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June 13, 2013

Innovative Energy Technologies Program
Research and Technology Branch
9th Floor, Petroleum Plaza North
9945 - 108th Street
Edmonton, Alberta T5K 2G6

Attention: Christopher Holly
Branch Head
Research and Technology

Dear Mr. Holly:

Re: Imperial Oil CSP IETP Annual Project Technical Report

Attached is Imperial Oil's 2012 Annual Project Report for the CSP pilot as required under IETP Approval 06-094.

Please contact me at (403) 284-7536 or at john.f.elliott@esso.ca with any questions or concerns.

Yours truly,

____

J.F. (John) Elliott, P.Eng.
Manager, Oil Sands Recovery Research

Attachment
cc: Michelle Sieben, IOR
cc: Martin Mader, ADOE

IETP Application No. 06-094

Imperial Oil Resources – Cyclic Solvent Process Pilot

2012 Annual Project Technical Report

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1 Abstract

Imperial Oil Resources (Imperial) is conducting a Cyclic Solvent Process (CSP) experimental pilot scheme at Cold Lake in the Clearwater formation to be operated under Energy Resources Conservation Board (ERCB) Approval 11604, dated May 5, 2011.

CSP is a non-thermal, in-situ bitumen recovery process that utilizes injected solvent to reduce the viscosity of the bitumen, enabling its production from wells drilled for that purpose. The liquid-phase solvent is injected into a horizontal well cyclically and, because of the large mobility contrast between the solvent and the bitumen, it fingers into the bitumen. Following injection, the solvent-bitumen blend is produced from the same well. Cyclic injection and production operations continue for multiple cycles over several years until the bitumen produced no longer justifies the cost of the solvent or until the bitumen production rate is no longer economic.

The pilot is located at K50 pad in Imperial's Cold Lake development and is being conducted in the Clearwater formation. Three horizontal wells will be operated using CSP as a recovery process. The project is currently in the construction phase with no operations and little surveillance completed to date.

This report summarizes progress that was made through year-end 2012.

2 Summary Project Status Report

2.1 Members of the project team

The following were key members of the CSP project team to the end of 2012, with changes from our initial application noted:

J.F. (John) Elliott, P.Eng.	Oil Sands Recovery Research Manager *Added to the team October 1, 2011* *Replacing T.J. Boone*
T.J. (Tom) Boone, PhD, P.Eng.	ExxonMobil Senior Technical Professional *New role on team October 1, 2011*
D.E. (Dave) Courtnage, P.Eng.	CSP Team Lead
M. (Mori) Kwan, PhD, P.Eng.	CSP Pilot Lead *Retired September 30, 2012*
X. (Xiaomeng) Yang, P.Eng.	CSP Reservoir Engineer
A.J. (Andrew) Hodgetts, P.Eng.	Projects Manager Brownfield/Research
V. (Vera) Ivosevic, P.Eng.	CSP Project Manager

2.2 Key activities

Key activities during the reporting period are described below:

- Drilling and completion of the horizontal wells, discussed in Section 3.2
- Execution of the initial cross-well seismic survey, discussed in Section 5.2
- Completion of detailed facilities design
- Initiation of construction activities

2.3 Production, material and energy balance flow sheets

As of year-end 2012, operation of the pilot had not started, and there were thus no injected or produced volumes to be reported. Operation of the pilot is expected to begin in the spring of 2014. In the future, injection volumes will be shown in Table 1. Production volumes will be shown in Table 2. Other energy balance data will be shown in Table 3.

2.4 Reserves

A revised Petrel-based geologic model estimate of bitumen-in-place in the pilot area is 832 k m3. The current reservoir simulation estimate of recovery is 10.6 km3 after the planned five cycles of the pilot. The ratio of these values is not indicative of the recovery factor of the process – the wells have been spaced farther apart than would be anticipated during a commercial project, and the process may not run to an economic limit. Recovery factor and reserves will be determined by reservoir simulation at the completion of the pilot.

3 Well Information

3.1 Well Layout Map

A well layout map is shown in Figure 1. Surface facility and pad locations are shown in Figure 2.

3.2 Drilling, completion, and work-over operations

The first well drilled in the pilot area was OV well 14-18. This well was drilled in 2009 and used for selecting the pilot location.

Five additional observation wells were drilled in 2011. They were completed beginning in late 2011, finishing in early 2012. These wells are equipped with passive seismic geophones, thermal fiber heaters, and pressure and temperature sensors, in various configurations as outlined in Table 4, to assist in monitoring the pilot.

The three pilot horizontal wells were drilled in March 2012. All wells met their directional requirements. Final time was 27.7 days rig release to rig release, 21.0 days spud to rig release.

Surface holes of 17.5 in were drilled and 13.375 in surface casings were set at the depths indicated in Table 5 and cemented in place. A wireline log was run on the first hole to confirm the depth of the Colorado Shale formation top. Casing was set 15 m into competent shale. Intermediate holes of 12.25 in were drilled to an angle of ninety degrees and 9.625 in intermediate casing was set at depths indicated in Table 5 and cemented in place. A cement bond log was run prior to drilling out the lateral section.

Results of the cement bond logs are shown in Table 6. All three bond logs were satisfactory. All required zones are properly isolated. Cementing best practices were followed and required pump rates were obtained.

Lateral holes of 8.5 in were drilled with each section 110 m long. Five and a half inch slotted liners were run into the lateral holes. There are five limited entry perforation screens per well. See Figure 3. One swell packer is run per well. Total depths of the wells are shown in Table 5.

Wireline retrievable bridge plugs were placed a minimum of 5 m below the Grand Rapids formation top in each well. Two to two and a half metres of frac sand were placed on top of the plugs to secure the mandrel from any debris that might fall in the hole, pending the completions later in the fall.

Completions of the horizontal wells began in late 2012, with two problems experienced that have prevented finishing the work.

On HW-02, problems installing the heater and instrumentation string were experienced. With the heater and instrumentation string at depth, the electrical test of the heater failed. It had passed just 50 m above that depth. On pulling out of the hole, the thermocouples were found wrapped around the stinger tubing and the heater splices were bent. A root cause failure analysis was performed, indicating three separate problems: water entered one of the heater cable splices; the thermocouple string was not delivered as ordered causing the clamps to do a poor job holding it to the tubing; and, the liner hanger has an abrupt transition causing the heater splice to temporarily catch. The heater is being repaired, the thermocouple string is being replaced and solutions for entry into the liner hanger are being developed. The completion should be finished in late 2013, as the facilities construction schedule permits.

On HW-03, problems getting a seal on the second casing string packer were experienced. Three attempts were made using the packer in our original design. A fourth attempt was made using an alternate-design packer. It also failed. A root cause failure analysis concluded that multiple attempts to stab into the packer seal bore had damaged the seal elements. The casing string has been pulled from the well and appears to confirm the cause of the problem. After discussions with the packer vendor, a new packer will be re-run into the well, as facilities construction permits.

The status of the HW completions is summarized in Table 7.

There were no workovers attempted in the reporting period.

3.3 Well operation

None of the wells was in operation during the reporting period.

3.4 Well list and status

The pilot consists of six observation (OB) wells and three horizontal production wells:

IMP 08 OV COLD LK 14-18-65-4	UWI 1AA/14-18-065-04W4/00
IMP 10 CSP OB-1 LEMING 14-18-65-4	UWI 105/14-18-065-04W4/00
IMP 10 CSP OB-2 LEMING 14-18-65-4	UWI 100/14-18-065-04W4/00
IMP 10 CSP OB-3 LEMING 14-18-65-4	UWI 102/14-18-065-04W4/00
IMP 10 CSP OB-4 LEMING 14-18-65-4	UWI 103/14-18-065-04W4/00
IMP 10 CSP OB-5 LEMING 14-18-65-4	UWI 104/14-18-065-04W4/00
IMP 11 CSP H-01 LEMING 3-19-65-4	UWI 100/03-19-065-04W4/00
IMP 11 CSP H-02 LEMING 14-18-65-4	UWI 110/04-18-065-04W4/00
IMP 11 CSP H-03 LEMING 14-18-65-4	UWI 111/04-18-065-04W4/00

The layout of the wells is shown in Figure 1. The six OB wells are drilled from three pads and the three horizontal wells are drilled from a fourth pad, as shown in Figure 2.

3.5 Wellbore schematics

A general schematic of the three horizontal wells, to be completed similarly, is shown in Figure 3. Schematics of the six observation wells are shown in Figures 4a through 4f.

3.6 Spacing and pattern

The horizontal wells are spaced approximately 200 m apart, with approximately 100 m of drainage length per well. Adding 50 m to the potential drainage area on each end of each HW, the pilot encompasses 120,000 m^2 (600 m x 200 m), which is roughly 32.5 acres per well.

4 Production Performance

4.1 Injection and production history

There has been no injection or production to date. The pilot is expected to begin operating in the spring of 2014.

4.2 Composition of injected and produced fluids

There has been no injection or production to date.

4.3 Predicted vs. actual comparisons

There has been no injection or production to date. Predictions are still being finalized.

4.4 Pressures

There has been no injection or production to date. All wells are assumed to be at original reservoir pressure.

5 Pilot Data

5.1 Additional data

Due to the early stage of the project, little surveillance data has been collected to date. All wells were logged after drilling and an initial 3D seismic survey was shot over the area in 2010. During 2012, the initial shoot of the cross-well borehole tomography was completed, as discussed in the next section.

5.2 Interpretation of pilot data

Cross-Well Borehole Tomography

Pilot surveillance plans include shooting cross-well borehole tomography between the wells in an effort to better identify and quantify the conformance of the solvent injection. An initial base survey has been completed, with two repeat surveys, for solvent mapping, in the plan.

The base survey was completed in April 2012, with processing and interpretation taking place over the rest of the year. Nine lines were shot, as shown in Figure 5. The longer lines used ZTrac sources, the shorter lines used piezo-electric sources. The results of all nine lines are shown in Figure 6. For better illustration of the results, a representative ZTrac line, OB-1 to 14-18, is shown in Figures 7a and 7b. A representative piezo-electric line, OB-2 to OB-3 is shown in Figures 8a and 8b.

Results of the base cross-well borehole tomography are as follows:

- The surveys were very useful in defining the structure of the Clearwater Formation for use in the geological model. The base 3D seismic survey and the base cross-well borehole tomography survey were complementary.
- The surveys assisted in identifying areas of carbonate concretion deposition. The surveys confirmed initial modeling that the carbonate concretion deposition is not a continuous bed.
- A significant amount of noise was realized in the piezo-electric lines, due primarily to the proximity of the wells, some less than 50 m apart. Initial processing was successful at removing a large amount of the noise, but at the cost of some of the frequency.

We will evaluate methods of improving the processing of the data, but the current results provide little uplift over 3D surface seismic. The repeat surveys of the piezo-electric lines will have to be re-evaluated prior to proceeding.

6 Pilot Economics

6.1 Sales volumes of natural gas and by-products

There has been no solution gas produced to date.
There has been no recovered propane produced to date.
There has been no recovered diluent produced to date.

6.2 Revenue

As the CSP pilot is part of Imperial Oil's Cold Lake Production Project, injection and production volumes are blended with Mahihkan plant volumes, and thus revenue is not calculated separately. This section provides the methodology of the estimated revenue calculation.

Revenue is derived from four sources: sale of produced bitumen, the theoretical sale of produced solution gas (offsets natural gas purchases elsewhere in the operation), the theoretical sale of recovered propane (offsets natural gas purchases elsewhere in the operation), and the theoretical sale of recovered diluent (offsets diluent purchases for shipping the bitumen).

Prices used in the revenue calculation are shown in Table 8, with the source of the data.

Revenue is calculated for each source in Table 9. There has been no production, and therefore no revenue to date.

6.3 Drilling and facilities costs

Table 10 summarizes drilling, facilities, and related costs by category, incurred in 2012. Often these costs are referred to as capital costs, but because of the uniqueness and short life of the facilities, they have not been capitalized. Total drilling and facilities costs in 2012 were 33,257 k$.

6.4 Direct and indirect operating costs

Table 11 summarizes direct and indirect operating costs by category, incurred in 2012. There have been no operating costs incurred to date.

