- Control utilities (instrument air) and related electronic controllers.
- Observation wells (separate ground disturbance), plus data monitoring equipment and related data system connection to the CPF.
- Winterization system to protect piping and equipment from frost damage.
- Ditching, berms, and contouring to manage surface water drainage collection. The topsoil will be conserved and stockpiled for reclamation.

C2.2.2 Drilling and Completion

Horizontal well pairs will be drilled vertically from surface to a surface casing depth of approximately 200 to 220 m (Figure C2.2-3) with a water based drilling fluid. The remainder of the vertical section and the horizontal section will be drilled with a gel-chem drilling fluid. The remaining drill hole will be drilled with the kick off point expected to start at a depth of approximately 225 to 245 m. The build section is expected to be drilled at not more than 9-10 degrees of dogleg/30 m, and is expected to intersect the target horizontal section depth at 90 degrees from vertical. Total measured depth of the well is expected to be approximately 1,700 m depending largely on the horizontal section. The surface casing will be cemented with thermal cement and will adhere to requirements of EUB Directive 8.

The intermediate hole will be drilled to minimize build section dogleg, preferably not more than 9 deg/30 m. The gentle build section will be capable of accommodating any required lift equipment. The well bore beyond the surface casing will be drilled with a directional bottom hole assembly (BHA), consisting of a mud motor and measurement while drilling (MWD) system. Intermediate casing will be high grade, utilizing premium high-strength connections cemented in place with thermal cement (Figures C2.2-3).

Drilling of the horizontal main hole will be done in conjunction with a gamma ray log to determine sections of pay compromised by clay, inclined heterolithic stratification (IHS) or breccia. The horizontal section will be lined with engineered slotted liner or wire wrap screens. The liner will be anchored and sealed in the production casing with a high temperature sealed liner hanger or packer assembly.

Pad drilling is expected to begin with all surface holes being drilled first. The drilling rig will then return to each well to drill intermediate hole to the horizontal section. Horizontal sections of production wells will be drilled first with the horizontal sections of injection wells being drilled last. Observation wells may be utilized for positioning production well trajectories. Injection wells will be drilled using ranging information from a magnetic source fed into the production wells during drilling. Injections wells ideally will over lay producers by 5 m for the length of the horizontal section.

Disposal of all drilling fluids will be according to EUB Directive 50. Gel chem. drilling fluids will be stored and disposed in remote sump locations yet to be determined based on suitable soil conditions. Total volume of drilling waste will be approximately 450 m^3 per horizontal wellpair. It is North American's intent, however, to reduce these volumes by reusing drilling fluids whenever practical. Pad drilling will all be done using a central mud system. Drilling order will also minimize oil and cuttings contamination and maximize the use of drilling fluids. See Section C2.2.7 for more information on drilling waste management.

C2.2.3 Producing Well Completion

Producing wells for the initial circulation phase will be completed with a toe injection string as well as a heel return string. Temperature monitoring will be accomplished with a 38.1 mm instrument string. The circulation phase is expected to last approximately 90 days and serves to heat the bitumen between injector and producer to establish communication. The circulation phase will see steam injected into the toe string, and return up the heel string (Figure C2.2-3).

When the circulation phase is completed the well will be completed with a pump. Currently under consideration are electric submersible pumps (ESP) (Figure C2.2-4) and tubing pumps (Figure C2.2-5).

C2.2.4 Injection Well Completion

The injection well will be completed in a similar manner to the producer for the circulation phase. North American will ensure compliance with EUB Directive 51. During the circulation phase, the injector will be completed with 88.9 mm toe injection and heel return strings (Figures C2.2-3). Also, the well will possibly have a 38.1 mm temperature instrument string. When the circulation phase is completed the injection well completion will be changed for steam injection.

During the steaming phase the injector may be completed with a toe injection string (Figures C2.2-4 and C2.2-5). The majority of the steam will be injected down the casing annulus. The well will have a 60.3 mm guide string, with possibly a 38.1 mm temperature instrument string.

C2.2.5 Observation Wells

Observation wells strategically placed during the pad drilling program will provide information for SAGD well bore placement during the drilling phase, as well as pressure and temperature monitoring throughout the Corner area for the life of the wells. Currently under consideration for monitoring observation wells is fibre optic temperature monitoring equipment and mechanical pressure monitoring equipment on the exterior of the casing. Fibre optic temperature sensing is capable of resolution of 1^o temperature/metre. Some of the observation wells will have mechanical pressure monitoring equipment strategically installed depending on the stratigraphy of the formation. The number and density of observation wells will be determined by directional drilling and reservoir monitoring needs.

During the drilling phase of a typical pad, North American may utilize observation wells placed along proposed well bore trajectories to serve as guidance targets. Magnetic source equipment will be placed in the observation well bores to provide ranging measurements. This information would assist in drilling straight horizontal sections.

During the production phase of the Project, selected observation wells may be equipped with temperature and pressure monitoring equipment for ongoing monitoring of steam chamber development, rise rates and overall well bore performance. Figures C2.2-6 and C2.2-7 depict typical temperature only and pressure/temperature observation wells, respectively.

C2.2.6 Water Source and Disposal Wells

Water source wells will be vertical well completions with ESP pump configurations. The wellbore itself is also being considered for wire-wrapped screen and a gravel packed liner for enhanced long term deliverability (Figure C2.2-8).

Water disposal wells will be vertical well completions with surface pumping equipment at the main plant to feed the wells. North American will drill a number of Class 1b water disposal wells, and is giving consideration to drilling one or more Class 1a water disposal wells (Figures C2.2-9 and C2.2-10, respectively). Water disposal well completions will ensure continued compliance with Directive 51.

C2.2.7 Drilling Waste Management

North American plans to use a water-based drilling fluid system. These mud systems generate waste material largely composed of bentonite clay. North American will separate drilling muds that contact oil bearing formations in an effort to minimize drilling mud contamination and therefore drilling waste disposal.

North American waste reduction methods will limit the volume of solid waste from the intermediate and horizontal hole sections. Drilling wastes will be monitored and analyzed and be disposed of according to EUB Directive 50. Special attention will be given to hydrocarbon levels and any materials that comply with Tier I Soil and Water Quality Guidelines for Hydrocarbons (CCME fractions) will be disposed of using the mix-bury-cover method. Any waste not meeting requirements of Directive 50 for hydrocarbon levels will be disposed of at an approved waste disposal facility or treated within the guidelines.

The drilling mud sump will be located nearby and separated into cells to isolate the various phases of drill mud and cuttings. The locations of the sump sites will be selected and constructed after soil sampling ensures the base material meets the required permeability limits.

C2.2.8 Casing Failure Monitoring Program

North American has adopted a very careful approach to the design, material selection, and integrity of the casing, liners, and tubulars. North American has researched the different options and techniques to provide for long term well bore integrity.

The monitoring program will entail detailed temperature and pressure monitoring of producer and injector instrumentation, as well as injection and production rates to detect early warning signs of compromised casings, liners or tubulars.

North American will develop procedures to track and identify failures (if any). Completion integrity will be monitored by operations staff who will monitor well performance at the production pad. Injection and production well pressures and temperatures will be monitored continuously, as will steam flow rates, and production flow rates. Any unanticipated changes in these parameters will be investigated.

The SAGD operation is a continuous process operated below the formation fracture pressure. As a result, the down hole tubulars are not subjected to the same stresses that occur from the high temperature and pressure fluctuations seen in cyclic steam processes.

C2.2.9 Well Performance Monitoring

Production well testing will be performed on each well pair at least twice per month. Daily oil, gas, and water will be closely recorded and allocated to the wells based on field pro-rations. Injection wells will also be monitored closely for steam injection rate and pressure. These parameters and any changes also provide a good measure of wellbore integrity changes, or breach.

Regular analysis of produced oil, gas, and water will assist North American to understand the reservoir performance and resource recovery.

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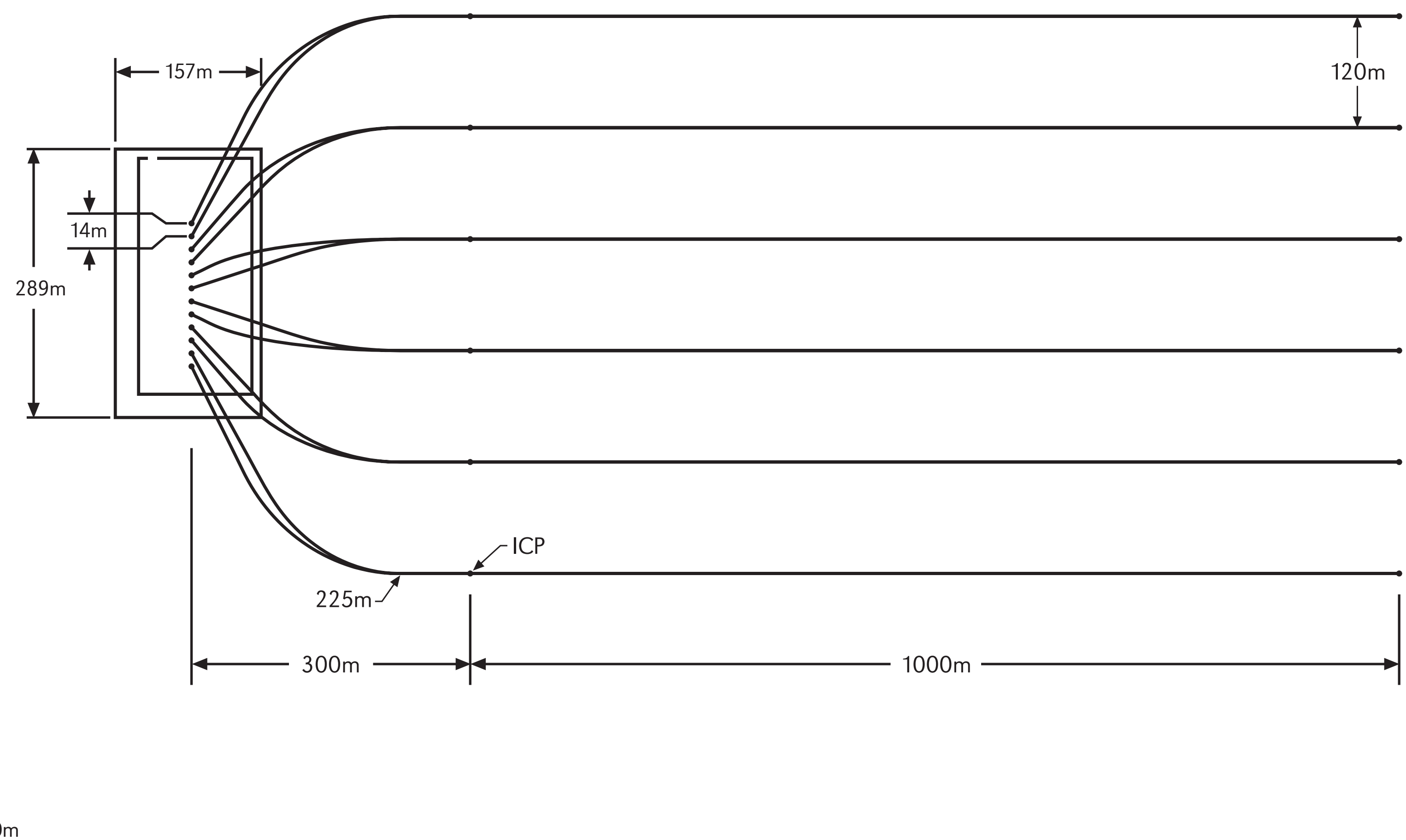
Appendix C - Corner Project

Well Pad and Well Trajectories



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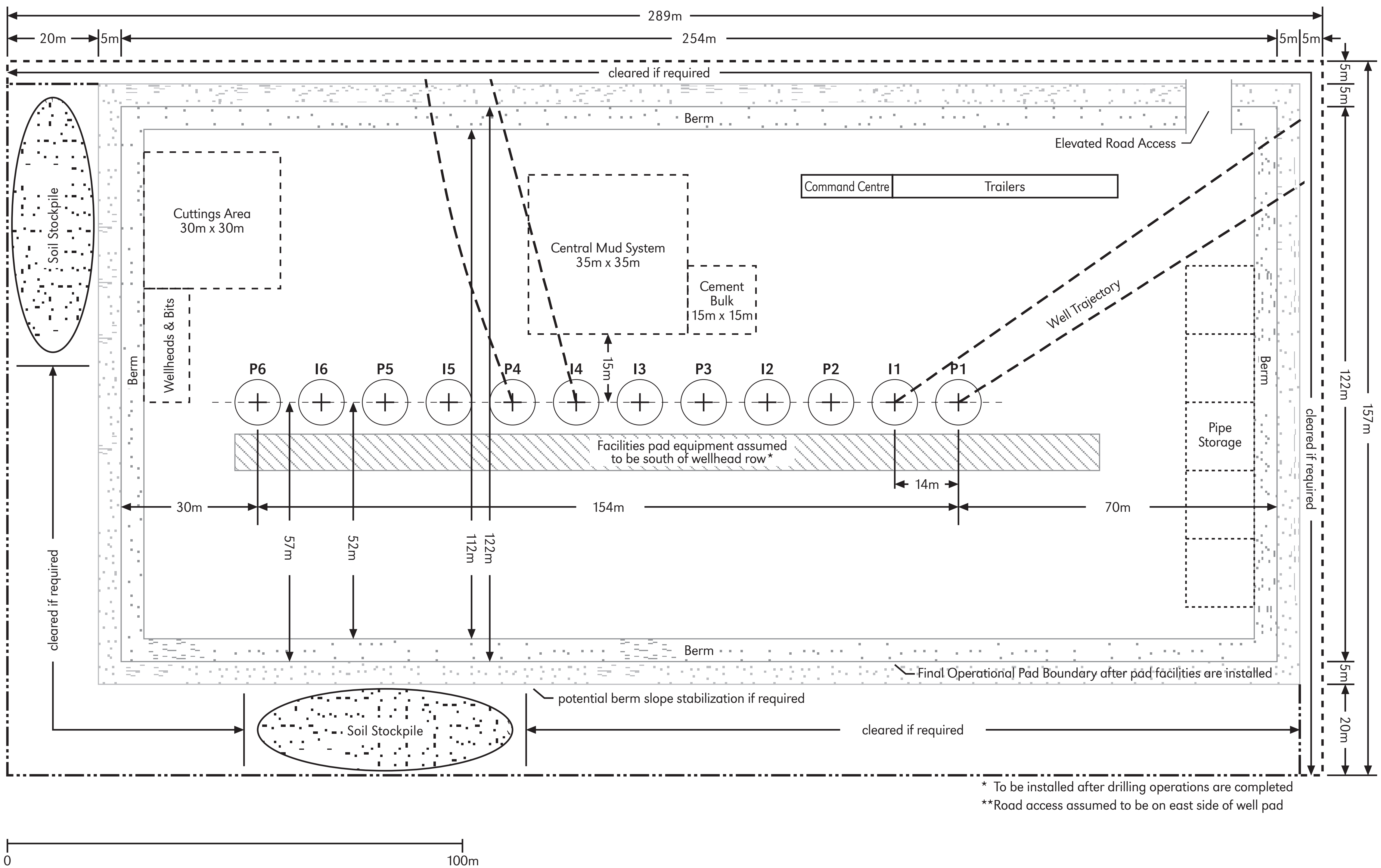
Appendix C - Corner Project

Typical Well Pad Layout During Drilling Operations



* To be installed after drilling operations are completed
**Road access assumed to be on east side of well pad

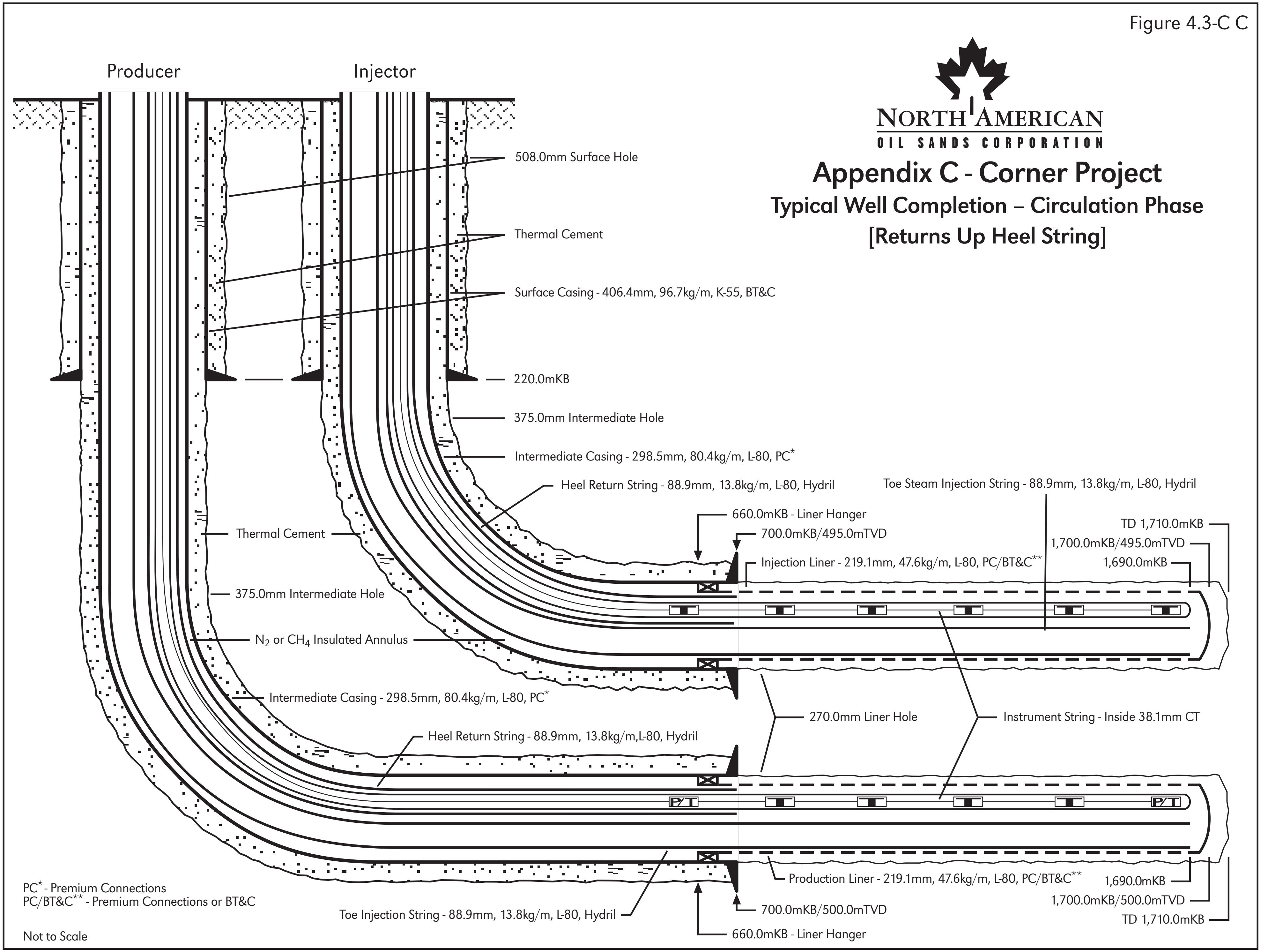


Figure 4.3-C C 070424

Figure 4.3-D C

NORTH AMERICAN OIL SANDS CORPORATION

Appendix C - Corner Project

Typical Well Completion – Operating Phase [Electric Submersible Pump]

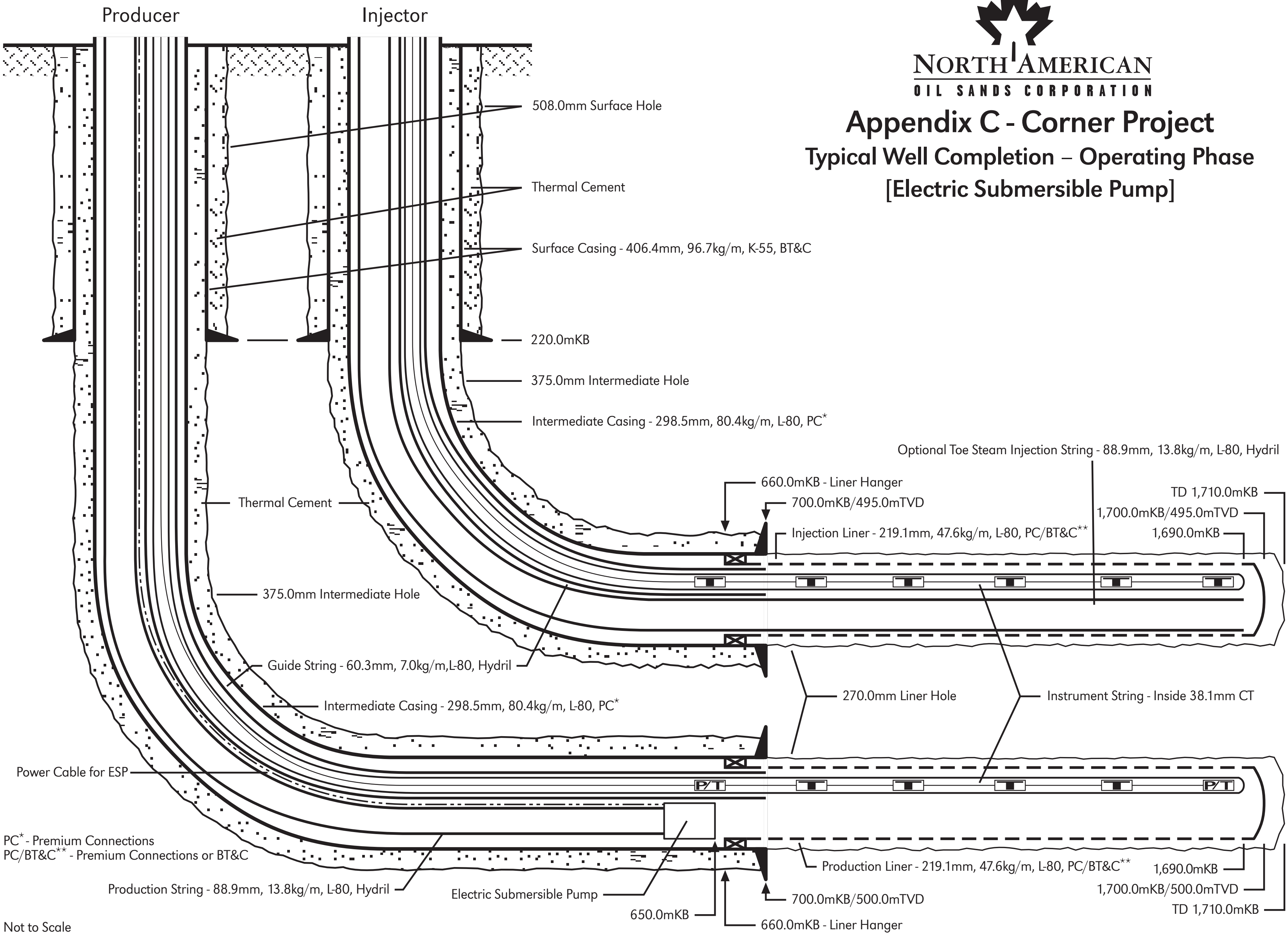


Figure 4.3 D C 070424

Figure 4.3-E C

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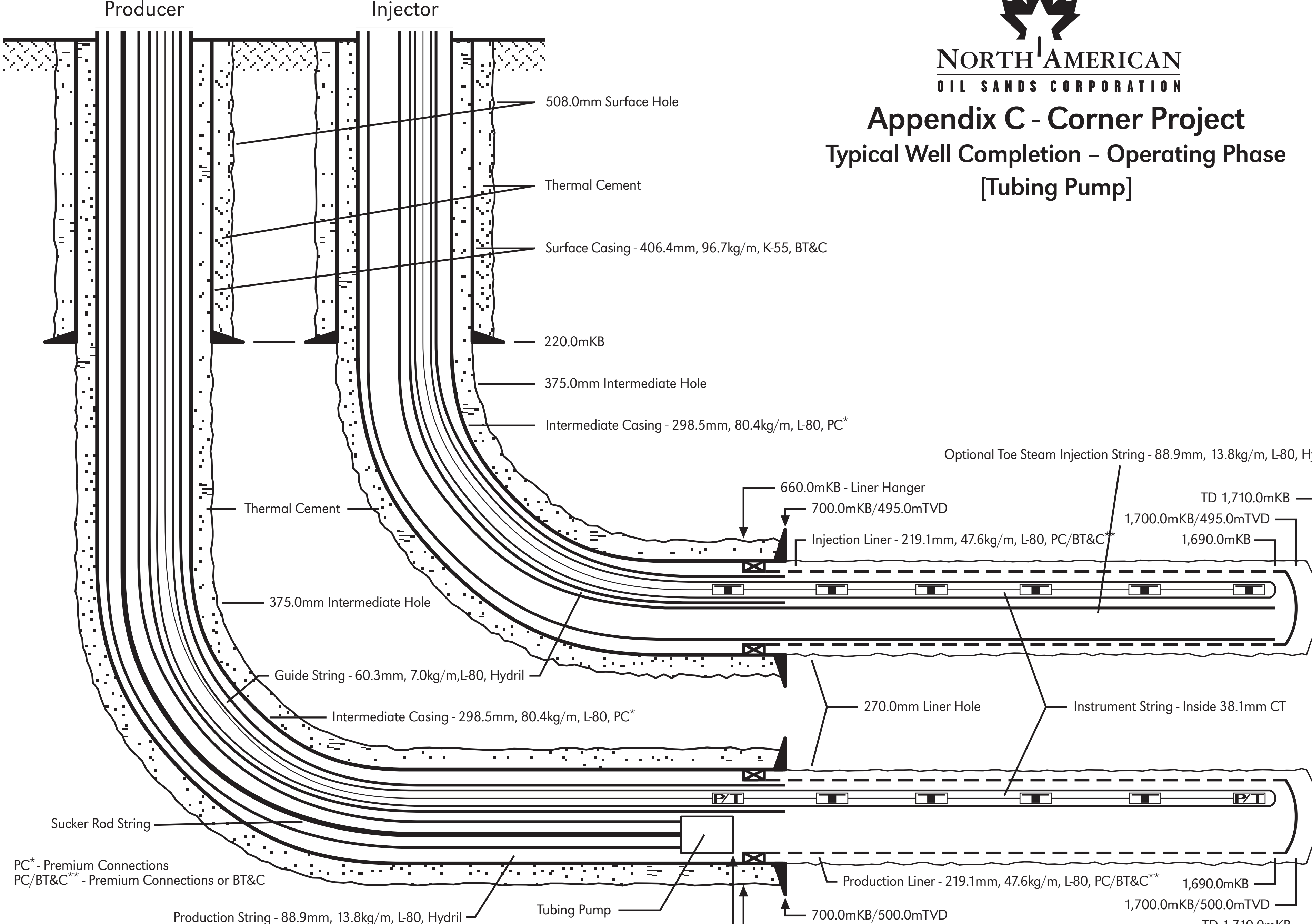
Appendix C - Corner Project

Typical Well Completion – Operating Phase [Tubing Pump]



PC* - Premium Connections
PC/BT&C** - Premium Connections or BT&C

Not to Scale

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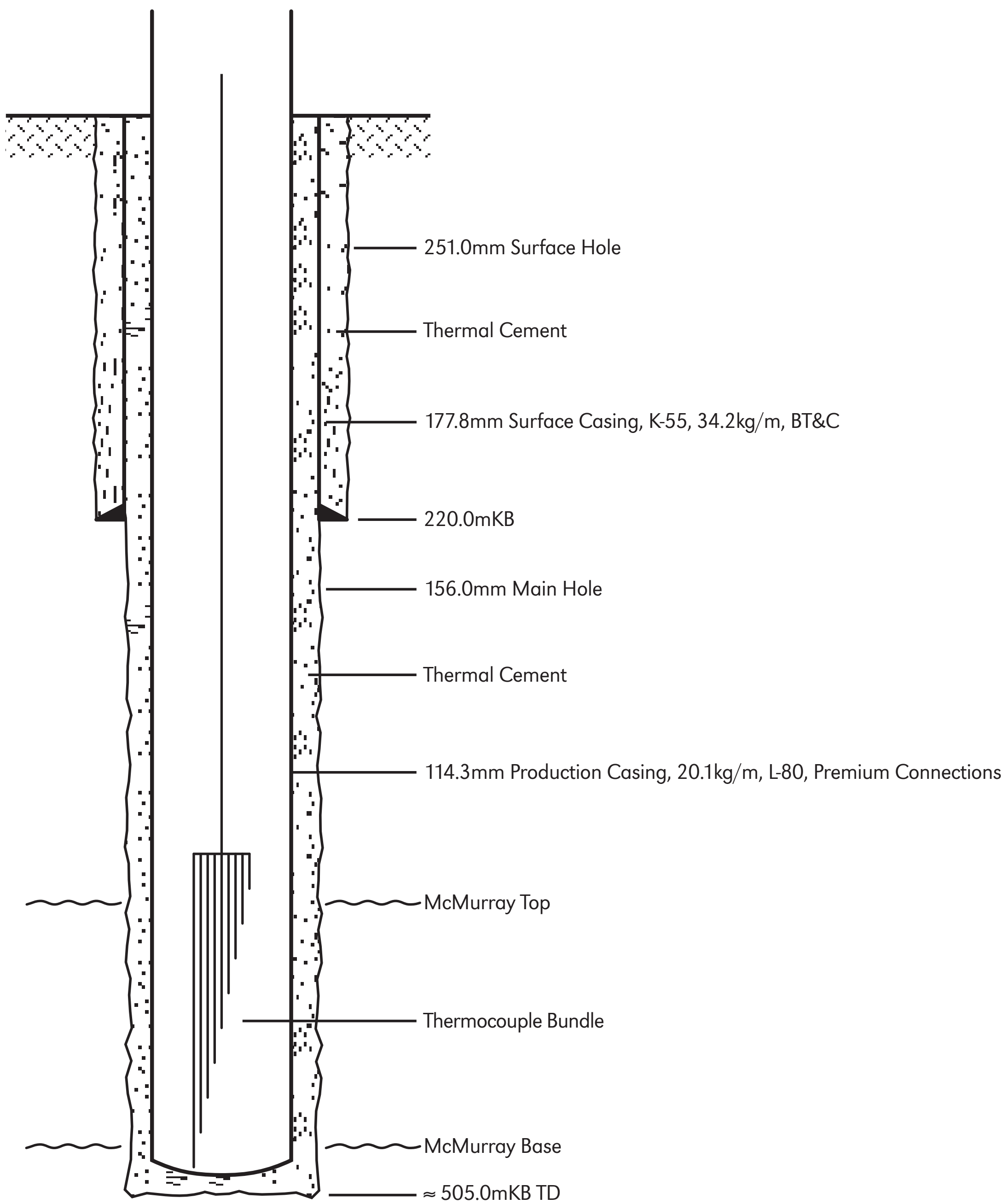
Appendix C - Corner Project

Typical Observation Well (Temperature only)



