	253	255	256
W05-02	260	260	259	253	256	257	256	254	253	245	255	255
W05-03	261	260	259	253	257	257	255	255	255	247	255	256
W05-04	260	259	258	252	257	257	255	254	254	253	255	254
W05-05	260	258	257	251	258	257	256	257	257	253	256	256
W05-06	260	258	257	251	257	258	256	256	257	254	257	255
W05-07	260	259	258	250	256	257	255	255	254	252	254	254
W05-08	260	258	257	250	258	257	255	257	257	253	254	254
W05-09	261	258	258	250	257	258	256	254	255	254	254	255
W06-01	253	251	253	250	254	254	253	250	245	241	242	244
W06-02	241	250	253	249	253	254	253	250	245	240	243	246
W06-03	243	250	253	250	254	253	252	250	244	233	243	225
W06-04	253	250	252	250	254	253	252	250	245	240	241	240

Assumption is 100% Steam Quality for Pads 1 through 6 * Steam Traps in all pads

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Monthly Well Pressures (Gas Blanket)

Well	HE Phase 1 Average Bottom Hole Pressure (kPa)											
	Jan-19	Feb-19	Mar-19	Apr-19	May-19	Jun-19	Jul-19	Aug-19	Sep-19	Oct-19	Nov-19	Dec-19
W01-01	3,787	4,309	4,411	4,366	4,309	4,390	4,075	4,081	4,060	4,099	4,009	3,992
W01-02	3,646	3,966	4,283	4,312	4,242	4,156	4,002	3,987	3,997	3,955	3,958	3,952
W01-03	3,675	3,959	4,248	4,276	4,202	4,139	4,028	4,000	3,999	3,768	3,946	3,959
W01-04	3,633	3,950	4,227	4,283	4,202	4,159	4,094	4,016	3,996	3,907	3,920	3,929
W01-05	3,643	4,083	4,249	4,271	4,168	4,102	4,037	4,034	4,036	3,961	3,974	3,968
W02-01	4,520	4,415	4,322	4,271	4,216	3,891	4,078	4,045	4,030	3,948	3,973	3,993
W02-02	4,519	4,398	4,335	4,290	4,227	4,106	4,093	4,065	4,045	4,032	3,986	4,006
W02-03	4,556	4,440	4,364	4,313	4,257	4,047	4,127	4,095	4,075	4,028	4,038	4,053
W02-04	4,596	4,455	4,394	4,353	4,310	4,075	4,156	4,138	4,099	4,057	4,100	4,073
W02-05	4,561	4,447	4,388	4,334	4,301	3,992	4,219	4,204	4,135	4,102	4,151	4,107
W02-06	4,196	4,514	4,613	4,264	4,183	4,343	4,298	3,964	3,969	4,120	4,555	4,506
W03-01	4,623	4,637	4,631	4,582	4,480	4,432	4,123	3,963	3,927	3,828	3,839	3,788
W03-02	4,602	4,613	4,608	4,555	4,458	4,536	4,196	4,019	3,808	3,589	3,782	3,811
W03-03	4,209	4,258	4,292	4,134	3,800	3,927	4,082	3,950	3,733	3,963	4,498	4,500
W04-01	4,452	4,321	4,335	4,314	4,243	4,158	4,104	4,083	4,055	3,971	3,951	3,970
W04-02	4,473	4,409	4,398	4,380	4,394	4,314	4,170	4,154	4,090	4,058	3,988	3,897
W04-03	4,490	4,411	4,396	4,368	4,360	4,281	4,152	4,150	4,105	4,080	4,005	3,922
W04-04	4,470	4,355	4,373	4,422	4,398	4,306	4,174	4,139	4,084	4,081	4,036	3,957
W04-05	4,525	4,398	4,511	4,357	4,325	4,333	4,185	4,121	4,141	4,128	4,114	3,988
W05-01	4,494	4,404	4,314	4,267	4,207	4,081	4,086	4,065	4,052	3,958	3,993	4,008
W05-02	4,546	4,544	4,492	4,384	4,262	4,278	4,255	4,112	4,074	3,665	4,068	4,087
W05-03	4,525	4,493	4,412	4,329	4,250	4,251	4,140	4,101	4,076	3,714	4,068	4,093
W05-04	4,458	4,384	4,338	4,306	4,248	4,140	4,081	4,028	4,021	3,921	3,992	4,050
W05-05	4,482	4,351	4,280	4,230	4,269	4,191	4,090	4,091	4,085	3,927	4,024	4,036
W05-06	4,495	4,315	4,292	4,198	4,210	4,268	4,123	4,087	4,106	3,986	4,055	4,042
W05-07	4,520	4,462	4,361	4,190	4,212	4,245	4,164	4,121	4,093	3,957	3,990	3,977
W05-08	4,519	4,328	4,288	4,174	4,222	4,212	4,015	4,119	4,110	3,925	3,947	3,874
W05-09	4,584	4,370	4,347	4,141	4,270	4,370	4,264	4,142	4,112	4,051	4,023	4,106
W06-01	4,046	3,913	4,071	4,125	4,122	4,111	4,040	3,859	3,553	3,320	3,336	3,367
W06-02	3,214	3,856	4,025	4,075	4,037	4,096	4,028	3,850	3,548	3,235	3,350	3,508
W06-03	3,363	3,768	3,991	4,124	4,134	4,082	4,003	3,835	3,541	3,278	3,352	3,371
W06-04	4,062	3,858	4,013	4,111	4,116	4,070	3,989	3,832	3,545	3,247	3,210	3,235

Highlighted cells indicates gas blanket it taken from the 8 5/8”. Following circulation, when 8 5/8" is used for steam injection, BHP is taken from the 11 3/4" string.

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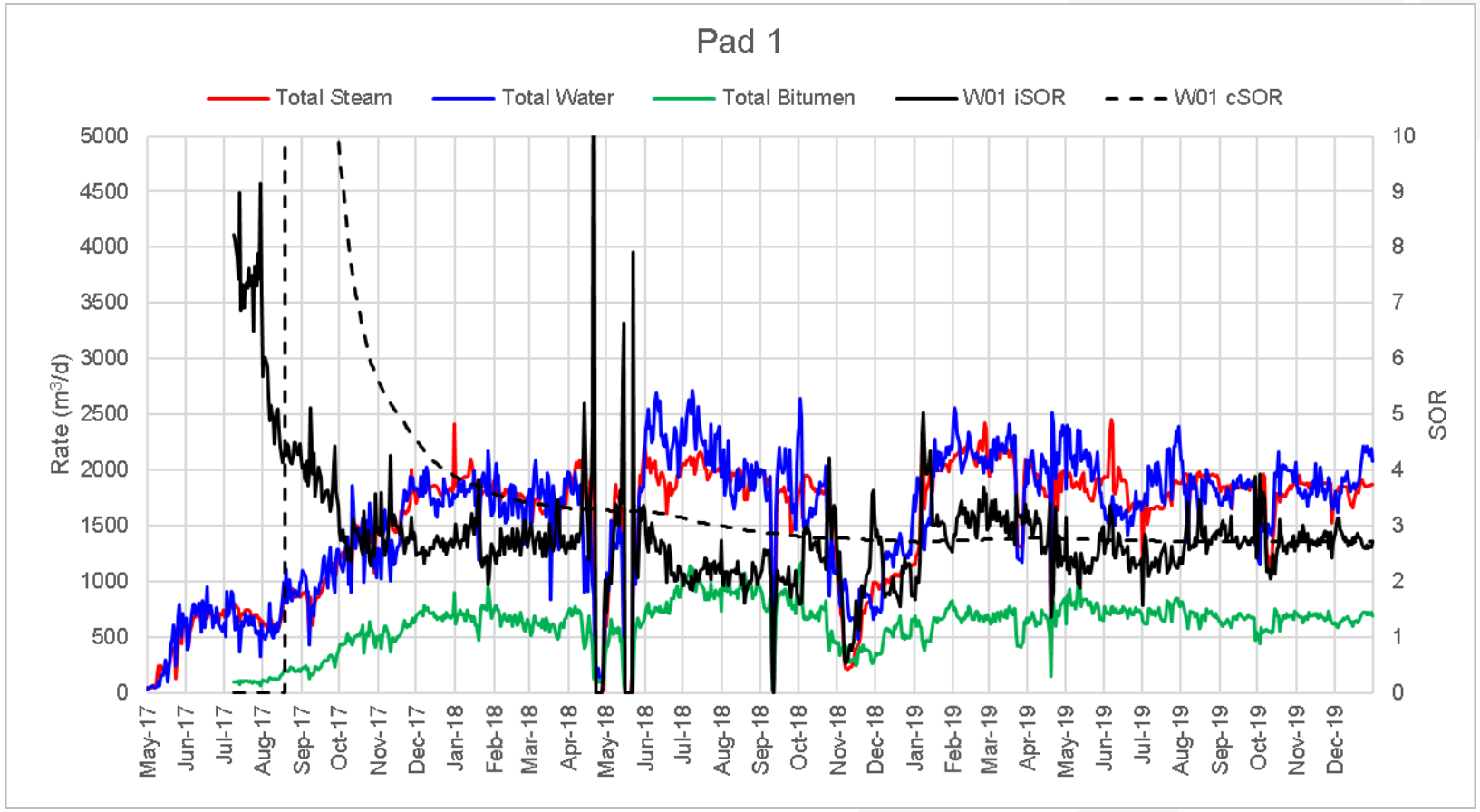
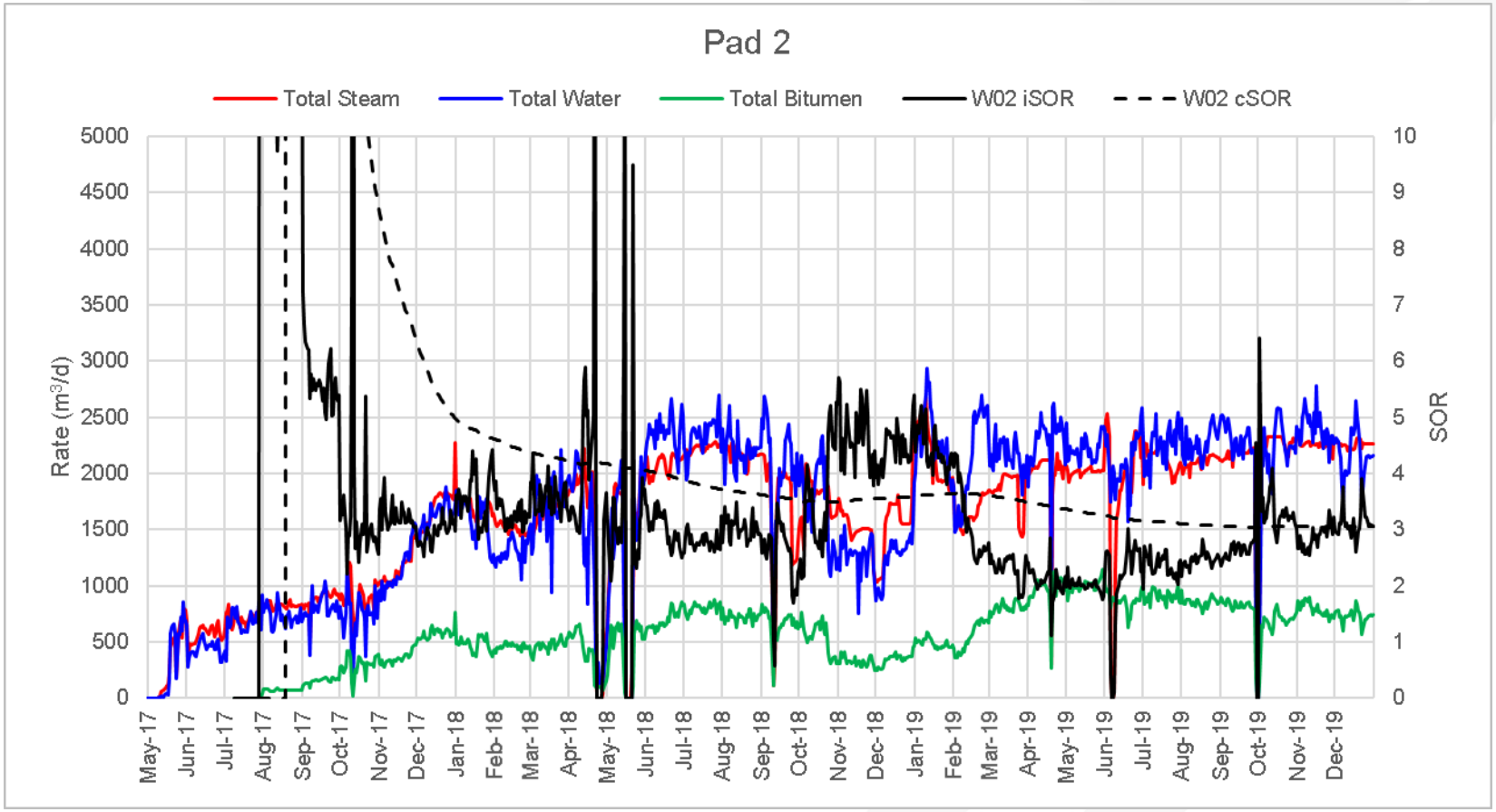
Appendix 7(h)