6.5 Injectant costs

Table 12 summarizes injectant costs by category, including trucking costs associated with transporting these volumes to site, incurred in 2012. There have been no injectant costs incurred to date.

6.6 Crown royalties

This pilot is part of Imperial Oil's Cold Lake Production Project, with revenue and costs impacting the total Cold Lake payable royalty. An estimation of the impact on royalty payable is shown in Table 13.

6.7 Cash flow

As revenue is only estimated for the pilot, cash flow can only be estimated. Using the data from Tables 9 through 13, it is estimated as follows:

Revenue	= Bitumen + Solution Gas + Recovered Propane + Recovered Diluent
	= 0 + 0 + 0 + 0
	= 0 k$
Costs	= Drilling & Facilities Costs + Operating Costs + Injectant Costs – CCEMC Credit
	= 33,257 + 0 + 0 – 2,400
	= 30,857 k$
Royalties	= -10,553 k$
Cash Flow	= Revenue – Costs – Royalties
	= 0 – 30,857 + 10,553
	= -20,304 k$

This estimation of cash flow does not include taxes.

6.8 Cumulative project costs and net revenue

Cumulative project costs to date are shown in Table 14. Cumulative project revenue is shown in Table 15.

6.9 Deviations from budgeted costs

Changes to individual cost components are expected. To date, there is no change to the total cost of the pilot.

7 Facilities

7.1 Major equipment items

Major equipment items include:

Vent Stack	STK-0061
Propane Vessel	V-0061, V-0062
Diluent Tank	T-0071, T-0072
Electric Solvent Heater	H-0051, H-0052
Diluent Transfer Pump	P-0071, P-0072
Propane Transfer Pump	P-0061, P-0062
Injection Pump	P-0051, P-0052
Utility Diluent Pump	P-0073
Diluent Filter	FIL-0071
Solvent Filter	FIL-0051, FIL-0052
Rotary Selector Valve	ROV-401
Liquid Separator	V-0003
Make-up Water Tank	T-0023
Vent Gas Pump	P-0030, P-0040
Liquid Cooler	E-0005
Make-up Water Pump	P-0024
Electric Test Fluid Heater	H-0053
Electric Production Fluid Heater	H-0054
Test Separator	V-0011
Pop Tank	T-0001
Instrument Air Package	PK-0021
Methanol Tank	T-0022
Methanol Injection Pump	P-0022

7.2 Capacity limitation, operational issues, and equipment integrity

No capacity limitations, operational issues or equipment integrity issues have been identified to date.

7.3 Process flow and site diagrams

For detailed PFDs and plot plan, please refer to Appendix A.

8 Environmental/Regulatory/Compliance

A copy of any approvals mentioned in the following sections, as well as amendments made, can be supplied upon request.

8.1 Regulatory Compliance

The project is operating under ERCB scheme approval 11604. To date, the pilot has been in full compliance, and no regulatory issues have arisen.

8.2 Environmental Considerations

The CSP pilot (construction, operation and reclamation) has been planned to align with the environmental objectives as outlined in the Cold Lake Expansion Project (CLEP) Environmental Impact Assessment (EIA) (Imperial Oil Resources, 1997) as well as with the requirements outlined in operating approval No. 73534-01-00 (as amended) issued by Alberta Environment and Sustainable Resources Development (ESRD) under the Alberta Environmental Protection and Enhancement Act (AEPEA). Numerous other directives and codes of practice have also been reviewed during the planning phase to ensure full compliance. Imperial has an internal database system populated with commitments, requirements and responsibilities as outlined in applicable regulations.

8.3 Air Quality

The CSP pilot has not resulted in any change to air emissions as considered in the EIA discussed previously. Imperial presently conducts air quality monitoring in the Cold Lake Operations (CLO) area outside of regulatory mandates and as a measure of due diligence, Imperial actively monitors the air quality of the CLO area air shed through placement of eleven passive air quality monitoring stations targeting H_2S and SO_2 gas emissions associated with operating CLO facilities.

8.4 Aquatic Resources

Imperial regularly conducts monitoring programs involving aquatic resources located within the CLO area including surface water, wetlands and groundwater. These programs are regularly expanded and modified as a consequence of field expansion. Imperial presently reports its water diversion volumes in response to corresponding regulations and is in full compliance with water diversion reporting requirements. The addition of the CSP pilot did not generate an increase in water demand.

A Wetland Monitoring Program (Imperial Oil Resources 2005) was implemented in 2006 in which wetland vegetation, water quality and flow dynamics are evaluated on a regular basis. Groundwater monitoring instrumentation is utilized proximal to wetland areas to monitor water flow and drainage performance as well as to monitor water quality/chemistry. Setback requirements associated with environmentally sensitive areas have been maintained in proposed pad and facilities designs.

8.5 Wildlife

Imperial develops its project schedules in a manner consistent with applicable regulations. Environmental aspects are considered and evaluated during the pre-construction planning phase of all Cold Lake projects with special attention paid to wildlife habitat and movement issues. The

CSP development was conducted with the objective of minimizing disturbance to wildlife habitat and movement.

During production, Imperial personnel adhere to the Wildlife Mitigation and Monitoring Plan which outlines specific actions and responsibilities designed to reduce operations-related risks to wildlife and wildlife habitat in the CLO area.

Reclamation plans are developed and implemented with particular attention paid to returning the land to an equivalent land capability. Wildlife use of reclaimed sites is a key aspect of reclamation success and will be monitored through the Cold Lake Reclamation Monitoring Program.

8.6 Noise

Through direct consultation with regulators and other stakeholders, Imperial has developed a noise prediction model to meet the requirements of ERCB Directive 038 (ERCB 2007). The entire Cold Lake Expansion Project has shown to be significantly below the allowable p sound level (PSL).

8.7 Reclamation

The CSP pilot decommissioning and reclamation activities will be addressed in accordance with EPEA Approval 73534-0-00, as amended.

9 Future Operating Plan

9.1 Project schedule

Availability and competition for some project resources and the problems with the well completions discussed in section 3.2 have impacted the original construction schedule. A current list of completion dates for key activities is given below:

Skid Fabrication	March 2013
Mechanical completion	December 2013
Well completions	January 2014
Pre-commissioning	March 2014
Commissioning	April 2014
Start Up	May 2014

We are investigating opportunities to accelerate the schedule.

9.2 Changes in pilot operation

Currently, no changes have been implemented to the pilot operation.

9.3 Optimization strategies

Currently, no optimization strategies have been implemented.

9.4 Salvage update

Currently, no plans to salvage any of the equipment on site have been developed.

10 Interpretations and Conclusions

10.1 Overall performance assessment

With construction ongoing, and pilot operation not yet commenced, no performance assessment of the recovery process has been made.

Table 1 – Material Balance Data – Production

Produced Volumes (m^3)	Bitumen	Water	Sol'n Gas	Propane	Diluent
January	0	0	0	0	0
February	0	0	0	0	0
March	0	0	0	0	0
April	0	0	0	0	0
May	0	0	0	0	0
June	0	0	0	0	0
July	0	0	0	0	0
August	0	0	0	0	0
September	0	0	0	0	0
October	0	0	0	0	0
November	0	0	0	0	0
December	0	0	0	0	0
Total 2012	**0**	**0**	**0**	**0**	**0**

Table 2 – Material Balance Data – Injection

Injected Volumes (m^3)	**Propane**	**Diluent**
January	0	0
February	0	0
March	0	0
April	0	0
May	0	0
June	0	0
July	0	0
August	0	0
September	0	0
October	0	0
November	0	0
December	0	0
Total 2012	**0**	**0**

Table 3 – Energy Balance Data

	Electricity (kWhr)	Steam (m^3)	Air (m^3)	Water (m^3)
January	0	0	0	0
February	0	0	0	0
March	0	0	0	0
April	0	0	0	0
May	0	0	0	0
June	0	0	0	0
July	0	0	0	0
August	0	0	0	0
September	0	0	0	0
October	0	0	0	0
November	0	0	0	0
December	0	0	0	0
Total 2012	**0**	**0**	**0**	**0**

Table 4: Observation Well Completions

Well	Completion				Status
	Thermal Fiber Heater	Passive Seismic Geophones	Pressure Measurement	Temperature Measurement	
14-18	✓			✓	Completed
OB-1		✓	✓	✓	Completed
OB-2		✓			Completed
OB-3	✓		✓	✓	Completed
OB-4	✓			✓	Completed
OB-5		✓	✓	✓	Completed

Table 5: Horizontal Well Casing Set Depths

	CSP H-01	CSP H-02	CSP H-03
Surface Casing (m MD)	181	183	183
(m TVD)	181	183	183
Intermediate Casing (m MD)	707	670	758
(m TVD)	465.4	465.2	465.3
Total Depth (m MD)	817.3	780.5	867.6
(m TVD)	465.4	465.2	465.3

Table 6: Horizontal Well Cement Bond Log Quality Summary

	CSP H-01	CSP H-02	CSP H-03
Good Quality (%)	94.5	98.1	95.9
Adequate Quality (%)	0.1	0.2	0.2
Low Quality (%)	5.4	1.7	3.9
Probable Cement Top (m KB)	14.3	15.0	17.7

Table 7: Horizontal Well Completions

Well	Liner	Dual Casing	Instrumentation	Pump
CSP HW-01	Installed	Installed	Installed	Later
CSP HW-02	Installed	Installed	Incomplete	Later
CSP HW-03	Installed	Incomplete		Later

Table 8: Prices Used in Revenue Calculation

Prices	2012	Units
Bitumen[1]	59.76	C$/bbl
Solution Gas[1]	2.33	C$/mcf
Recovered Propane[2]	9.29	C$/bbl
Recovered Diluent[3]	100.84	C$/bbl

[1] Actual average prices from Imperial Oil's 2012 10-K filing
[2] Propane price is a natural gas equivalent based on a heating value of 1016 MJ/mcf for natural gas and 4052 MJ/bbl for propane
[3] Sproule database December 31, 2012 – FOB Edmonton, diluent is pentanes plus

Table 9: Revenue Calculated by Revenue Source

Revenue (k$)	2012
Bitumen	0
Solution Gas	0
Recovered Propane	0
Recovered Diluent	0
Total Revenue	**0**

Table 10: Drilling and Facilities Costs

Drilling and Facilities Costs (k$)	**2012**
Preliminary Engineering	0
Surface Facilities	20,378
OB Well Drilling	-117
HW Drilling	5,289
Completions	6,233
Geo Surveillance	1,474
Total Drilling and Facilities Costs	**33,257**

Table 11: Operating Costs

Direct and Indirect Operating Costs (k$)	**2012**
Operating Costs	0
TOTAL	0

Table 12: Injectant Costs

Injectant Costs (k$)	**2012**
Propane	0
Diluent	0
TOTAL	0

Table 13: Estimated Crown Royalty Calculation

Crown Royalties (k$)	2009	2010	2011	2012	Total
Pilot Revenue[1]	0	0	0	0	0
Pilot Costs[2]	563	1,631	8,991	33,257	44,441
CCEMC Credit[3]				2,400	2,400
Pilot Cash Flow	-563	-1,631	-8,991	-30,857	-42,041
Cold Lake Royalty Rate[4]	27.8%	30.9%	33.8%	34.2%	-
Cold Lake Royalty Impact	-156	-504	-3,039	-10,553	-14,252
Total Cold Lake Royalties[4]	438,162	628,311	934,732	680,330	-

[1] Estimated, see section 6.2 for assumptions
[2] Based on IETP claim form submissions, see sections 6.3, 6.4 and 6.5
[3] Grant received from Climate Change and Emissions Management (CCEMC) Corporation offsetting pilot costs. Credit is shown in year earned, independent of when it was received.
[4] Total Cold Lake rate and royalties paid, which include CSP Pilot costs and revenue. Values may change from previous submissions due to revisions.