Not to Scale

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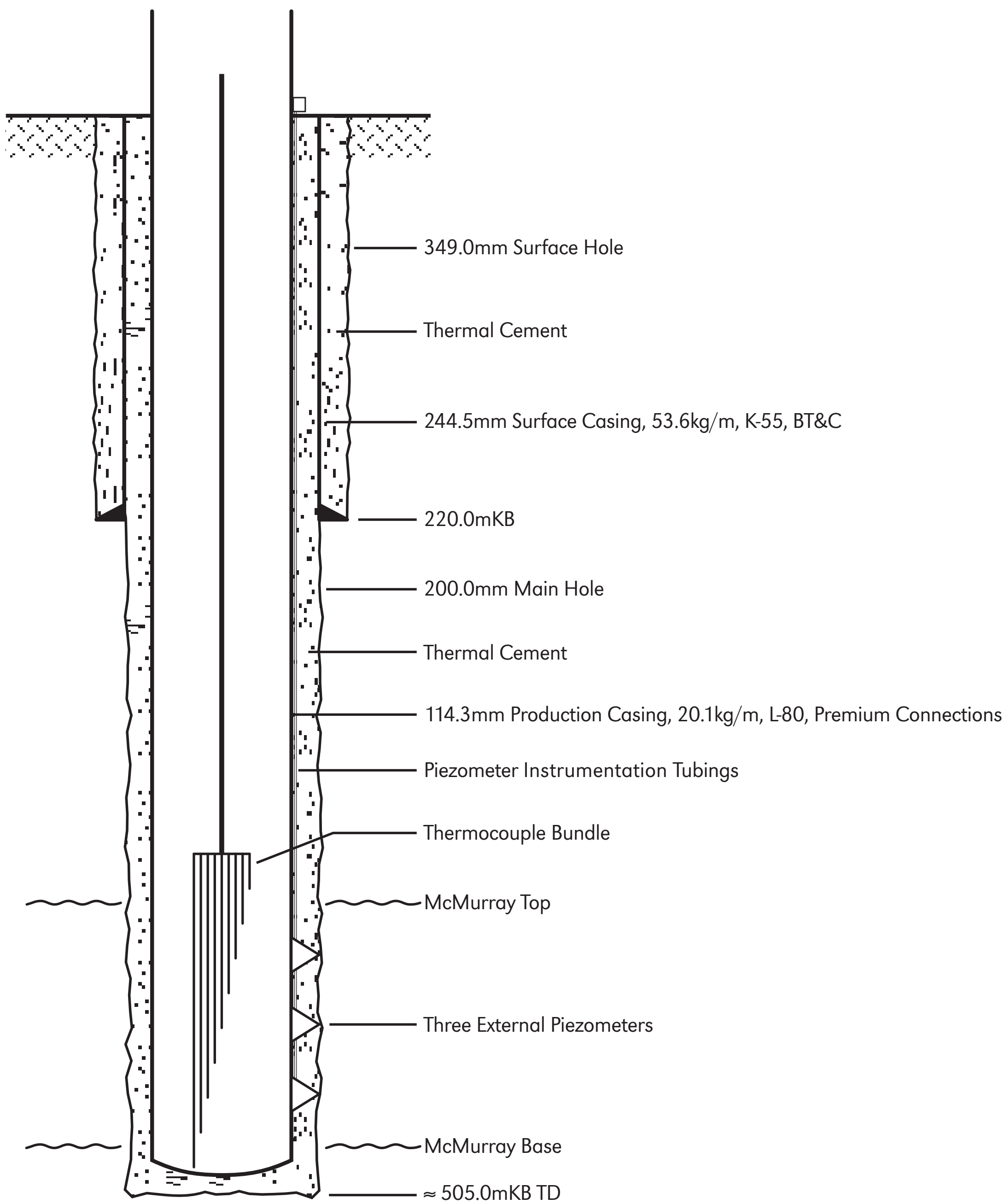
Appendix C - Corner Project

Typical Observation Well (Pressure & Temperature)



Not to Scale

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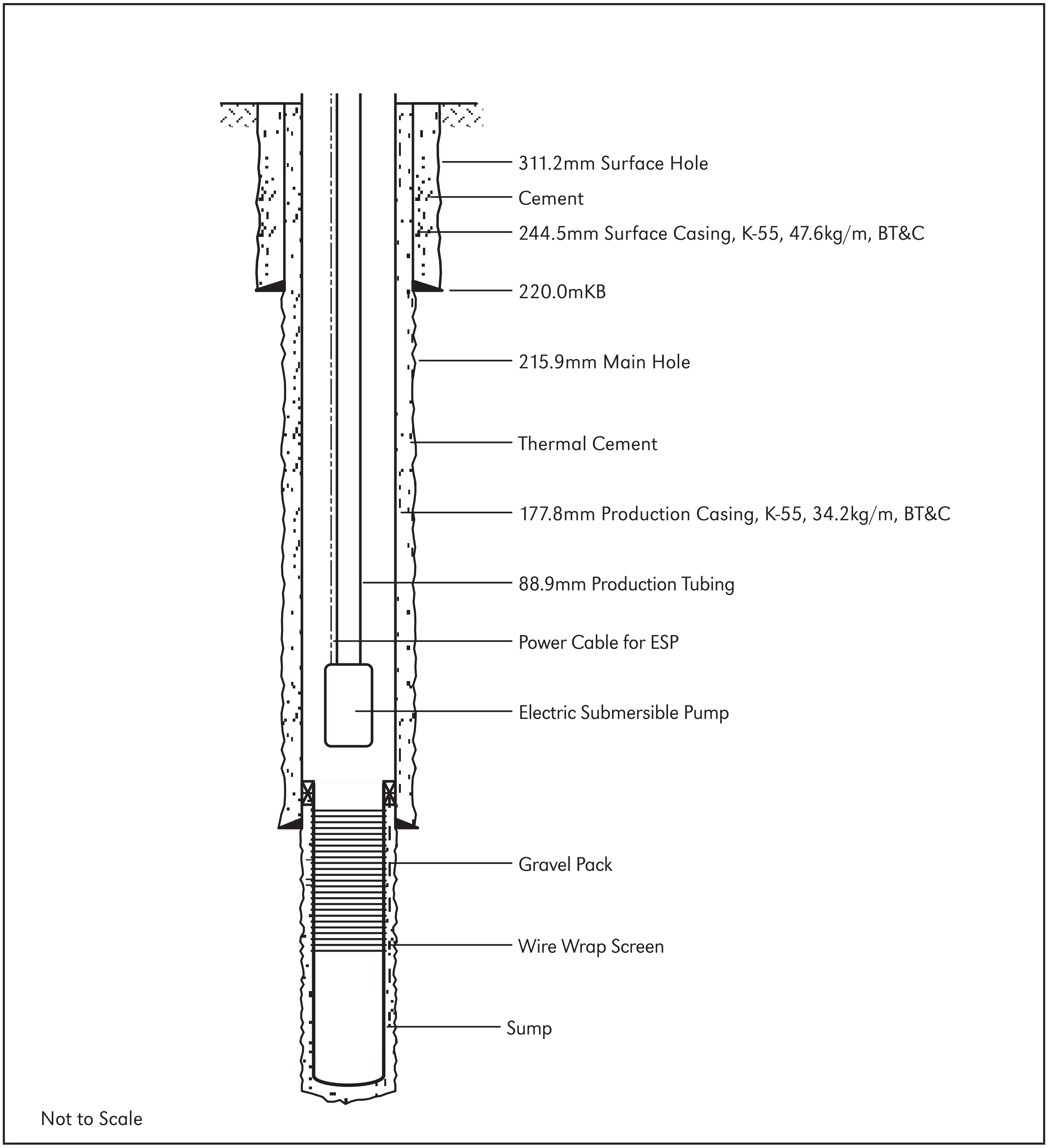
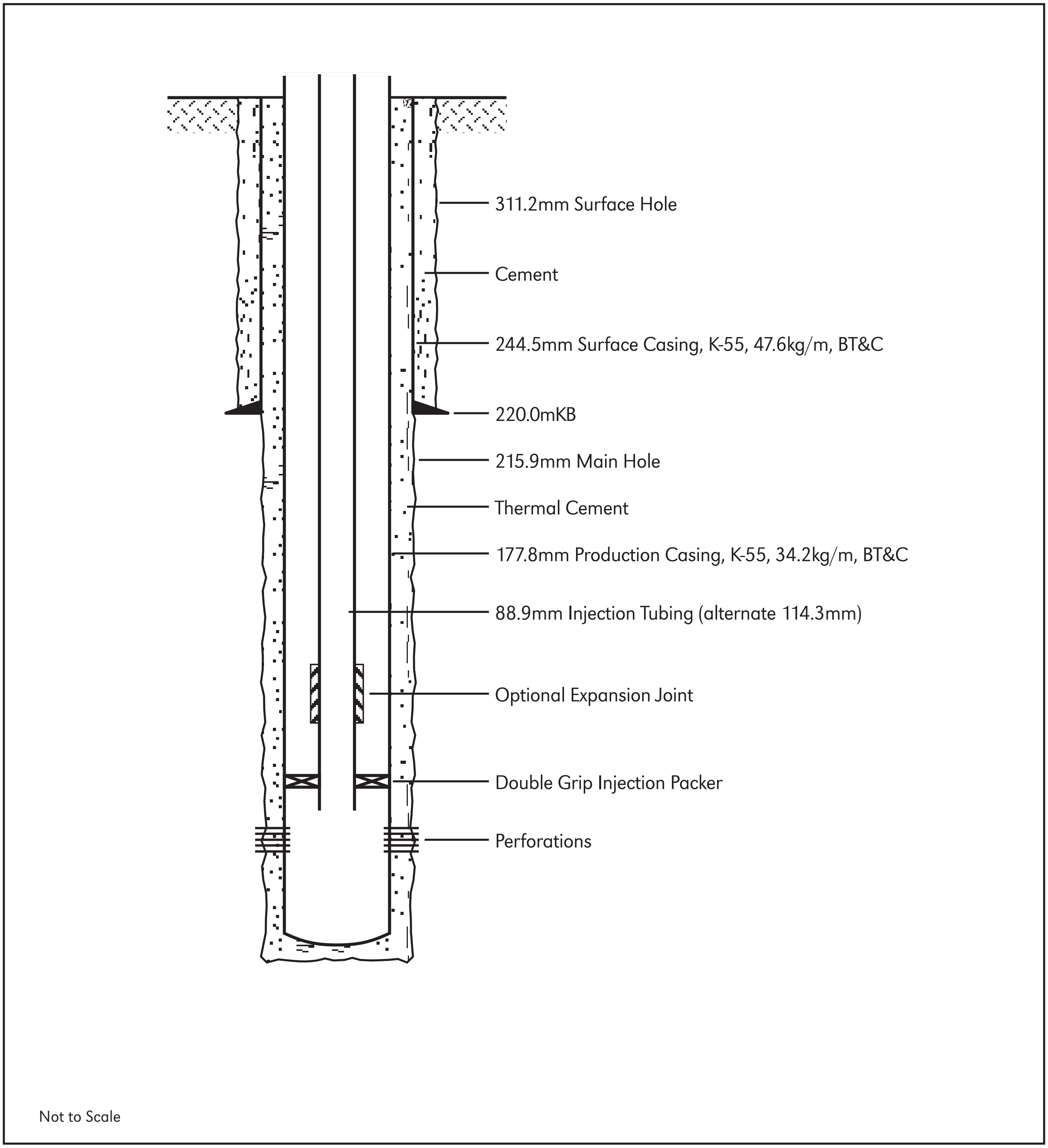
Appendix C - Corner Project

Typical Water Source Well



Appendix C - Corner Project

Typical Water Disposal Well (Class 1b)



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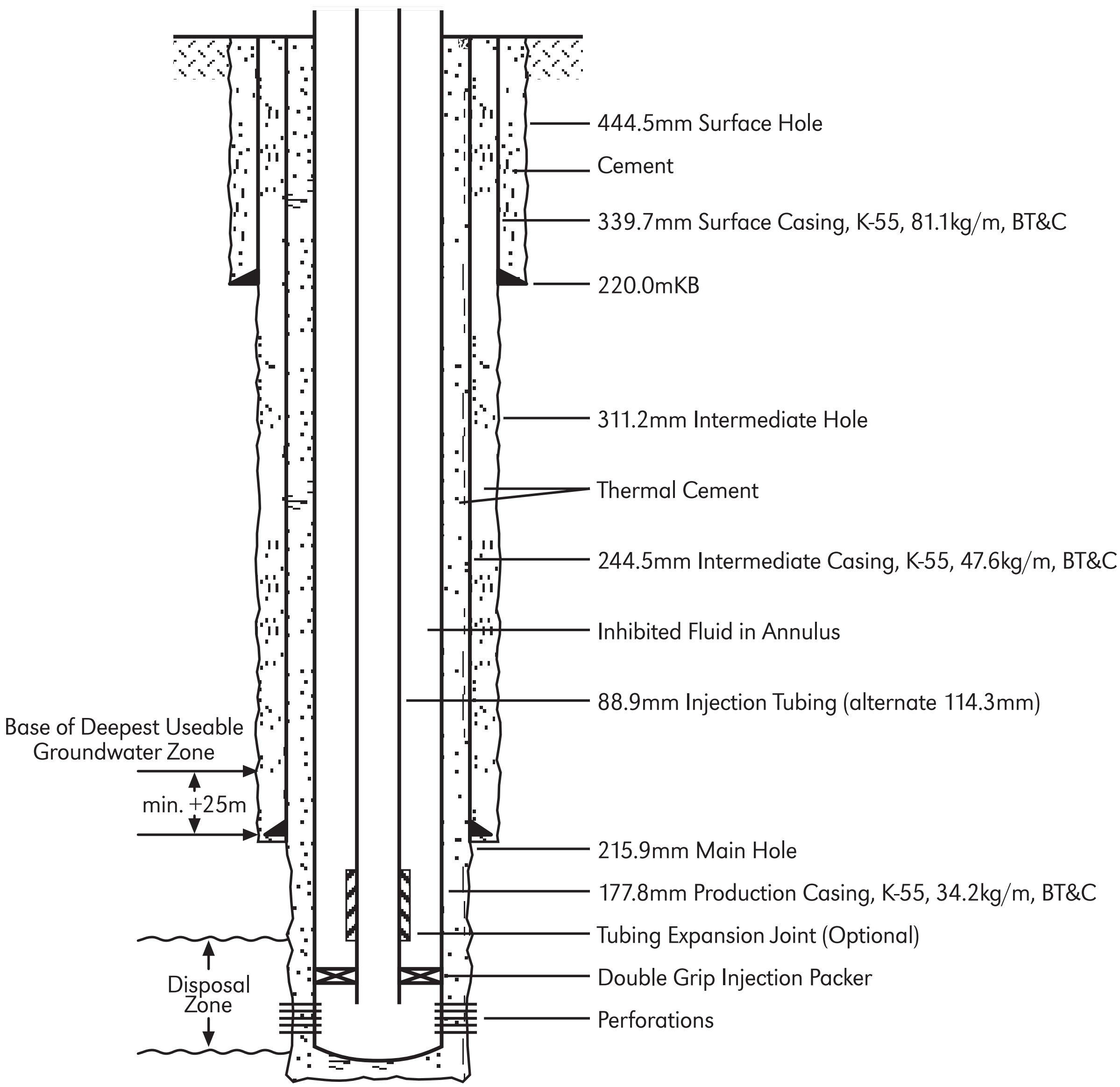
Appendix C - Corner Project

Typical Water Disposal Well (Class 1a)



Not to Scale

C2.3 Central Processing Facility

The collection and treating processes for produced fluids at the Corner Hub will be identical to the Leismer Demonstration, Commercial and Expansion Hubs, for a bitumen production capacity of 6,360 m^3/d. The central processing facility will include:

- Steam generation facilities;
- Production treatment (bitumen, water and gas) facilities;
- Sulphur removal equipment;
- Water treatment, recycle and disposal facilities;
- Electrical, air, water and instrumentation utility systems;
- Heat exchange equipment;
- Storage tanks; and
- Support buildings, including warehouses, offsite connections, truck racks and utilities.

C2.3.1 Production Treating, Steam Generation, Storage Tanks, Offsites and Utilities

The Corner Hub will utilize North American's standard process design, as Section 5.2, Volume 1 which consists of bitumen treating, water recycle and steam production. The following components are sources of air emissions:

- 8 OTSGs (73 MW, 250 mmBTU/h);
- 2 glycol heaters (2.78 MW);
- 1 slop treater (0.55 MW);
- 1 sulphur plant process heaters (2.78 MW);
- 2 high pressure (HP) flares; and
- 2 low pressure (LP) flares.

The Corner CPF will be provided with the necessary tankage, including diluted bitumen sales oil storage tanks, slop tanks, produced water skim tank, BFW tank, and diluent tank. All tanks will comply with secondary containment as required by EUB Directive 55.

C2.3.2 Sulphur Removal

The maximum sulphur inlet for the Corner Hub is in the range of one to three tonnes of sulphur per day and, as such, based on EUB Interim Directive 2001-3 requires 70% sulphur recovery. In its entirety, the Kai Kos Dehseh project will have an overall inlet sulphur rate greater than 10 t/d, and, as such, North American has designed each sulphur removal package to meet the 90% removal rate.

Sulphur will be removed from the produced gas prior to mixing with natural gas for combustion in the steam generators. The sulphur recovery unit is a small skid mounted, package unit capable of capturing a minimum of 90% of the sulphur as elemental sulphur of suitable quality for sale. This unit operates similarly to the larger scale Claus type units, where H_2S is oxidized to elemental sulphur over a fixed bed catalytic reactor. The gas phase process maintains the sulphur in the gas phase until it is recovered in the sulphur condenser. The treated gas leaves the process for the fuel gas mix drum prior to being consumed as fuel in the steam generators.

Pretreatment absorbers are expected to be required due to volatile organic compounds present in the produced gas. This would consist of two parallel packed towers upstream of the line labeled “sour gas”. These vessels capture heavy hydrocarbons in the inlet gas stream. The activated carbon media is periodically regenerated and the captured hydrocarbons recycled back into the oil treatment process.

Molten sulphur storage will be provided at the Corner CPF. The product will be trucked off site for sale.

C2.4 Water

C2.4.1 Camp for SAGD Drilling Program

The SAGD drilling crew will be housed in the existing camp located in NW 14-78-9W4M. This camp was used during the 2006/2007 winter drilling program. This camp has a licensed water well and approved domestic wastewater treatment facility.

C2.4.2 Camp for Construction and Operations

The construction and operations camp for the Corner Hub will be the same camp used to house the construction and operations workforce for the Leismer Demonstration/Commercial/Expansion Hubs. The camp is an integrated facility located in S1/2 32-78-9 W4 with a total of 450 rooms which accommodates the planned workforce.

The drilling camp in Section 14-78-9 W4 may be used for extra capacity during construction peaks and plant turnarounds.

C2.4.3 Central Processing Facility Potable Water, Utility Water and Domestic Wastewater Treatment

A Quaternary water well will be licensed for domestic and utility use. The utility water system will be sized for the clean service uses such as pump seal water and critical chemical dilution. The domestic supply will meet Potable Water Regulation AR122/93, and will be used for personal contact services such as safety showers, lavatories and kitchen/eating areas. During operations bottled potable water will be supplied at the CPF for operations personnel.

The domestic wastewater treatment system will be a septic tank and infiltration system designed in accordance with the Alberta Private Sewage Systems Standard of Practice 1999. The two 100% infiltration mounds will be dosed with a pressure dosing system, allowing one tile field to be in-service, and the second resting.

The septic tank design system will be based on 105 site people at 90 litres per day, for a design flow rate of 9.45 m^3/d.

C2.4.4 Produced Water and Water Reuse Process

The produced water treatment process at the Corner Hub consists of deoiling using:

- Skim tank,
- Induced static flotation, and
- Oil removal filters.

Chemicals are added at key points to improve oil and solids removal in the process.

The water reuse plant at the Corner Hub consists of the following:

- Warm lime softening for hardness, organics and silica reduction
- After filter for solids reduction
- Two stage weak acid cation exchange for hardness reduction to OTSG specifications.

Chemicals are added at key points to promote silica adsorption, hardness reduction, solids agglomeration, ion exchange regeneration, and oxygen scavenging and hardness chelation. The excess solids produced are stored in a sludge pond, and periodically dewatered and disposed off-site in a Class II (or better) licensed third party landfill.

C2.4.5 Water Management Plan

The water management plan at Corner for 6,360 m^3/d bitumen production is based on the following:

- Saline water make-up from the Basal McMurray and reduced Grand Rapids make-up starting the second year of operation.
- Greater than 90% of the produced water is reused after the first year of operation.

- An estimated average of 7% reservoir retention over the life of the project with an estimated 10% maximum reservoir retention after the first year.
- OTSG blowdown recycle to the boiler feedwater with total dissolved solids (TDS) limit of 8,000 mg/L.
- Excess flashed OTSG blowdown will be disposed into the Basal McMurray.
- Balanced push/pull from and to the Basal McMurray is planned. Saline water sources have been identified and confirmatory drilling, testing and modelling programs are being carried out.
- Initial steaming of each new well pad will require the maximum Grand Rapids make-up for approximately one month. The maximum demand is based on the water requirement for one OTSG prior to produced water returns. Based on the current start-up plan, for the initial 11 pads, the maximum rate is expected to be sustained for a cumulative 12 months.

The estimated water makeup and disposal requirements are summarized in Table C2.4-1.

Table C2.4-1 Estimated Corner Hub Water Demands

Water Demand	10% Reservoir Retention Long-Term Push-Pull (m^3/ calendar day)	7% Reservoir Retention Long-Term Push-Pull (m^3/ calendar day)
Initial Make-up (Lower Grand Rapids Aquifer)	3,850[1]	3,850[1]
Normal Disposal (Basal McMurray Aquifer)	1,900[3]	1,784
Maximum Disposal (Basal McMurray Aquifer	4,210[2]	3,930[2]
Normal Make-up (Lower Grand Rapids Aquifer)	1,960[3]	1,292
Maximum Make-up (Lower Grand Rapids Aquifer)	3,850[3]	2,730
Normal Make-Up (Basal McMurray)	1,900[3]	1,778

1 Initial steaming of each new well pad will require the maximum make-up for approximately one month.

2 Short-term – if blowdown recycle to warm lime softening is not functioning

3 Values are shown rounded from Table C2.4-2 and Figure C2.1-2.

C2.4.6 Water Balance and Contingency Operating Conditions

The most common upset condition expected at the Corner Hub is short-term increased reservoir retention. Reservoir retention is the most significant variable affecting the water make-up required to sustain the SAGD process. Reservoir retention is the produced water or condensed steam which does not return from the producing zone.

The consequence of increasing reservoir retention is increased make-up as shown in Table C2.4-2.

In Corner, with bottom and top water in the reservoir, some production of reservoir water, in addition to the condensed steam, is expected. The exact amount is going to depend on both the detailed geology and the strategies developed and optimized during actual operations. North American plans to operate the SAGD to minimize reservoir retention since it has the negative impact of increasing operating cost and increased water make-up.

Extensive modelling has been done for the Corner Hub to understand the effects of changing SORs and reservoir retention on the water balance as the Corner Hub develops and strives to meet the water recycle rates. Table C2.4-1 summarizes key balance parameters based on a produced water TDS of 3,500 mg/L. The actual produced water may vary and is expected to be less saline, however the trends and expected recycle rates are achievable within a plus 10% range on the produced water and easier to achieve with lower TDS concentrations. In order to achieve the 90% recycle rate, a portion of the blowdown must be recycled. The remainder of the blowdown is sent to disposal to purge the TDS from the system, and keep the boiler feedwater TDS below a normal maximum of 8,000 mg/L.

The Table C2.4-2 represents the best estimate of how the reservoir is expected to respond based on evaluation of the geology and experience from other operations. The water reuse plant and the overall project are designed with significant flexibility and are capable and expected to meet or exceed 90% recycle within one year of operation. The following is a discussion of Table C2.4-2:

- The plan for 0 to 6 months is to initiate steam in the circulation mode on both the injector and producer for approximately 3 months, followed by conversion of the well pairs to SAGD mode (steam in the injector and production from the producer) and gradual SAGD production. Key aspects of this period are possibly high reservoir retention and high SORs as the steam chamber develops and the best operating pressure and steaming strategy is developed. Produced water reuse will be practiced within days of getting produced water returns at the Corner Hub or the produced water will be directed to Leismer in place of make-up water there. Grand Rapids will be used as the make-up water source during this period. Disposal of excess OTSG blowdown will be to the Basal McMurray.
- From 6 to 18 months the conversion of all the well pairs to SAGD is planned and the production rate should gradually increase. Key aspects of this period are decreasing reservoir retention and decreasing SOR as experience is gained with this reservoir and the steam chamber development continues. Produced water recycle will be at or above plan some days but the average is expected to be slightly above the 90% level. Grand Rapids will continue to be the make-up water source during this period. Disposal of excess OTSG blowdown will be to the Basal McMurray.
- The stream day operation from 18 to 36 months is expected to have a service factor of about 90%, and reservoir retention and SOR are expected to continue to improve. Water recycle should meet or exceed the 90% level and production should be fairly stable at the 6,360 m^3/d level. Greater than 90% water recycle rate is expected to be met on a yearly basis. Push/pull operation into and out of the Basal McMurray will be practiced.
- The stream day operation for the long-term is expected to have a service factor in the range of 92%, and the reservoir retention in the range of 0 to 7%, with SOR in the range of 2.8 to 3.0. Produced water recycle is planned to exceed the 90% recycle rate with partial saline water makeup. The performance of push/pull from and to Basal McMurray should be known. If it is successful, then it will be continued. If it causes bitumen production issues it will be modified or discontinued.

Table C2.4-2 North American Water Management Plan for Corner Hub (6,360 m^3/d)

		Stream Day				Calendar Day	
			Start-up		Long-Term Operations	Maximum Reservoir Retention	Average Reservoir Retention
		0 to 6 months	**6 to 18 months**	**18 to 36 months**	**High Recycle**	**Long –Term Push-Pull**	**Long –Term Push-Pull**
				Stream Day Factor 90%	Stream Day Factor 92%	**Push - Pull**	**Push - Pull**
Oil Production Rate	m^3/d	1,590	3,981	7,073	6,917	6,360	6,360
Reservoir Retention	%	25%	15%	10%	7%	10%	7%
Reservoir Retention	m^3/d	2,187	2,388	2,263	1,356	1,908	1,247
SOR		5.5	4.0	3.2	2.8	3.0	2.8
Steam (Note 1)	m^3/d	8746	15932	22634	19368	19080	17811
BFW Flow	m^3/d	11,286	20,545	29,205	24,991	24,619	22,982
BFW TDS	mg/L	5,594	5,903	7,435	7,523	7,432	7,521
PW Reuse as per EUB	%	87%	89%	99%	99%	99%	99%
BD Recycle	%	69%	69%	66%	66%	66%	66%
Saline Make-up	%	0%	0%	50%	59%	49%	58%
Source Grand Rapids	m^3/d	2,980	3,837[4]	2,317	1,402	1,958[4]	1,292
Source Grand Rapids TDS	mg/L	1,837	1,8371,837	1,837	1,837	1,837	1,837
Basal McMurray	m^3/d	0	0	2,261	1,936	1,902[4]	1,778
Source TDS	mg/L	14,061	14,061	14,061	14,061	14,061	14,061
Water lost to BS&W (Note 2)	m^3/d	4	10	19	17	32	32
Disposal Flow	m^3/d	781	1,421	2,267	1,940	1,883[4]	1,784
Disposal TDS	mg/L	34,469	36,454	46,027	46,595	46,012	46,583
Water lost to Sludge	m^3/d	11	21	33	29	36	36
Fuel Gas to Steam Plant (Note 3)	sm3/d	624,097	1,136,150	1,615,045	1,381,992	1,361,667	1,270,889

Notes:

1 Cold water equivalent.

2 Assumes 50% of BS&W is water.

3 Calculated at 32.7 MJ/m^3, 90% firing efficiency. Produced gas at 17.3 MJ/m^3 also included at same efficiency. GOR 8.0 ^{3}/m^3 fuel for utilities not included.

4 These values are shown rounded in Table C2.4-1.

C2.4.7 Disposal Water Quality

The only planned disposal stream is flashed OTSG blowdown. The TDS of the boiler blowdown will be approximately four to six times the TDS of the boiler feedwater (BFW). The boiler blowdown is planned to be recycled to a BFW TDS limit of 8,000 mg/L, and the boiler blowdown will then be in the range of 32,000 to 48,000 mg/L. The hardness and silica concentrations of the blowdown are estimated at 2 to 6 mg/L and 200 to 300 mg/L respectively. There is limited information on the Basal McMurray in the area. The Basal McMurray is expected to be 11,000 to

20,000 mg/L TDS within two townships of the plant site. The modelling has been done assuming a 14,000 mg/L TDS for the Basal McMurray.

C2.4.8 Evaluation of Disposal Alternatives

The criteria used in evaluating the disposal systems were process and operating reliability, capital and operating cost. The main blowdown disposition alternatives considered for the disposal stream were:

- Disposal into the McMurray bottom water in the vicinity of the Corner Hub as part of the balanced push/pull concept.
- Transfer of water to the Leismer hubs and disposal into the McMurray bottom water in the vicinity of the Leismer hubs as part of the balanced push/pull concept.
- Transfer of disposal water to the Leismer hubs and disposal into a water section in the McMurray in the Leismer hubs area which is isolated from areas with SAGD potential.
- Mechanical evaporation followed by crystallization of the disposal stream.

Disposal of OTSG blowdown into the Basal McMurray long-term without withdrawal from the same zone was evaluated and judged likely to cause reservoir recovery issues.

Selected disposal strategy for the Corner Hub is disposal into the McMurray bottom water in the vicinity of the Leismer hubs as part of the balanced push/pull concept. Pipeline infrastructure has been included in the Project footprint to accommodate water transfers between the development areas.

North American is continuing to monitor the application of evaporation/crystallization process at other SAGD operations to better identify costs and operational issues. The results from current operations and the on-going evolution of this technology may prove it to be a viable alternative should the push/pull concept not meet expectations.

C2.4.9 Hydrogeologic Evaluation

Start-up of each Corner OTSG will require up to 3,850 m^3/d of water (water required for one OTSG). This water demand (maximum withdrawal rate) is expected to be required for one year.

The hydrogeologic assessment, including well testing and numerical groundwater modelling provided in Volume 3 Section 5.6 Impact Assessment, concludes that sufficient water is available to meet the long-term water demands of the Corner Hub. To summarize, the total long-term water demands and supporting aquifers for the Corner Hub is 1,960 m^3/d from the Lower Grand Rapids Aquifer and 1,900 m^3/d from the Basal McMurray Aquifer. The hub will also dispose of 1,900 m^3/d into the Basal McMurray Aquifer.

C2.5 Chemical Consumption

A variety of chemicals, lubricating oils and domestic and office supplies are required for operations at the CPF. Storage and tracking of the supplies and disposal of waste products includes provisions for secondary containment, leak detection and inventory reconciliation as necessary and as required by Regulation. The largest chemical consumption streams include hydrated lime, magnesium oxide (dry), hydrochloric acid (HCl) and sodium hydroxide (NaOH). Storage capacity for chemicals is generally based on ten to fourteen days supply plus one bulk truckload. Smaller amounts of secondary chemicals such as filtration coagulants, demulsifiers, dispersants, and water treatment aids are also consumed. Chemical consumption estimates for these secondary chemicals are provided as part of the detailed design of the CPF. Table C2.5-1 presents the estimated chemicals that will be consumed during operation of the Corner Hub.

Table C2.5-1 Chemical Consumption

Chemical	Consumption Rate for 6,360 m^3/d (40,000 bpd) bitumen production (t/d)
Hydrated lime	14.71
Magox	7.58
Soda Ash	3.31
HCl (32%)	9.06
Caustic (50%)	6.60
Demuslsifier	0.95
Reverse demulsifier	2.23
Flocculant	0.04
Hypochlorite	0.30
Coagulant	0.40
Polymer	0.51
O2 scavenger	0.29
After filter aid	0.03
Chelant	0.10
Filming amine	0.10

C3 APPLICATION FOR APPROVAL

C3.1 Existing Approvals

North American has received EUB approval for the Leismer Demonstration Hub, which is included within the Kai Kos Dehseh Project area.