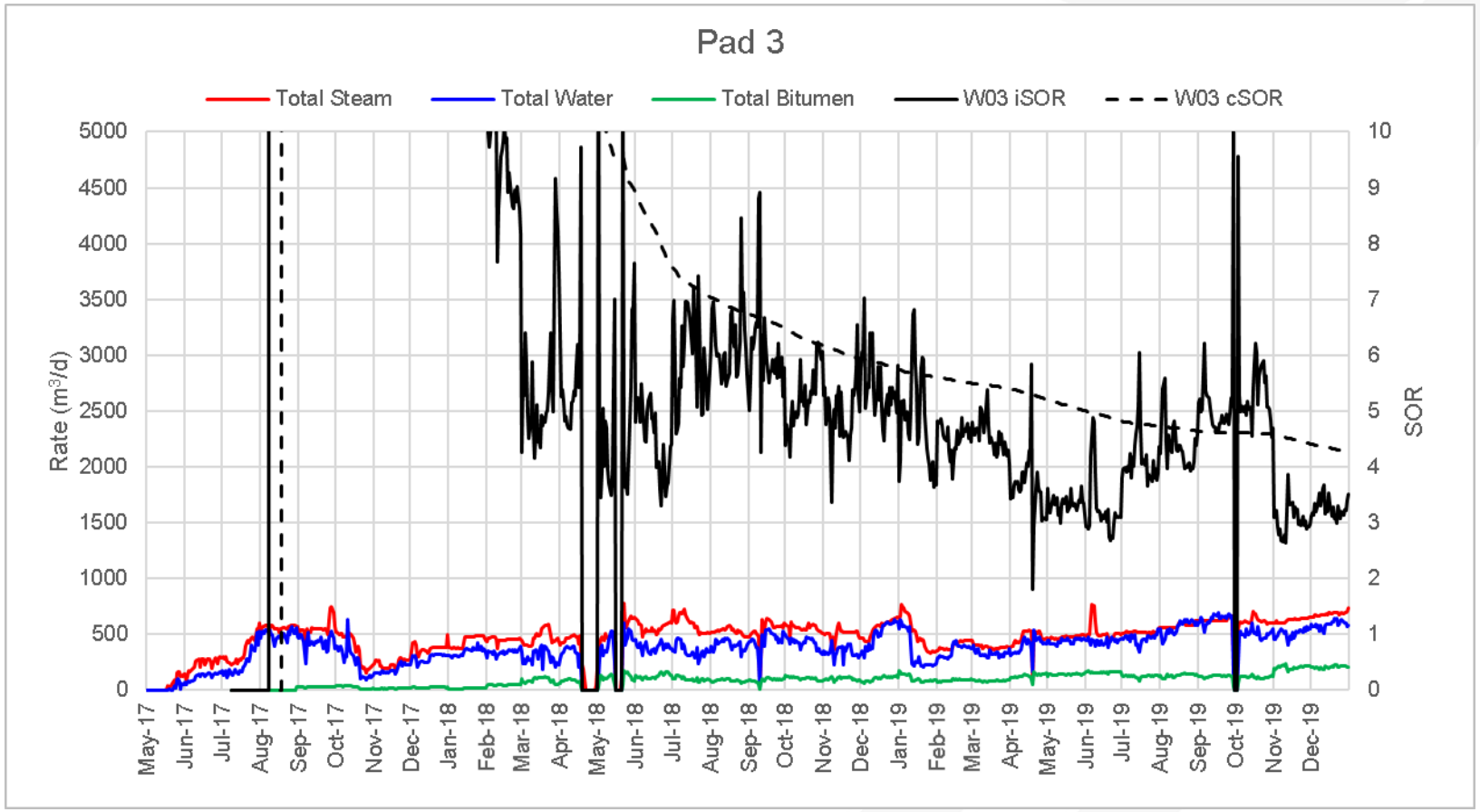
HE Phase 1 Pad Basis Performance – Pad 1



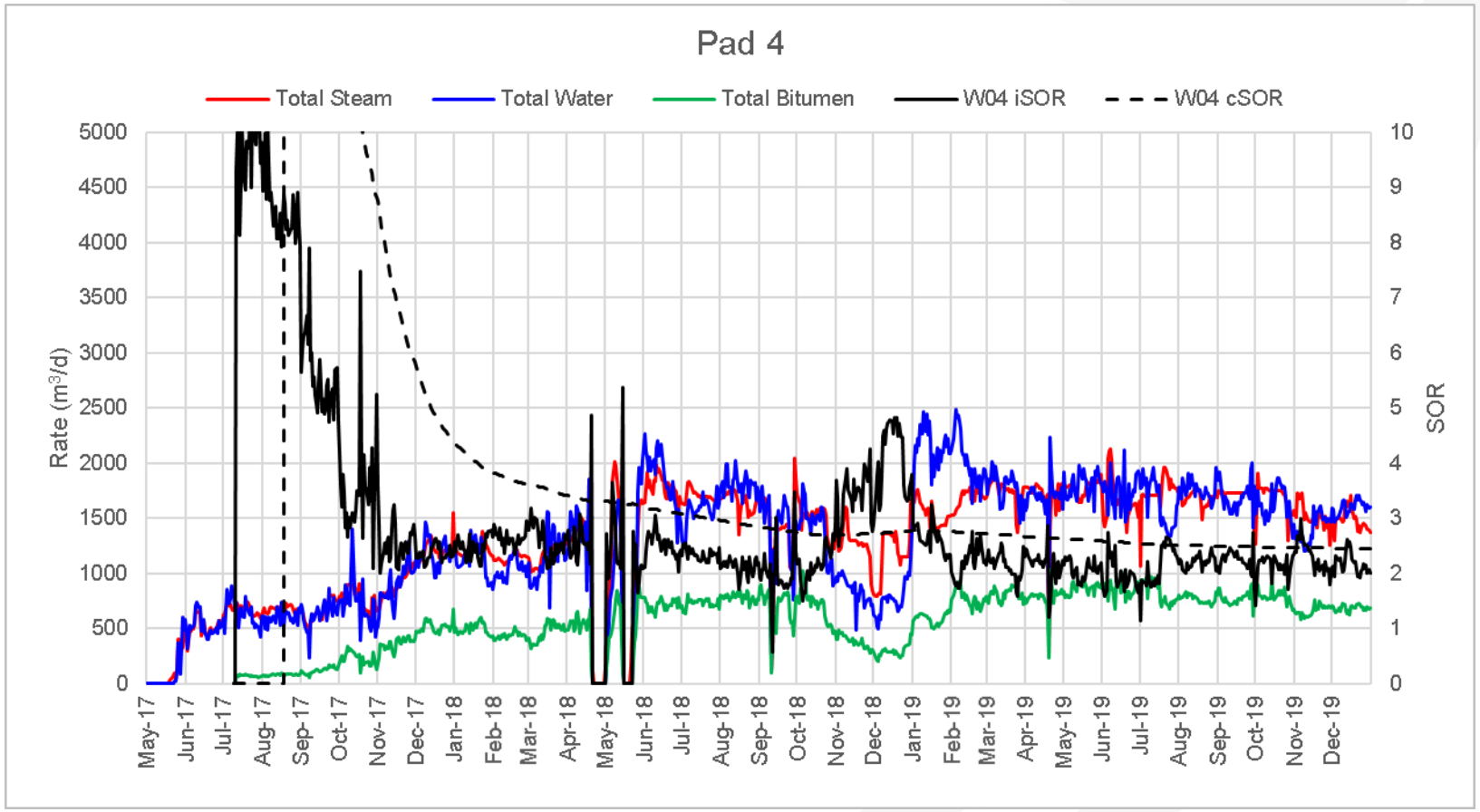
HE Phase 1 Pad Basis Performance – Pad 2