Table 14: Cumulative Project Costs

Cumulative Costs (k$)	2009	2010	2011	2012	Total
Drilling & Facilities Costs	1,375	829	8,980	33,257	44,441
Operating Costs	0	0	0	0	0
Injectant Costs	0	0	0	0	0
Total Costs	**1,375**	**829**	**8,980**	**33,257**	**44,441**

Table 15: Cumulative Project Revenue

Cumulative Revenue (k$)	2009	2010	2011	2012	Total
Bitumen	0	0	0	0	0
Solution Gas	0	0	0	0	0
Recovered Propane	0	0	0	0	0
Recovered Diluent	0	0	0	0	0
Total Revenue	**0**	**0**	**0**	**0**	**0**

[1] Estimated, see section 6.2 for assumptions

Figure 1: Well Layout

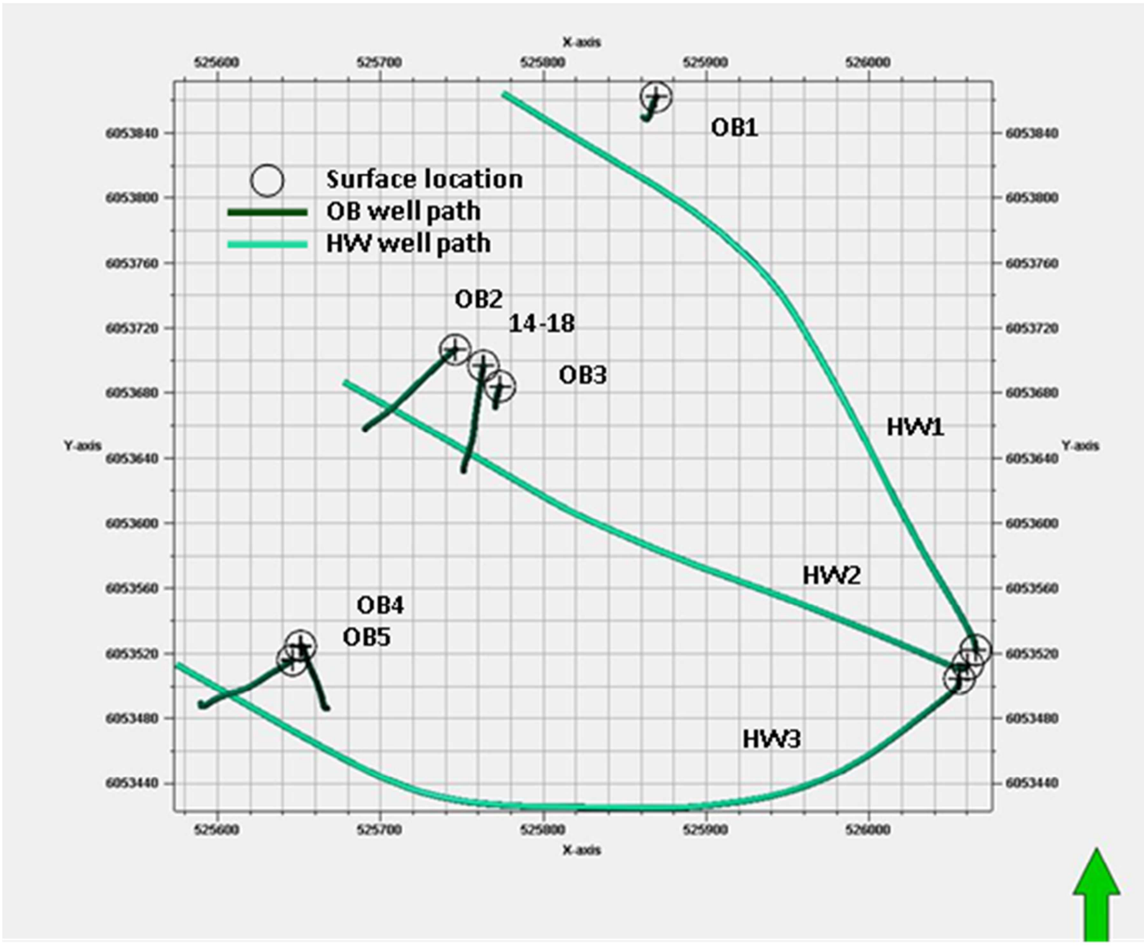


Figure 2: Surface Facility and Pad Locations

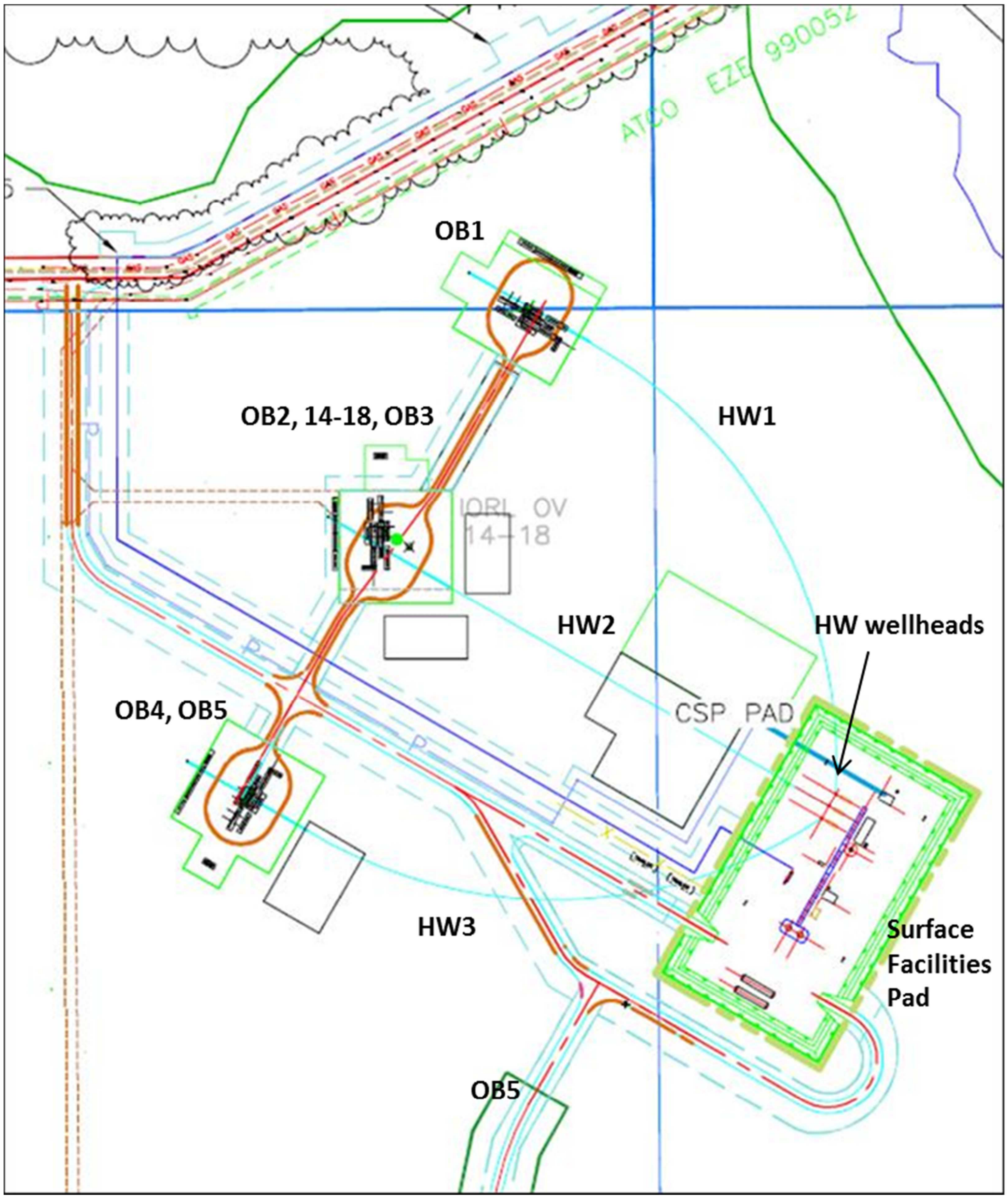


Figure 3: General CSP Horizontal Well Schematic

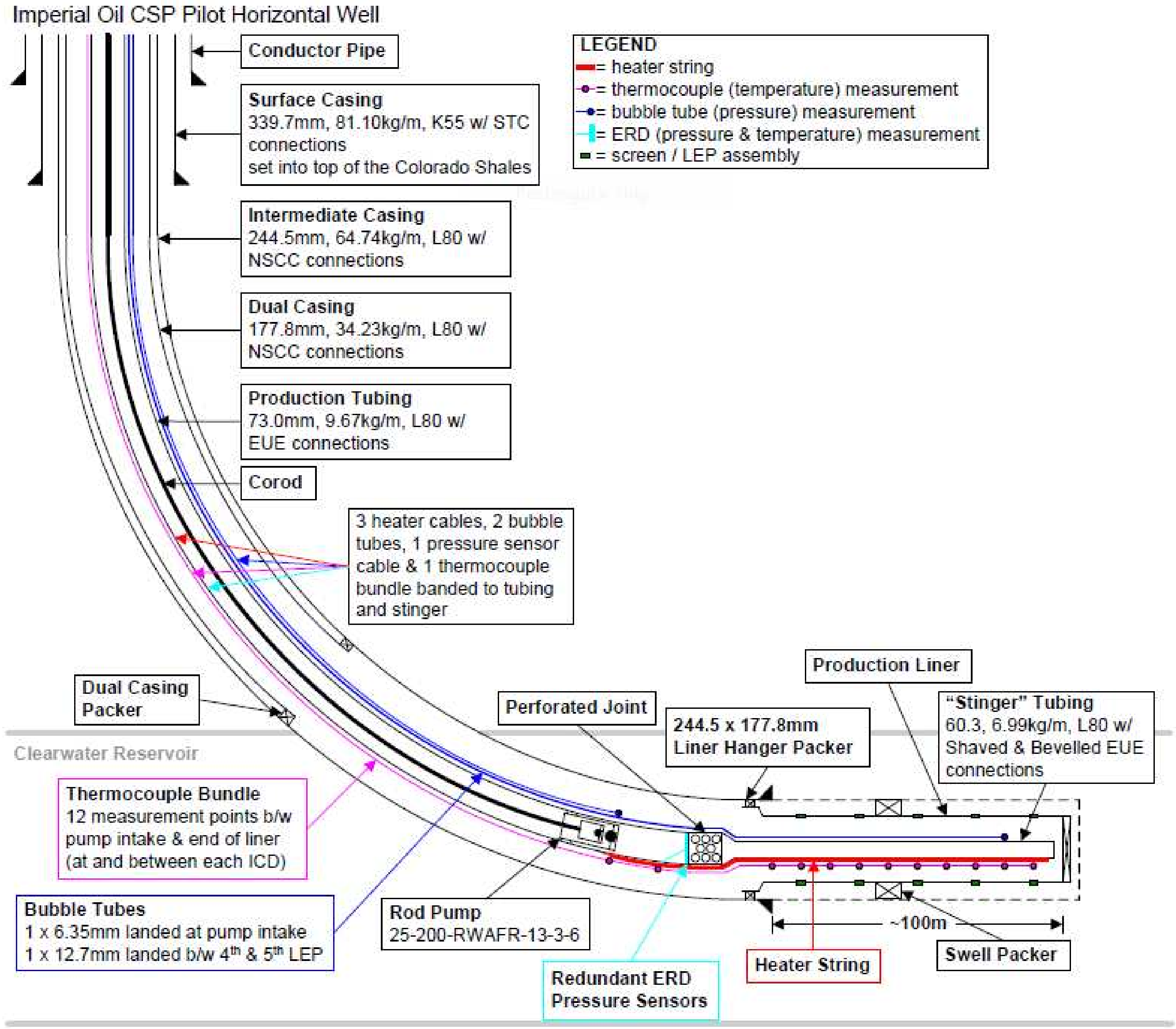


Figure 4a: Completion Diagram for Well OB1

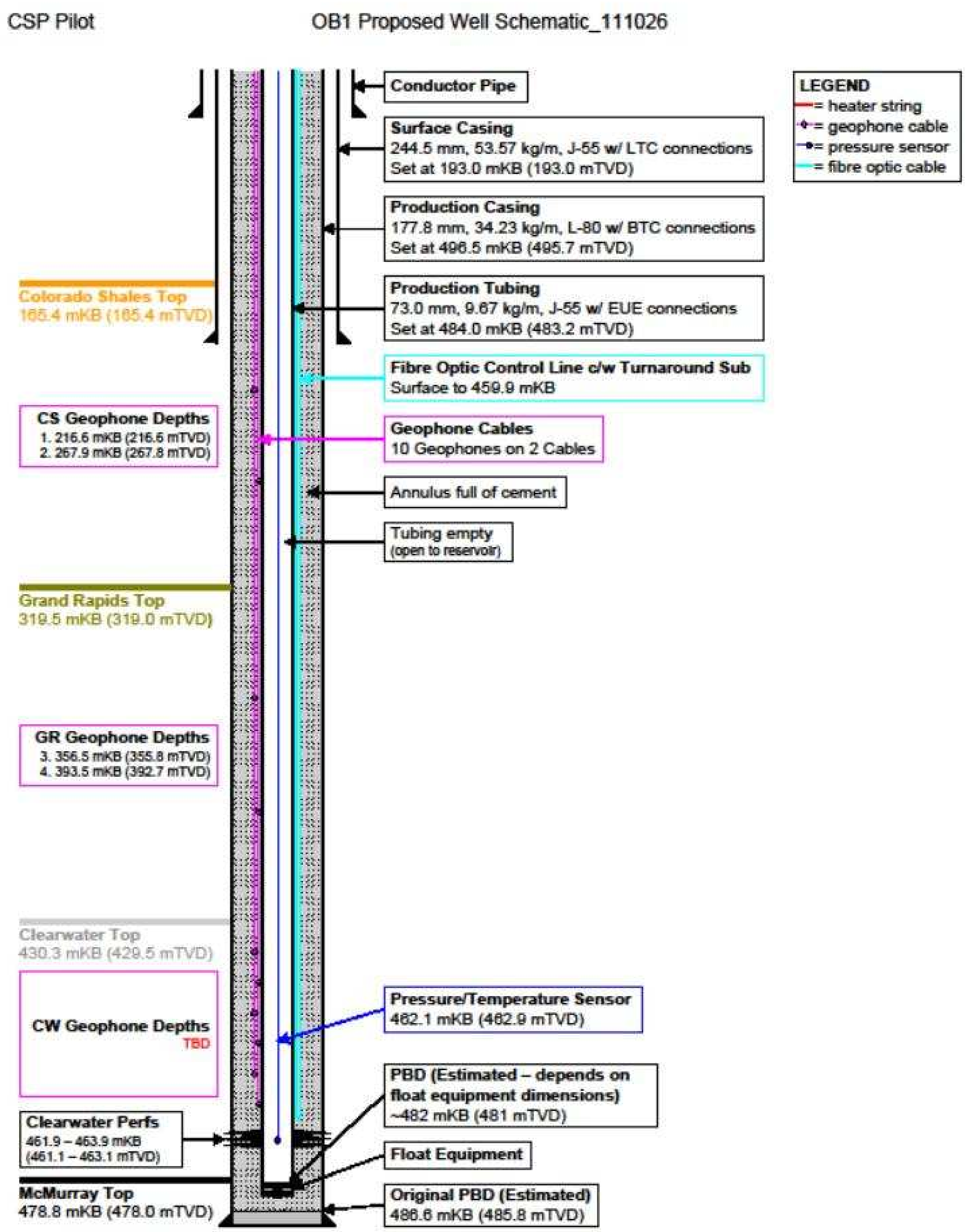
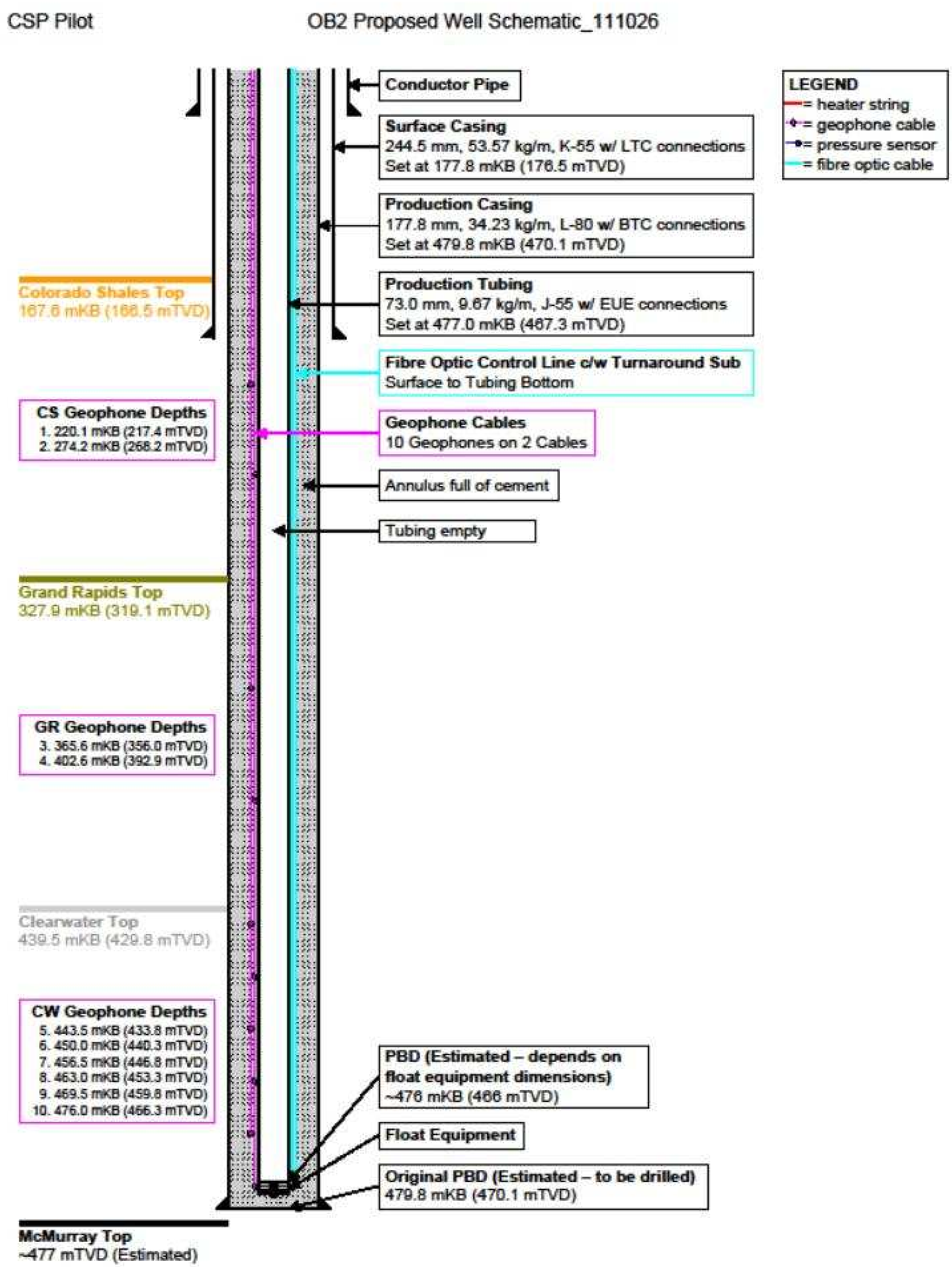