C3.2 Request for Approval

North American hereby applies for regulatory approval to construct, operate and reclaim the proposed Corner Hub on a portion of the oil sands leases located in Townships 76 to 83, Ranges 8 to 13 West of the 4th Meridian. The CPF for the Corner Hub will be located in the SE ¼ of 31 and SW ¼ of 32 in 80-08 W4M.

The Corner Hub will use SAGD to produce bitumen at a rate of 6,360 m^3/d (40,000 barrels per day (bpd)) on an annual average calendar day basis. North American will seek approval for additional phases of the Corner Hub under future amendments.

This appendix (Application for Approval of the Corner Hub of the Kai Kos Dehseh Project) comprises the Application for Approval of the Corner Hub and serves to meet requirements under the Alberta Oil Sands Conservation Act (AOSCA), the Alberta Environmental Protection and Enhancement Act (AEPEA) and the Water Act. The document is provided as an integrated Application to the EUB and AENV as outlined in the EUB/AENV Memorandum of Understanding on the Regulation of Oil Sands Developments (IL 96-07).

With this Application, North American is seeking approval from:

1. The EUB for:

   Approval to construct and operate a bitumen recovery scheme, under Section 10 of the Oil Sands Conservation Act, from the Athabasca Oil Sands Deposit in the McMurray Formation, at Oil Sands Leases located between the southeast portion of Section 34-80-8 W4M and northwest portion of Section 16-81-9 W4M, owned by North American Oil Sands Corporation; and

2. AENV for:

   a. Approval to construct and operate the Corner Hub, including facilities to recover and treat bitumen and produced water, under Division 2 of Part 2 and Section 63 of the AEPEA;

   b. A Conservation and Reclamation Approval, under Division 2 of Part 2 and Part 5 of the AEPEA to develop, operate and reclaim components of the Corner Hub; and

c. A groundwater diversion license to operate a groundwater well(s) as a fresh water for start up and utility supply.

d. A groundwater diversion license to operate groundwater well(s) as a water supply for steam generation.

Original Signed by

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C3.3 Application for Oil Sands Project

Under Alberta Regulation 276/2003, Activities Designation Regulation, the proposed Corner Hub is listed in Schedule 1 and is, therefore, designated as an activity for which an approval is required. The information needed to satisfy the requirements for joint EUB and AENV approval is contained herein.

C3.4 Associated Applications for the Corner Hub

North American will file applications for other aspects of the Corner Hub under various other statutes. The provincial application and approval requirements applicable to the Corner Hub that will be submitted under separate cover include, but are not limited to:

- Public Lands Act, for surface rights;
- Historical Resources Act, for clearance to construct the facilities;
- Pipelines Act and Alberta Environmental Protection and Enhancement Act, for the construction and operation of pipelines between the central facilities and Production Pads, water supply wells, water disposal wells, fuel gas, diluent and sales pipelines;
- Oil and Gas Conservation Act, for well licenses; and
- Municipal Government Act, Part 17, for a development permit from the Regional Municipality of Wood Buffalo for the construction and operation of the Corner Hub and related infrastructure.

C4 CORNER HUB GEOLOGY AND RESERVOIR

C4.1 Geological Description of the Corner Hub Development Area

C4.1.1 Geological Database

North American evaluated the regional geology in the Corner Regional Geological Study Area (Corner RGSA) defined by Section 34-80-8 W4 and Section 16-81-9 W4. The Corner Hub is located in the central part of the Corner RGSA. Map boundaries were selected to include the proposed plant site (Section 31-80-8 W4) and proposed source and disposal well areas

North American has conducted extensive geological and geophysical investigations throughout the Corner area including 2D and 3D seismic and extensive exploratory and delineation drilling combined with selective coring. A summary map of Geological and Geophysical Control for the Corner RGSA (Figure C4.1-1) illustrates the distribution of wells, cores and high resolution micro imager logs (HMI). Drilling density over the Corner Hub initial development area is approximately 32.4 ha spacing (80 acres). Of the 32 wells in the Corner Hub development area, 17 have been cored. Twenty nine of the wells in the Corner Hub development area were drilled by North American over the last three years.

All wells within the Corner RGSA have been wireline logged. One well (11-4-81-9 W4) is of limited use as it is a horizontal well that only penetrated the uppermost portion of the McMurray and does not provide full information on the SAGD potential. In addition, 68 wells have high resolution micro imaging (HMI) logs, of which 29 are in the Corner Hub initial development area.

Much of the Corner Hub development area is covered by a 24 km^2 3D seismic survey acquired by North American in Q1, 2006. An additional 22 km^2 3D seismic survey was added to the existing survey in Q1, 2007 but the new data does not impact the initial development area proposed for the Corner Hub development area. Other parts of the Corner RGSA are less well defined but will be the subject of additional exploration in future years.

The standard log suite for North American wells includes gamma, neutron, density, PE, SP, resistivity, HMI and sonic. Shear dipole sonic logs are available on seven wells.

All seismic data were interpreted in the Seisware geophysical software. Simandoux shaly sand analysis was carried out by petrophysicists at Weatherford Canada. All log data and seismic surfaces used were integrated in both Petrol and Geographix Discovery geological-geophysical software.

Additional drilling will continue in areas outside of the Corner area in future years and will be the subject of future commercial applications. Selected infill steering and observation wells (locations yet to be determined) will be drilled about one year before the actual horizontal drilling for the Corner Hub is initiated, approximately in 2010.

C4.1.2 Regional and Corner Hub Geology and Geophysics

The regional geological picture is for the overall Corner RGSA. This evaluation is closely aligned with the EUB's review of geological data in the area presented in Report 2003-A (EUB-Athabasca Wabiskaw – McMurray Geological Study).

C4.1.2.1 Regional Stratigraphy

The bitumen resource is in the McMurray Formation, which is the basal unit of the Lower Cretaceous Mannville Group. In northeastern Alberta, the Mannville Group is composed primarily of unconsolidated clastic sedimentary rocks that are divided into three Formations. From oldest to youngest, these formations are the McMurray Formation, the Clearwater Formation and the Grand Rapids Formation. Figure C4.1-2 illustrates the regional stratigraphy in the Corner RGSA.

The McMurray Formation rests unconformably on the carbonates of the Devonian Beaverhill Lake Group. The unconformity at the base of the McMurray Formation was formed during a lengthy period of sub aerial exposure and erosion and resulted in deeply incised valleys that influenced the deposition of the lower McMurray bitumen sand reservoirs. The lower sands are fluvial in nature while the upper sediments are deposited in estuarine and interdistributary bay environments. The basic regional sequence in the Corner area consists of stacked progradational parasequences designated, from top down, A1, A2, B1, B2 considered to have been deposited in interdistributary bay settings. C channel deposits underlie the parasequences. McMurray estuarine channels originate at many stratigraphic levels within the stratigraphic section. If a McMurray channel is contained within two of the regional muds, it is named after the sequence it is in (a B1 channel is bound by the A2 mud and underlying B1 mud). Any channels that have cut through the B2 muds or are stacked without preserved regional muds are termed “McMurray channels”.

The Clearwater Formation in the Corner area includes the basal Wabiskaw Member, consisting of transgressive marine silty sandstones. An interval of marine shale overlies the Wabiskaw in the Corner RGSA. The Clearwater B sandstone that is developed in some areas is not present in the Corner RGSA.

The Grand Rapids Formation gradationally overlies the Clearwater and consists of the Lower Grand Rapids Member sandstone and an Upper Grand Rapids Member comprised of stacked coarsening upwards shale to sandstone cycles.

The Mannville Group is overlain by the shales and minor sands of the Colorado Group which are truncated in areas by pre-Quaternary erosion. The Colorado Group is overlain by tertiary aged sand and gravel and by Quaternary glacial deposits.

C4.1.2.2 Devonian

The Devonian in the Corner area consists of dolomitized fossiliferous limestones and argillaceous limey mudstones of the Beaverhill Lake Group. Figure C4.1-3 shows the Wabiskaw to Sub-Cretaceous Unconformity isopach. This map integrates well control with a depth converted Wabiskaw to Devonian isochron. Variations in thickness are largely controlled by paleotopograhic relief on the surface of the Pre- Cretaceous unconformity with isopach thicks occurring over paleotopographic lows. Most of the isopach displays moderate relief and generally is between 52 m (well 3-1-81-9 W4) and 70 m (well 13-2-81-9 W4) thick. The edge of a deeper paleovalley is evident in several well bores along the far western edge of the Corner RGSA. The isopach attains thicknesses of 75 m in a series of wells along the western side of Sections 4 and 16-81-9 W4 and attains a maximum thickness of 79.6 m in well 12-16-81-9 W4. A second low is evident in Sections 5 and 9-81-8 W4 where a northeast trending paleotopographic low has provided accommodation space for up to 10 m of additional McMurray section. Well 16-5-81-8 W4 is 68.9 m thick compared to a thickness of 57.6 m in well 14-5-81-8 W4. The lows are considered to be buried erosional features as they do not persist above the McMurray Formation. Figure C4.1-4 shows a seismic slice across the isopach thick in the vicinity of Section 5-81-8 W4 where the low can be seen to be infilled with McMurray sediment. There is no indication of the feature in overlying strata confirming it is not a post-McMurray karst feature penetrating to surface.

Figure C4.1-5 shows the present day structure on the Sub-Cretaceous Unconformity. This map was prepared by integrating geological well control with the 3D depth converted structure on the Devonian surface. Present day relief on top of the Devonian indicates the presence of an east-west trending high along the south edge of the Corner area. Structure on the Devonian rises from 232 masl (15-6-81-8 W4) to 248 masl (5-31-80-8 W4). This feature is a paleotopographical high as the McMurray Formation isopach thins 14 m to the south in the same two wells.

McMurray Formation

General stratigraphy in the Corner RGSA follows that established by the EUB and has been previously discussed (Section 4.1.2.1). The regional sequences consist of basal mudstones grading up to sandier wave rippled to bioturbated sandier facies. The relatively uniform isopachs of the regional parasequences (<10m) precludes development of a thick enough sandstone reservoir to be economically exploited with today’s SAGD technology. Sedimentary structures and trace fossils indicate deposition in a restricted marine interdistributary bay fill setting. The thicker, exploitable reservoirs occur in the sandstone dominant portions of fluvial and estuarine deposits.

The McMurray Formation ranges from 23 m (well 2-31-81-8 W4) to about 68 m in thickness (two wells in 12-16-81-9 W4 W4) in the Corner RGSA, as shown in Figure C4.1-6, the McMurray to Sub-Cretaceous Unconformity isopach. Again, the pronounced north east trending thickening on the eastern side of the initial development area is evident and results from the infill of an erosional low on the pre-Cretaceous unconformity surface. This map is similar to the Wabiskaw to sub-Cretaceous Unconformity isopach since the Wabiskaw is of relatively uniform thickness. It should be noted that the McMurray isopach presented in Figure C4.1-6 has not included information from the 3D since the Wabiskaw is a more consistent seismic top than the McMurray.

Structure on the top of the McMurray is illustrated in Figure C4.1-7. Present day relief on the top of the McMurray does not display any strong trends but consists of random, small closures (up to about a section in size). The maximum relief on these closures is 14 m (wells 10-3-81-9 and 3-10-81-9 W4). Remaining closures are typically 3 m or less.

Wabiskaw Member of the Clearwater Formation

The Wabiskaw Member sharply overlies the McMurray Formation. The Wabiskaw consists of transgressive marine glauconitic silty sandstones. The Wabiskaw is approximately 10 m thick in the Corner RGSA and ranges from 9 to 13 m.

Structure on the top of the Wabiskaw is shown in Figure C4.1-8. Since the Wabiskaw is a more consistent seismic pick than the top of the McMurray, the map of Figure C4.1-8 was selected for integration with 3D depth converted isochron data to produce the Structure map on the sub-Cretaceous Unconformity (Figure C4.1-5). The Wabiskaw parallels the McMurray structure in the Corner RGSA with no strong trends developed.

Clearwater Formation

The Clearwater Formation in the Corner RGSA largely consists of marine shales. The upper Clearwater A sandstone is not present in the Corner RGSA.

Grand Rapids Formation

In the Corner RGSA, the Grand Rapids Formation consists of an Upper and Lower member. The Lower Member is a blocky, clean sandstone and a thin coal (<2 m) is commonly present towards the top. Gross porous sandstone maps are presented and discussed in Section C4.3.4.

The Upper Grand Rapids is 40 to 60 m thick and consists of stacked progradational parasequences with basal marine shales grading up into clean porous sandstones. Gas over water may be locally present in these upper sandstones.

Joli Fou Formation

Tight marine shales of the Joli Fou Formation directly overlie the Upper Grand Rapids Formation. The Joli Fou is truncated by the Quaternary unconformity and is overlain by unconsolidated glacial sediments. In the Corner rea, the Viking formation is commonly preserved and locally, Cretaceous sediment as high up as the base of Fish Scales may be present.

Quaternary

The Mannville Group is overlain by the shales and minor sands of the Colorado Group which are truncated in areas by pre-Quaternary erosion. The Colorado Group is overlain by Tertiary aged sand and gravel and by Quaternary glacial deposits.

C4.1.3 Corner Hub Geology

C4.1.3.1 Type Log of the McMurray Formation for the Corner Area

Figure C4.1-9 illustrates well AA/11-06-081-08W4/00, which was selected as the type log for the Corner area.

C4.1.3.2 Log and Core Comparison

The Corner RGSA has a total of 75 wells with 17 cores in the McMurray. The Corner initial development area has a total of 32 wells (29 were drilled in the last three years) and 17 cores. A wireline company was retained to carry out Simandoux shaly sand analyses on the cored wells in the vicinity of the Corner area. Core and log data compared favorably and an example is illustrated in Figure C4.1-10 for the type log AA/11-06-081-08W4/00. Log parameters and a Pickett plot, used to determine Rw are shown in Figure C4.1-11.

Several things can be noted from the core to log comparison of Figure C4.1-10. Saturations match most closely in the cleaner reservoir intervals. The largest discrepancy can be seen in highly interbedded sections where core sampling tends to high-grade the cleaner sandstone beds and where logs tend to average their response across the interbedded sands and shales. Net SAGD pay maps for the Corner area were prepared by using 6 weight percent bitumen cutoffs as determined by Simandoux analysis and consistent with Report 2003-A.

Of particular interest, the Rw as determined from the Pickett plot (Figure C4.1-11) and core-log calibrations is quite consistent at a value of 0.55. Rw variations in the McMurray can be quite significant, particularly in areas close to surface or outcrop, and may result in a need for frequent coring to determine oil saturations. North American believes there is already enough core control in the area to verify that Rw is consistent and no additional coring is required in the Corner initial development area to address that specific issue.

Table C4.1-1 summarizes the McMurray reservoir characteristics from all cores taken in the Corner initial development area.

Table C4.1-1 Reservoir Characteristics Cores in the Project Area

Parameter	Core Range
Porosity	27% to 41%
Permeability	2 to 10 Darcies
Bitumen Saturation	50% TO 90%

C4.1.3.3 Seismic Characterization of the McMurray Formation

North American conducted 3D seismic utilizing a mini-vibrator source in the Corner area, a portion of which covered the Corner initial development area, in the first quarter of 2006. Additional 3D seismic was added in 2007 within the Corner RGSA but does not immediately impact the Corner area. Interpretation of the merged 2006 / 2007 3D seismic data volumes will be included in subsequent applications. Innovative grid design achieved high resolution sampling, while limiting surface environmental impact to 10 ha net in a 24 km^2 total 3D area. North American imaged and mapped the Middle McMurray channel sequences and oil sand prone porosity zones, achieving 5 m bed resolution. Coherency and signal to noise ratio of the mini-vibe seismic, spatial sampling and pre-stack time migration processing have combined to produce highly interpretable seismic with excellent agreement to the wireline log data. Identification of channel facies from seismic will help refine infill drilling programs and reduce the need for high density drilling patterns to delineate the McMurray channels.

2006 Corner 3D Seismic acquisition parameters are as follows:

- 112 m source line interval, 140 m receiver line interval (Reverse acquisition geometry)
- Source: Single Mini-vibe 12,000 lbs., non-linear sweep 8-180 Hz
- Infill dynamite around lakes and impassable areas (about 0.5 % of source points)
- 1 ms sample rate, ARAM 24 bit recorder
- Processed by Kellman, March/April, 2006
- Subsurface bin size = 14 m X 14 m
- Bandwidth in migrated stack 10-165 Hz., after NMO stretch
- Dominant frequency of 100 Hz., at 2400 m/s- resolving 5 m beds
- Detection of hard shales within these sands down to 3 m thickness, detection of gas zones down to 2 m

Channel fairway interpretation successfully separates the regional wells from the sand dominated channel facies. Figures C4.1-12 and C4.1-13 (both are vertical depth converted seismic slices) clearly show the transition from thick pay sandy channel facies to thin pay regional McMurray facies. Figure C4.1-13 compares the seismic character between the 11m gross pay well 3-6-81-8W4 and the 28m gross pay well at 11-6-81-8W4. The cyan coloured “Porosity Top” interpretation tracks the strong blue seismic event. The top of porosity seismic event has a dramatic structural drop moving from 11-6 to 3-6. The lack of reflectivity (muted seismic response characterized by weaker colours on the seismic displays) indicates a lack of shale breaks within the good pay sections for both 11-6-81-8W4 (Figure C4.1-13) and a number of wells on Figure C4.1-12.

High resolution 3D seismic, in addition to providing very accurate structural information, can effectively map channel fairways and sand prone facies. Integrating the 3D seismic with well data (logs and core), depth converting the data and building a geological structural model within Petrel has effectively allowed North American to define the bounding reservoir limits, including the “15 metre gross SAGD pay” interval and the all important structure on the “Base SAGD Pay” surface. This integrated reservoir “picture” enables effective horizontal well placement to optimize recovery.

Reservoir Characteristics

Integrated geology and geophysics permit a detailed description of the reservoir in the Corner initial development area. The Corner initial development area can be described as a contiguous east-west trending channel reservoir partly constrained by a paleotopographical high to the south. Figures C4.1-14 and C4.1-15 are south-north and west-east cross sections through the Corner initial development area.

The reservoir in the Corner initial development area is dominantly a B2 channel but the occasional occurrence of B1 and C channels necessitates the use of the RGS terminology “McMurray Channels”. Figure C4.1-14 is an east-west cross section that illustrates the relationships and wells 11-6-81-8 W4 and 5-6-81-8 W4 illustrate logs from the prospective area. Figure C4.1-16 is the McMurray Net SAGD Pay map prepared with 6 weight % bitumen cutoffs. The net SAGD pay map indicates that a roughly east west trending reservoir has over 15 m of pay in an area of about 10 km in length and a width of 800 to 1,600 m. The thickest well drilled to date in the trend is 1-10-81-9 W4 with 38.6 m of pay. Table C4.1-2 summarizes the cutoffs used to estimate bitumen resources.

Table C4.1-2 Cutoffs Used to Estimate Bitumen Resources

Parameter	Value
Bitumen Saturation (core)	6 Wt. %
Bitumen Saturation (logs)	RT ≥ 20 ohms at 27% phi
Sand porosity (density log)	27%
Gamma ray (log)	75 API

There are three main caprock sequences in the Corner initial development area, the B2 mudstone, the B1 regional and the A2 mudstone. The B2 mudstone is locally present over C level channels and can locally be up to 4.9 m thick (3-12-81-9 W4) but is more typically about 2 m thick (Figure C4.1-17). It occurs in discontinuous patches up to several LSD's in size The full B1 regional parasequence (Figure C4.1-18) is present over all of the exploitable bitumen pay in the Corner area and ranges from 5.7 m(11-6-81-8 W4) to 11.8 m (7-1-81-9 W4). The regional B1 in the Corner area is a coarsening up sequence of interbedded shales and sandstones with the lowermost shale being 0.5 to 1 m thick. The final caprock over the McMurray channels in the Corner area is the A2 regional mudstone (Figure C4.1-19). It is present throughout the Corner area and ranges from 1.3 m (14-4-81-8 W4) to 2.7 m (11-2-81-9 W4) in thickness.

Figure C4.1-20 shows the structure on the top of the gross SAGD pay. A roughly east-west trending structural closure is present along the central axis of the channel that crosscuts trends noted on the Pre-Cretaceous unconformity surface. The feature presumably reflects compactional drape over the thickest sandstone sequences.

Figure C4.1-21 is a structure map on the base of the SAGD pay. This map was used to select elevations for individual well pairs. A 40 ohm cutoff was used rather than a 6 weight percent bitumen cutoff as North American wishes to avoid any transition zone when considering well placement. It can be noted that structural contours on the base of the SAGD pay are effectively parallel to the 15 m pay edges suggesting well pairs would optimally parallel the channel edges. Some localized bottom water is present and will also impact well placement and is discussed in detail in Section C4.2. In areas ≤4 m of bottom water, the wells will be placed 1 m above the 40 ohm cutoff. In areas of ≥4 m bottom water, the well will be placed 4 m above the thicker bottom water areas. The transition from water to 6 weight percent to 40 ohms is fairly abrupt in the Corner Project area and is usually less than 2 m. Table C4.1-3 includes volumetrics, by pad, for bitumen in place above the producing wells to the top of the 6 weight % pay and volumetrics for stranded oil in place from the producing wells to the base of 6 weight % bitumen. These volumes were calculated in Geographix for the pad areas by using grid operations top and base of net ≥ 6 weight percent bitumen surfaces and a third surface determined by the selected elevations for the horizontal wells with a final gross to net reduction.

Table C4.1-3 SAGD Pad Volumes

Pad	Drainage Area (Ha)	No. of Well Pairs	Volume Classification	Avg Pay Thickness (m)	Avg Bitumen Saturation (fraction)	Avg Porosity (fraction)	Net To Gross (fraction)	6 wt% OBIP (e6m3)	Est. Recovery Factor (fraction)	Est. Recoverable Bitumen (e6m3)
C01	38.2	3	Above Producer Level	17.2	0.875	0.313	0.960	1.728	0.673	1.163
			Below Producer Level	2.0	0.863	0.319	1.000	0.210	0.000	0.000
			Total	19.2				1.939	0.600	1.163
C02	86.9	6	Above Producer Level	19.6	0.816	0.337	1.000	4.684	0.651	3.049
			Below Producer Level	1.9	0.734	0.329	1.000	0.399	0.000	0.000
			Total	21.6				5.082	0.600	3.049
C03	66.9	6	Above Producer Level	21.8	0.822	0.333	0.922	3.682	0.661	2.434
			Below Producer Level	2.1	0.818	0.326	1.000	0.375	0.000	0.000
			Total	24.0				4.057	0.600	2.434
C04	62.1	5	Above Producer Level	21.8	0.850	0.343	0.943	3.722	0.685	2.548
			Below Producer Level	3.4	0.790	0.343	0.917	0.524	0.000	0.000
			Total	25.1				4.247	0.600	2.548
C05	77.9	5	Above Producer Level	21.5	0.870	0.341	0.987	4.903	0.694	3.401
			Below Producer Level	3.5	0.832	0.343	0.984	0.766	0.000	0.000
			Total	24.8				5.669	0.600	3.401
C06	88.1	6	Above Producer Level	21.7	0.749	0.336	0.995	4.788	0.665	3.186
			Below Producer Level	2.8	0.622	0.340	1.000	0.522	0.000	0.000
			Total	18.1				5.309	0.600	3.186
C07	60.1	6	Above Producer Level	22.0	0.790	0.336	0.938	3.293	0.644	2.120
			Below Producer Level	1.6	0.760	0.330	1.000	0.241	0.000	0.000
			Total	23.6				3.534	0.600	2.120
C08	70.8	5	Above Producer Level	22.3	0.866	0.343	0.959	4.499	0.645	2.904
			Below Producer Level	2.3	0.787	0.347	0.766	0.340	0.000	0.000
			Total	24.6				4.839	0.600	2.904

Pad	Drainage Area (Ha)	No. of Well Pairs	Volume Classification	Avg Pay Thickness (m)	Avg Bitumen Saturation (fraction)	Avg Porosity (fraction)	Net To Gross (fraction)	6 wt% OBIP (e6m3)	Est. Recovery Factor (fraction)	Est. Recoverable Bitumen (e6m3)
			Above Producer Level	18.1	0.822	0.325	0.928	3.660	0.711	2.604
C09	81.6	6	Below Producer Level	3.7	0.783	0.332	0.866	0.680	0.000	0.000
			Total	21.7				4.340	0.600	2.604
			Above Producer Level	18.1	0.811	0.342	0.896	3.099	0.696	2.156
C10	68.9	6	Below Producer Level	4.5	0.673	0.345	0.688	0.495	0.000	0.000
			Total	22.6				3.593	0.600	2.156
			Above Producer Level	18.0	0.795	0.316	0.948	2.976	0.650	1.933
C11	69.4	6	Below Producer Level	1.6	0.760	0.318	0.916	0.246	0.000	0.000
			Total	19.7				3.221	0.600	1.933

Figure C4.1-22 shows well pair and pad locations for the Corner area. Figure C4.1-23 shows the pad and horizontal well locations in conjunction with the structure map on the base of the SAGD pay. Table C4.1-4 lists the producer horizontal wells and their structural elevations.used in the calculations for Table C4.1-3. Individual plots of each horizontal producer well in the Corner area with a depth converted 3D seismic profile and key horizons are included at the back of this Appendix (Section C7.0) (58 total).

Table C4.1-4 Gas Wells in the Vicinity of the Project Area

Well Pair Name	Well (productive) length (m)	Elevation of horizontal well (TVDSS m) -	Drilling Direction
01-C01-P3	1000	235	SW
02-C01-P2	1000	237	SW
03-C01-P1	970	238	SW
04-C02-P6	1200	234	NE
05-C02-P5	1200	235	NE
06-C02-P4	1200	235	NE
07-C02-P3	1000	234	NE
08-C02-P2	1000	233	NE
09-C02-P1	1000	233	NE
10-C03-P6	1030	234	WSW
11-C03-P5	940	235	WSW
12-C03-P4	870	236	WSW
13-C03-P3	820	239	WSW
14-C03-P2	780	239	WSW
15-C03-P1	940	244	WSW
16-C04-P5	910	241	ENE

Well Pair Name	Well (productive) length (m)	Elevation of horizontal well (TVDSS m) -	Drilling Direction
17-C04-P4	950	239	ENE
18-C04-P3	950	235	ENE
19-C04-P2	950	233	ENE
20-C04-P1	950	231	ENE
21-C05-P5	1000	233	ENE
22-C05-P4	1000	236	ENE
23-C05-P3	1000	238	ENE
24-C05-P2	1200	237	ENE
25-C05-P1	1200	239	ENE
26-C06-P1	1000	243	NE
27-C06-P2	1000	243	NE
28-C06-P3	1200	242	NE
29-C06-P4	1200	240	NE
30-C06-P5	1070	236	NE
31-C06-P6	770	236	NE
32-C07-P5	880	241	NW
33-C07-P4	910	242	NW
34-C07-P3	940	243	NW
35-C07-P2	920	241	NW
36-C07-P1	930	239	NW
37-C08-P1	960	240	ESE
38-C08-P2	940	239	ESE
39-C08-P3	910	239	ESE
40-C08-P4	880	237	ESE
41-C08-P5	850	238	ESE
42-C08-P6	820	238	ESE
43-C09-P6	1000	239	WNW
44-C09-P5	1000	239	WNW
45-C09-P4	1000	240	WNW
46-C09-P3	1000	240	WNW
47-C09-P2	1000	238	WNW
48-C09-P1	820	239	WNW
49-C10-P5	1000	236	NW
50-C10-P4	1000	232	NW
51-C10-P3	1000	231	NW
52-C10-P2	1000	233	NW
53-C10-P1	1000	235	NW
54-C11-P5	1000	235	NW
55-C11-P4	1000	235	NW
56-C11-P3	1000	235	NW
57-C11-P2	1000	235	NW
58-C11-P1	1000	240	NW

Significant to recovery processes, an upper associated top thief zone, generally in continuity with SAGD pay, is widespread over the Corner channel complex. Figure C4.1-24 is an isopach of the McMurray associated net gas. Associated gas occurs in several discrete areas and can be up to 9.7 m thick in the Corner area (9-2-81-9 W4). Figure C4.1-25 is a McMurray associated net top lean isopach. At first glace at the logs, the interval appears to be top water but it is actually above 10 ohms resistivity and, in core, it can be seen to contain about 2 weight percent bitumen.

Non-associated bitumen and non-associated gas are present in the regional sequences (typically A or B1). Non-associated gas (Figure C4.1-26) runs along an apparent compactional drape feature. down the central axis of the channel complex. The gas is not very thick and up to 1.9 m is present (well 15-2-81-9 W4). Figure C4.1-27 is an isopach of the McMurray net non-associated bitumen. The non-associated bitumen is mostly localized on the western edge of the Corner area where up to 3.9 m may be present (well 15-3-81-9 W4).

Table C4.1-5 is a listing of all the gas wells, status and owners in the vicinity of the Corner initial development area.