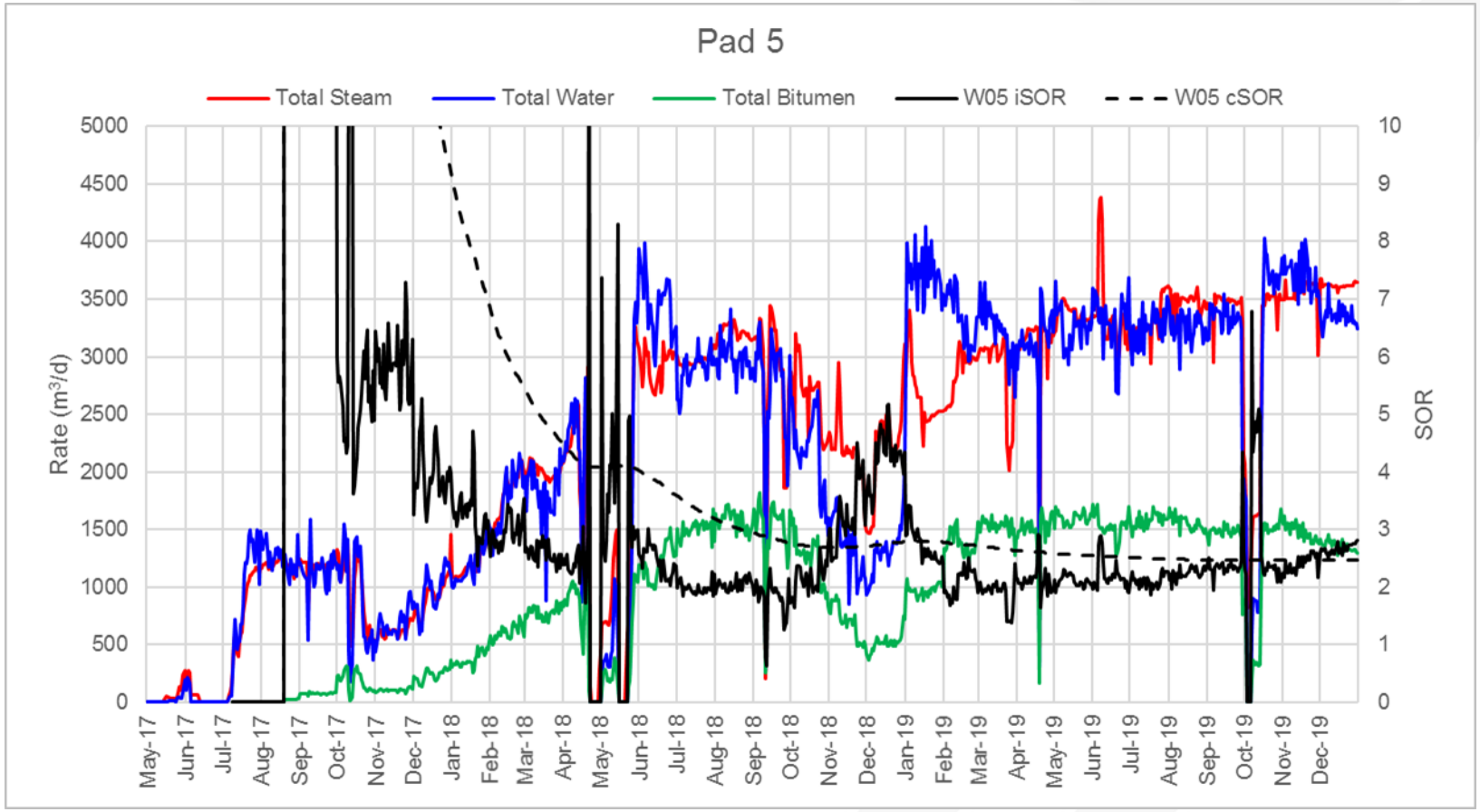
HE Phase 1 Pad Basis Performance – Pad 3



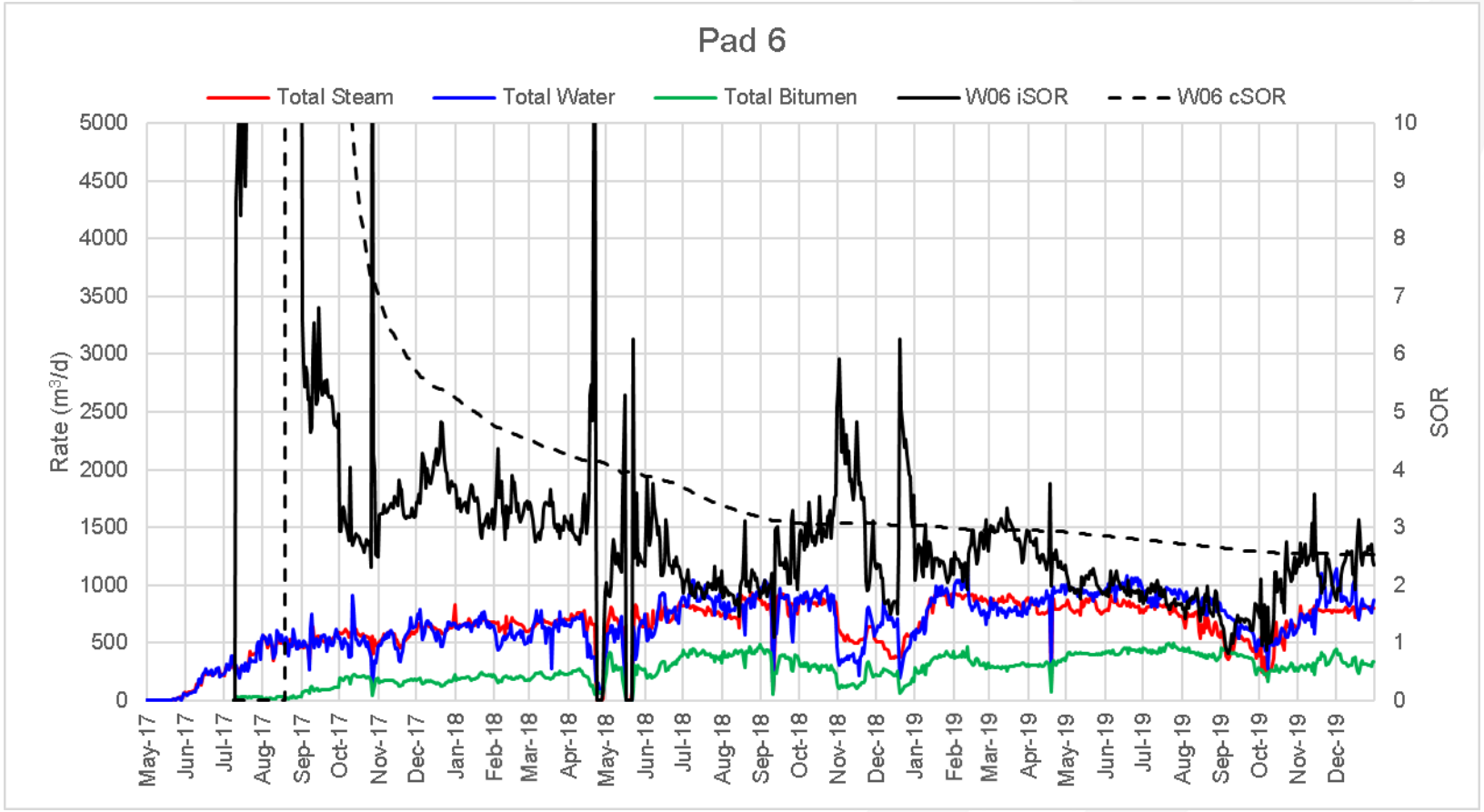
HE Phase 1 Pad Basis Performance – Pad 4