Figure 4b: Completion Diagram for Well OB2



<u>Figure 4c: Completion Diagram for Well OB3</u>

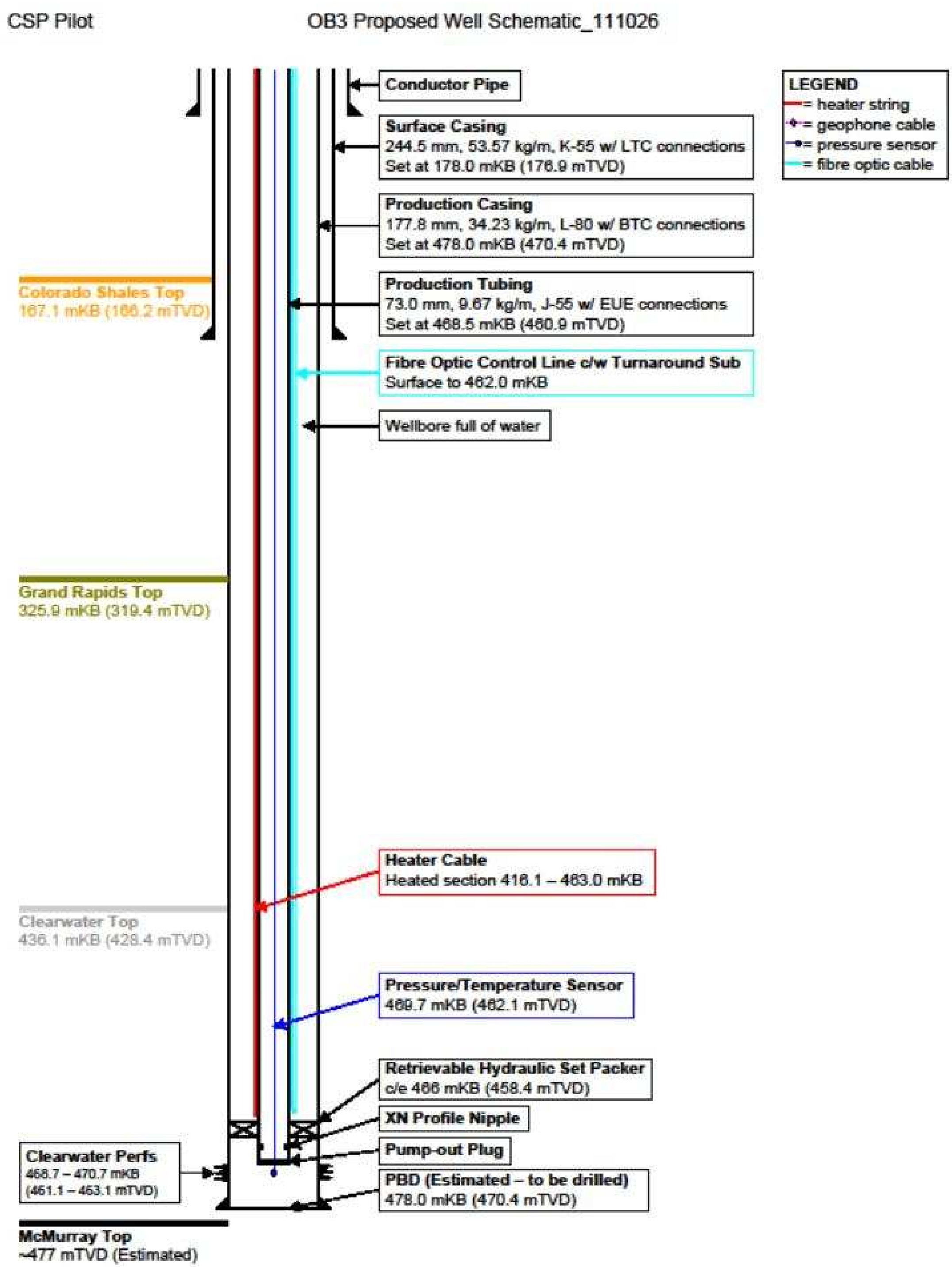


Figure 4d: Completion Diagram for Well OB4

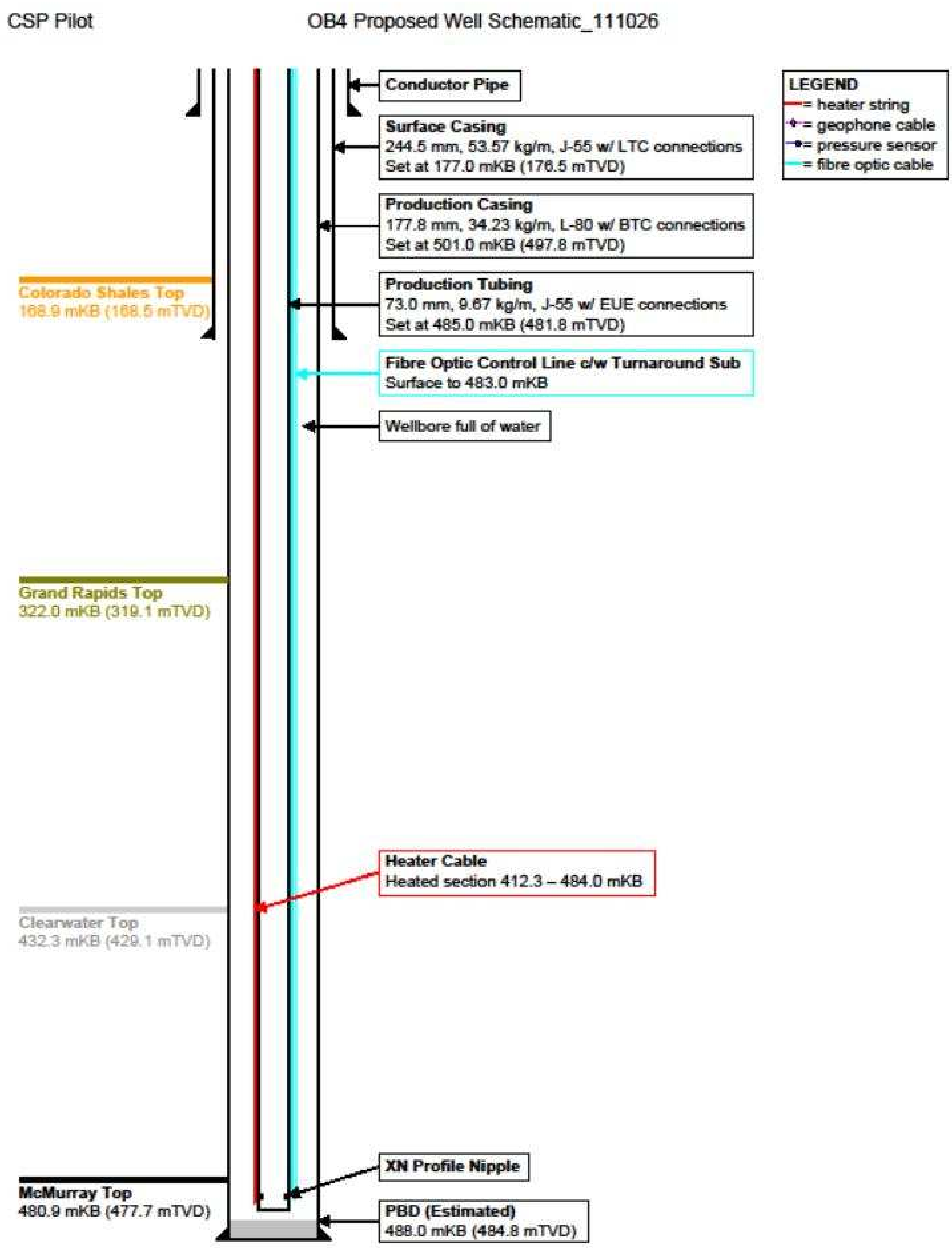


Figure 4e: Completion Diagram for Well OB5

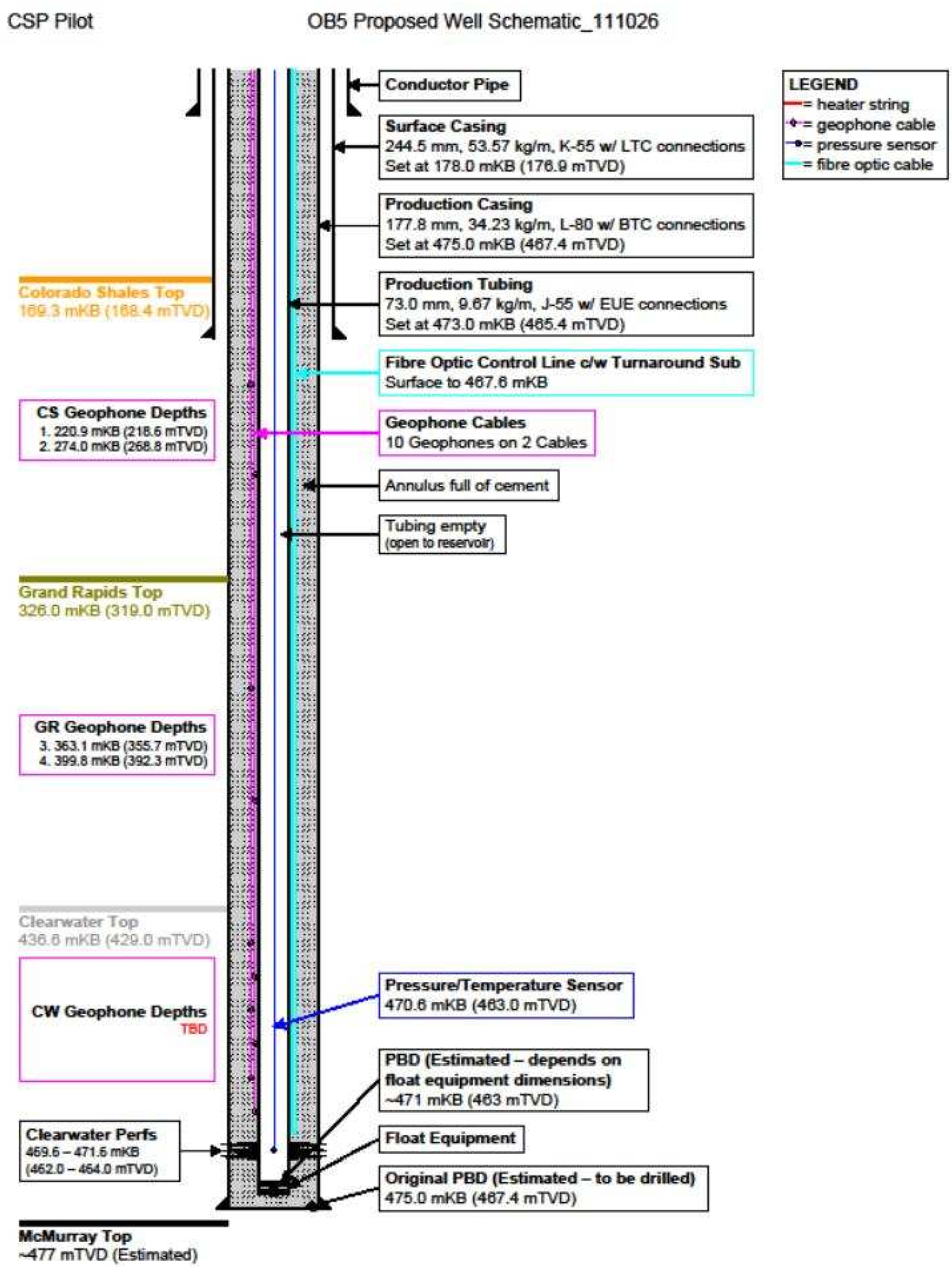


Figure 4f: Completion Diagram for Well 14-18

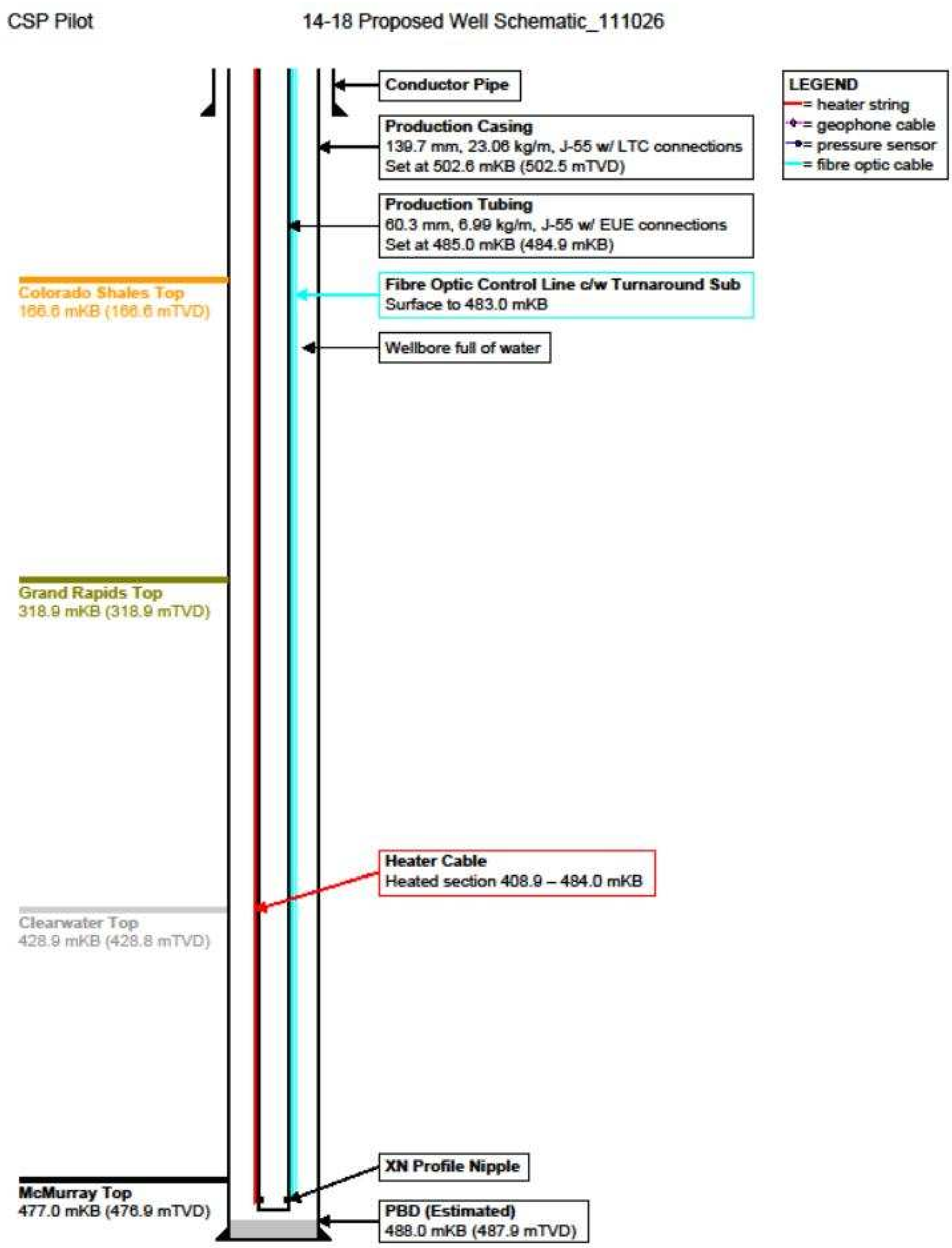


Figure 5: Cross-well Borehole Tomography Lines

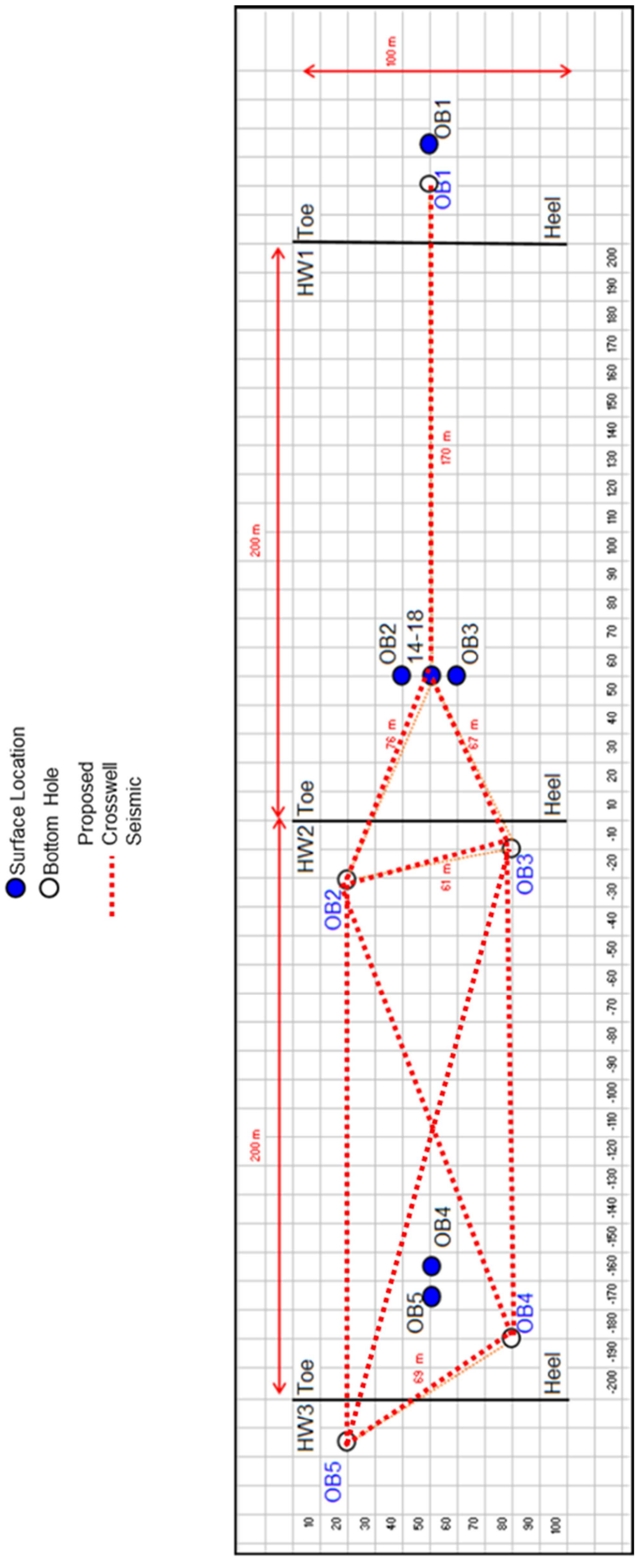