Table C4.1-5 Gas Wells in the Vicinity of the Project Area

Well	Gas Zone	Status as of May, 2007	Owner	Associated or Non Associated Gas	In Corner Initial Development Area
00/05-31-080-08W4/0	McMurray B and A1 Seq	Suspended	Devon Canada Corporation	Associated	No
00/15-34-080-08W4/0	McMurray B1 Seq	Suspended	Devon Canada Corporation	Non Associated	No
00/11-34-080-09W4/0	McMurray B1 and A1 Seq	Suspended	Encana Corporation	Associated	No
00/11-35-080-09W4/0	McMurray B1, B2, A1,A2 Seq	Suspended	Encana Corporation	Associated	Yes
00/11-35-080-09W4/2	McMurray B1, B2, A1,A2 Seq	Suspended	Encana Corporation	Non Associated	Yes
00/01-04-081-08W4/0	McM B1 Seq, Wab C Sand, Wab D Valley Fill, McM A Channel	Suspended	Primewest Energy Inc.	Non Associated	No
00/06-05-081-08W4/0	McM Channel, Wab C Sand, McM A2 Seq	Suspended	Devon Canada Corporation	Non Associated	Yes
00/05-06-081-08W4/0	McM Channel, McM A1 and A2 Seq	Suspended	Devon Canada Corporation	Associated	Yes
00/13-08-081-08W4/0	McM Channel and McM A2 Seq	Abandoned Zone	Devon Canada Corporation	Non Associated	No
00/06-09-081-08W4/0	McM B1 Seq, Wab C Sand, McM A2 Seq	Flowing	Primewest Energy Inc.	Non Associated	Yes
00/16-16-081-08W4/0	McM Channel, McM A Channel, Wab C Sand	Suspended	Paramount Energy Operating Corp.	Non Associated	No
00/05-01-081-09W4/2	McM regionals (A2, B1, B2)	Flowing	Paramount Energy Operating Corp.	Non Associated	Yes
00/14-04-081-09W4/0	McM A1 Seq	Suspended	Paramount Energy Operating Corp.	Associated	No

Well	Gas Zone	Status as of May, 2007	Owner	Associated or Non Associated Gas	In Corner Initial Development Area
00/12-09-081-09W4/0	McM A1 Seq	Suspended	Paramount Energy Operating Corp.	Associated	No
00/09-10-081-09W4/0	McM Channel, McM A1 and A2 Seq	Suspended	Paramount Energy Operating Corp.	Associated	No
00/13-11-081-09W4/0	McM Channel, McM A1, A2, B1 Seq	Suspended	Paramount Energy Operating Corp.	Associated	No
00/13-11-081-09W4/3	McM Channel, McM A1, A2, B1 Seq	Flowing	Paramount Energy Operating Corp.	Non Associated	No
00/11-14-081-09W4/0	McM A1 Seq	Suspended	Paramount Energy Operating Corp.	Associated	No
00/12-16-081-09W4/0	McM A1 Seq, McM Channel	Flowing	Paramount Energy Operating Corp.	Non Associated	No

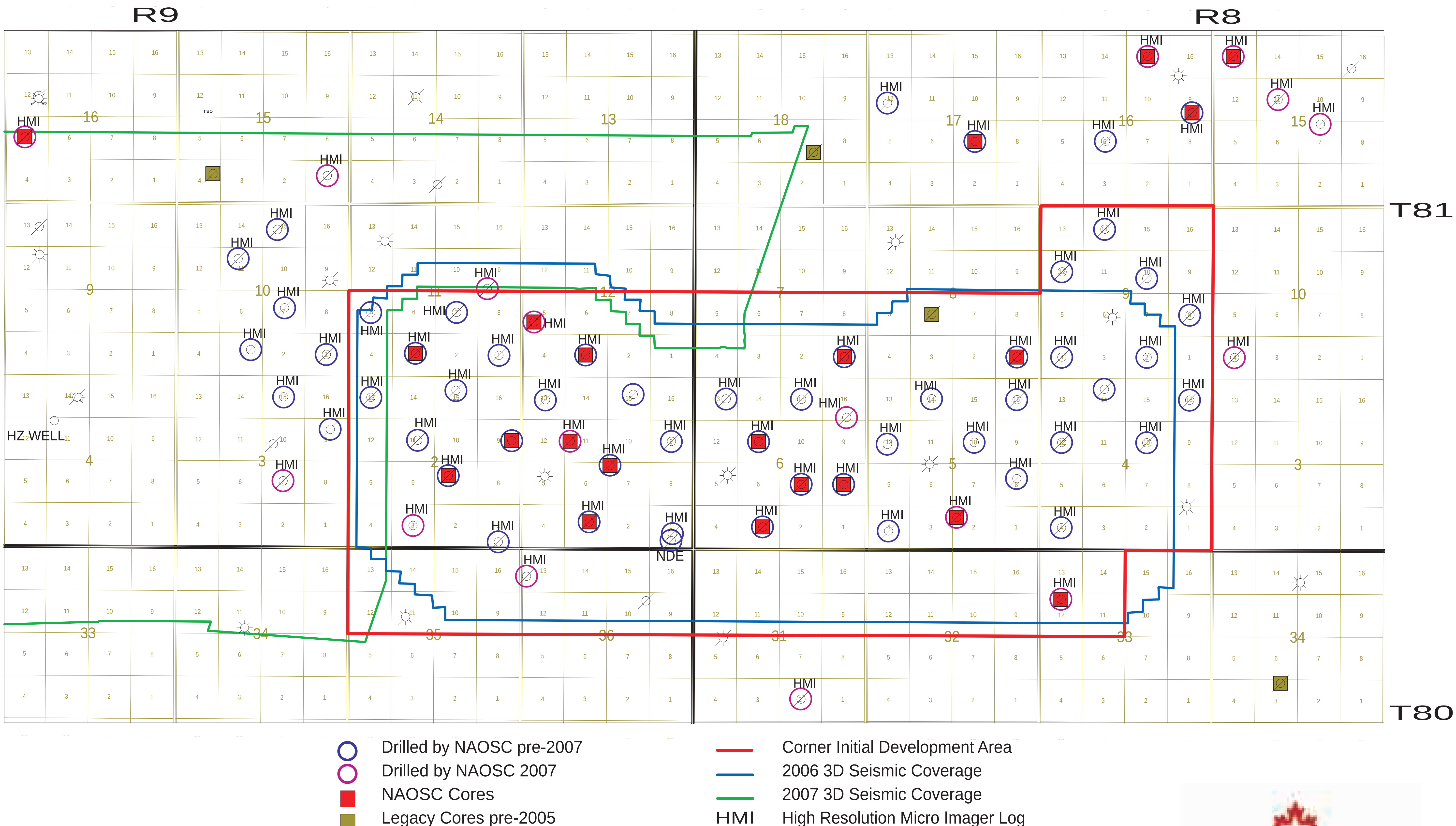


Figure C4.1-1 Geological and Geophysical Control

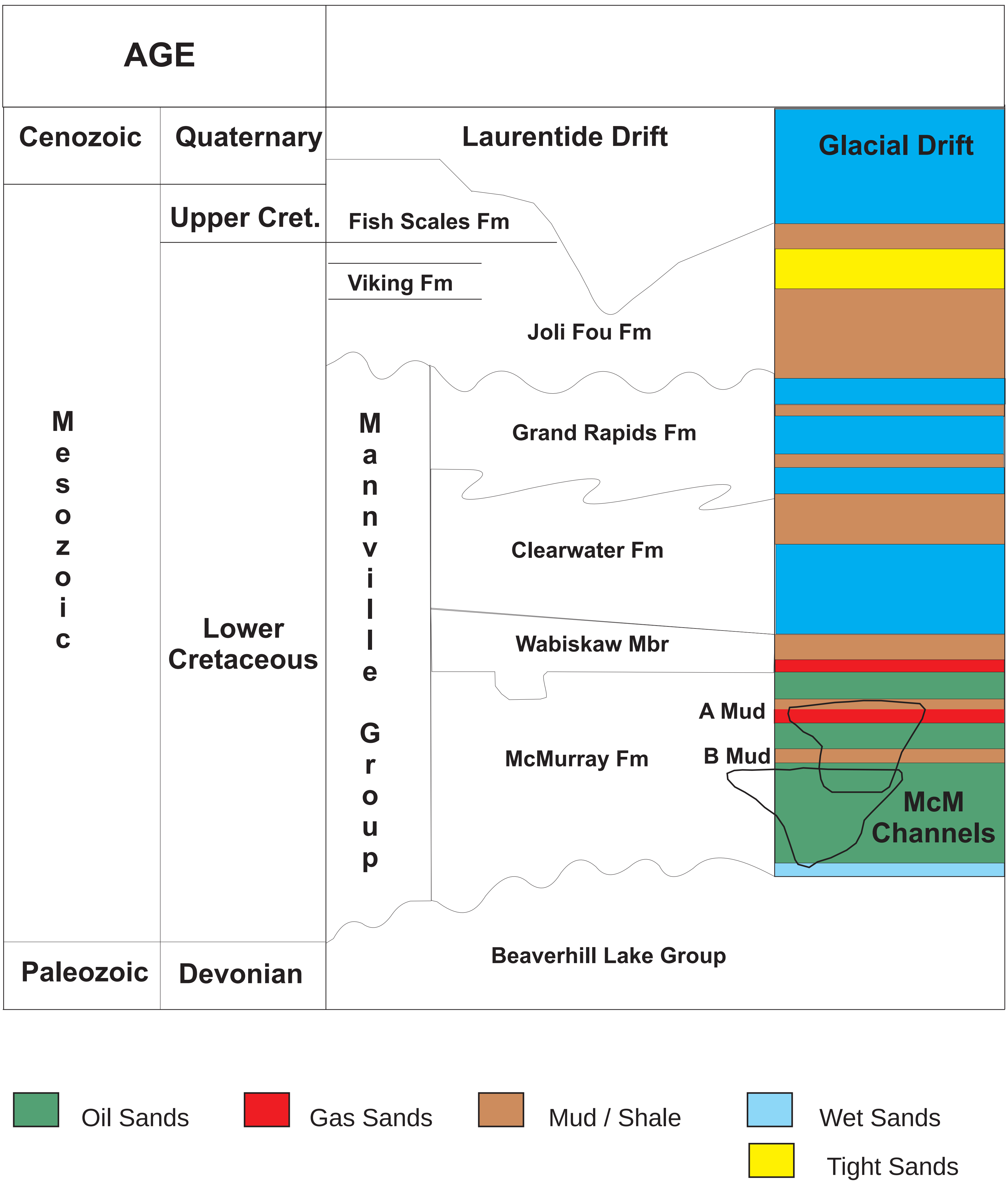
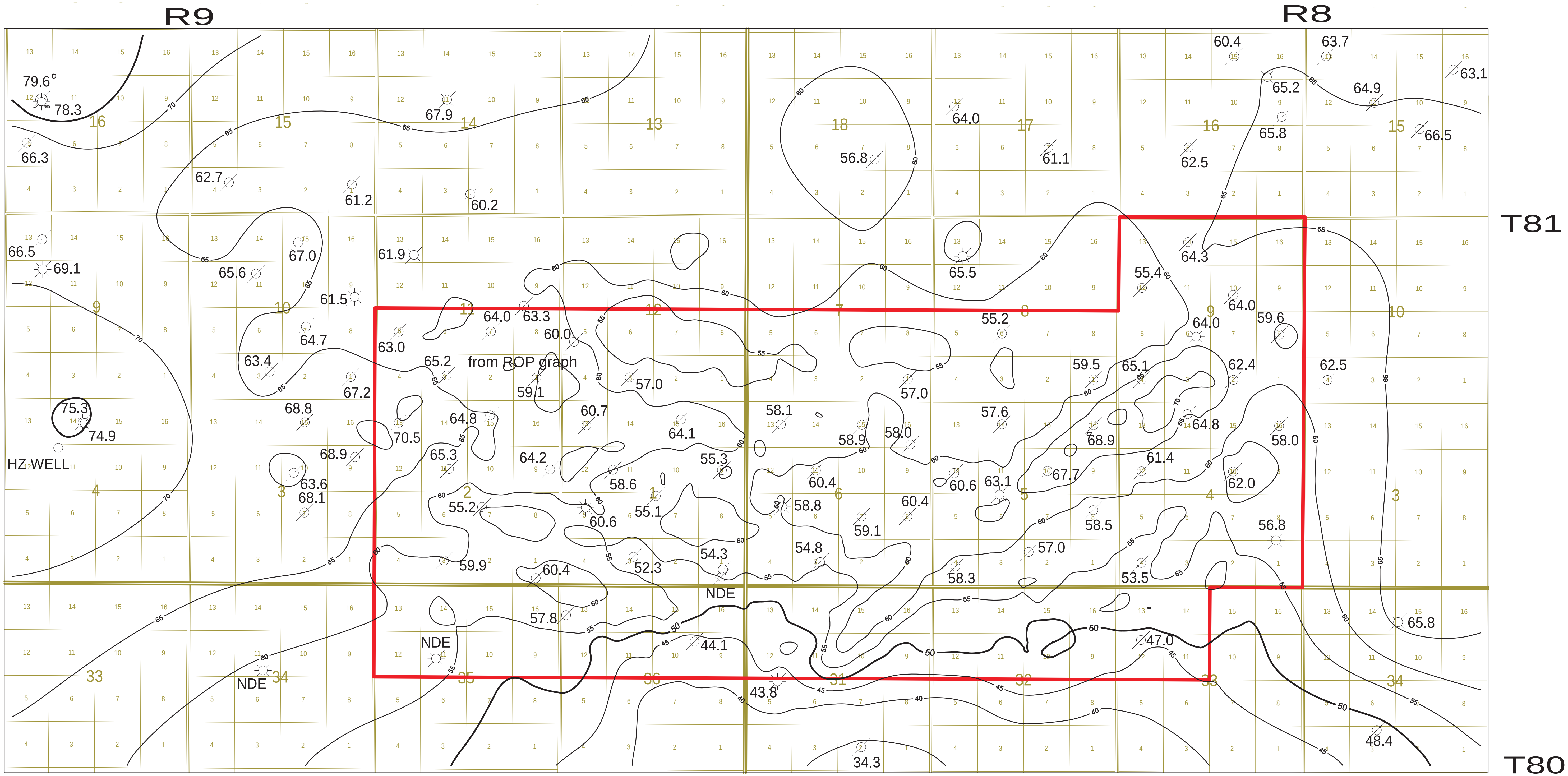


Figure C4.1-2 General Stratigraphy in the Regional Study Area

NORTH AMERICAN
OIL SANDS CORPORATION



Corner Initial Development Area

HZ WELL Horizontal Well

ROP Rate of Penetration

NDE Not Deep Enough

Figure C4.1-3 Wabiskaw to Sub-Cretaceous Unconformity Isopach

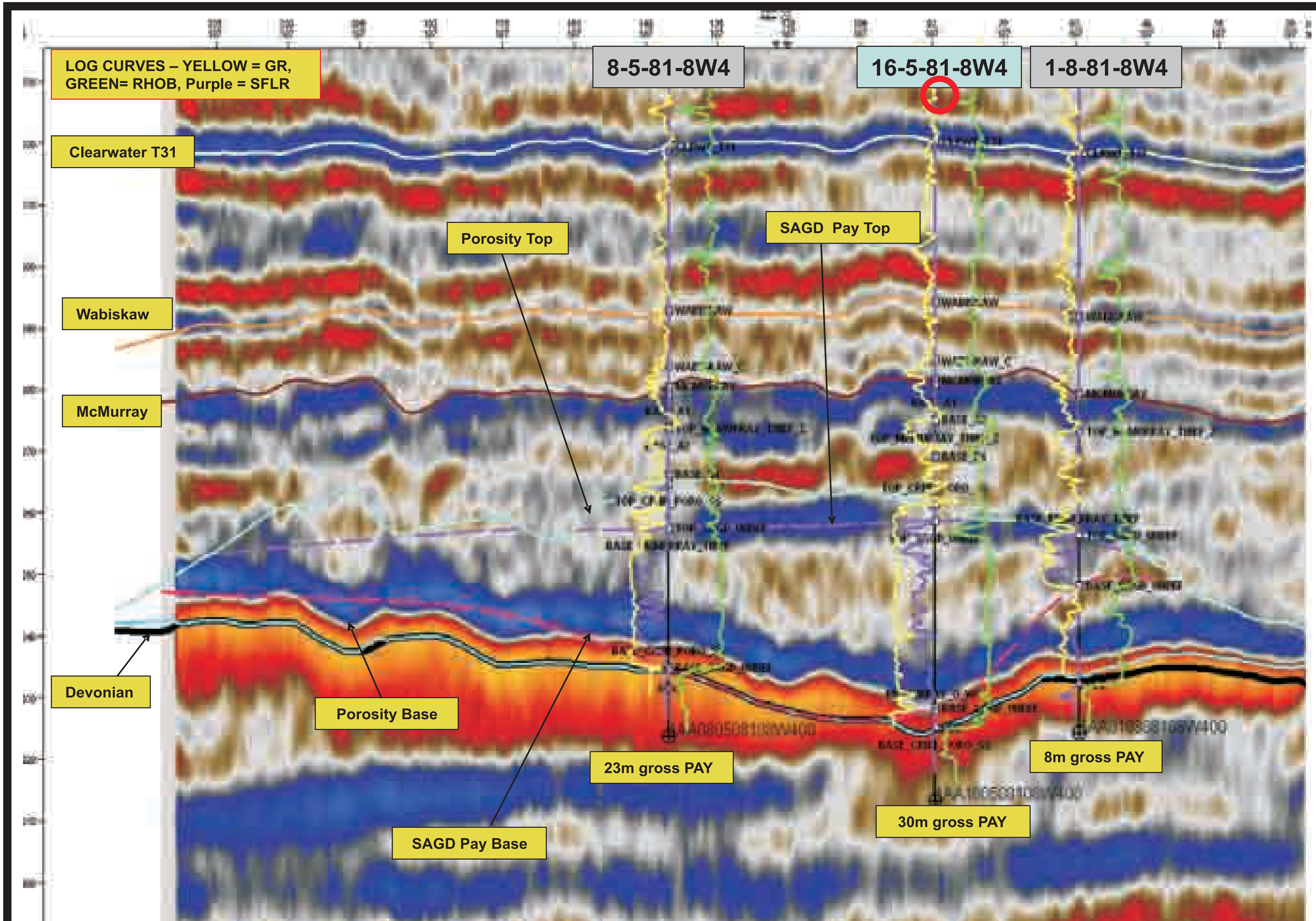
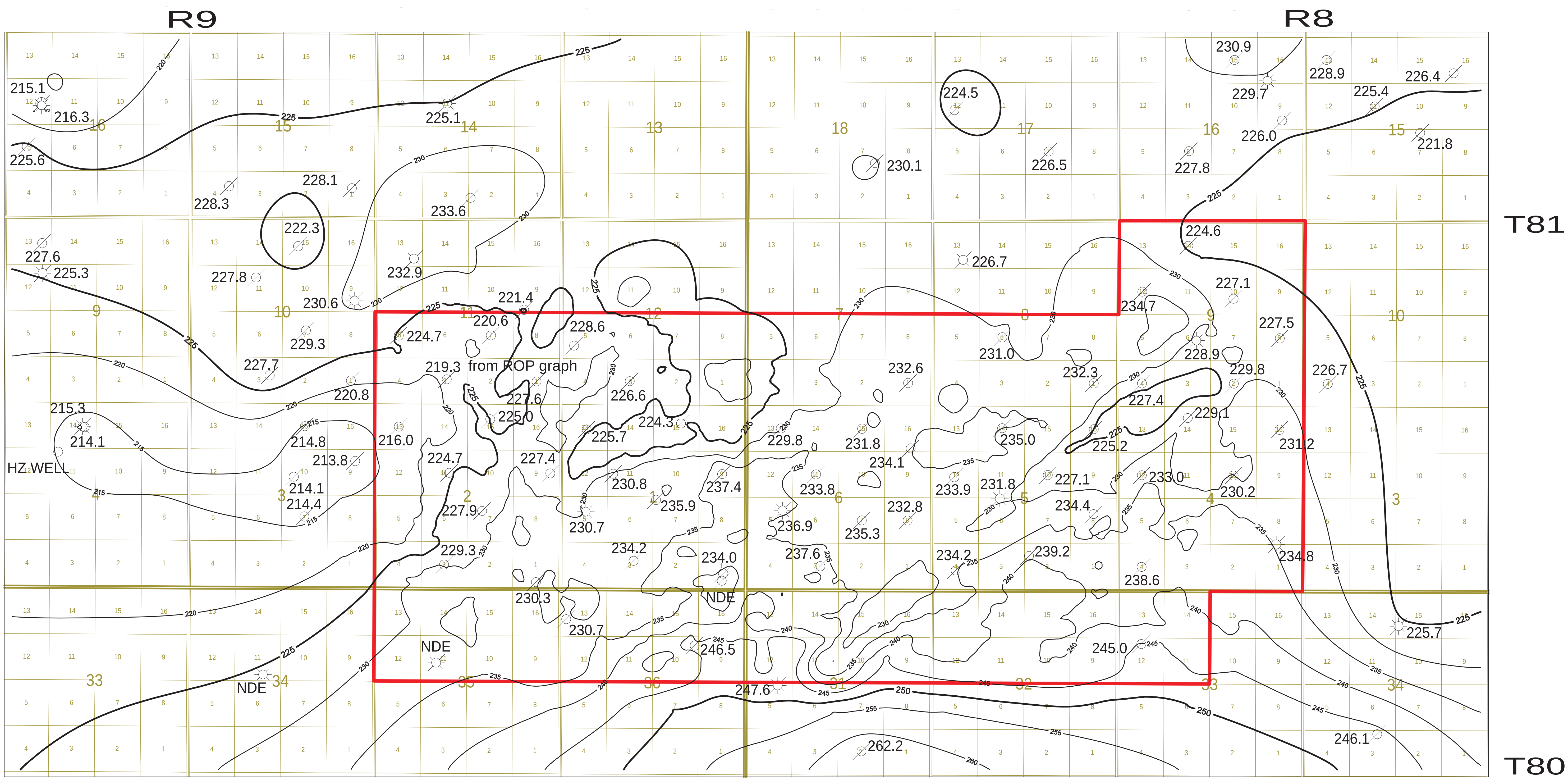
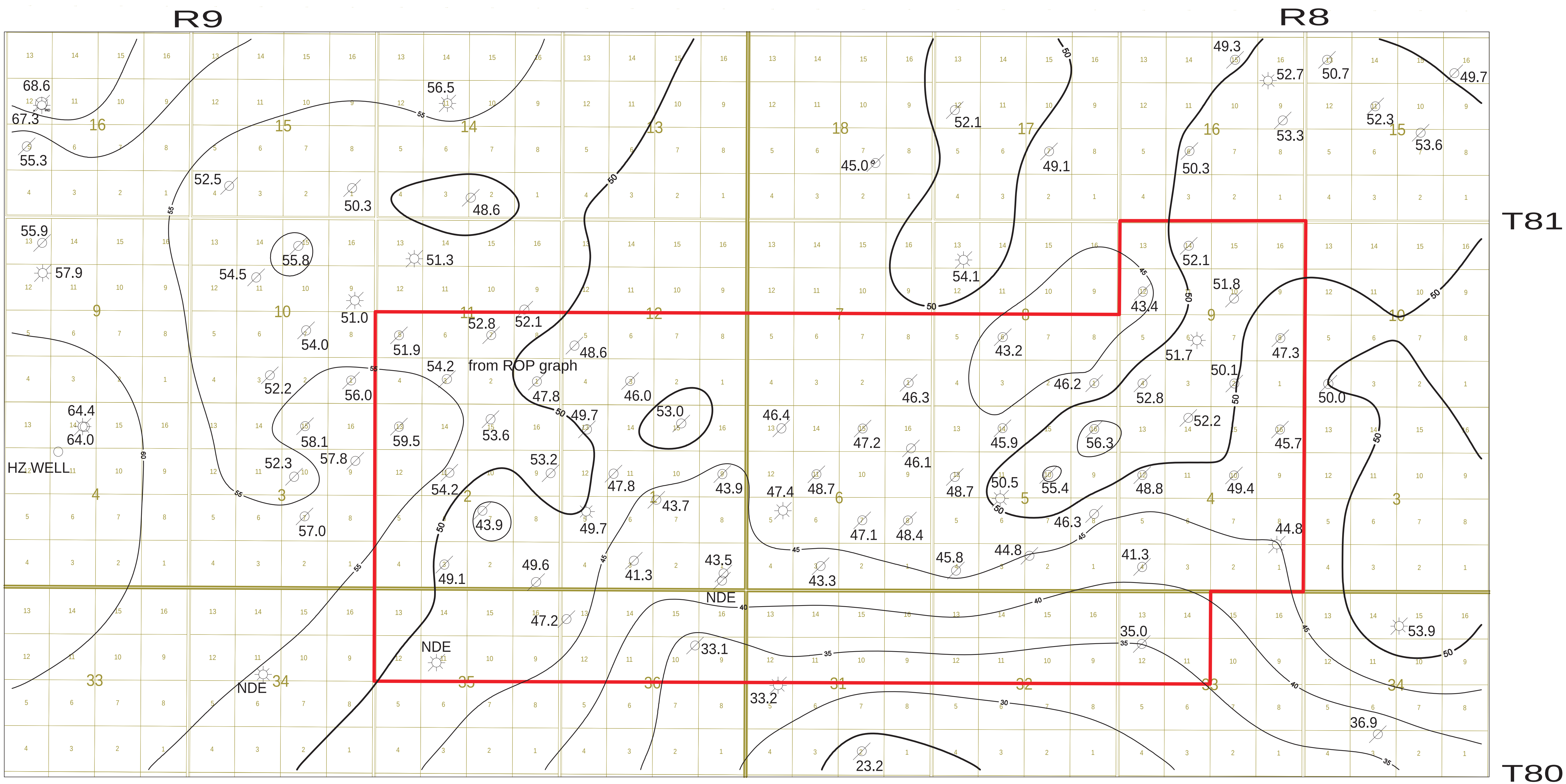


Figure C4.1-4 Seismic Profile Across the SW-NE Trending Devonian Low



Corner Initial Development Area
NDE Not Deep Enough
HZ WELL Horizontal Well
ROP Rate of Penetration

Figure C4.1-5 Structure on the Sub-Cretaceous Unconformity



Corner Initial Development Area
NDE Not Deep Enough
HZ WELL Horizontal Well
ROP Rate of Penetration

Figure C4.1-6 McMurray to Sub-Cretaceous Unconformity Isopach

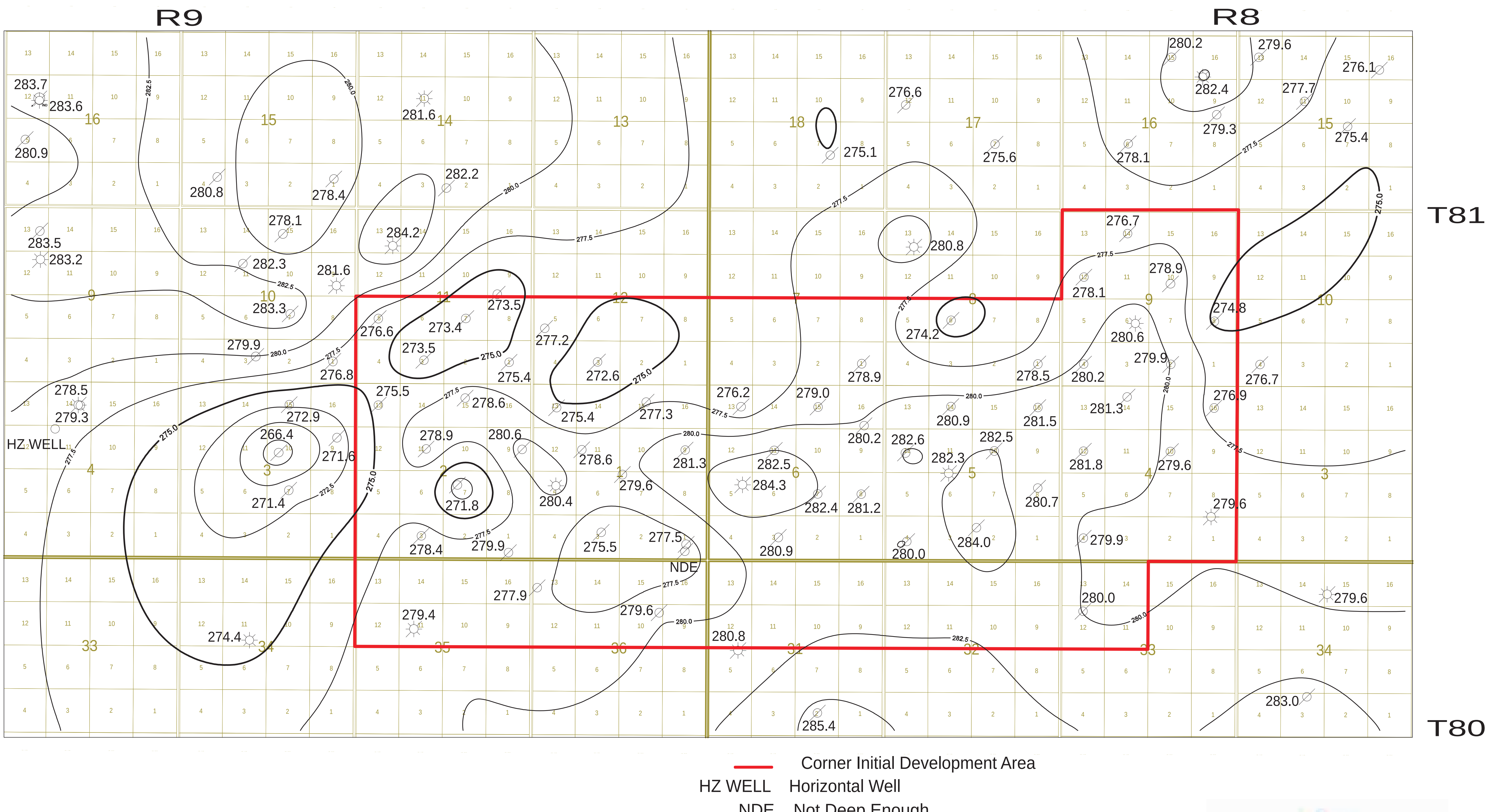
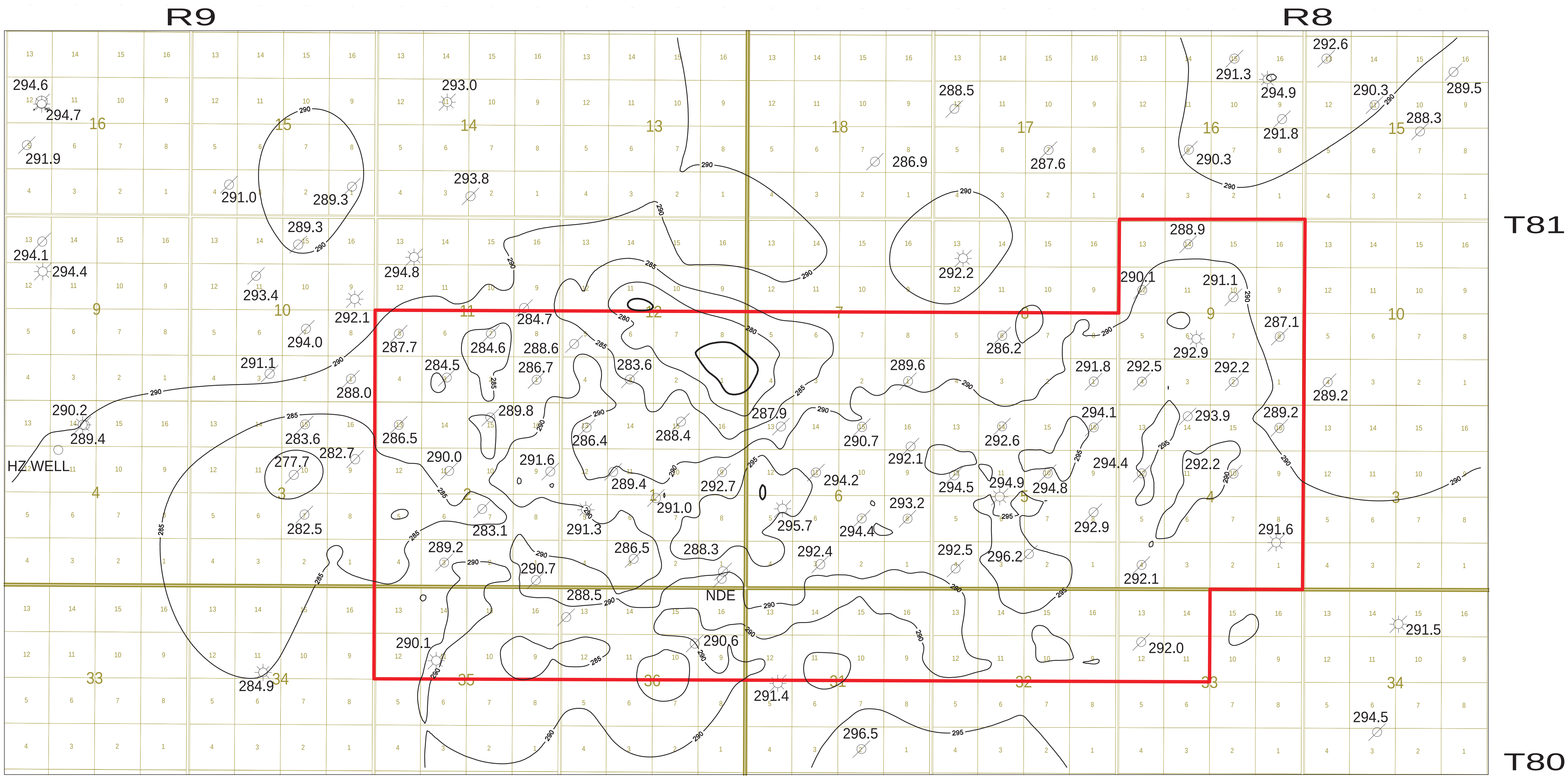