HE Phase 1 Pad Basis Performance – Pad 5



HE Phase 1 Pad Basis Performance – Pad 6



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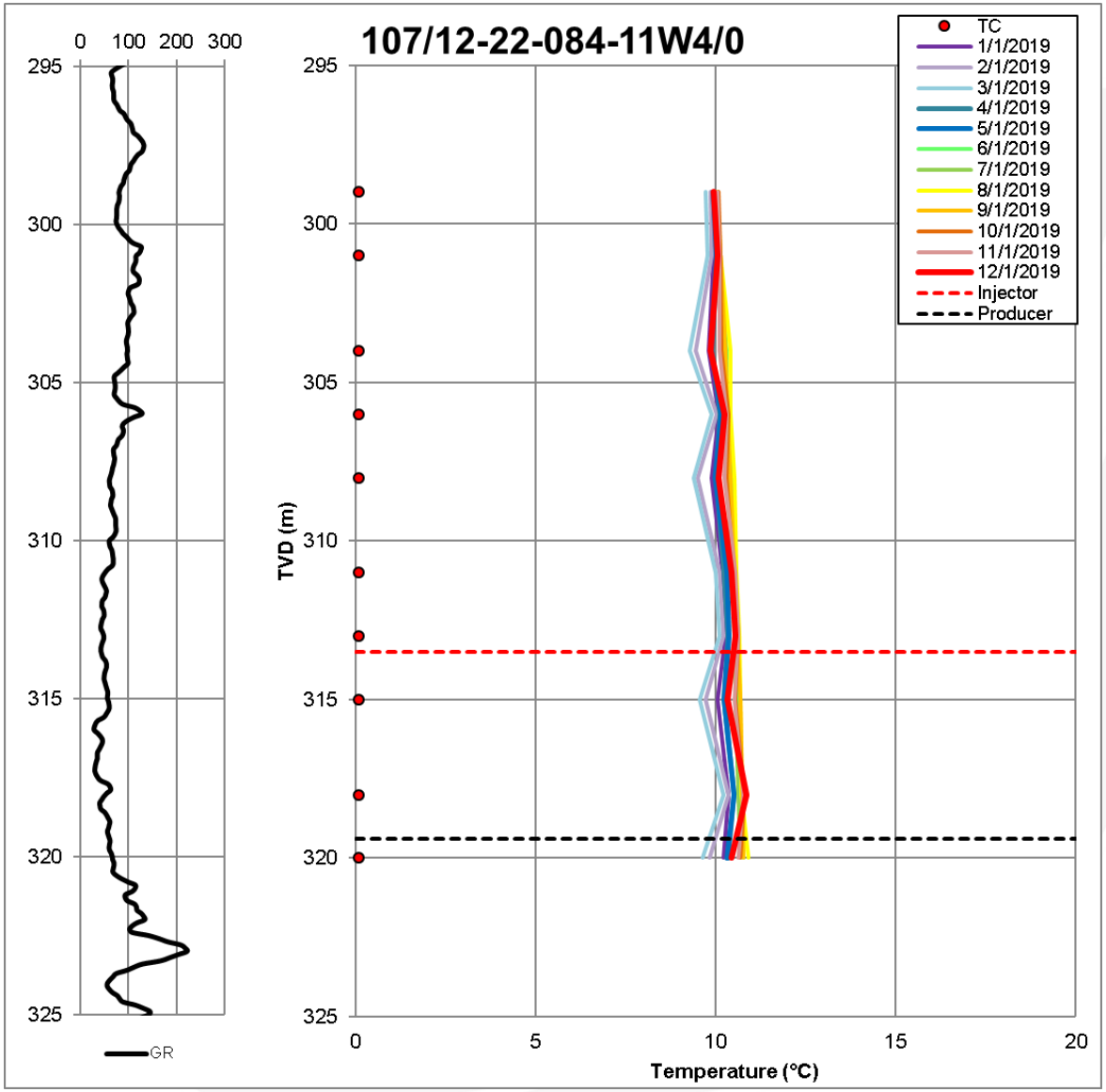
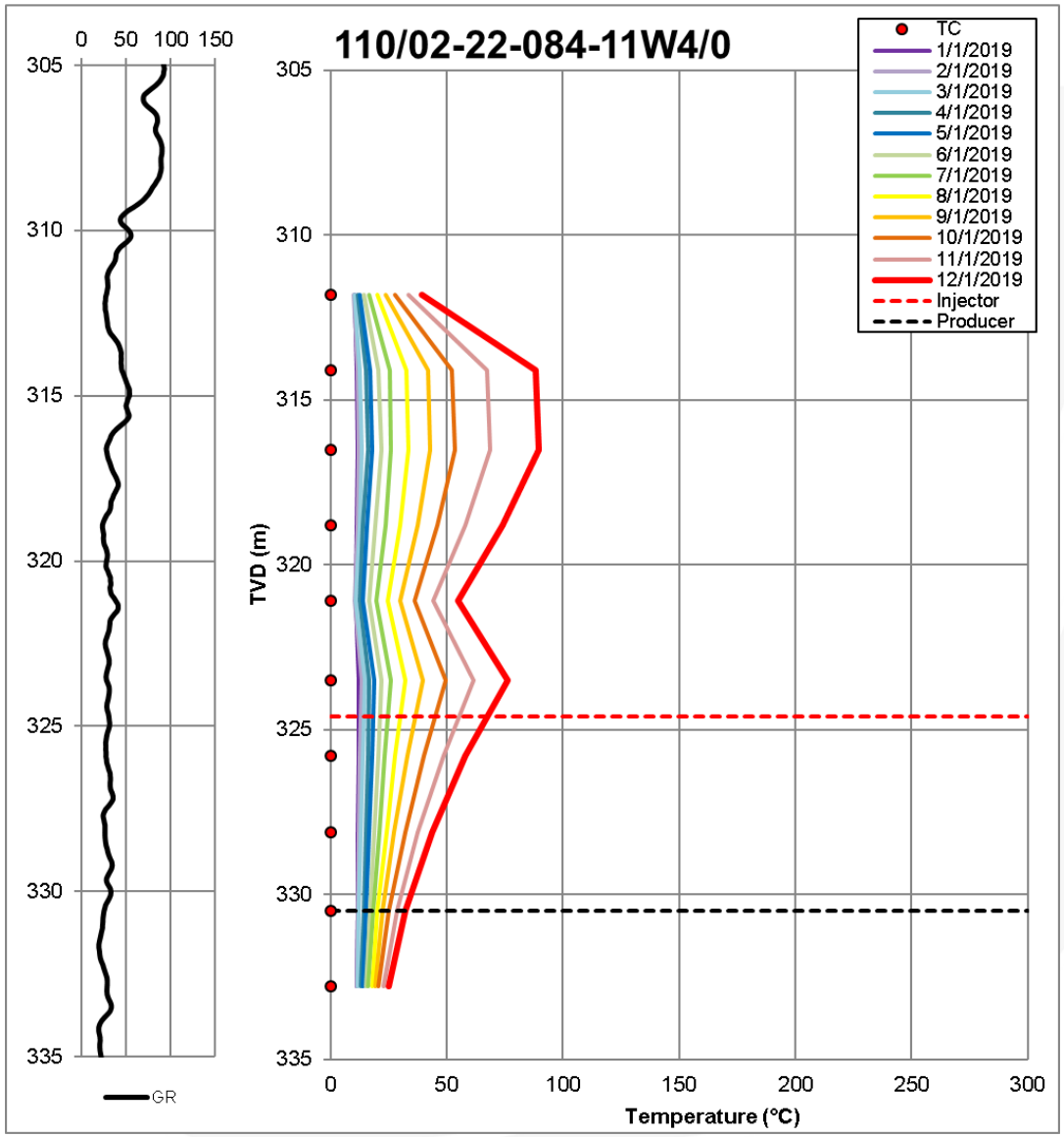
Appendix 5(b)