Figure 6: Results of Base Cross-Well Borehole Tomography

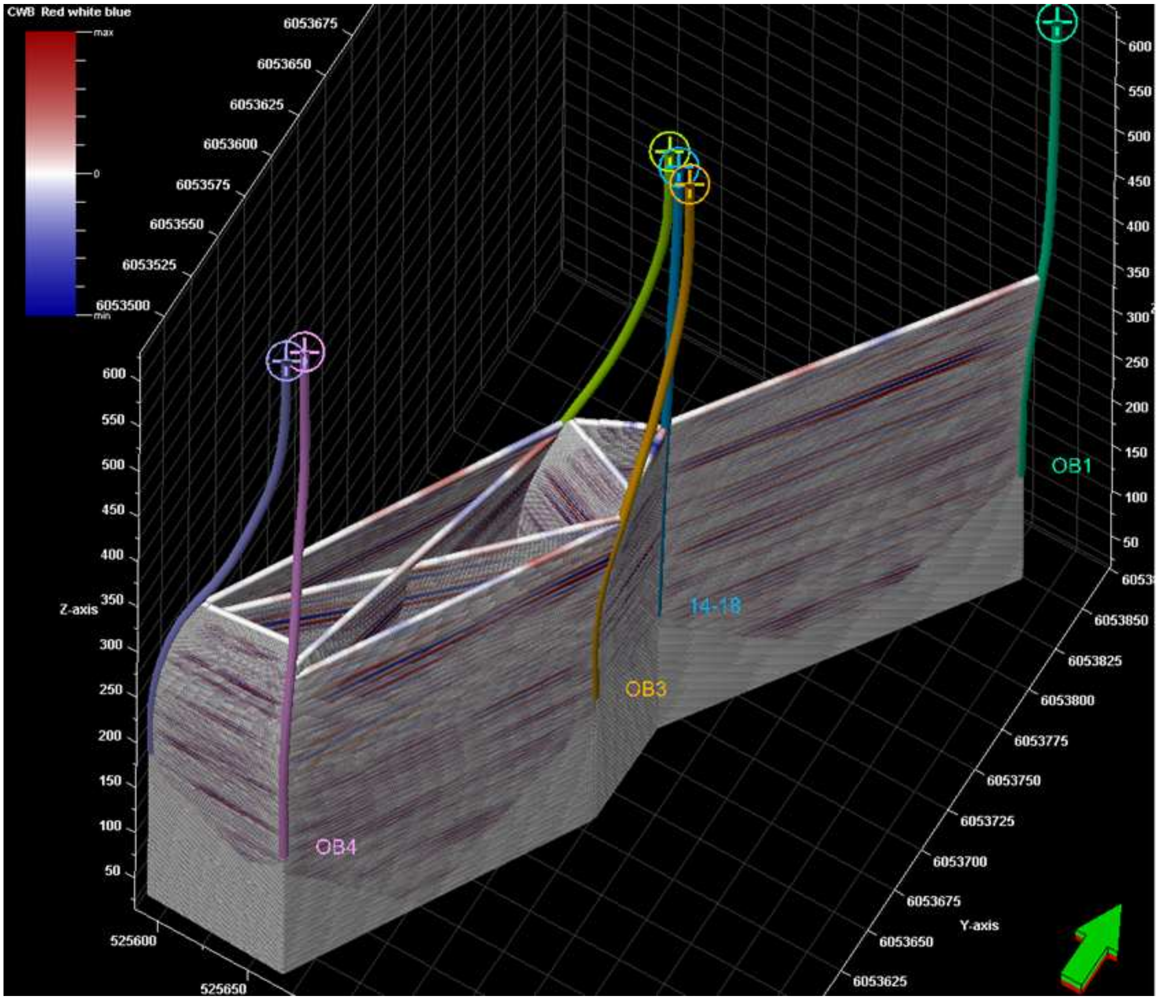


Figure 7a: Representative ZTrac Survey – OB1 to 14-18

(Clearwater Formation shown by orange bar)

OB1 **14-18**

ILD **ILD**

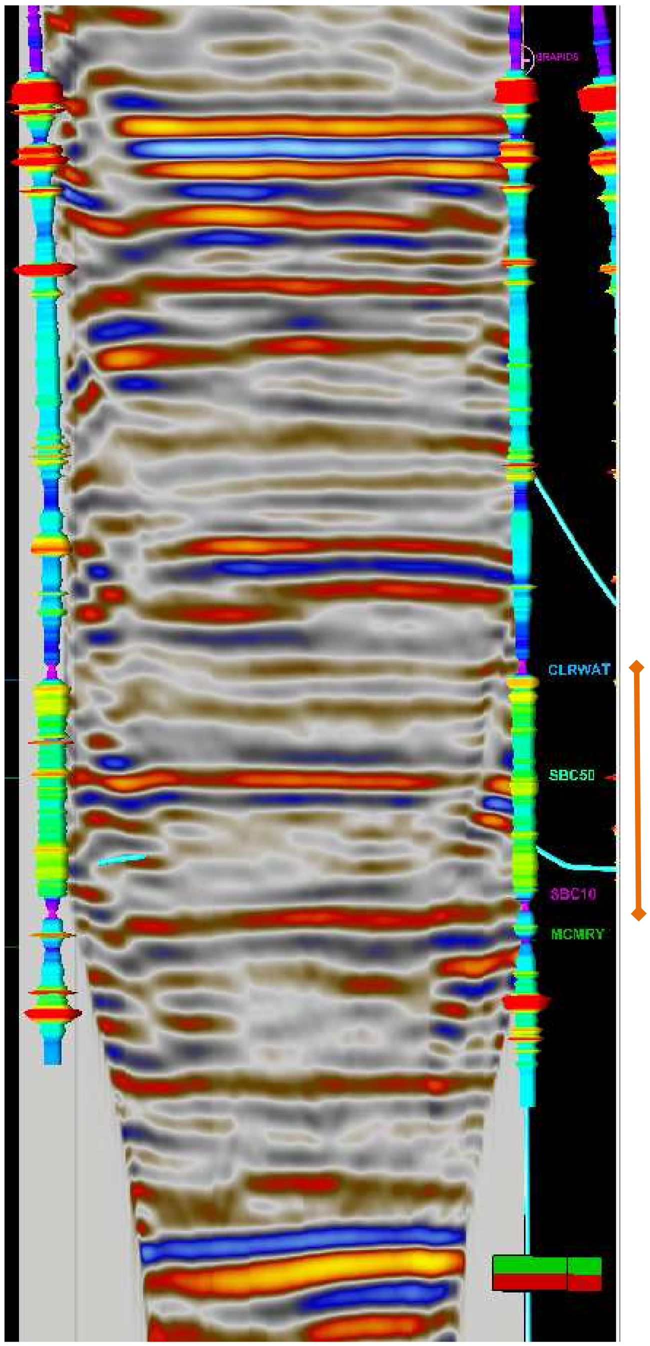


Figure 7b: Representative ZTrac Survey – OB1 to 14-18 Clearwater Only
(Clearwater Formation shown by orange bar)

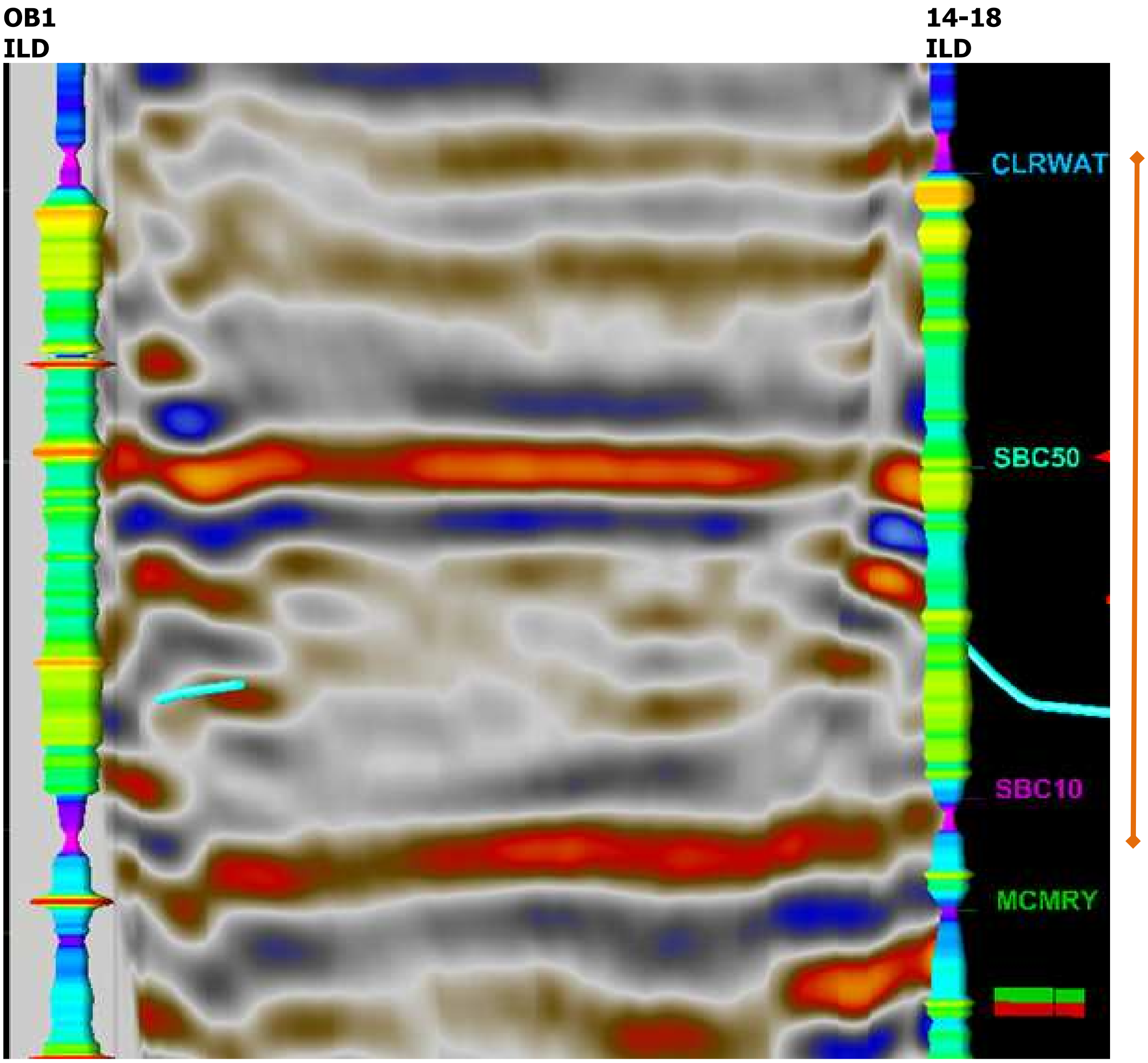


Figure 8a: Representative Piezo Electric Survey – OB2 to OB3

(Clearwater Formation shown by orange bar)