Figure C4.1-7 Structure on the Top McMurray



Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough

Figure C4.1-8 Structure on the Top of Wabiskaw

AA/11-06-081-08W400

NORTH AMERICAN OIL SANDS CORP

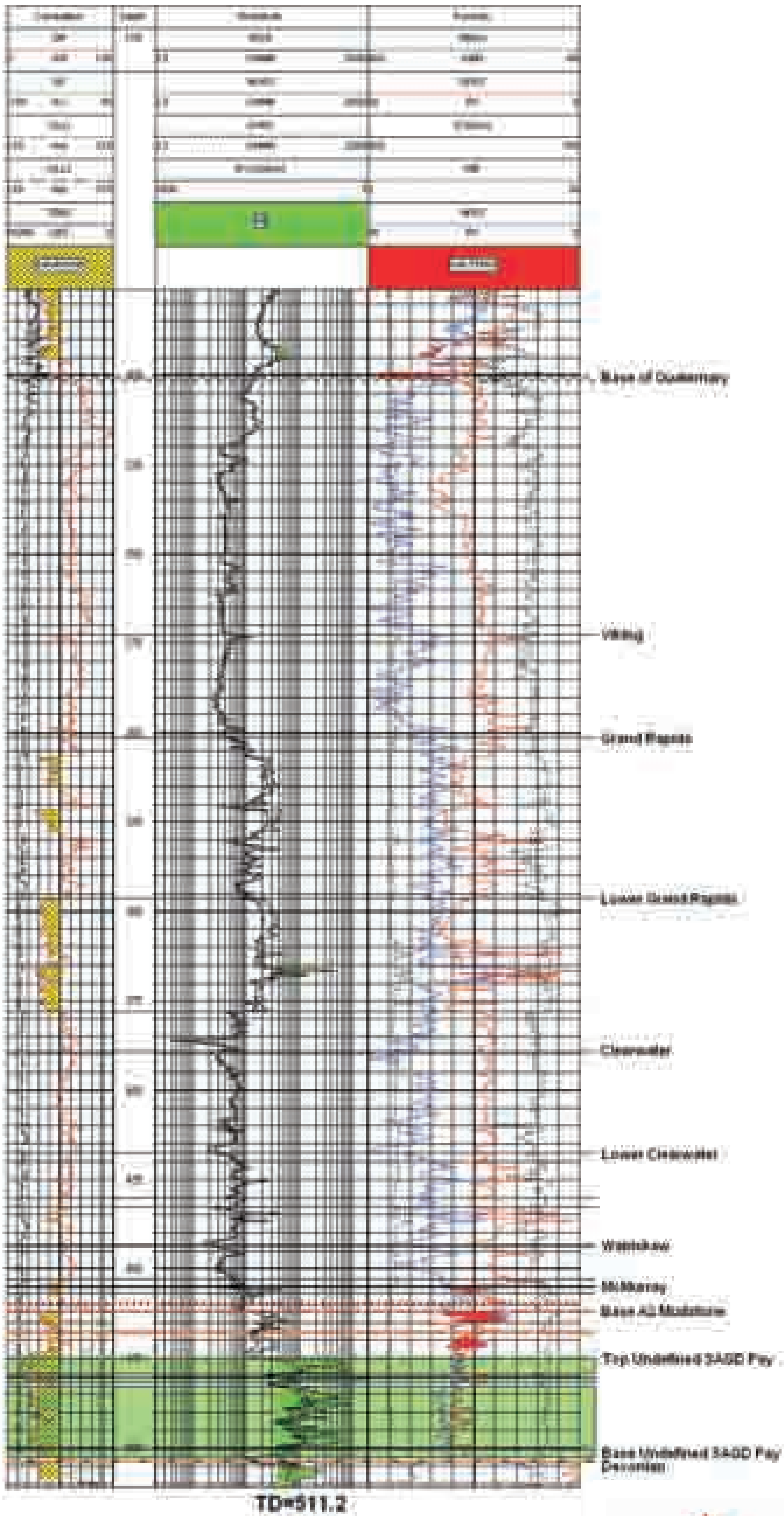


Figure C4.1-9 Type Log AA/11-06-081-09W4/00

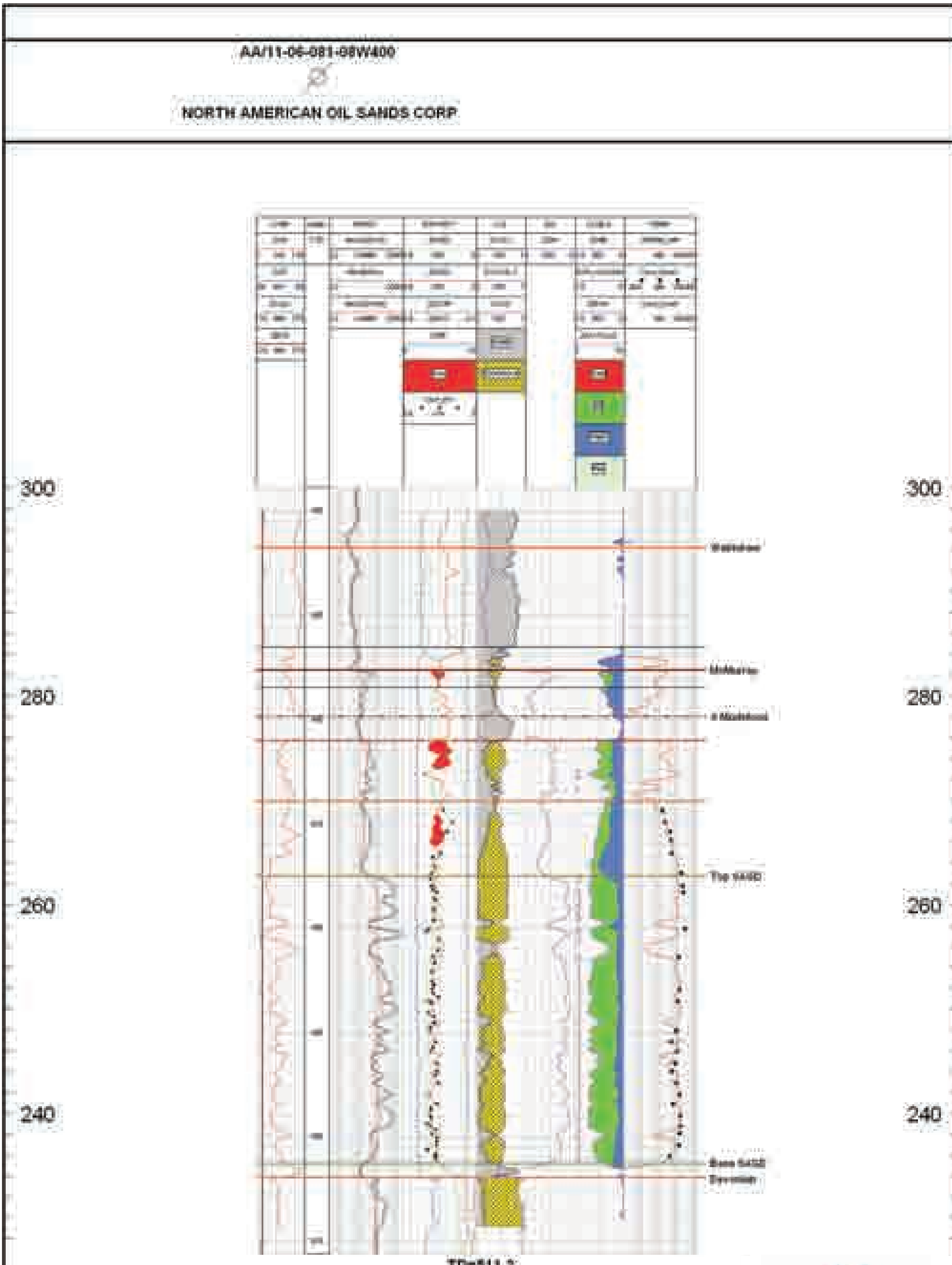
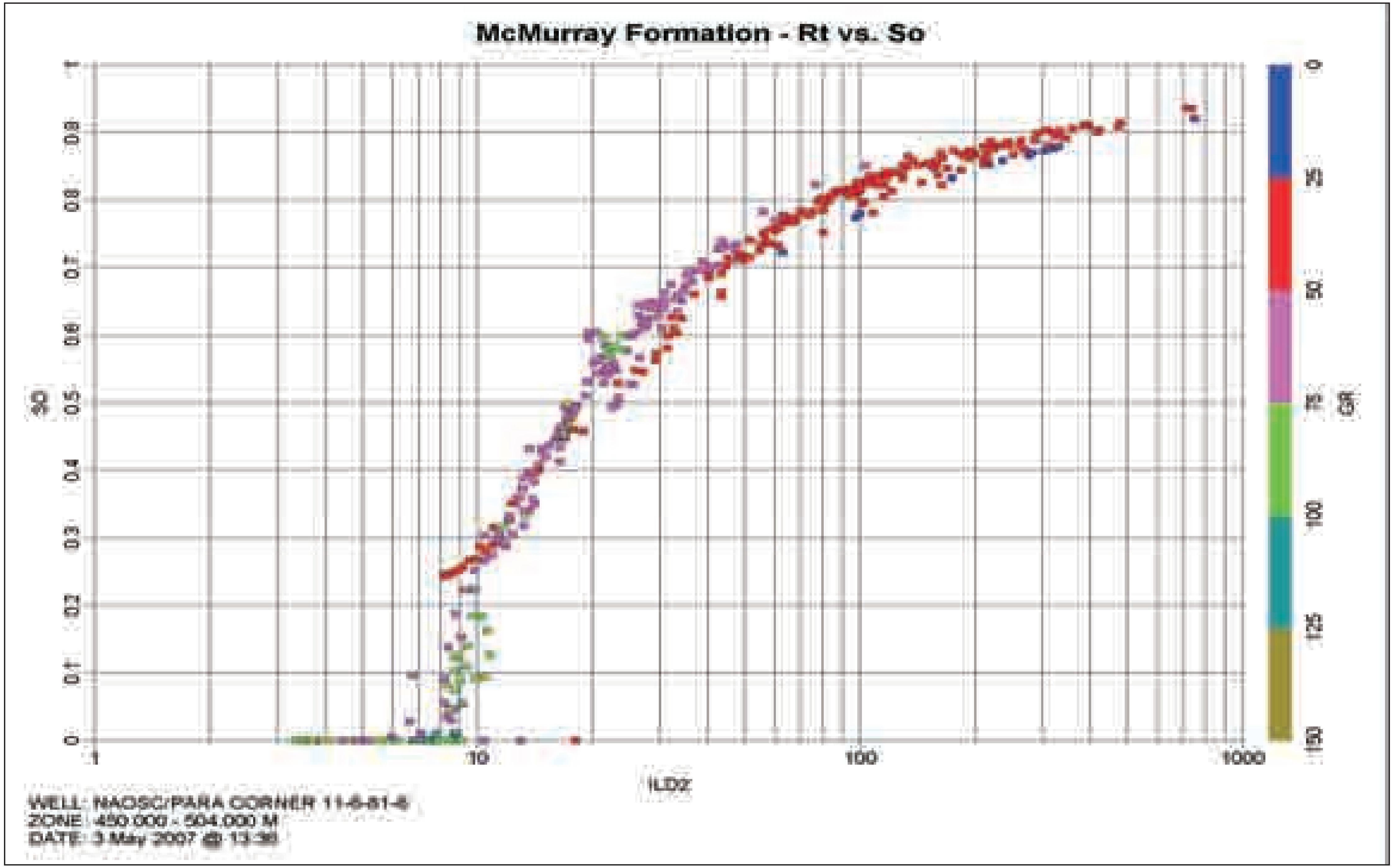