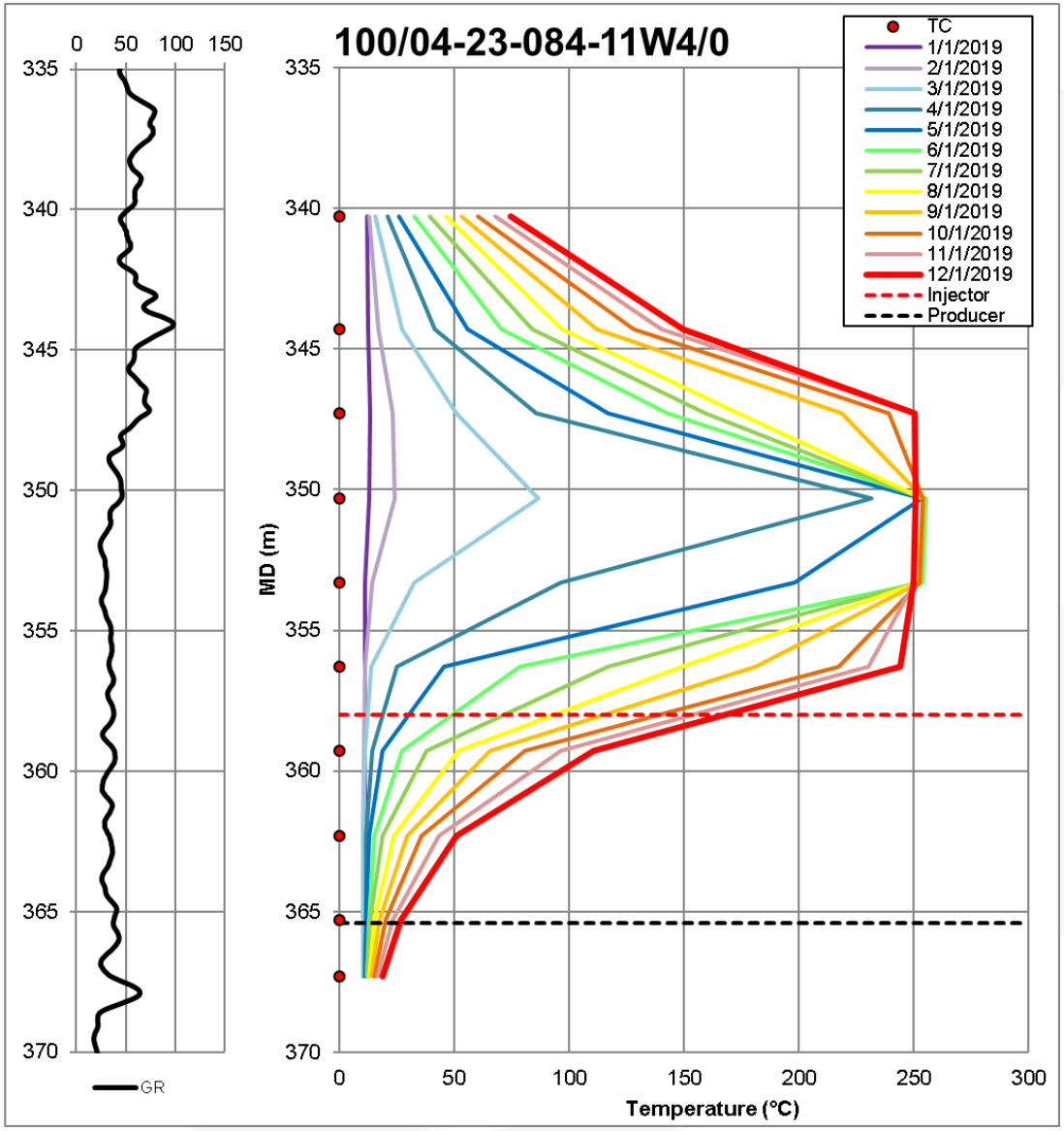
HE Phase 1 Observation Wells



HE Phase 1 Observation Wells

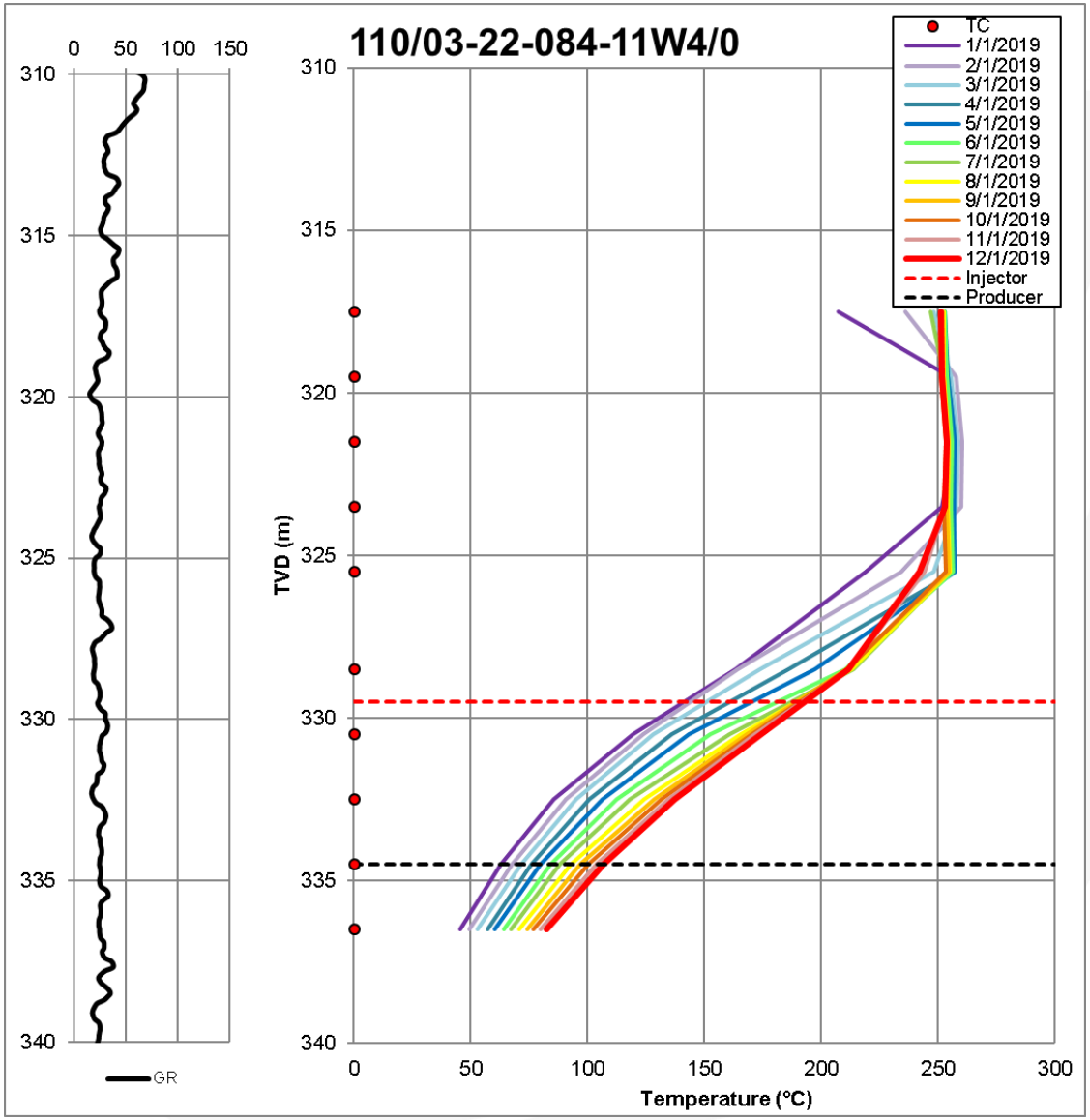


HE Phase 1 Observation Wells

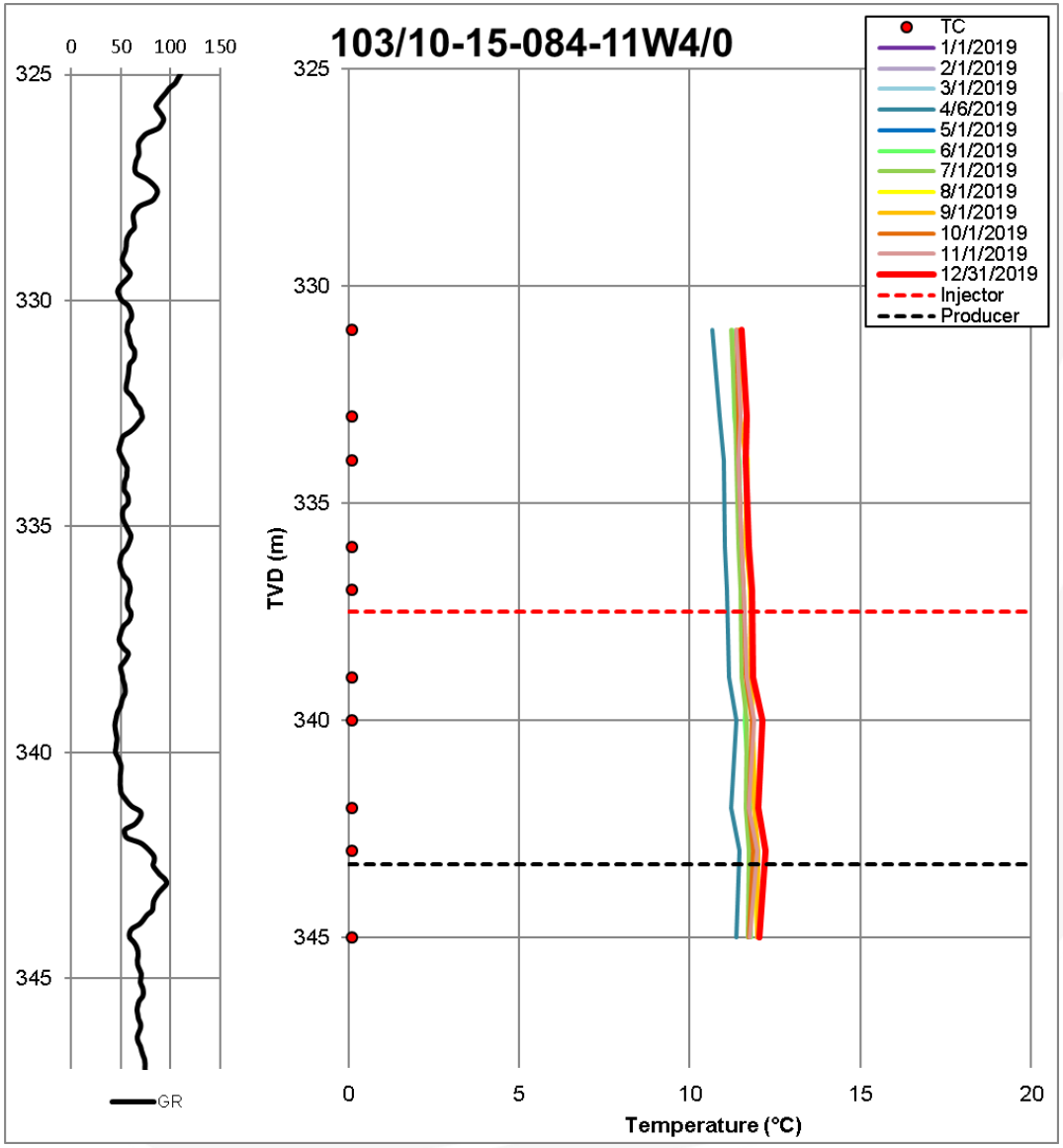


*Well is deviated. MD shown.