OB2 **OB3**
ILD **ILD**

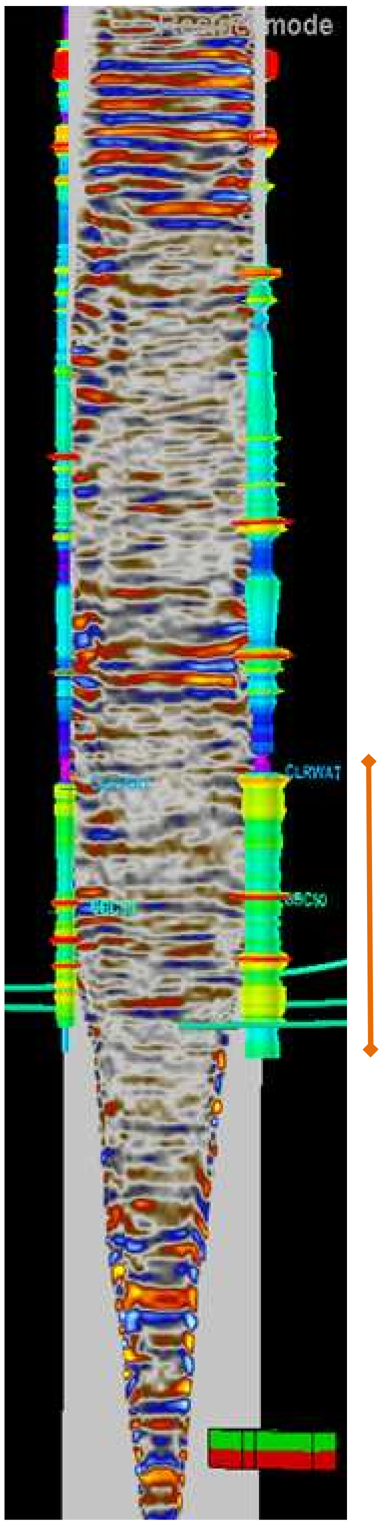
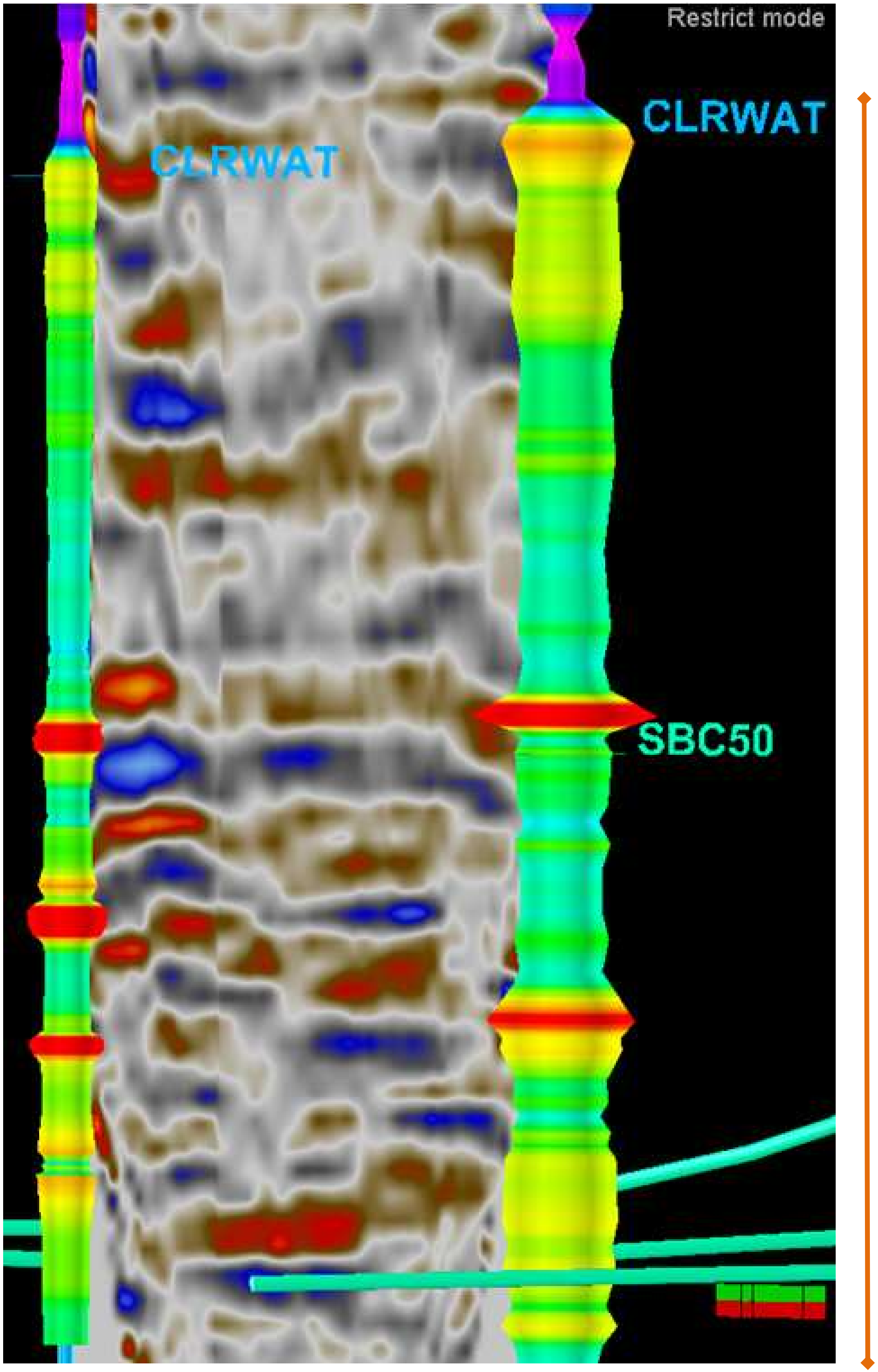


Figure 8b: Representative Piezo Electric Survey – OB2 to OB3 Clearwater Only
(Clearwater Formation shown by orange bar)

OB-2
ILD

OB-3
ILD



Appendix A

Process Flow Diagrams (PFDs)

&

Site Maps

073-0951-010-007 01

AutoCAD

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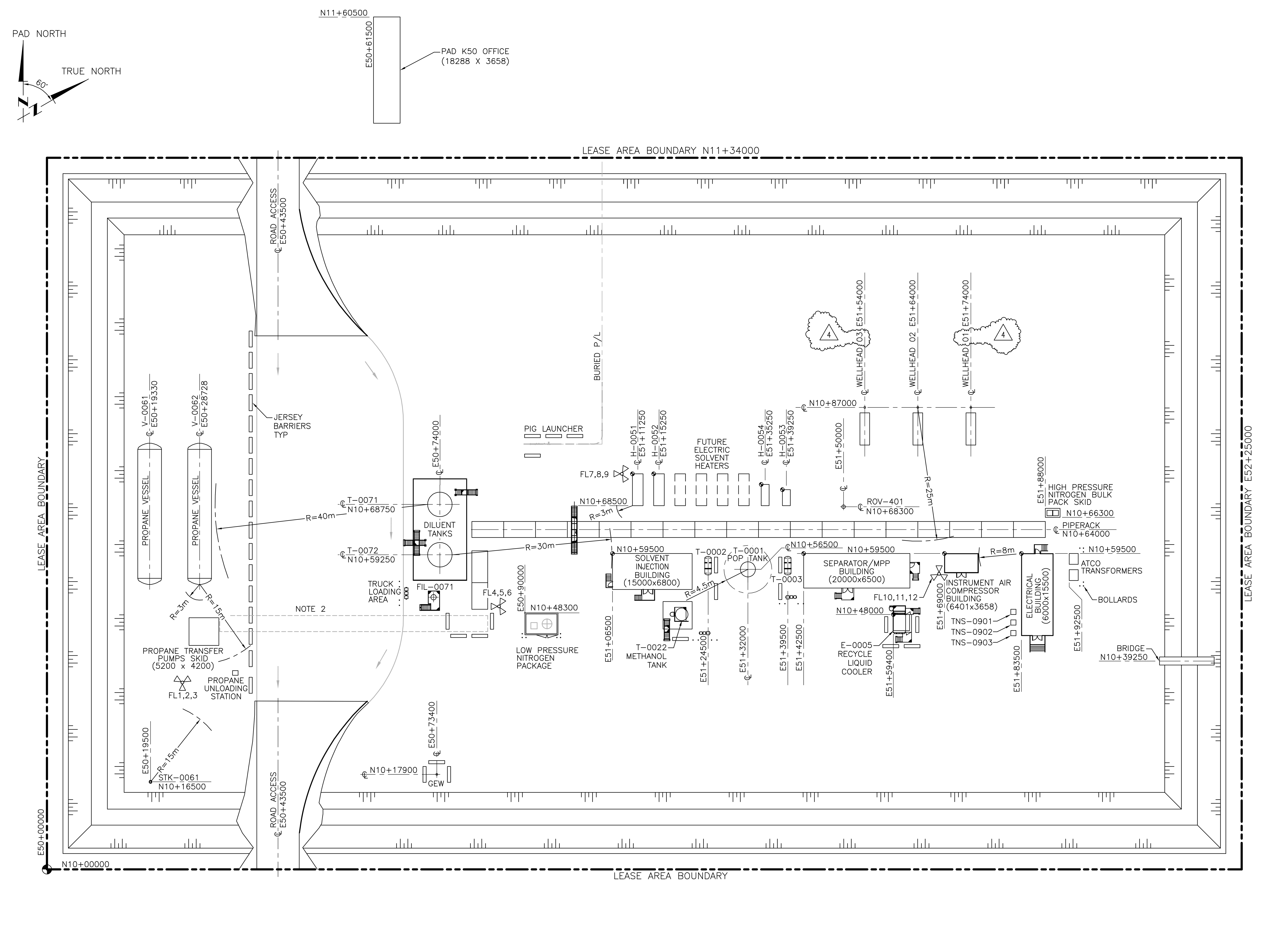

0 1 5 10 20 30 40 50 60m

BAR SCALE 1:400

LEGEND ⊕ = DATUM

MAJOR EQUIPMENT LIST

TAG No.	DESCRIPTION	LOCATION
E-0005	RECYCLE LIQUID COOLER	AS SHOWN
FIL-0051/0052	SOLVENT FILTER	SOLVENT INJECTION BUILDING
FIL-0071	DILUENT FILTER	AS SHOWN
H-0051/0052	ELECTRIC SOLVENT HEATER	AS SHOWN
H-0053	ELECTRIC TEST FLUID HEATER	AS SHOWN
H-0054	ELECTRIC PRODUCTION FLUID HEATER	AS SHOWN
P-0022	METHANOL INJECTION PUMP	SEPARATOR/MPP BUILDING
P-0023	MAKE-UP WATER PUMP	SEPARATOR/MPP BUILDING
P-0024	PURGE LIQUIDS PUMP	SEPARATOR/MPP BUILDING
P-0030/0040	MULTI-PHASE VENT GAS PUMP	SEPARATOR/MPP BUILDING
P-0051/0052	INJECTION PUMP	SOLVENT INJECTION BUILDING
P-0061/0062	PROPANE TRANSFER PUMP	PROPANE TRANSFER PUMP SKID
P-0071/0072	DILUENT TRANSFER PUMP	SOLVENT INJECTION BUILDING
P-0073	UTILITY DILUENT PUMP	SOLVENT INJECTION BUILDING
PK-0021	INSTRUMENT AIR PACKAGE	AS SHOWN
ROV-401	8-WAY ROTARY SELECTOR VALVE	AS SHOWN
STK-0061	VENT STACK	AS SHOWN
T-0001	POP TANK	AS SHOWN
T-0002	CLOSED DRAIN TANK (BURIED)	AS SHOWN
T-0003	CLOSED DRAIN TANK (BURIED)	AS SHOWN
T-0022	METHANOL TANK	AS SHOWN
T-0023	MAKE-UP WATER TANK	SEPARATOR/MPP BUILDING
T-0071/0072	DILUENT TANK	AS SHOWN
V-0003	LIQUID SEPARATOR	SEPARATOR/MPP BUILDING
V-0011	TEST SEPARATOR	SEPARATOR/MPP BUILDING
V-0061/0062	PROPANE VESSELS	AS SHOWN
–	LOW PRESSURE NITROGEN PACKAGE	AS SHOWN
–	WELLHEADS	LEASE AREA