Figure C 4.1-10 Core to Log Comparison
AA/11-06-081-08W4/00 Shaley Sand Analysis



ARCHIE'S WATER SATURATION: **Rt @ 20ohms = 55% So ~ 6wt%**

$(Sw)^n = a/(PHI)^m \times Rw/Rt$ **Rt @ 40ohms = 70% So ~ 11wt%**

Rw = 0.55, a=1.0, m=1.8, n=2.0

Figure C 4.1-11 Rt vs So – Modified Pickett Plot of AA/11-06-081-08W4/00

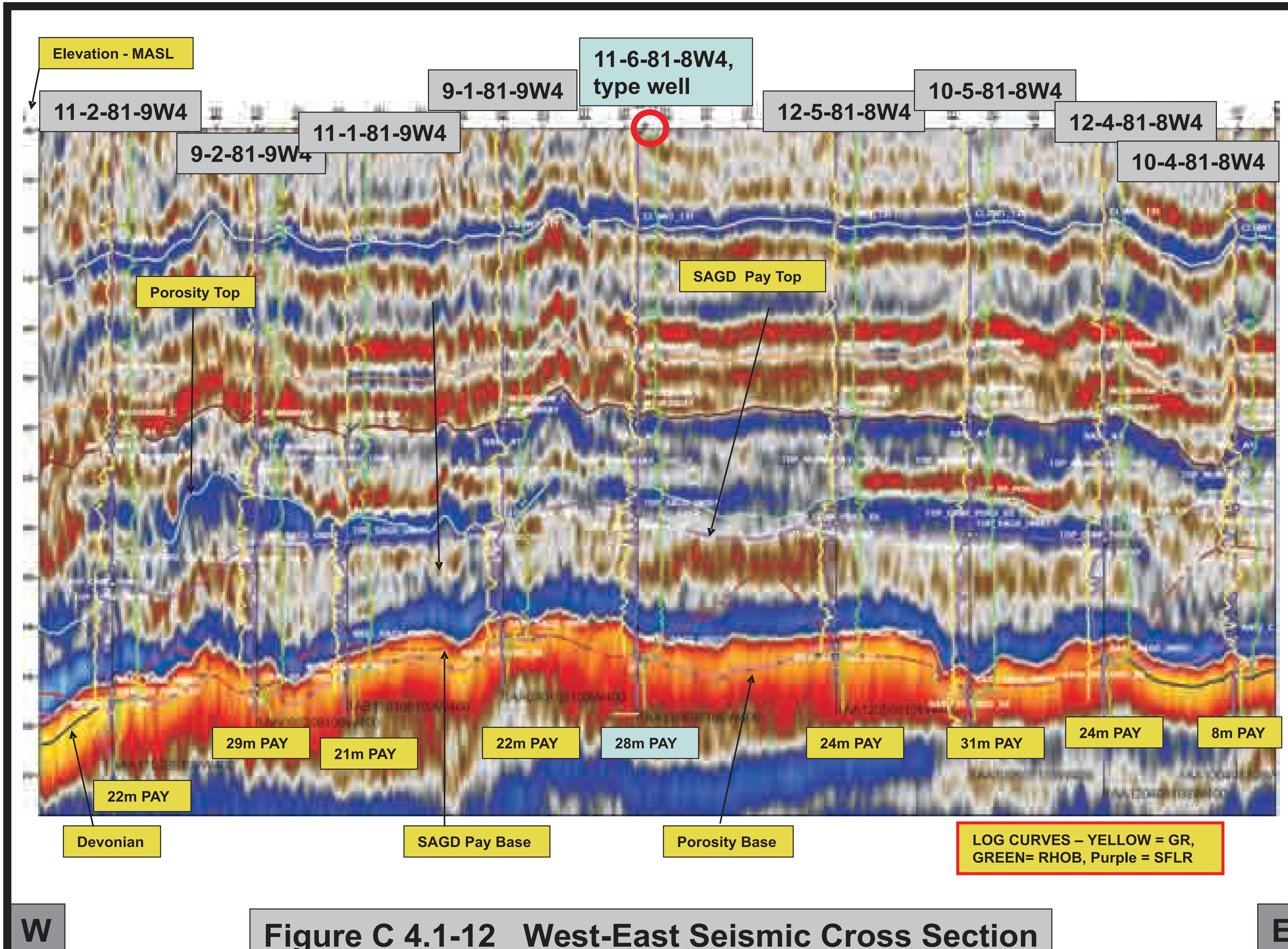


Figure C 4.1-12 West-East Seismic Cross Section

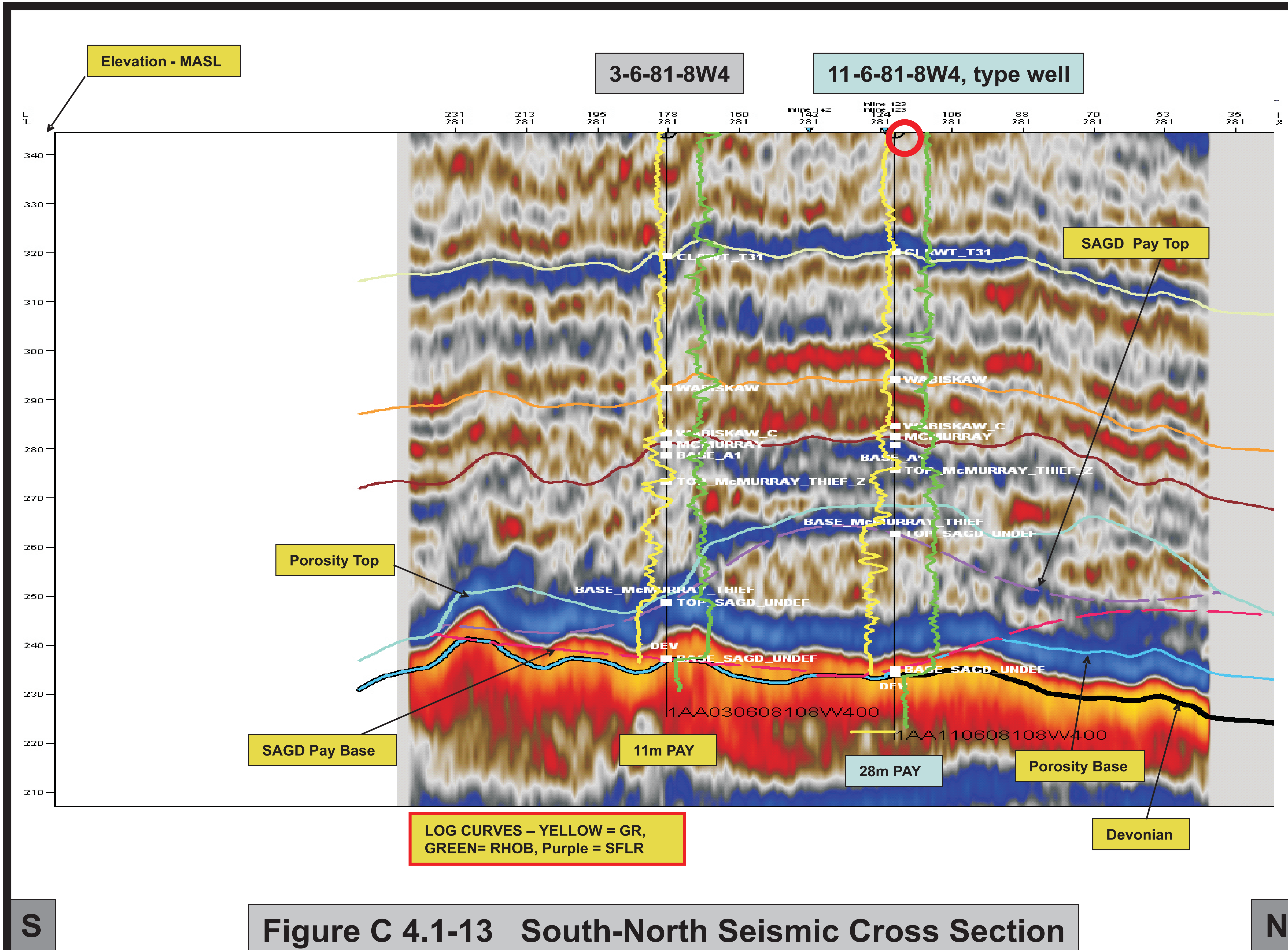


Figure C 4.1-13 South-North Seismic Cross Section

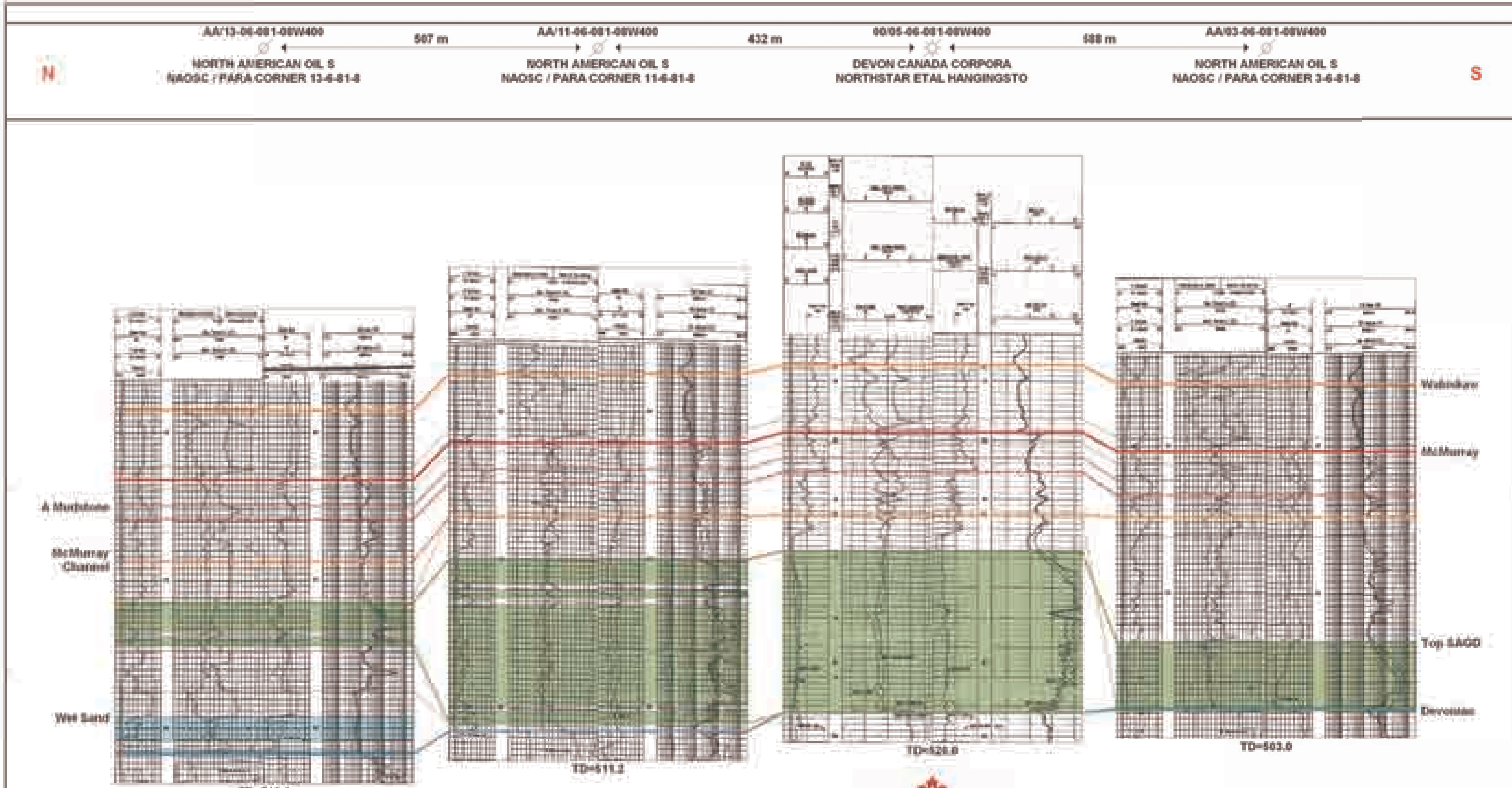


Figure C 4.1-14 North-South Cross Section

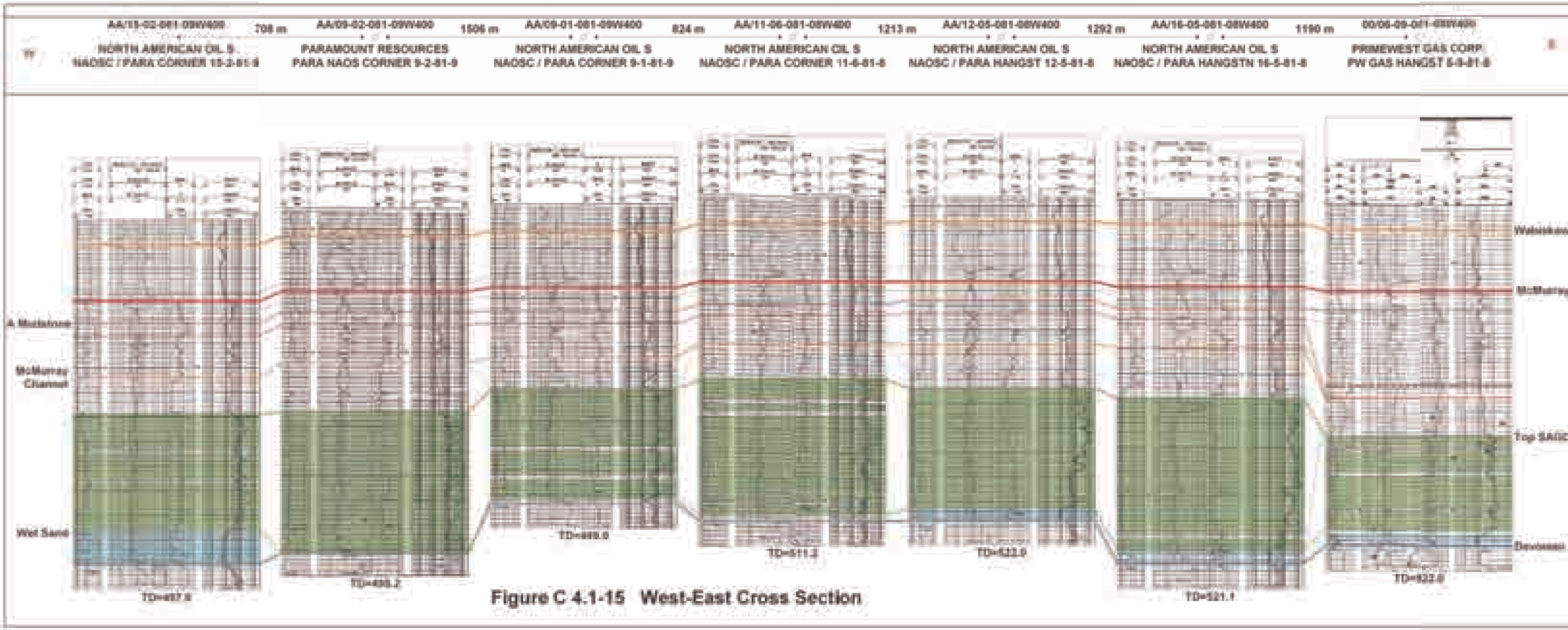


Figure C 4.1-15 West-East Cross Section

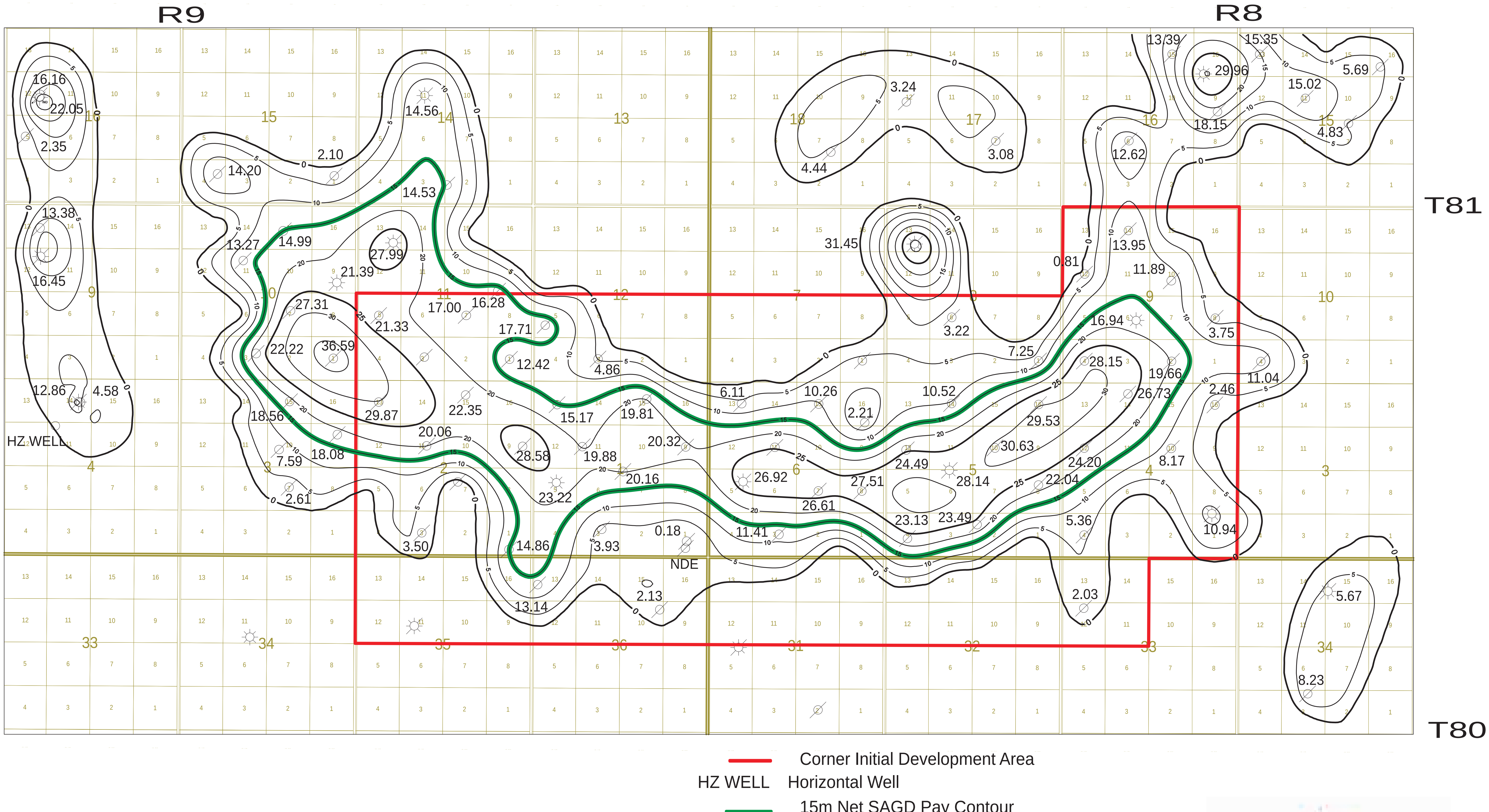
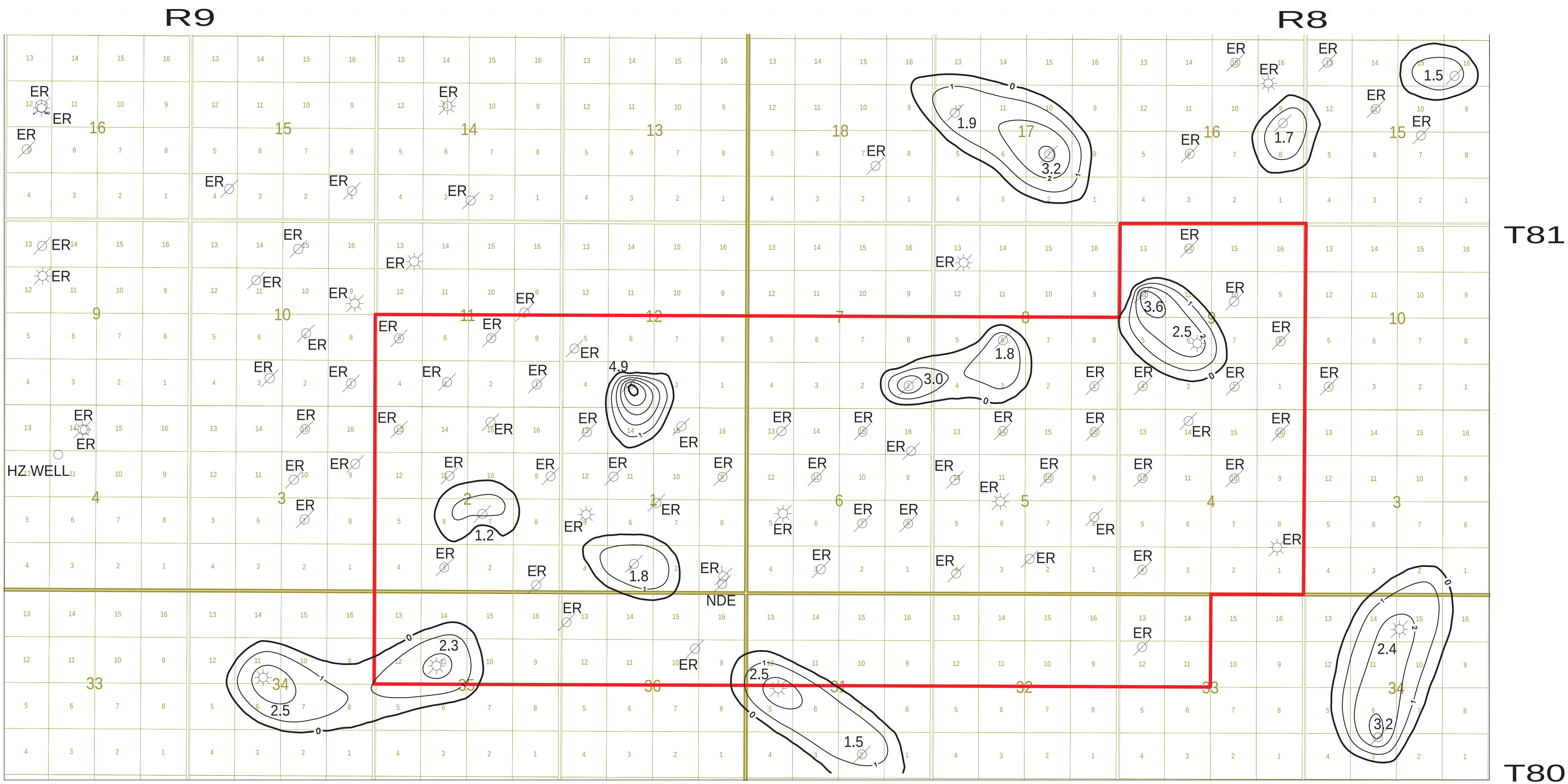
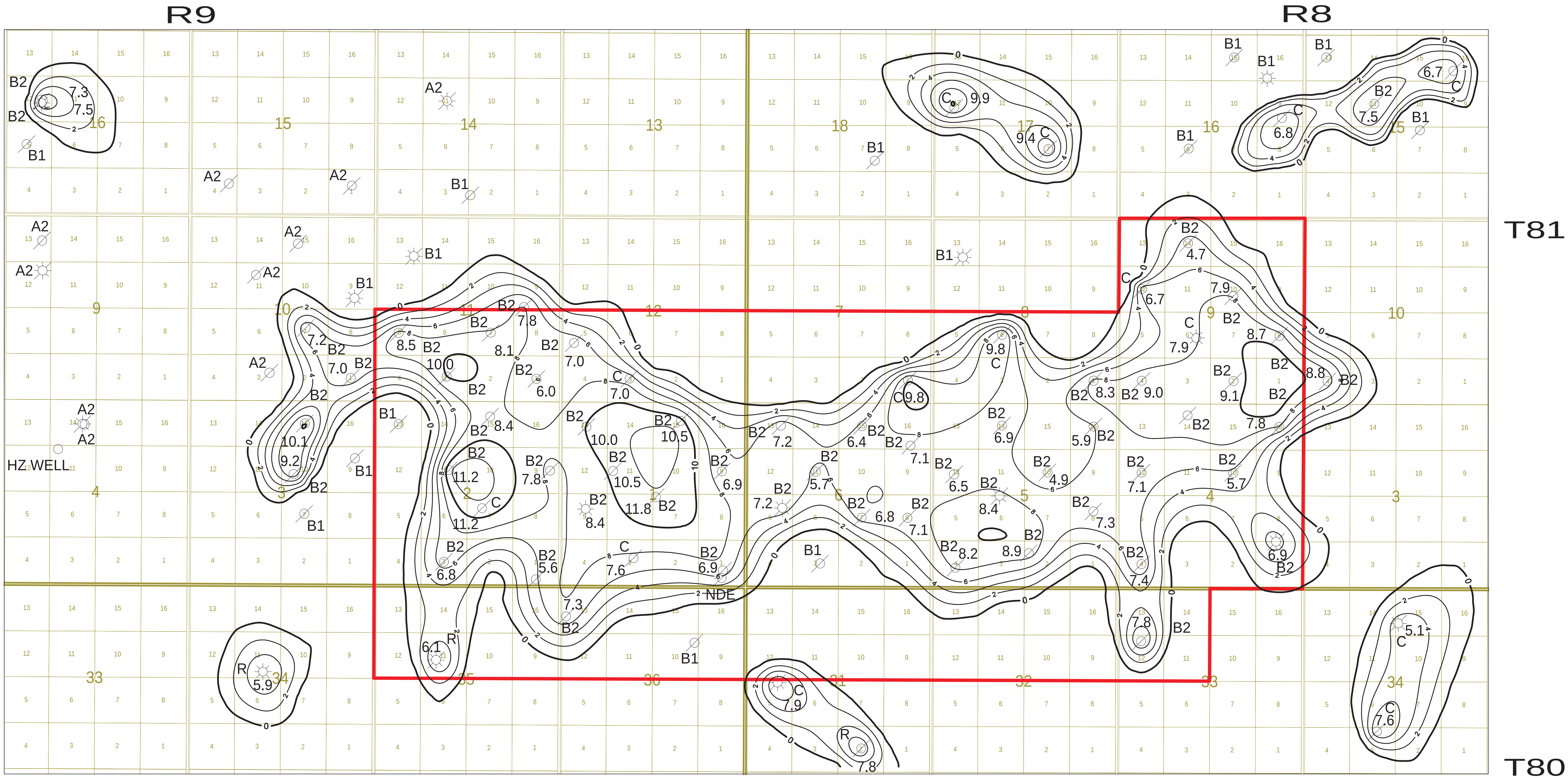


Figure C 4.1-16 McMurray Channel Net SAGD Pay at 6 Weight % Bitumen Cutoff



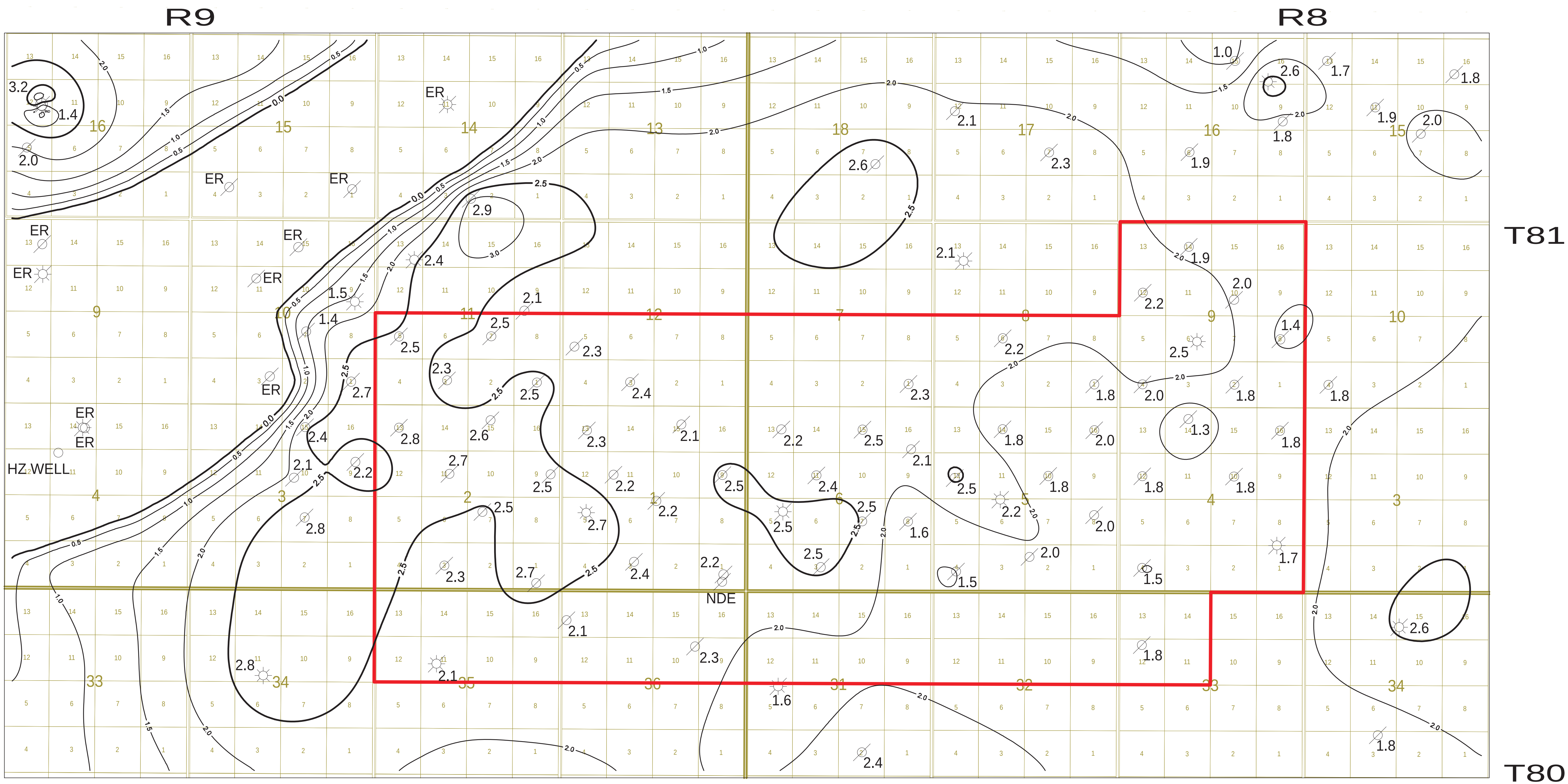
Corner Initial Development Area
HZ WELL Horizontal Well
ER Eroded
NDE Not Deep Enough

Figure C 4.1-17 B2 Regional Mudstone Cap Rock Isopach



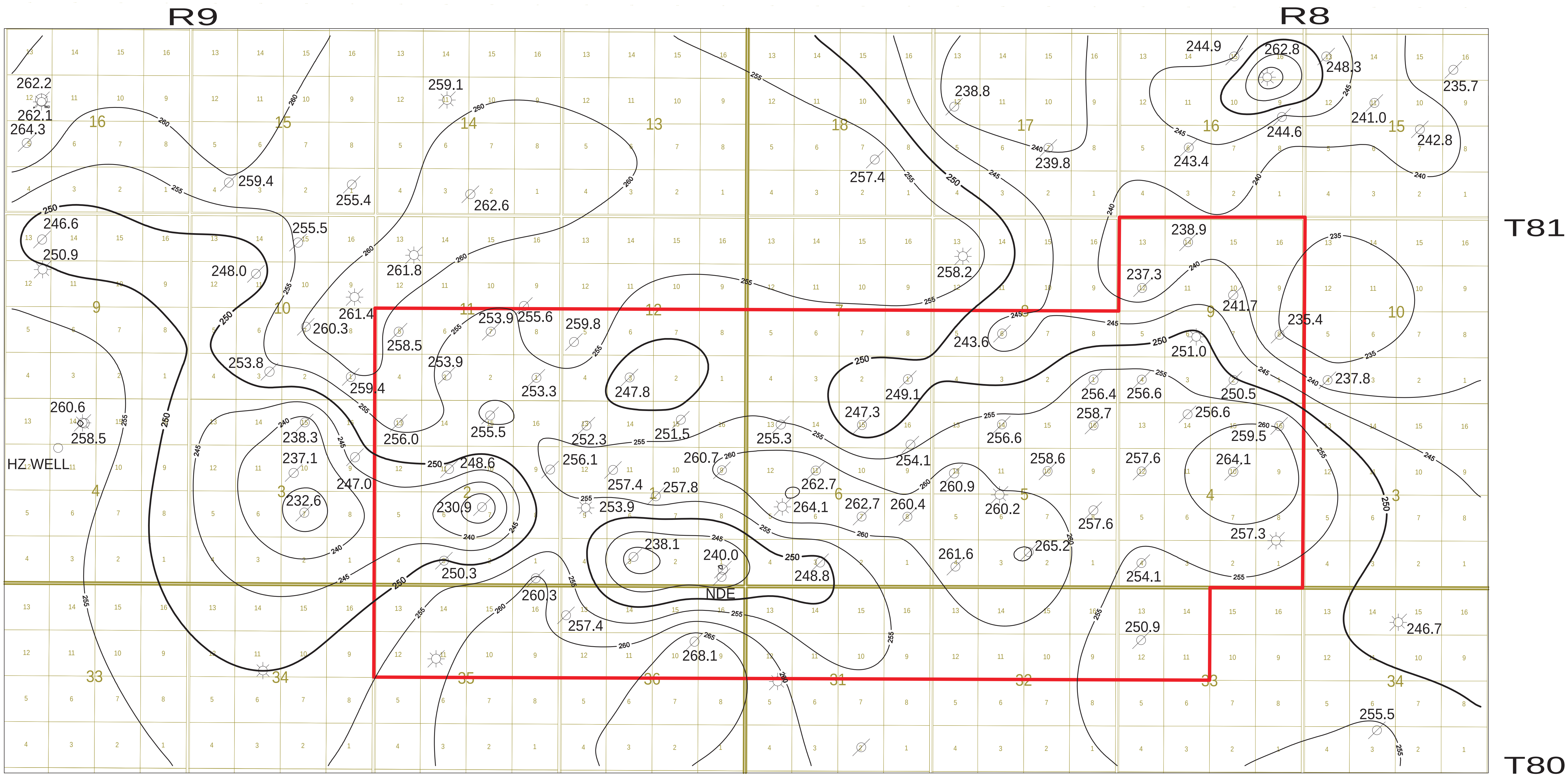
A2 McMurray Channel Designation
R Regional Parasequence - No Channel Present
Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough

Figure C 4.1-18 B1 Regional Parasequence Cap Rock Isopach



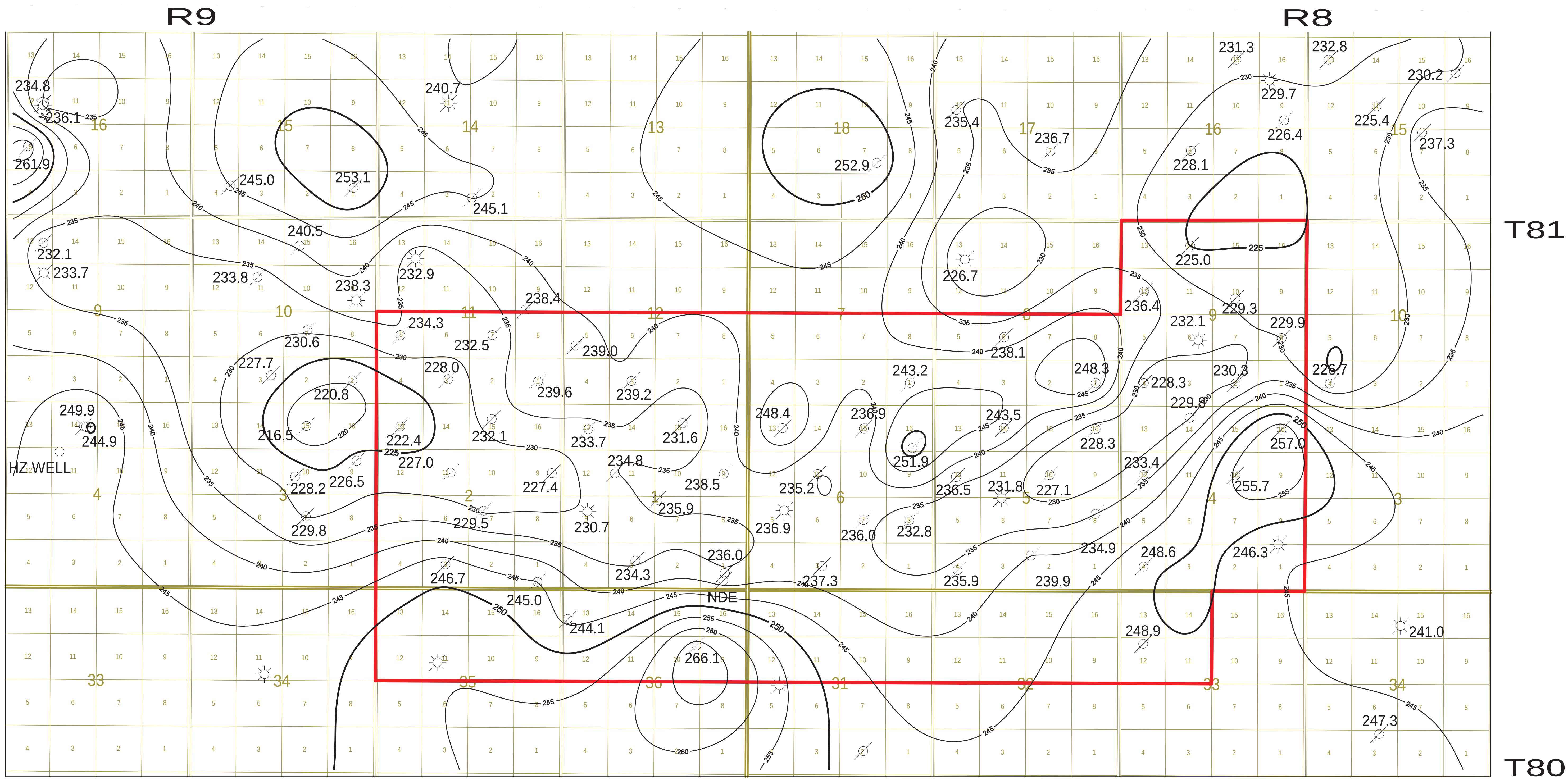
(red line)	Corner Initial Development Area
HZ WELL	Horizontal Well
ER	Eroded
NDE	Not Deep Enough

Figure C 4.1-19 A2 Regional Mudstone Cap Rock Isopach



Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough

Figure C 4.1-20 Structure Top of Gross SAGD Pay (= 40 ohm cutoff)



Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough

Figure C 4.1-21 Structure Base of Gross SAGD Pay (= 40 ohm cutoff)

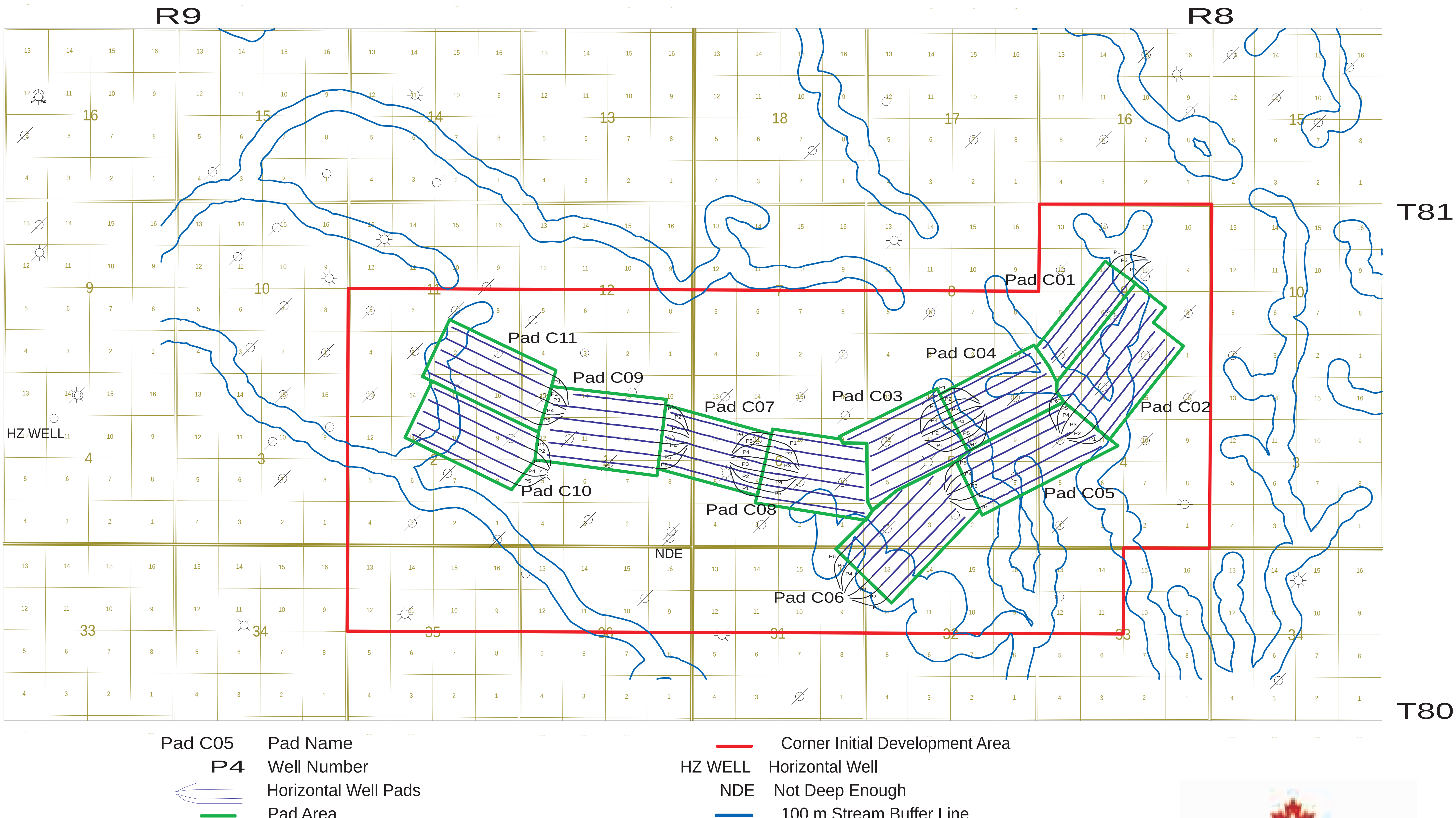
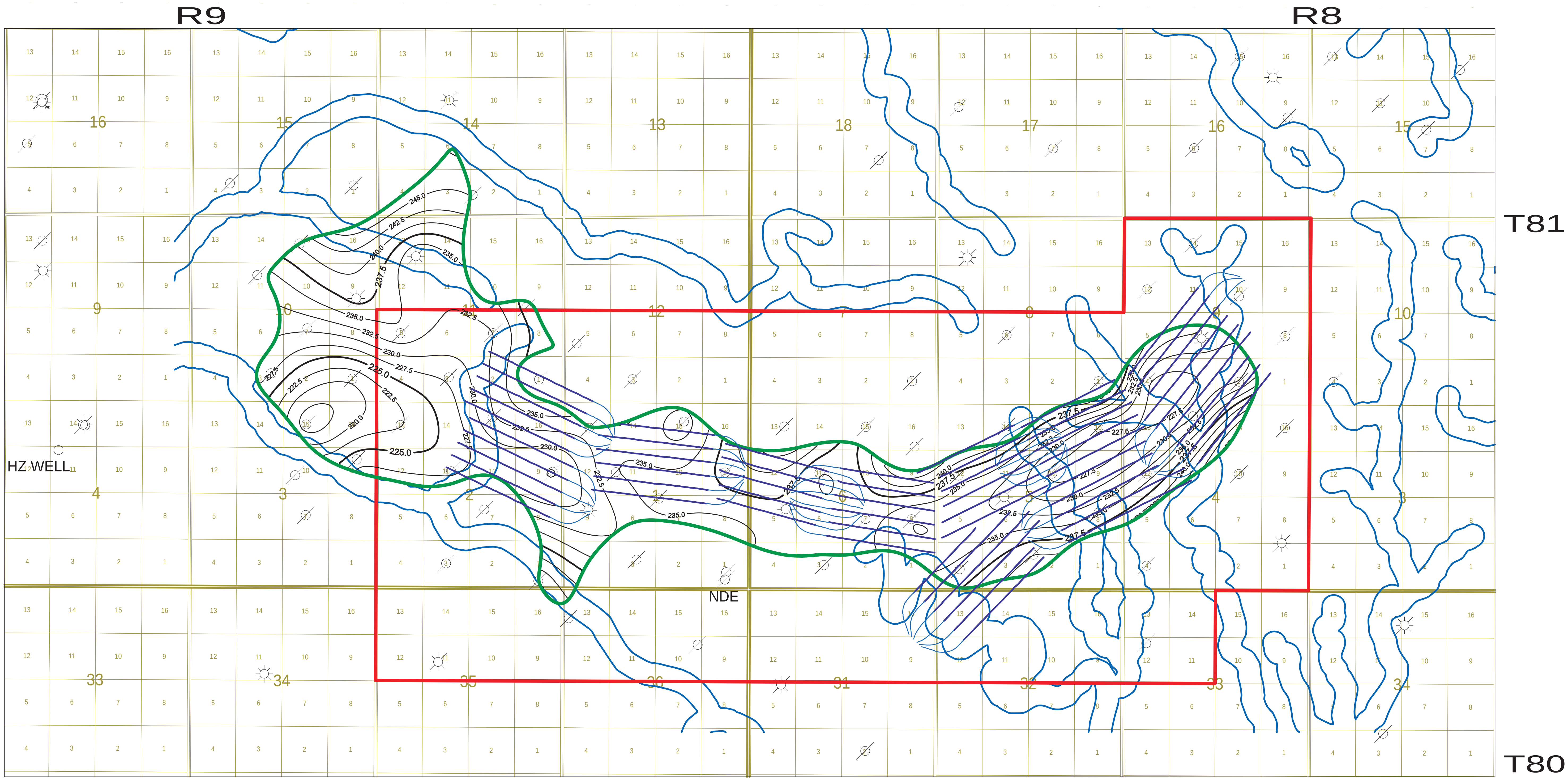


Figure C 4.1-22 Location of Pads and Horizontal Wells



Horizontal Well Pads
15m Gross SAGD Pay Bounding Surface
100m Stream Buffer Line
Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough

Figure C 4.1-23 Location of Pads and Horizontal Wells with Base of SAGD Structure