HE Phase 1 Observation Wells

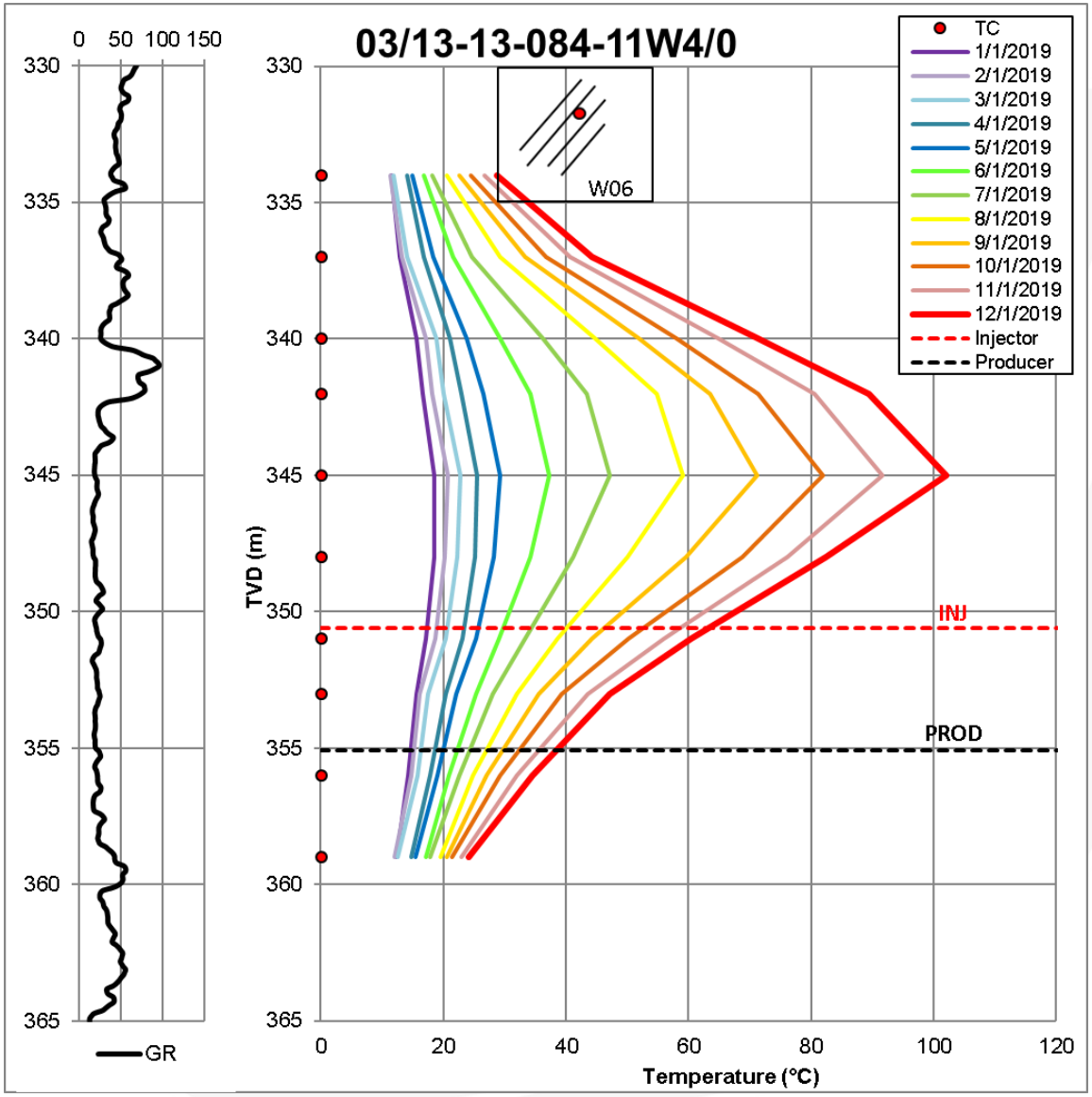


HE Phase 1 Observation Wells

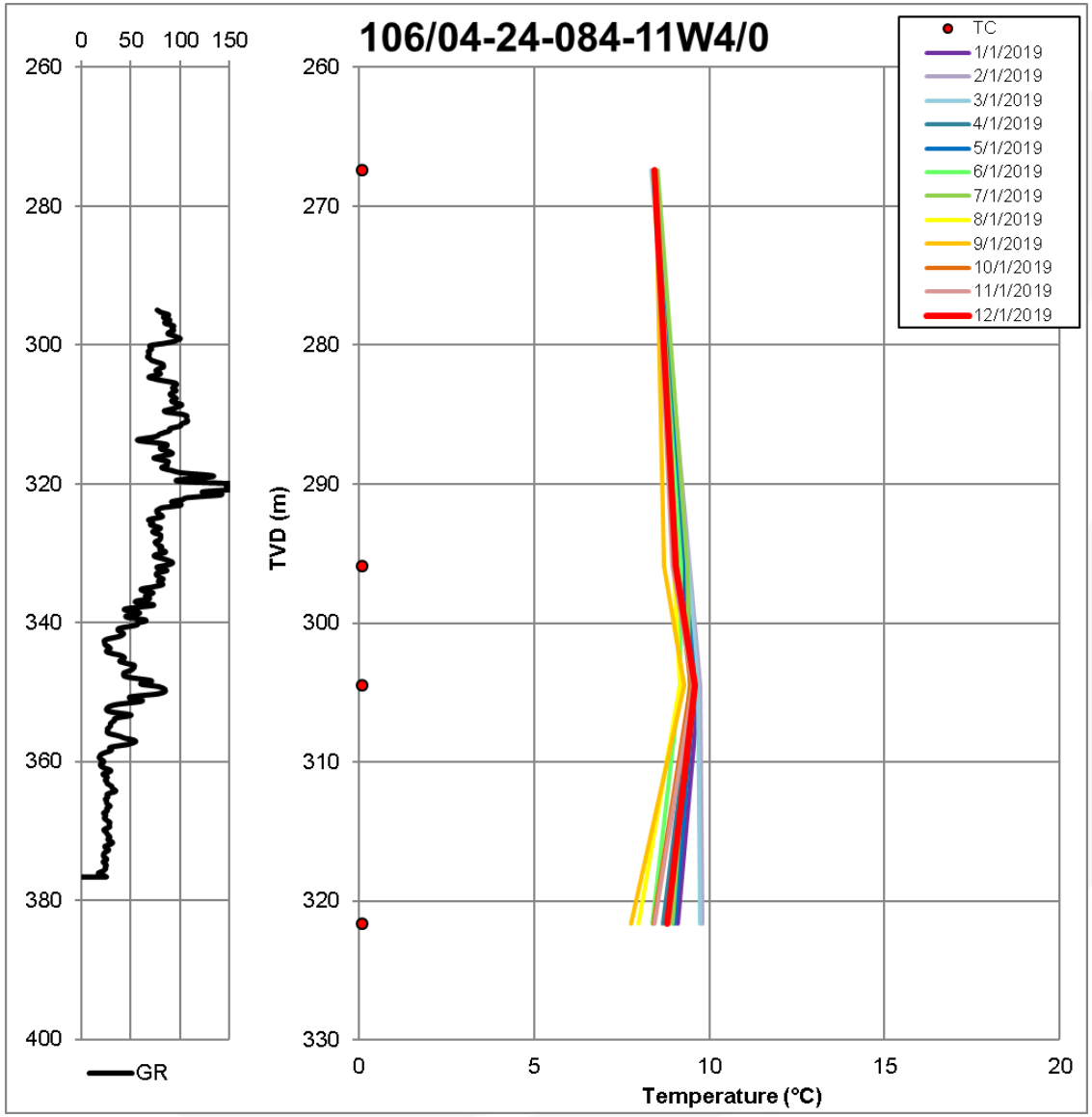


RTU issues on the first of the month for April and December 2019

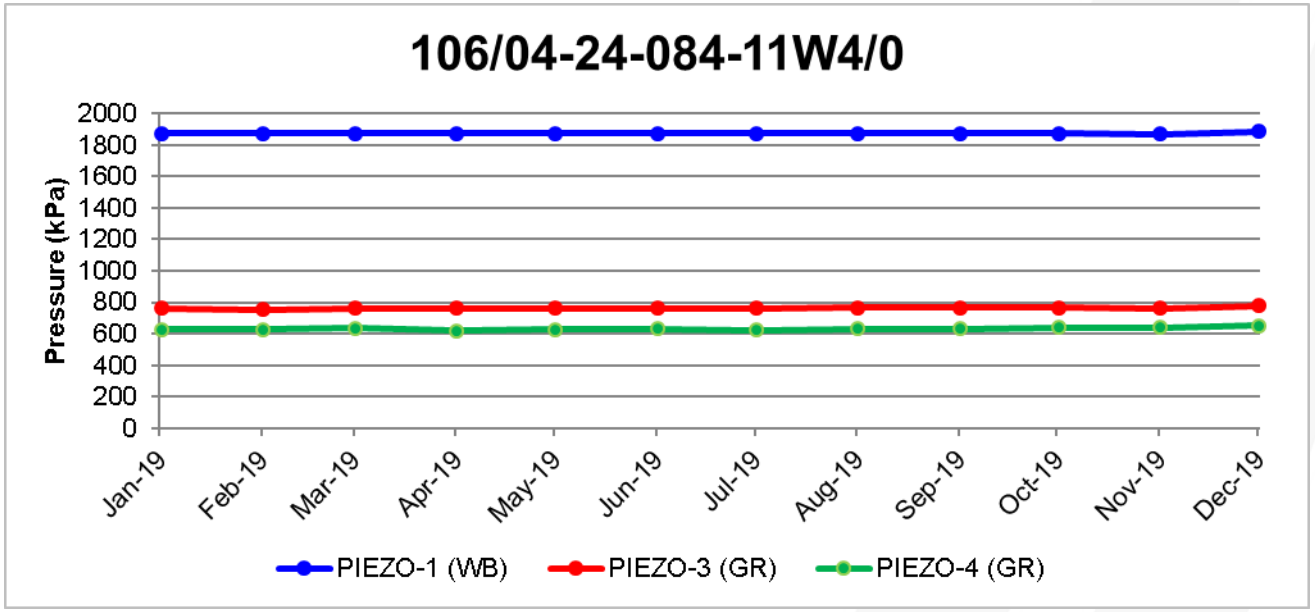
HE Phase 1 Observation Wells