EQUIPMENT SPACING (m)	OIL WELL	ELECTRICAL BUILDING	PROCESS BUILDING	PROCESS EQUIPMENT	DOGHOUSE AREA	PIPERACK WITH VENT/DRAIN	PIPERACK W/O VENT/DRAIN	POP TANK (TANK CENTER)	TEMPORARY TANKAGE	FOREST COVER	DILUENT TANK
OIL WELL	5/10										
ELECTRICAL BUILDING	20	–									
PROCESS BUILDING	20	8	–								
PROCESS EQUIPMENT	20	8	–	–							
DOGHOUSE AREA	25	–	25	25	–						
PIPERACK WITH VENT/DRAIN	–	15	–	–	30	–					
PIPERACK W/O VENT/DRAIN	–	3	–	–	2	–	–				
POP TANK (TANK CENTER)	24	20	4.5	4.5	30	–	–	–			
TEMPORARY TANKAGE	20	25	–	–	25	–	–	–	–		
FOREST COVER	30	20	20	20	20	15	15	20	20	–	
DILUENT TANK	45	45	30	30	30	–	–	30	–	45	–

(ALL DISTANCES ARE MINIMUM)

DESIGN NOTES:

1. LOCATION OF GROUNDWATER EVALUATION WELL (GEW) TO BE SUPPLIED BY FIELD.
2. UNDERGROUND PIPING AND CABLES.

GENERAL CONSTRUCTION NOTES:

A. CONSTRUCTION CONTRACTOR SHALL:
- LOCATE AND INSTALL ALL HYDROTEST VENTS AND DRAINS AS PER DRAWING 073-0051-080-044 01.
- PAINT PSV AND CAR SEALED VALVES WITH INTERNATIONAL ORANGE ENAMEL PAINT.
- INSTALL CAR SEALED VALVES WITH THE VALVE STEM IN THE HORIZONTAL (PREFERRED) OR DOWNWARD POSITION UNLESS OTHERWISE NOTED.
- GREASE THE UNDERSIDE OF ALL SLIDING PIPE SHOE BASE PLATES AND ALL DIRECTIONAL ANCHORS WITH HIGH TEMPERATURE GREASE (RATED TO −40°C AND 100°C).
- LOCATE AND INSTALL PERSONNEL PROTECTION ON LINES AS PER EBP 14-1-1, PAR.4.14 AND AS PER PIPING GENERAL ARRANGEMENTS.
- DO NOT PLACE VENTS AND DRAINS ON HYDROCARBON PIPING AND PIPELINES WITHIN 15m OF THE ELECTRICAL BUILDING AND 30m OF THE DOGHOUSE AREA.

B. INSTRUMENTATION CONNECTIONS:
- PRESSURE CONNECTIONS ARE 3/4 NPT UNLESS NOTED OTHERWISE. INSTALL AS PER DETAIL 4 ON DRAWING 073-0051-080-044 01.
- TEMPERATURE CONNECTIONS ARE 1 NPT UNLESS NOTED OTHERWISE.
- ORIFICE TAPS ON HORIZONTAL PIPES TO BE HORIZONTAL IN LIQUID SERVICE AND VERTICAL (UPWARD) IN GAS SERVICE. PROVIDE NIPPLES AND GATE VALVES AS PER LINE SPECIFICATION. UNUSED TAPS TO BE PLUGGED WITH HXHD PLUGS COMPLYING WITH PIPING SPECIFICATIONS AND SEAL WELDED. ROOT PASS ON THE ORIFICE FLANGE/PIPE BUTT WELD TO BE GROUND SMOOTH TO THE INSIDE PIPE WALL.

C. DEVIATION/DECISION RECORD:
- MOC C-6067 DEVIATION TO GP 29-02-03, TABLE A-2 AND B-1. DO NOT PRIME OR PAINT ANY INSULATED PIPING.
- MOC C-442 DEVIATION TO EBP 3-30-3, USE OF PLATED CARBON STEEL COMPRESSION FITTINGS WITH STAINLESS STEEL FERRULES IS ALLOWED IN AIR AND CHEMICAL SERVICE (PIPING CLASS ZJCE0).
- MOC C-5981 DECISION RECORD, EQUIPMENT SPACING. SEE EQUIPMENT SPACING TABLE (THIS DRAWING).

Imperial Oil

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IMPERIAL OIL RESOURCES

NO.	DATE	REVISIONS	DRAWN	CHECK	DESIGN	APPR.
4A	13 05 03	RE-ISSUED FOR CONSTRUCTION AS PER MOC O-4765 (XO.2010.48016)	PNP	RG	RDJ	RM
3	13 04 30	RE-ISSUED FOR CONSTRUCTION (XO.2010.48016)	PNP	RG	RDJ	RM
2	13 04 26	RE-ISSUED FOR CONSTRUCTION AS PER MOC O-7416 (XO.2010.48016)	BM	RG	RDJ	RM
1	12 05 25	RE-ISSUED FOR CONSTRUCTION (XO.2010.48016)	BM	MG	RDJ	RM
0	12 05 04	ISSUED FOR CONSTRUCTION (XO.2010.48016)	BM	RG	RDJ	RM

DRAFTING | ENGINEERING

IOR DWG NO.	TITLE

REFERENCE DRAWINGS

SEAL/STAMP

PERMIT

APPROVED FOR CONSTRUCTION

DATE | REV.

PROJECT ENGINEERING

CLPP MAHIHKAN FIELD PHASES 7-10
PAD K50 CSP SHORT HORIZONTAL WELL PILOT
PLOT PLAN

CONTRACTOR NAME	SCALE	IOR DRAWING NUMBER	REV.
WORLEYPARSONS CANADA SERVICES LTD	1:400	073-0951-010-007 01	4A
CONTRACTOR DWG NUMBER XO.2010.48016			

Version: 4

D-STD

Filename: N:\IOR_ALLIANCE\00_CAD\GENERAL\FILENET\073-0951-010-007-01.DWG User ID: HARRY.KAHR Plot date/time: May 30, 2013 - 10:21am XREF drawings: 073-0951-XRF-M00023 [073-0951-XRF-M00023.DWG] IMAGE attachments:

073-0951-020-568 01

AutoCAD

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Imperial Oil

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IMPERIAL OIL RESOURCES

NO.	DATE	REVISIONS	DRAWN	CHECK	DESIGN	APPR.	IOR DWG NO.	TITLE
0	12 03 06	ISSUED FOR CONSTRUCTION (XO.2010.48016)	BM			WK	073-0951-020-600 01	PAD K50 HEAT AND MATERIAL BALANCE - PROCESS FLOW DIAGRAM

DRAFTING | ENGINEERING | REFERENCE DRAWINGS

SEAL/STAMP: PROFESSIONAL ENGINEER ALBERTA — ANUP KUMAR ROY — 5 MAR 2012

PERMIT TO PRACTICE
IMPERIAL OIL RESOURCES
Signature
Date MAR. 5, 2012
PERMIT NUMBER: P00884
The Association of Professional Engineers, Geologists and Geophysicists of Alberta
PERMIT

APPROVED FOR CONSTRUCTION
DATE MARCH 5, 2012 REV. 0
PROJECT ENGINEERING

CLPP MAHIHKAN FIELD PHASES 7-10
PAD K50 CSP SHORT HORIZONTAL WELL PILOT
PROCESS FLOW DIAGRAM

CONTRACTOR NAME	SCALE	IOR DRAWING NUMBER	REV.
WORLEYPARSONS CANADA SERVICES LTD	NONE	073-0951-020-568 01	0
CONTRACTOR DWG NUMBER XO.2010.48016			

Version: 4

D-STD

Filename: Y:\FILENET\073-0951-020-568-01.DWG User ID: YAN.X.WANG Plot date/time: March 05, 2012 - 9:26am XREF drawings: IMAGE attachments:

073-0951-020-569 01

AutoCAD

CADD DRAWING NO MANUAL CHANGES

V–0003 LIQUID SEPARATOR	T–0023 MAKE–UP WATER TANK	P–0030/0040 MULTI PHASE VENT GAS PUMP	E–0005 RECIRC LIQUID COOLER	P–0023 MAKE–UP WATER PUMP	P–0024 PURGE LIQUIDS PUMP
SIZE: 736 mm I.D. x 2550 mm S/S	WORKING CAPACITY: 6.4 m^3	CAPACITY: 153 m^3/hr (ACTUAL) SUCTION CONDITIONS: TEMPERATURE: 42°C PRESSURE: 70 kPag DENSITY: 49.4 kg/m^3 POWER: 75 kW (100 HP) 2 x 100% NOTE 1	PROCESS DUTY: 203 kW	RATED CAPACITY: 0–100 l/h DIFF PRESS: 350 kPa POWER: 0.74 kW (1 HP) 480 V/3 Ph/60 Hz	RATED CAPACITY: 0–1000 l/h DIFF PRESS: 1500 kPa POWER: 2.2 kW (3 HP) 480 V/3 Ph/60 Hz

NOTE:
1. MPP IS DESIGNED FOR 4538 sm^3/d FLOW OF DRY VENT GAS.

Imperial Oil
Esso

IMPERIAL OIL RESOURCES

CLPP MAHIHKAN FIELD PHASES 7-10
PAD K50 CSP SHORT HORIZONTAL WELL PILOT
PROCESS FLOW DIAGRAM

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0	12 03 06	ISSUED FOR CONSTRUCTION (XO.2010.48016)	BM			WK

IOR DWG NO.	TITLE
073-0951-020-600 01	PAD K50 HEAT AND MATERIAL BALANCE - PROCESS FLOW DIAGRAM

REFERENCE DRAWINGS

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IMPERIAL OIL RESOURCES
Signature
Date Mar. 5, 2012
PERMIT NUMBER: P00884
The Association of Professional Engineers, Geologists and Geophysicists of Alberta
PERMIT

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DATE March 5, 2012 REV. 0
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CONTRACTOR NAME	SCALE	IOR DRAWING NUMBER	REV.
WORLEYPARSONS CANADA SERVICES LTD	NONE	073-0951-020-569 01	0
CONTRACTOR DWG NUMBER XO.2010.48016			

Version: 4

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Filename: N:\IOR_ALLIANCE\00_CAD\GENERAL\FILENET\073-0951-020-569-01.DWG User ID: JAMES.HANNAM Plot date/time: March 02, 2012 - 2:31pm XREF drawings: IMAGE attachments:

073-0951-020-570 01

AutoCAD

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NOTES:
1. PIPE SPOOL TO BE REPLACED BY WATER-CUT METER IF REQUIRED.
2. FUTURE CONNECTION FOR GAS PIPING OF WATER-CUT METER.

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NO.	DATE	REVISIONS	DRAWN	CHECK	DESIGN	APPR.	IOR DWG NO.	TITLE
0	12 03 06	ISSUED FOR CONSTRUCTION (XO.2010.48016)	BM			WK	073-0951-020-600 01	PAD K50 HEAT AND MATERIAL BALANCE - PROCESS FLOW DIAGRAM

DRAFTING — ENGINEERING — REFERENCE DRAWINGS

SEAL/STAMP: PROFESSIONAL ENGINEER, ALBERTA, ANUP KUMAR ROY

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IMPERIAL OIL RESOURCES
Signature
Date Mar. 5, 2012
PERMIT NUMBER: P00884
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PERMIT

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DATE March 5, 2012 REV. 0
PROJECT ENGINEERING

CLPP MAHIHKAN FIELD PHASES 7-10
PAD K50 CSP SHORT HORIZONTAL WELL PILOT
PROCESS FLOW DIAGRAM

CONTRACTOR NAME	SCALE	IOR DRAWING NUMBER	REV.
WORLEYPARSONS CANADA SERVICES LTD	NONE	073-0951-020-570 01	0
CONTRACTOR DWG NUMBER XO.2010.48016			

Version: 4 D-STD

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