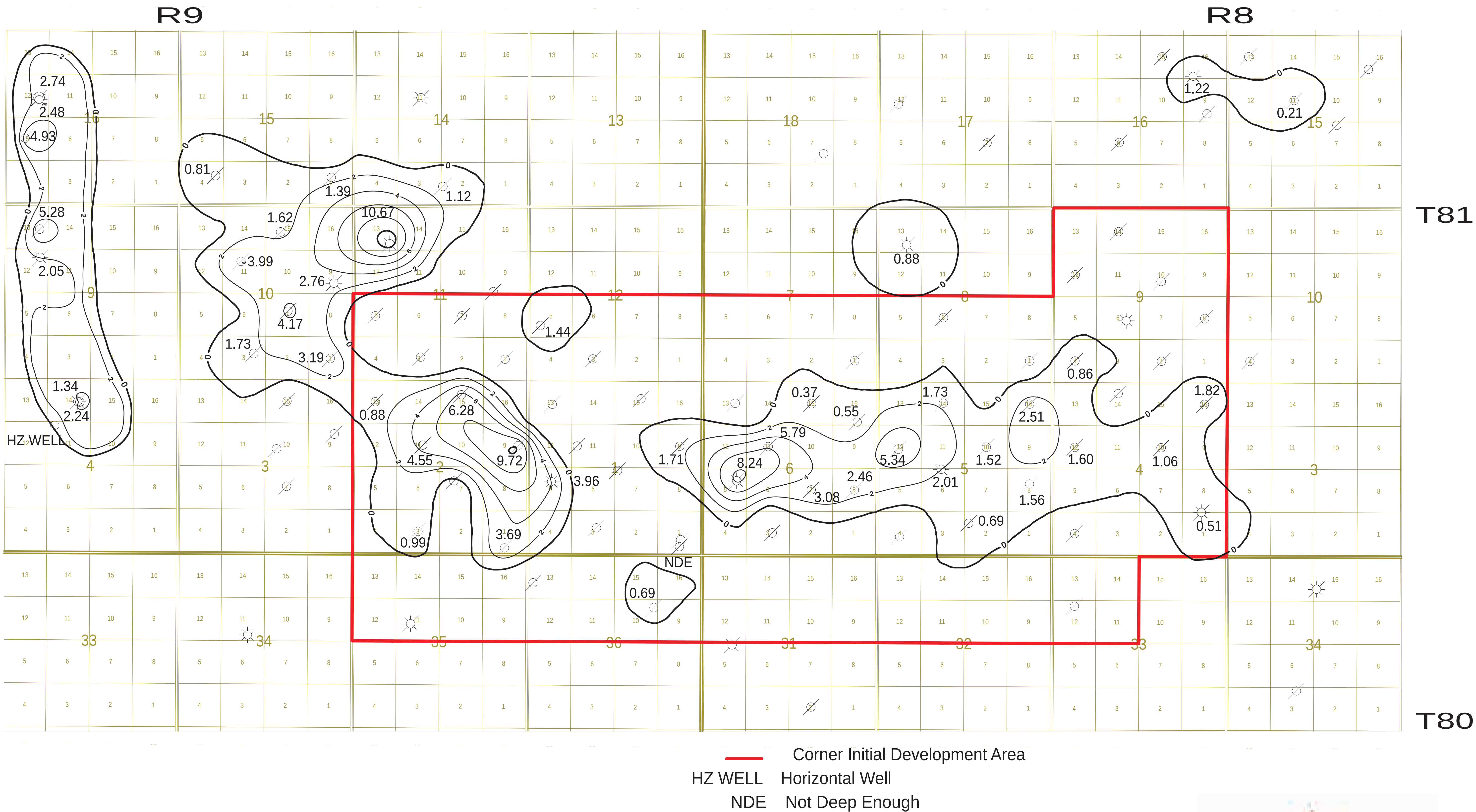
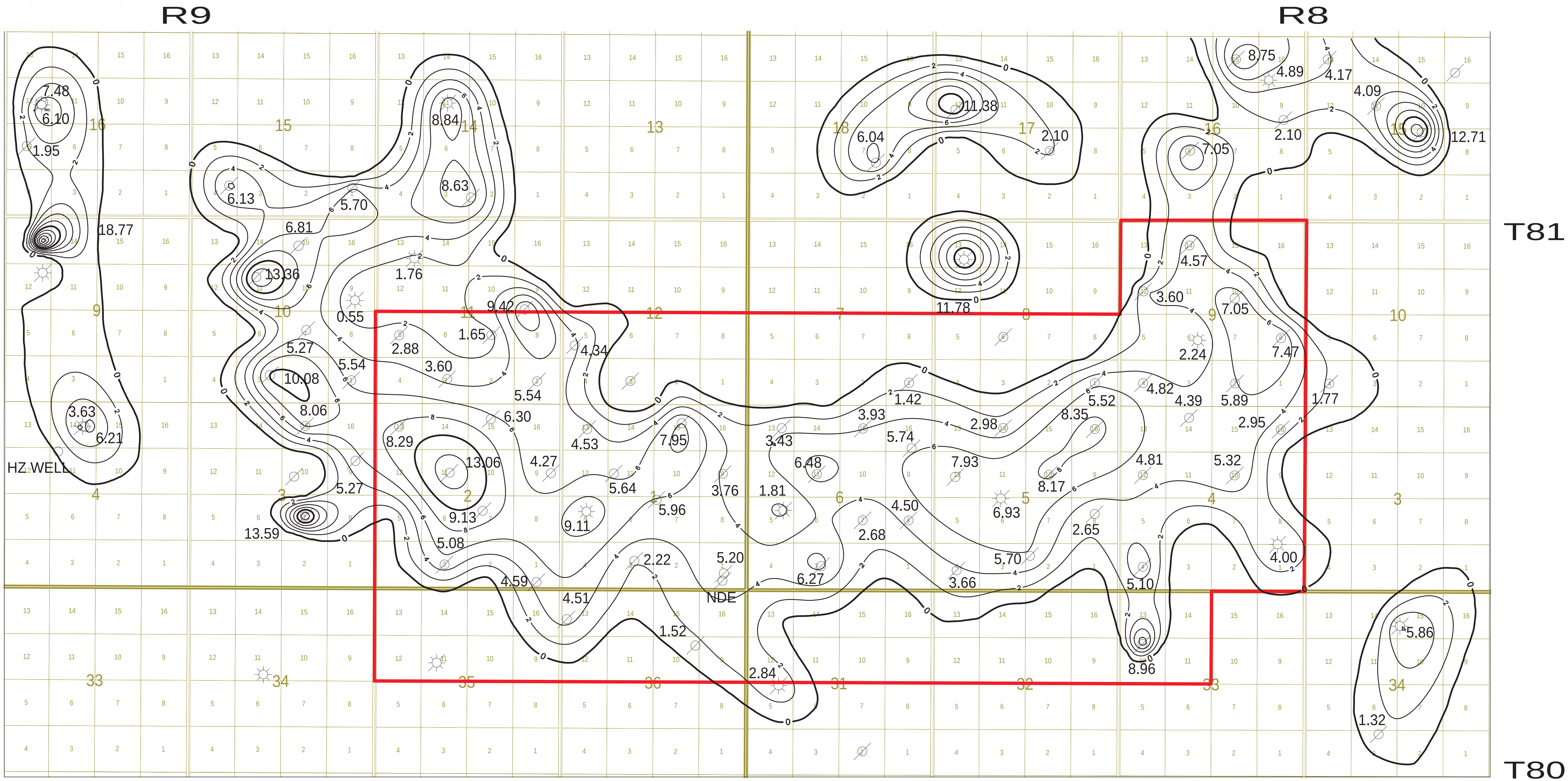
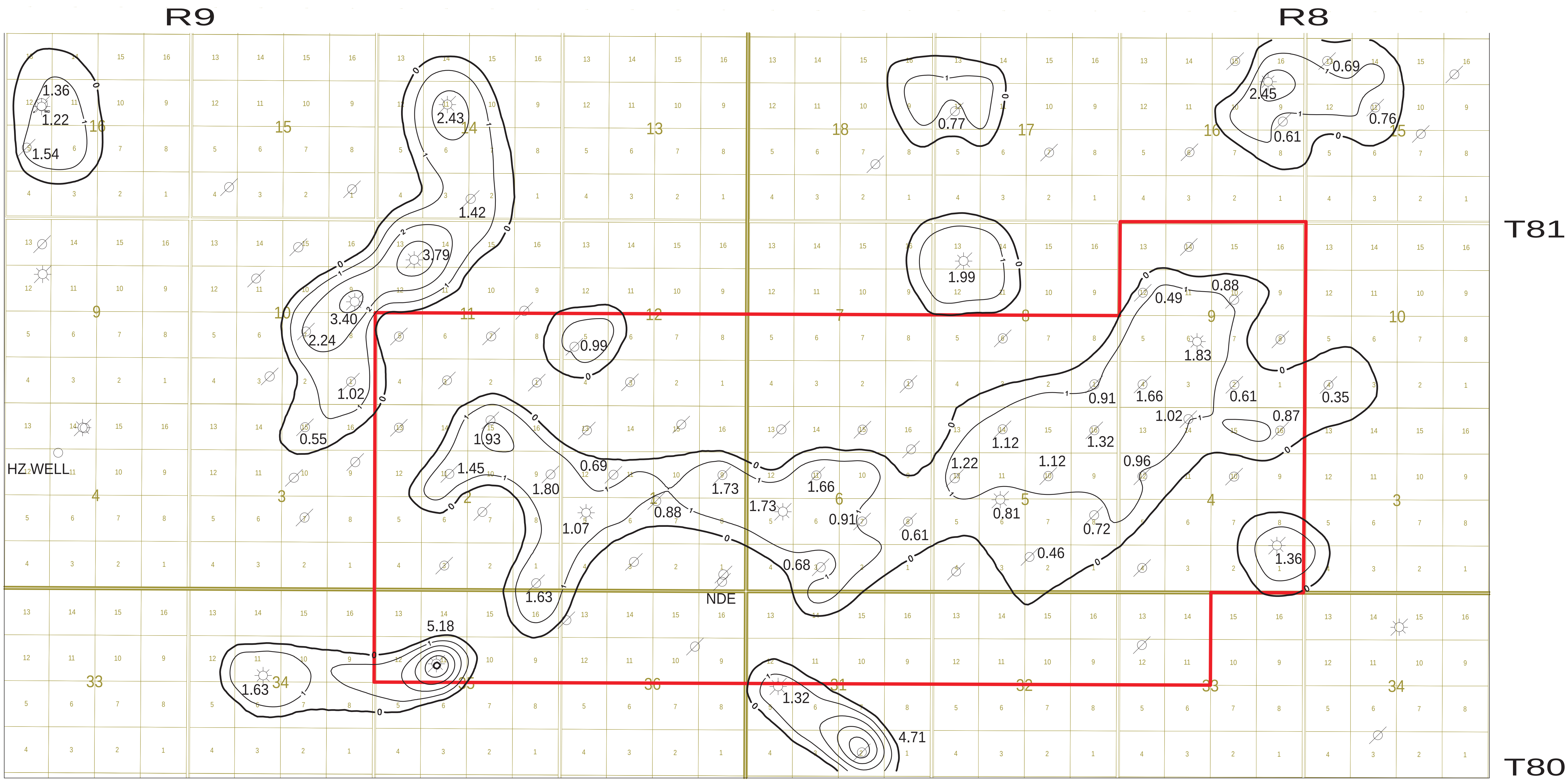


Figure C 4.1-24 McMurray Associated Net Gas Isopach



Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough

Figure C 4.1-25 McMurray Associated Net Lean Isopach



Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough

Figure C 4.1-26 McMurray Non-Associated Net Gas Isopach

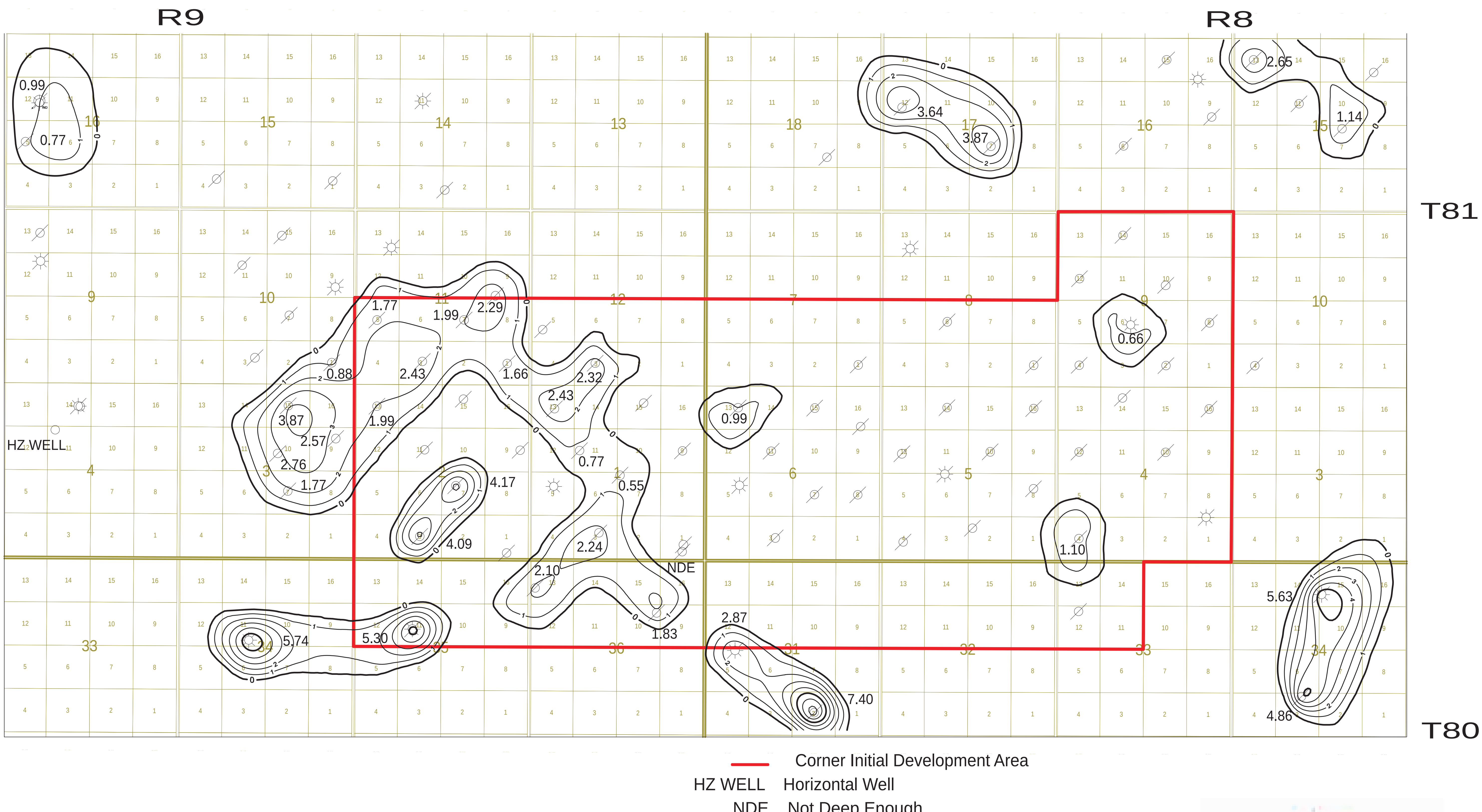


Figure C 4.1-27 McMurray Non-Associated Net Bitumen Isopach

C4.2 Reservoir Recovery Process

C4.2.1 Recovery Process Selection

North American will employ SAGD to recover bitumen from the McMurray formation. SAGD is an in-situ thermal process that has shown commercial viability at a number of operating projects within the province. SAGD has many technological and environmental advantages. It can economically recover on the order of 50% of the developable bitumen in place and requires less fuel for steam generation as compared to other steam processes. SAGD is a continuous process during normal operations and does not have heating and cooling cycles that could damage wellbore casings. It preserves the integrity of the reservoir cap rock because it injects steam below the pressure at which the reservoir can fracture.

North American is initially planning to develop areas with 15 m or greater of SAGD pay thickness. Areas with pay less than 15 m are being evaluated for future development and will depend on technology advancements and economic conditions at that time. Due to the immobile nature of the bitumen, areas with less than 15 m of pay will not be affected nor be stranded by the proposed developments, in fact, it is anticipated that infrastructure installed for the proposed development will aid in bitumen recovery from areas with pay thinner than the current 15 m cutoff.

Although SAGD recoveries are among the highest of any known commercial recovery process, North American will continue to evaluate any follow-up process that can further increase resource recovery.

C4.2.2 Description of the Process Used

C4.2.2.1 Steam Assisted Gravity Drainage

The SAGD process involves drilling two long horizontal wells that are separated vertically by approximately 5 m. The upper wellbore is used to inject steam into the reservoir. The injected steam adds energy in the form of heat to the reservoir, mobilizing the bitumen. The mobilized bitumen then flows by gravity to the lower production wellbore where fluids are gathered and brought to surface.

The SAGD process can be categorized into three general operating phases; startup, production and blowdown. The startup process involves circulating steam into both the injection and production wellbores until thermal communication is established between the pair, typically after approximately 90 days of circulation. The production phase involves continuous steam injection into the upper wellbore with concurrent bitumen production from the lower production well. The production phase typically runs until the costs of steam injection and associated production operations can not be offset by the revenues of bitumen production. The final phase is blowdown. Currently the injection of non-condensable gases is the leading candidate to optimize bitumen recoveries through the blowdown phase. Steam injection is shut down and replaced by non-condensable gas injection into the injection well. Non-condensable gas injection is used to maintain steam chamber pressures and support continuing bitumen production from the lower production well. The blowdown phase would continue until the costs of gas injection and associated production operations can not be offset by the revenues of bitumen production. North

American will continue to investigate other blowdown process options to maximize the economic recovery of bitumen.

C4.2.2.2 Well Pair Geometry and Placement

SAGD well pair spacing will be on the order of 120 m between adjacent wells. SAGD well pair lengths will be on the order of 500 m to 1,200 m with an initial target of 1,000 m. The actual length of each pair will be a function of pad geometry and local reservoir geology with consideration given to surface access limitations.

In reservoir areas with no bottom water or lower transition zones it is North American intention to place the SAGD production well as close to the base of the clean porous sand as possible, generally within 1 m to 3 m of the reservoir base. In reservoir areas with gradual transition between bottom water and bitumen the horizontal producers will be placed above the transition zone. This position results in a relatively high recovery factor with less risk of encountering problems with horizontal drilling operations (i.e., lost circulation). In areas with thick bottom water (> 5 m), the producer position may be adjusted upwards to approximately 3 m to 5 m above the oil water contact. Under these conditions, numerical model sensitivity studies show recoveries will be better with a slightly higher well pair placement. The higher placement limits the amount of heat lost to the bottom water and reduces the amount of bitumen draining and lost into the water zone. In all areas SAGD production wells will be allowed to deviate a few metres up or down to maximize resource recovery wherever possible.

C4.2.2.3 Reservoir Modelling

North American constructed static reservoir models using a geostatistical approach to populating 3D grid data. The first step was to generate variograms for reservoir properties such as effective porosity and water saturation. The next step involved the construction of an effective porosity trend model. The trend model was made with two vertical trend curves; one trend when inside a McMurray channel (SAGD) interval, and a second trend for the regional McMurray areas. Sequential Gaussian simulation was then used to populate the 3D models with porosity and water saturation values. Several structural controls were used as secondary Gaussian simulation variables in order to realistically constrain the model within geologically-defined bounding surfaces. The models were hung from the Top McMurray surface and ended at the Devonian. Within this interval, top and base of SAGD surfaces were used in the porosity trend modeling. In addition, an oil-water contact surface was used to better conform the transition between bottom water and bitumen. Top gas was estimated directly and based on geological mapping. Horizontal permeability was calculated as a function of the modeled effective porosity and vertical permeability was taken as a fraction of the horizontal permeability.

The SAGD recovery process was modeled using CMG's STARS thermal reservoir simulator. Model flow properties were extracted from North American's shaley sand data set, compiled over the last few years of delineation drilling throughout the project area. Shaley sand analysis provides shale-corrected porosities, permeabilities and fluid saturations.

Delineation drilling in the Corner development area has encountered bottom water, top lean bitumen (top water) and top gas throughout the Corner development area. The bottom water can be thick and extensive in some areas and has an initial pressure on the order of 2,500 kPag, measured via an openhole formation pressure tester (SFT). Top water is generally localized and for reservoir modeling it is assumed to be of finite extent. SFT measurements during delineation drilling operations indicate top water is in hydrostatic equilibrium with the underlying bitumen. Top gas can present in associated and non-associated pockets over the Corner development area. Non-associated gas is separated from the SAGD interval with continuous regional mudstones, and are not in pressure communication with the lower channels. Associated gas pockets are generally thin and sparse. Encountered associated gas was also SFT pressure tested and indicated it too was is in hydrostatic equilibrium with the underlying bitumen.

SAGD depletion modeling assumed steam chamber pressures on the order of 2,500 kPag. This is the target average operating pressure for long term SAGD depletion.

C4.2.2.4 Performance Prediction

The Corner initial development area performance prediction was derived from a pad model representing a P50 realization of Corner Pad 03, a six well pair pad in 5-081-08W4M. A representative average well pair profile is presented in Table 4.2-1. The presented injection and production rates shown are 90% of the simulated rates to account for downtime and non-ideal field operations. The presented rates also account for steam volumes required to start up a SAGD well pair. Numerically, the SAGD startup was simulated using direct energy injection rather than a rigorously simulated steam circulation phase. Direct energy injection occurs for 90 days with a temperature limit of 240^{o} C. This corresponds to an elevated circulation pressure on the order 3,250 kPa. The direct energy injection rate is assumed equivalent to field circulation rates of 120 m^3/d CWE steam per individual wellbore (240 m^3/d per SAGD well pair). Using these assumptions North American expects 21,600 m^3 of steam per well pair will be required for the circulation startup. This calculated volume has been manually added to the simulated steam volumes in the performance prediction table.

Bitumen recovery factors were determined using the total amount of bitumen in place which includes volumes above and below the SAGD production well depth. The economic life of continuous steaming operations was assumed to end when (a) 50% of the pad OBIP was recovered, or (b) the instantaneous steam oil ratio (ISOR) exceeded 4.0. Under continuous steaming operations the Corner pad model achieved 50% bitumen recovery before exceeding the ISOR upper limit. North American expects that optimized blowdown operations will recover an additional 5 – 15% OBIP. Assuming midpoint blowdown recovery factors of 10% North American expects the full cycle bitumen recovery factor in the Corner Hub area will be approximately 60% OBIP.

Table C4.2-1 Single Well Pair Performance Prediction

Year	Corner Initial Development Area		
	Bitumen Production (m^3/d)	Steam Injection (m^3/d)	SOR
1	123	296	2.42
2	219	476	2.17
3	243	603	2.48
4	210	592	2.82
5	180	557	3.09

C4.3 Hydrogeology

C4.3.1 Hydrostratigraphy

Hydrostratigraphy provides a classification of the geological units according to hydrogeological characteristics. The geological column for the region, shown on the left hand side of Figure C4.3-1, has been arranged into a series of aquifers and aquitards, based on the relative hydraulic characteristics of each unit or adjacent units. Six aquifers have been identified in the region as being feasible for providing the Kai Kos Dehseh Project with some or all of its groundwater demand and meeting some or all of its disposal requirements. These aquifers are listed below (with increasing depth) and are discussed in Sections 4.3.3 to 4.3.7 (Volume 1).

i. Empress Terrace Aquifer

ii. Empress Channel Aquifer

iii. Lower Grand Rapids Aquifer

iv. Clearwater A Aquifer

v. Clearwater B Aquifer

vi. Basal McMurray Aquifer

vii. Grosmont Aquifer

C4.3.2 Methodology

North American has updated mapping to reflect recent drilling for key zones within the Corner RGSA. Updated geology focussed on the Mannville Group and included the Lower Grand Rapids, Lower Clearwater B and McMurray Formations. The Clearwater A sandstones are not present in the Corner RGSA.

The geology review process paid particular attention to the Lower Grand Rapids, and Basal McMurray aquifers as the lower Clearwater B is thin. The determination of these aquifers was based on the following criteria;

- less than 60 API gamma response;
- greater than 30% density porosity;
- resistivity less than 10 Ω (Basal McMurray Aquifer only); and
- good spontaneous potential response.

C4.3.3 Empress Formation Aquifers

The Empress Formation is defined as all stratified sediments that rest on bedrock and are covered by the first occurrence of glacial till in the area (Andriashek, 2003). These drift sediments consist of Tertiary age “stratified gravel, sand, silt and clay of fluvial, lacustrine, and colluvial origin” (Whitaker and Christiansen, 1972) and exist within bedrock channels (channel aquifer) and on bedrock terraces or interfluve benches (Terrace Aquifer).

The Empress Channel and Empress Terrace Aquifers are important regional aquifers beneath the Project area. Isopach maps of the Empress Channel and Terrace Aquifers are provided as Figures 4.3-2 and 4.3-3 (Section 4.3, Volume 1).

Groundwater in the Empress Aquifers is considered to be non-saline with total dissolved solids (TDS) concentrations expected to be less than 1,000 mg/L. Testing of the North American 11-14-78-9 W4M camp water supply well identified TDS concentrations of 748 mg/L and 816 mg/L.

C4.3.4 Lower Grand Rapids Aquifer

The Grand Rapids Formation of the upper Mannville Group represents a regional regression event (Bachu et al., 1993). The lower portion of the Grand Rapids Formation consists primarily of thick sandstone bounded at the top and bottom by shale (Bachu et al., 1993). This sandstone is regionally extensive and, in the Corner RGSA, ranges from 13.8 m in well 15-34-80-8 W4 to 40 m in well 12-16-81-9 W4 (Figure C4.3-2).

Groundwater in the Lower Grand Rapids Aquifer is considered to be non-saline with expected total dissolved solids concentrations ranging from 1,000 to 3,500 mg/L (Figure 4.3-5, Volume 1). Tests conducted by North American, during the winter of 2007, identified TDS concentrations in the Lower Grand Rapids Aquifer ranging from 1,340 mg/L to 1,520 mg/L

C4.3.5 Clearwater A and B Aquifers

The regional Clearwater Formation is composed of several thick, coarsening-upwards, sand successions each separated by thin shale layers (Hitcheon et. al., 1989). Beneath the Kai Kos Dehseh Project area, there are two substantial sand bodies in the Clearwater Formation known as the Clearwater A and B aquifers (Maher, 1989). The Clearwater A Aquifer is present in the vicinity of Corner but occurs north of the Corner RGSA. The Clearwater A isopach is provided on Figure 4.3-6 (Section 4.3, Volume 1). The Clearwater B is present in the Corner RGSA however as shown in more detailed mapping it is insignificant, with a maximum thickness of 2.8 m in two wells in Section 16-81-8 W4 (Figure C4.3-3).

Groundwater in the Clearwater Aquifers is considered to be transitional between non-saline and saline with expected TDS concentrations ranging from 2,500 mg/L to 8,000 mg/L. Salinity maps for the Clearwater A and B are shown in Figures 4.3-8 and 4.3-9 (Section 4.3, Volume 1). Tests conducted by North American, during the winter of 2007, identified TDS concentrations in the Clearwater B Aquifer ranging from 6,340 mg/L to 7,610 mg/L.

C4.3.6 Basal McMurray Aquifer

The McMurray Formation consists predominantly of fluvial and estuarine sediments deposited in the valleys of the sub-Cretaceous Unconformity surface (Hitcheon et. al., 1989). The lower sands of the McMurray Formation are fluvial in nature. Fluvial sands that are water saturated are referred to as the Basal McMurray Aquifer. A gross isopach map of the Basal McMurray Aquifer is provided as Figure C4.3-4. Beneath the Corner RGSA, the Basal McMurray Aquifer trends in an east-west direction with thickness generally less than 10 m. The thickest bottom water in the Corner RGSA is west of the Corner initial development area where about 14 m is present in Section 3-80-9 W4.

Figure C4.3-5 is the McMurray net bottom water thickness map. The dominant east-west trend is evident and net thickness ranges from 0.6 m (14-4-81-8 W4) to a maximum of 9.7 m (7-3-81-9 W4).

Figure C4.3-6 is the structure on the McMurray bitumen/water contact. In large areas, bitumen is in direct contact with the Devonian or basal shales so the oil/water contact does not have a significant influence on horizontal well placement. Wells 16-5-81-8 W4 and 6-9-81-8W4 both have isolated oil/water contacts but the water is 2.7 m or less in thickness and will not significantly impact well emplacement. A cluster of 5 wells in the vicinity of the east edge of Section 6-81-8 W4 have bottom water up to 2.9 m thick but the oil/water contacts are all close to +235 m. The greatest relief on the oil water contact is in a cluster of wells on the west side of the Corner initial development area where a difference of 5.1 m is present between wells 11-2-81-9 W4 and 15-2-81-9 W4. As discussed previously, horizontal wells will run roughly perpendicular to the tilted surface and will be able to account for the structural change.

Groundwater in the Basal McMurray Aquifer is considered to be saline with TDS concentrations ranging from 10,000 mg/L to 15,000 mg/L. Figure 4.3-11 (Section 4.3, Volume 1) illustrates Basal McMurray Aquifer salinity. Tests conducted by North American, during the winter of 2007, identified TDS concentrations in the Lower Grand Rapids Aquifer ranging from 10,700 mg/L to 13,500 mg/L.

C4.3.7 Hydrogeologic Evaluation

The hydrogeologic assessment, including well testing and numerical groundwater modelling provided in Volume 3 Section 5.6 Impact Assessment, concludes that sufficient water is available to meet the water demands of the Corner Hub. To summarize, the water demands and supporting aquifers for the Corner Hub are 1,960 m^3/d from the Lower Grand Rapids Aquifer and 1,900 m^3/d from the Basal McMurray Aquifer. The Corner Hub will also dispose of 1,900 m^3/d into the Basal McMurray Aquifer.

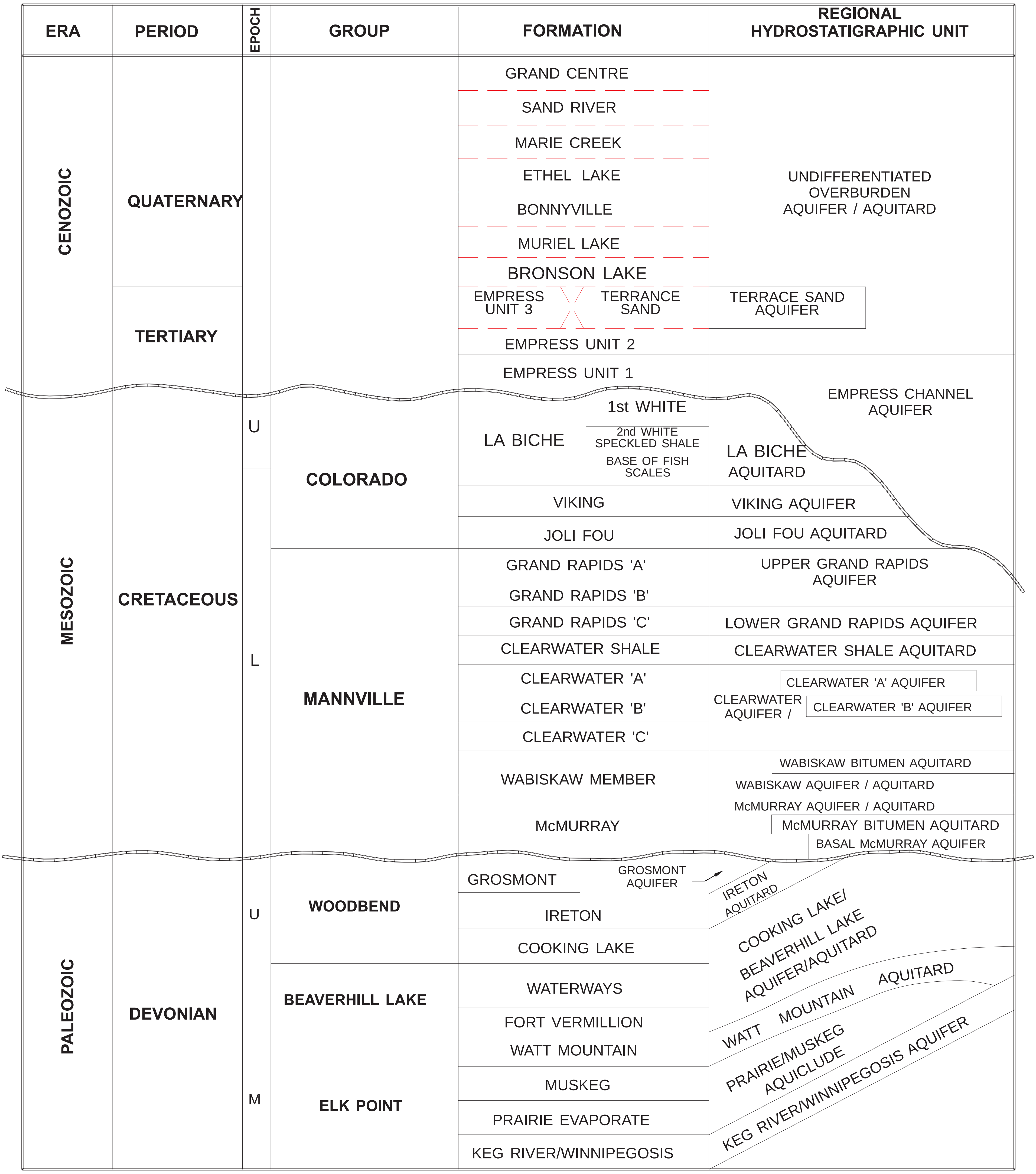
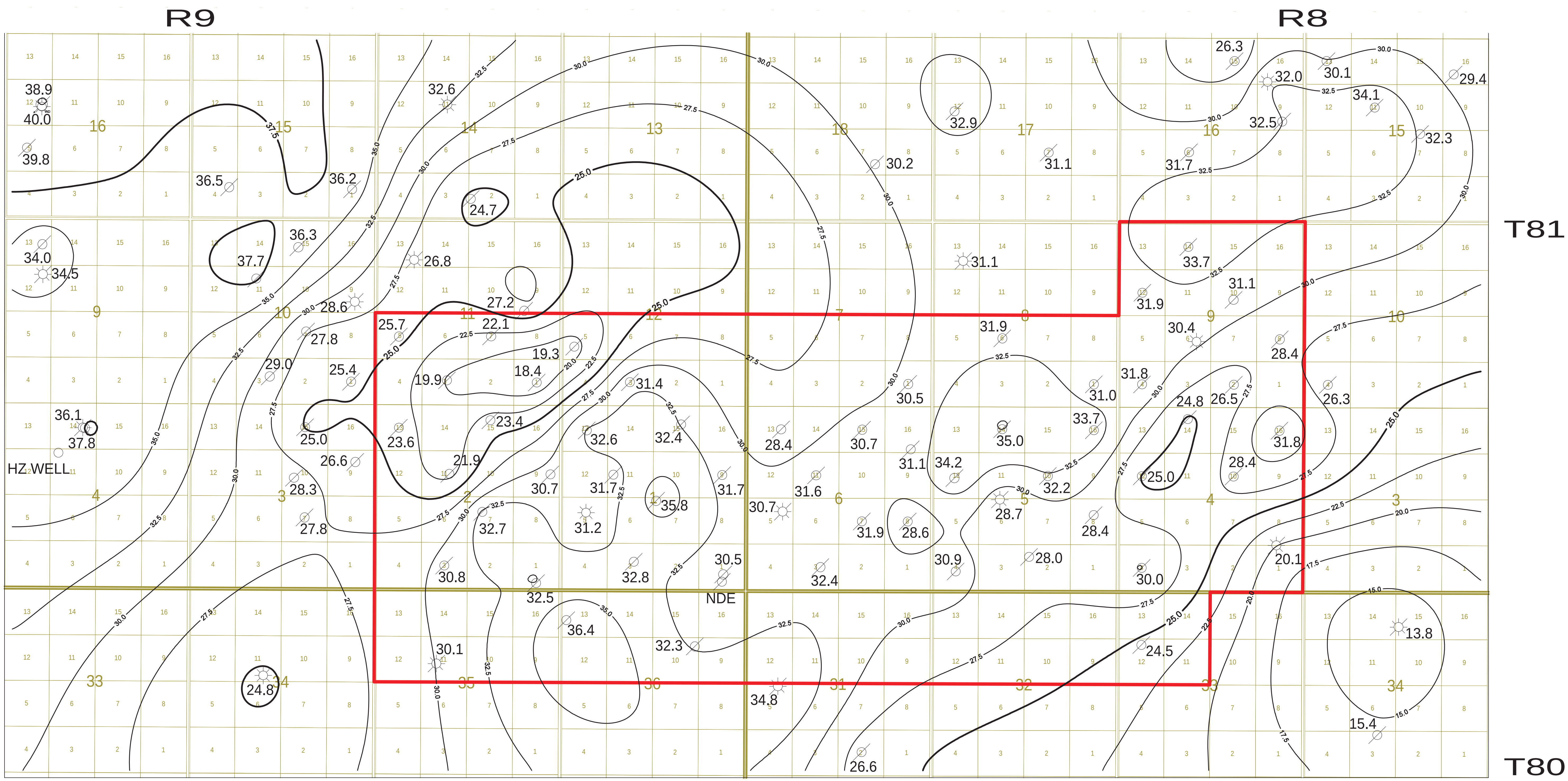
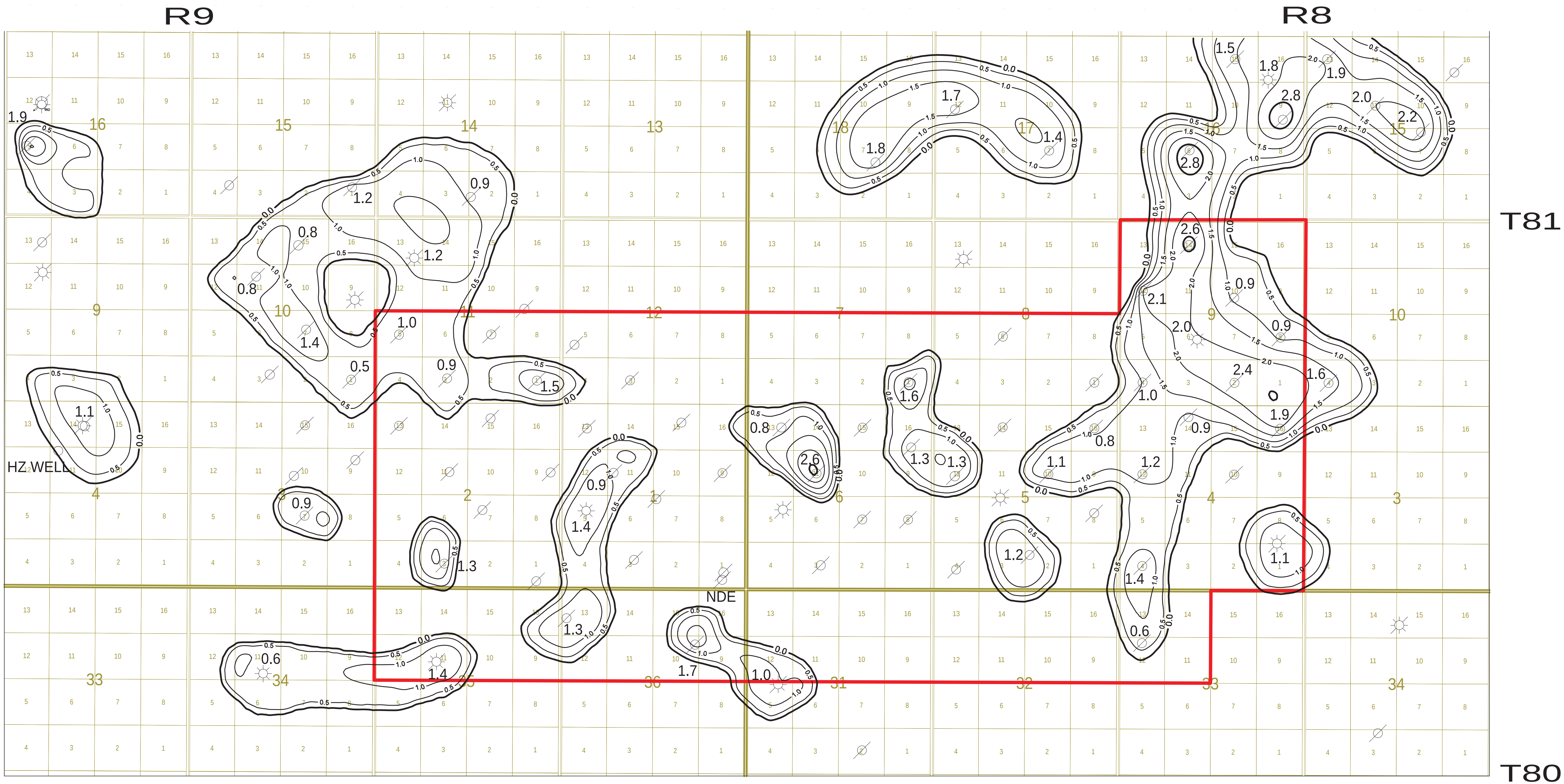