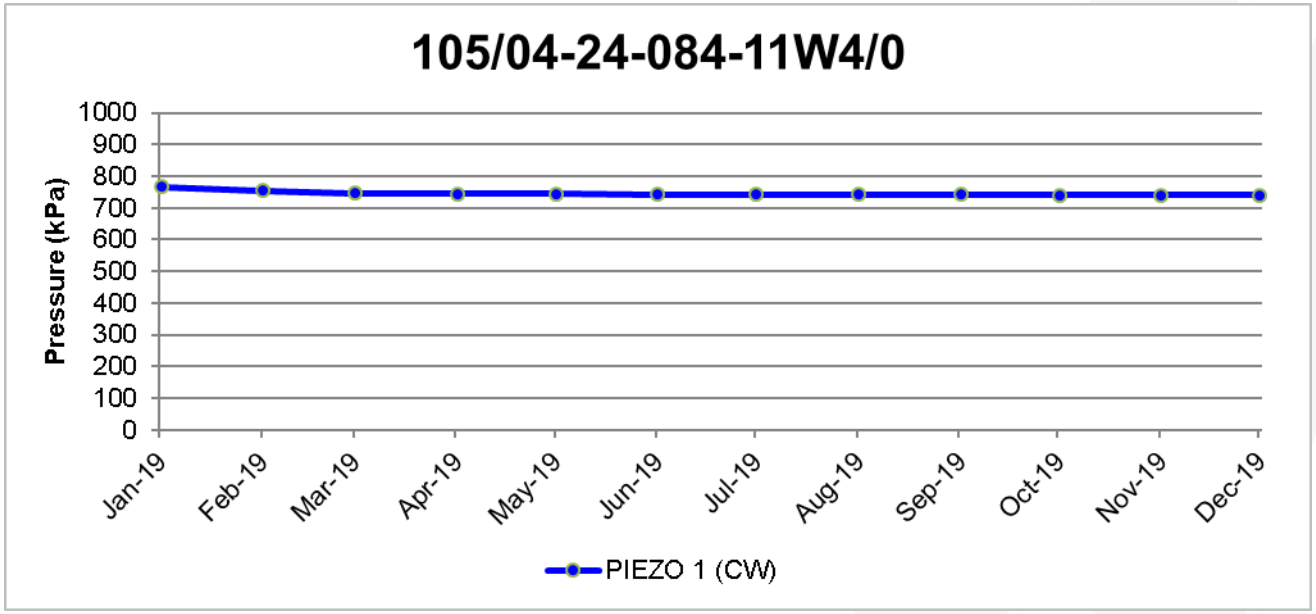
HE Phase 1 Observation Wells



HE Phase 1 Observation Wells

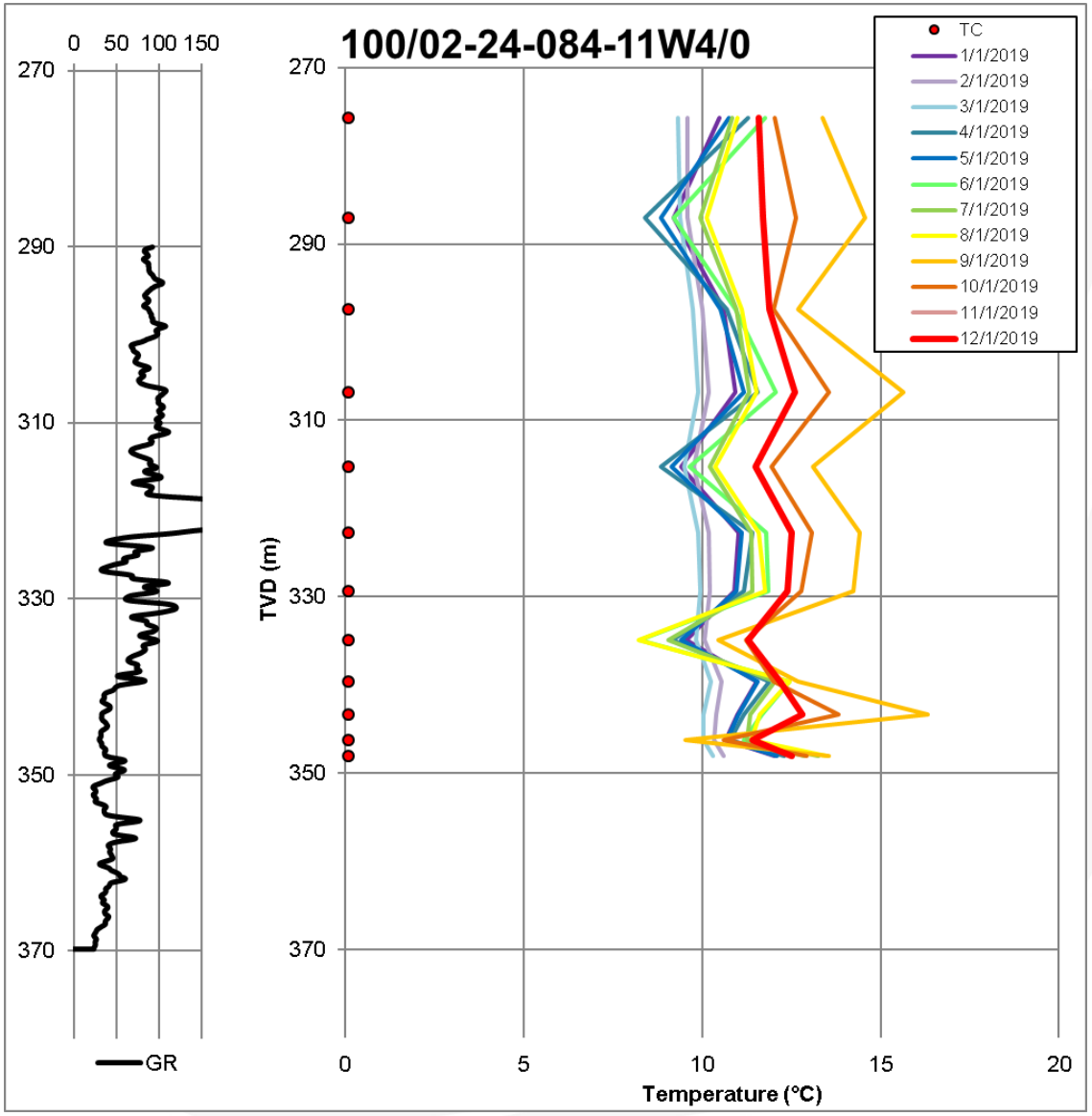


HE Phase 1 Observation Wells

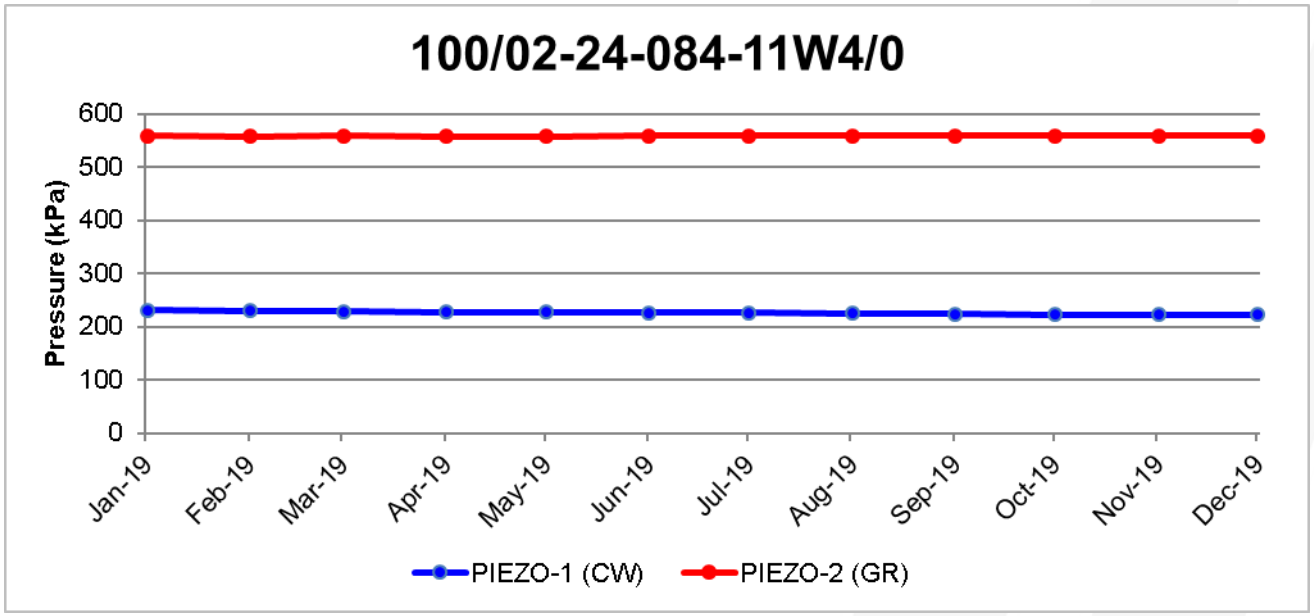


Well is deviated and has a hanging piezometer. Depth matches GR, but measures CW.

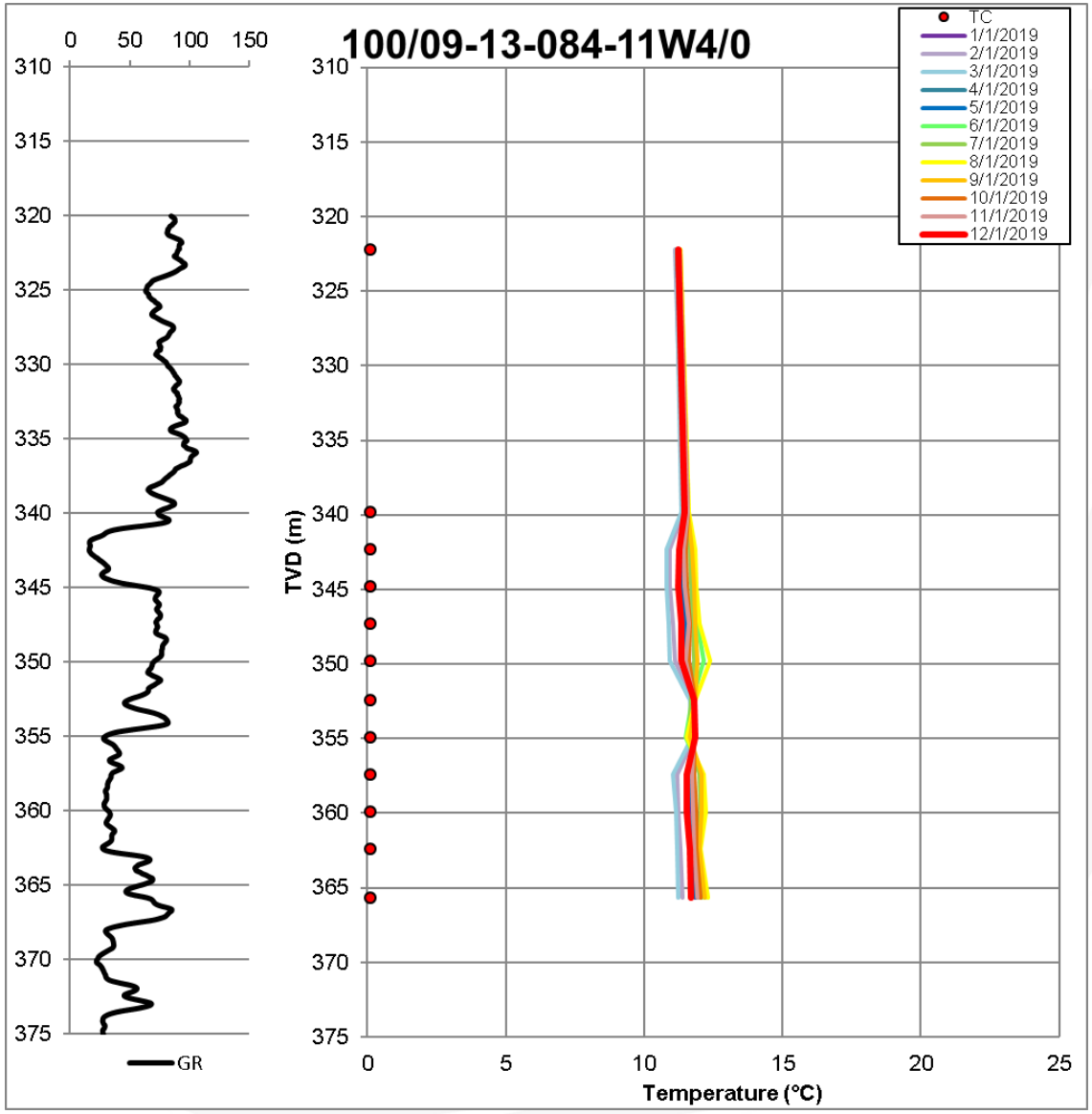
HE Phase 1 Observation Wells



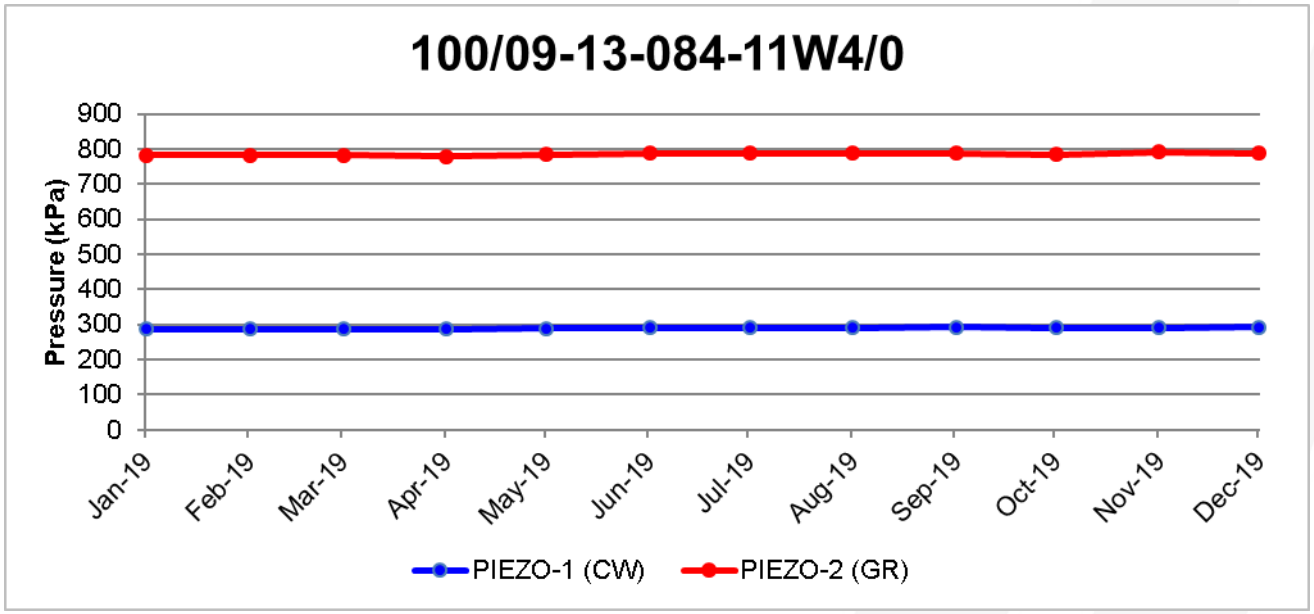
HE Phase 1 Observation Wells



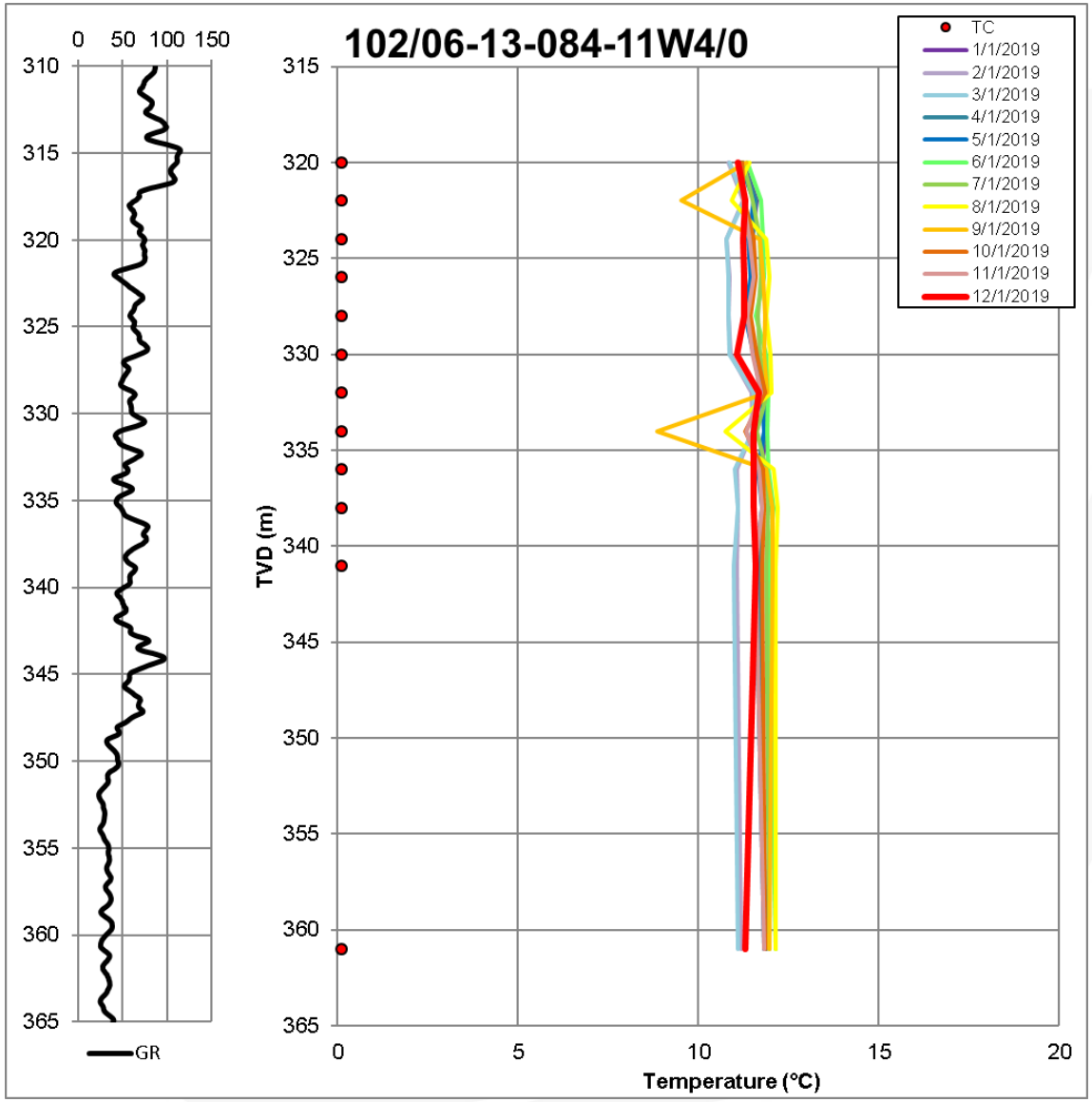
HE Phase 1 Observation Wells



HE Phase 1 Observation Wells



HE Phase 1 Observation Wells



HE Phase 1 Observation Wells