Figure C4.3-1
Geological Column



Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough

Figure C 4.3-2 Lower Grand Rapids Gross Porous Sandstone Isopach

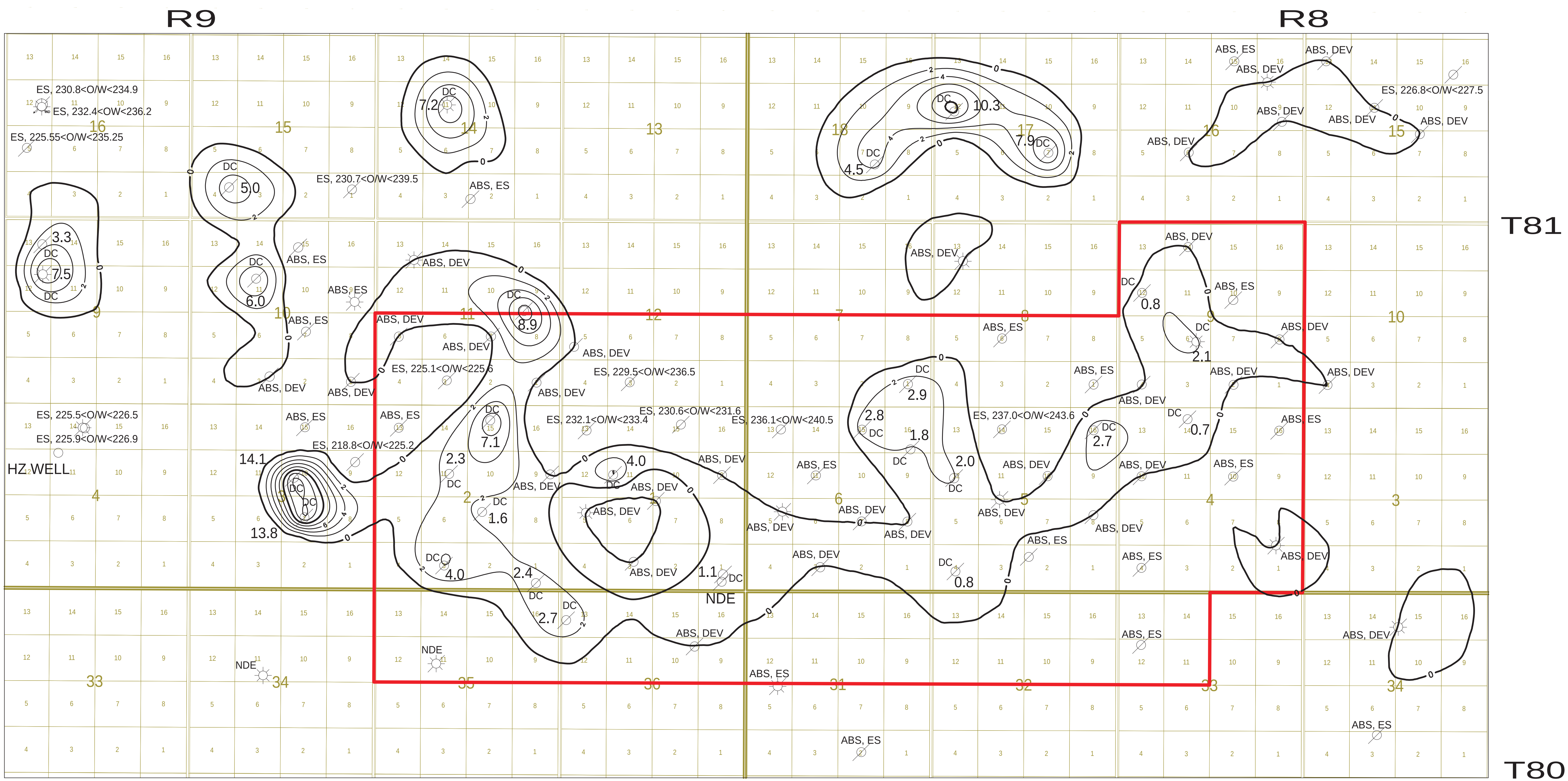


Corner Initial Development Area

HZ WELL Horizontal Well

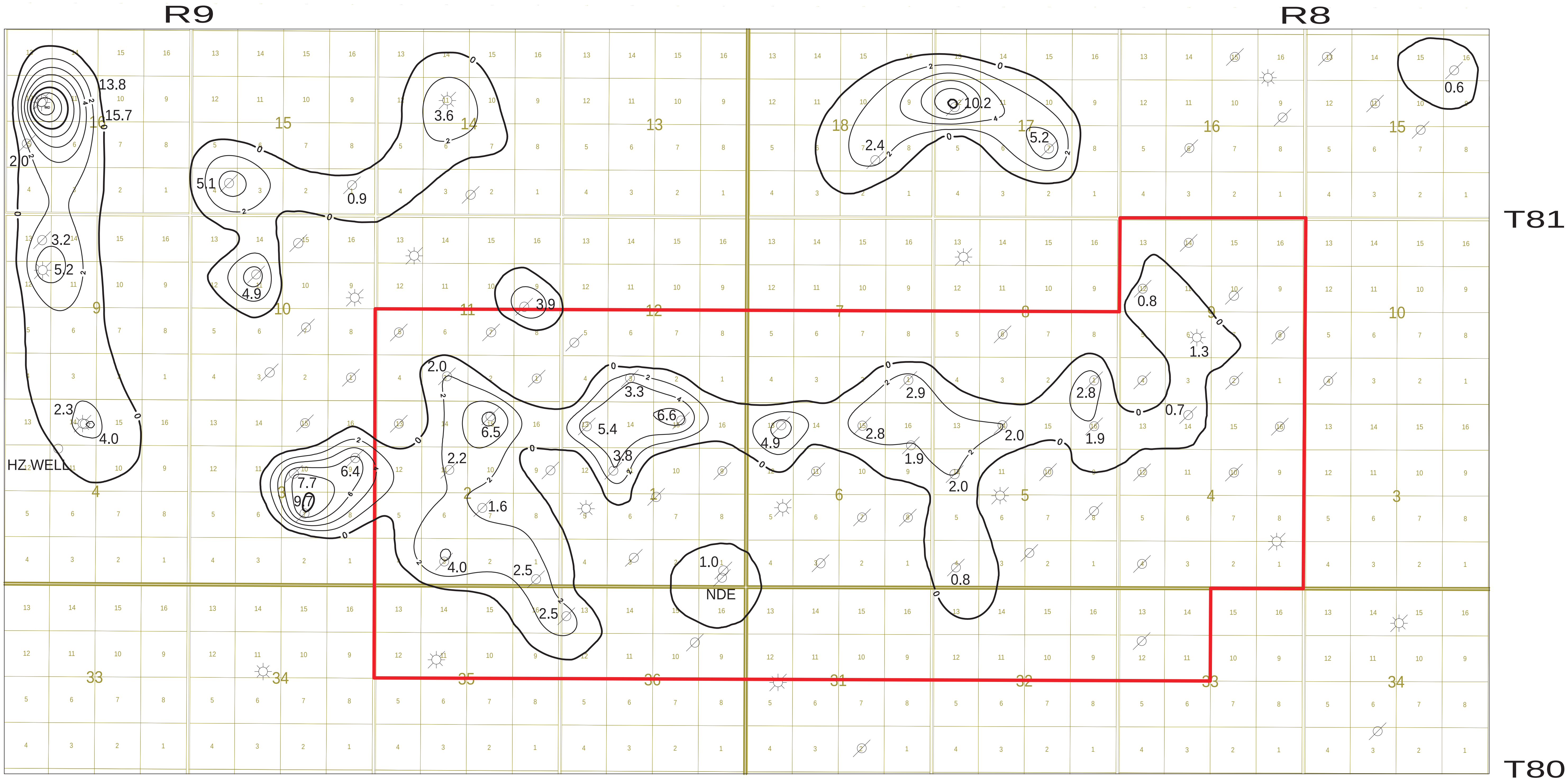
NDE Not Deep Enough

Figure C 4.3-3 Isopach Map of the Clearwater B Sandstone



(red line)	Corner Initial Development Area
HZ WELL	Horizontal Well
NDE	Not Deep Enough
DC	Direct Contact
ES	Encased in Shale
ES, x<B/W<y	Encased in Shale, between lowest bitumen and highest wet sand
ABS, ES	Shale directly on Devonian
ABS, DEV	Bitumen directly on Devonian

Figure C 4.3-4 McMurray Gross Bottom Water Isopach

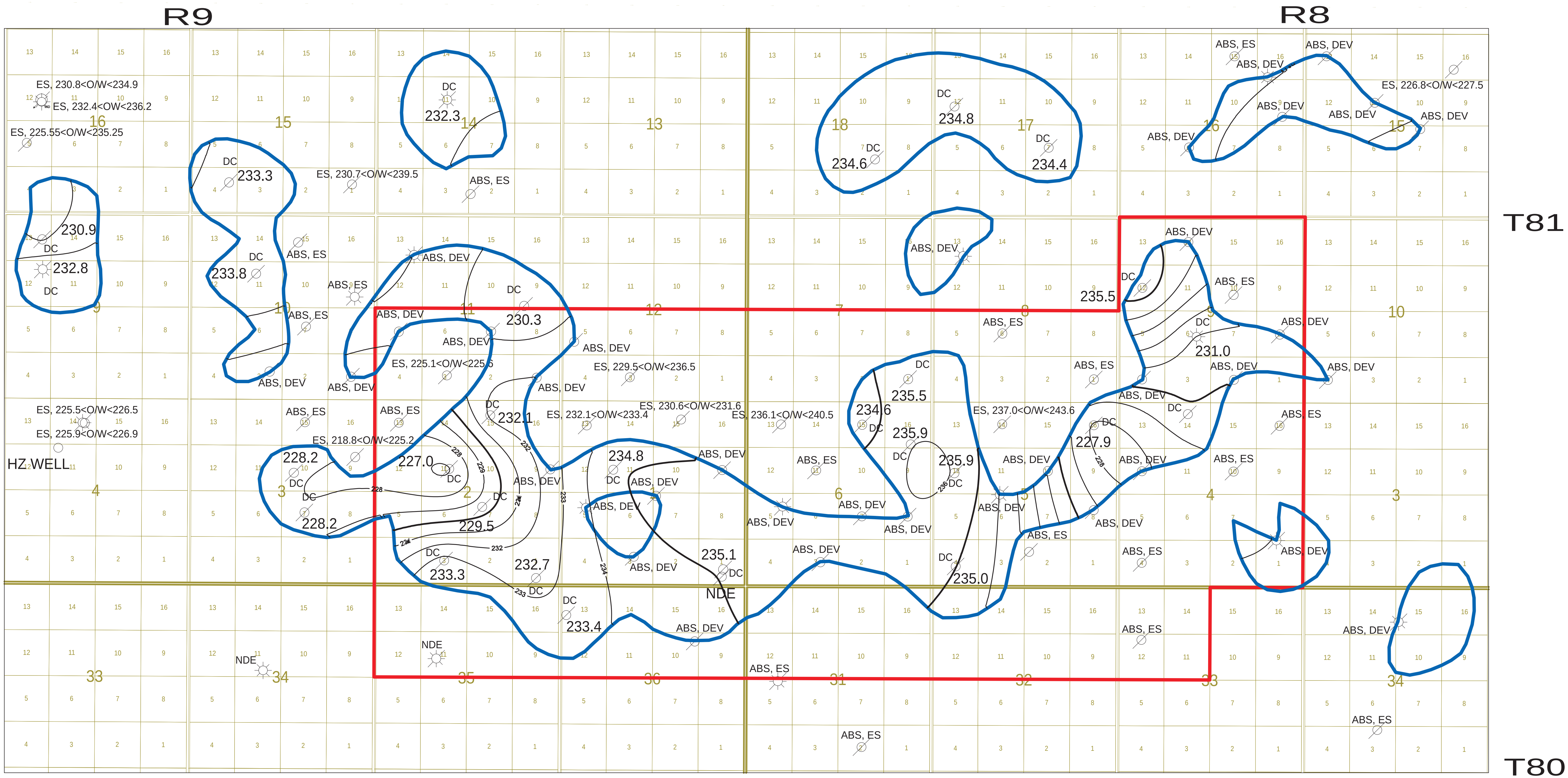


Corner Initial Development Area

HZ WELL Horizontal Well

NDE Not Deep Enough

Figure C 4.3-5 McMurray Net Bottom Water Isopach



(red line)	Corner Initial Development Area	DC	Direct Contact
HZ WELL	Horizontal Well	ES	Encased in Shale
NDE	Not Deep Enough	ES, x<B/W<y	Encased in Shale, between lowest bitumen and highest wet sand
(blue line)	Limit of Bottom Water	ABS, ES	Shale directly on Devonian
		ABS, DEV	Bitumen directly on Devonian

Figure C 4.3-6 Structure on McMurray Bitumen-Water Contact

C5 CORNER HUB CONSERVATION & RECLAMATION PLAN

C5.1 Introduction

This section provides site-specific conservation and reclamation (C&R) practices and mitigation activities for the Corner Initial Development Area. General C&R measures (e.g., re-contouring, decompaction, weed/erosion control, surface water management, etc.) applicable to all the Kai Kos Dehseh development areas are presented in the conceptual C&R plan (Volume 1, Section 8).

Preceding application for approval of the Kai Kos Dehseh Project, North American had applied for regulatory approval of its Leismer Demonstration Project. As part of the regulatory review, revisions to the original Leismer Demonstration Project C&R plan were made. Specifically, North American has made the following commitments:

- Corduroy will not be used in the construction of pads developed on deep (>40 cm) peats;
- A minimum of 40 cm of peat will be salvaged from areas developed in deep peats; and
- Borrow areas will be developed in upland areas only.

The commitments have been incorporated into the conceptual C&R plan presented in Volume 1, Section 8 and in to this detailed C&R plan. Future Pre-Development Assessments (PDAs) will be done on the Corner Initial Development facility areas to provide additional detail on soils and terrain, and revised site-specific C&R procedures, if required.

C5.2 Corner Initial Development Conservation And Reclamation

Initial development in the Corner lease includes 2 adjacent CPFs, a LACT Unit beside (north of) them and 10 separate production pads (C1 to C10) and associated facilities (access, water source and disposal wells, pipelines, powerlines). There is also an additional production pad planned to be located on the LACT Unit.

Table C5.2-1 lists the potential facility disturbance on the Corner Initial Development Area footprint. Table C5.2-2 presents the soils on the Corner Initial Development footprint and Figure C5.2-1 illustrates the mapped soil units on the Corner Initial Development Area footprint.

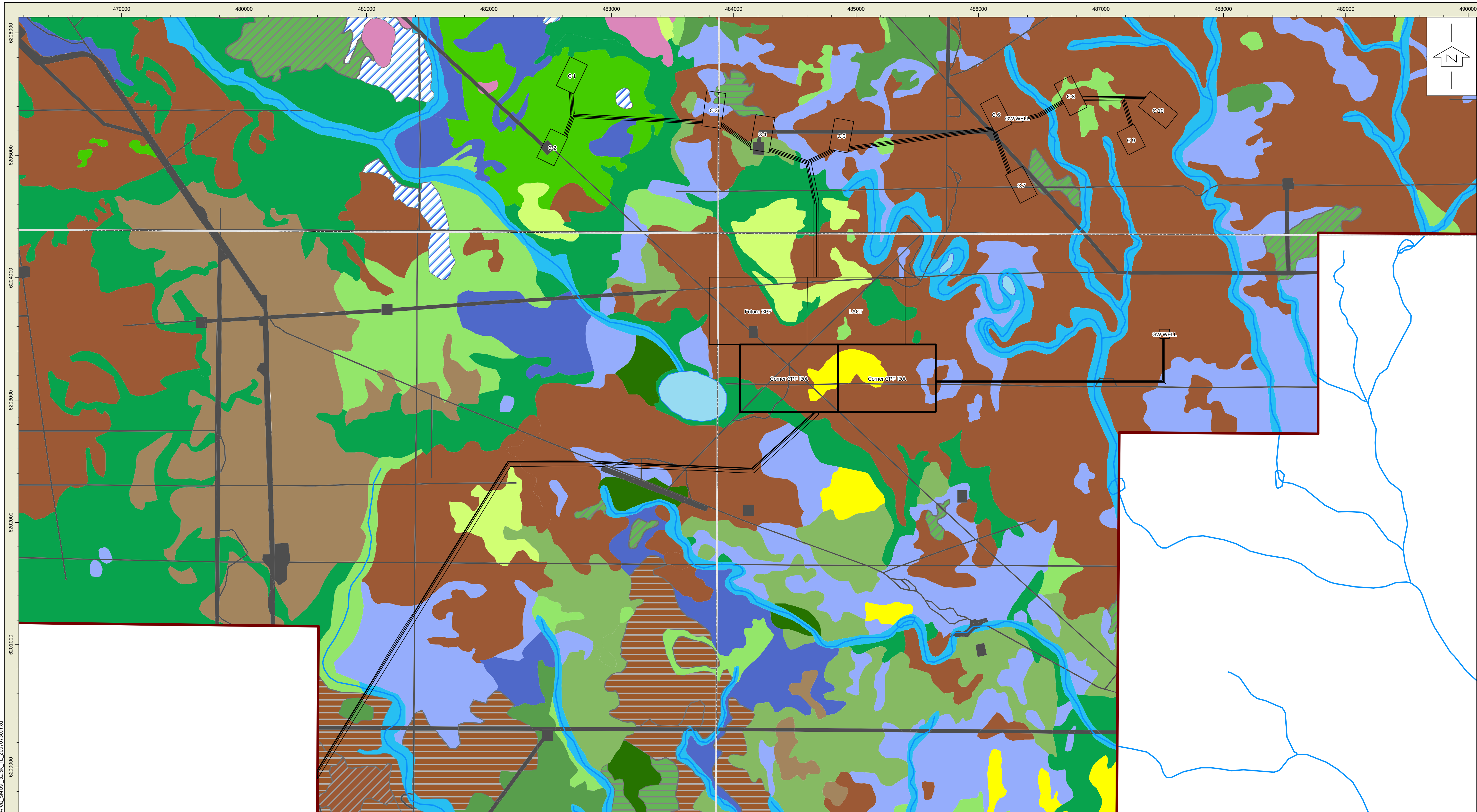
Table C5.2-1 Facility Areas on Corner Initial Development Area Footprint

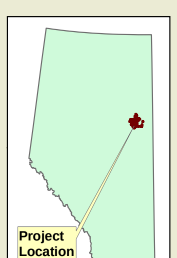
Corner IDA Facility	Area on Footprint (ha)
2 Central Plant Facilities (CPF)	88.0
LACT Unit (including a production pad within)	44.0
10 Production Well Sites	41.9
Access Roads in ROWs	6
Well Site ROWs (excluding access roads)	9.7
GW Well	0.6
Pipeline ROWs	3.4
Total	193.6

Table C5.2-2 Corner Initial Development – Soil Types and Area Extent

Soil Map Units	CPF1	CPF2	LACT Unit (includes Pad C11)	Pad C1	Pad C2	Pad C3	Pad C4	Pad C5	Pad C6	Pad C7	Pad C8	Pad C9	Pad C10	GW Well	Roads / Connectors / ROW	Total
Hartley (HLY)			1.3	4.1	3.2							1.2			4.3	14.1
Kinosis (KNS)	31	28.7	26			1.8	2.3	3.5	4.1	3.9	3.2	3.4	4.5	.6	8.2	121.2
McLelland (MLD)		7.1	9.4												2.8	19.3
Muskeg (MUS)			5.7													5.7
Mildred (MIL)	9	5.4														14.4
Mariana (MRN)						0.8	1.0								1.6	3.5
Steepbank (STP)	3.2					1.9		0.1							0.8	6.0
Existing Disturbance	0.8	2.8	1.7		0.9		1.2	0.5		0.2					1.2	9.2
River/Lake/Stream Channel															0.2	0.2
Total	44	44	44.1	4.1	4.1	4.5	4.5	4.1	4.1	4.1	3.2	4.5	0.6	.6	19.1	193.6

Note: Refer to Figure C5.2-1 for C&R naming convention of pads





Legend

- North American Soils LSA
- Lake
- River / Stream

C1-C10: Corner Initial Development Production Well Site
CPF IDA: Corner Initial Development Area Central Plant Facility
GW Well: Groundwater Well Site

Soil Map Units

ALG-1	FRT-1	KNS-3	MKW-1	MRN-3	SRT-2	SC
ALG-2	HLY-1	KNS-4	MLD-1	MRN-4	STP-1	ZUN
DOV-1	HLY-2	LVK-1	MLD-2	MUS-1	STP-2	
DOV-2	KNS-1	MIL-1	MRN-1	MUS-2	Lake	
FIR-1	KNS-2	MIL-2	MRN-2	SRT-1	RB	

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0 0.2 0.4 0.8 1.2 1.6 2 km

NAD 83 UTM Zone 12

Title:

SOIL MAP UNITS ON CORNER INITIAL DEVELOPMENT AREA (IDA) FOOTPRINT

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
SC/DH/LZ	July 30, 2007

File: Figure. C 5.2-1 Corner Ini Dev Area _SMUs _32.5k_TL_20070730

Drawn by:	Checked:	Fig. No.:
TR/JC/LZ	LZ/SC	C 5.2-1

C5.3 Land Capability for Forest Ecosystems Classification

Figures C5.3-1 and C5.3-2 illustrate the pre-disturbance and target post reclamation Land Capability Classification for Forest Ecosystems for the Corner Initial Development footprint.

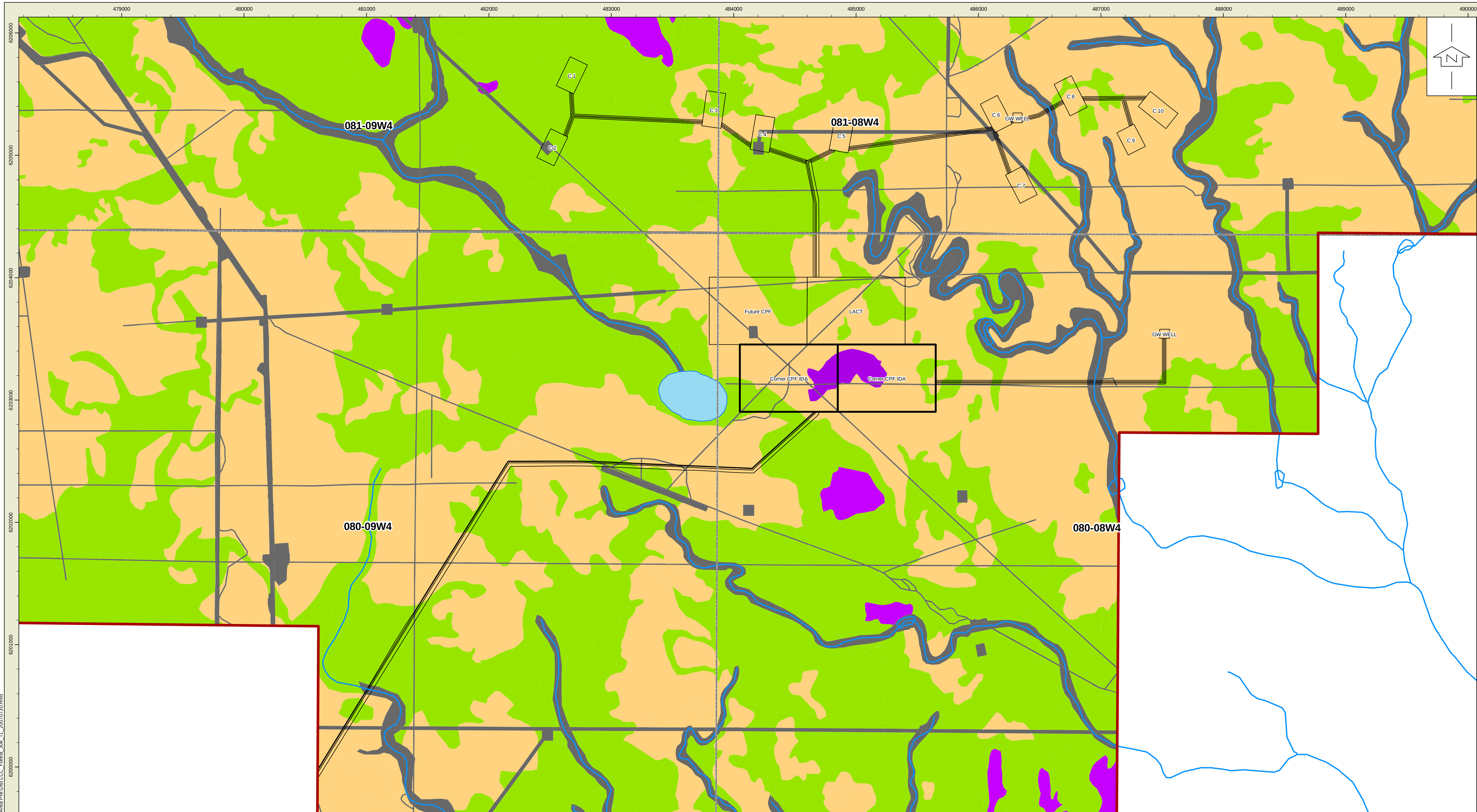
Table C5.3-1 compares the pre-disturbance and post reclamation Land Capability for Forest Ecosystem classes.

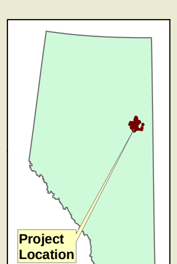
Table C5.3-1 Pre-disturbance and Post Reclamation Land Capability for Forest Ecosystem Classes for the Corner Initial Development Footprint

Forest Capability Class	Baseline		Post Reclamation	
	Area (ha)	% of Footprint	Area (ha)	% of Footprint
Class 1 High Capability	0	0	0	0
Class 2 Moderate Capability	0	0	0	0
Class 3 Low Capability	121.2	62.6	129.9	67.1
Class 3/5 (Low Capability/Non-Productive) Complex	0	0	36.4	18.8
Class 4 Conditionally Productive	14.4	7.4	14.8	7.7
Class 5 Non-Productive	48.6	25.1	12.3	6.3
Unclassified (Lakes, Rough Broken, Stream Channel, Disturbed soil map units)	9.5	4.9	0.2	0.1
Total	193.6	100	193.6	100

The Class 3/5 complex represents the reclamation approach for padded sites developed on areas of deep peat (Class 5), where a portion will be reclaimed to an upland ecosite phase (Class 3), and the edges to the ‘transitional g1’ ecosite phase (Class 5). The areas of padded well sites, CPFs, access roads and camps developed on peatland that will be reclaimed to the ‘transitional g1’ ecosite phase represents the greatest change to land capability from the baseline conditions (see Figures 8.6-3 and 8.6-4 in Volume 1, Section 8).

The siting of well sites, CPFs, access roads and camps on deep peats will result in a reduction of some peatland area; however, reclamation to the ‘transitional g1’ area is an initial step in mitigation of this loss. As experience is gained in reclamation of wetland areas, the area of peatland reclaimed to areas with similar characteristics can be expanded over time.





Legend

- North American Soils LSA
- Lake
- River / Stream

C1-C10: Corner Initial Development Production Well Site
CPF IDA: Corner Initial Development Area Central Plant Facility
GW Well: Groundwater Well Site

Land Capability for Forest Ecosystems

- Unclassified (Baseline Disturbances, Lakes, Stream Channels, Rough Broken)
- Class 2 (Moderate Capability)
- Class 3 (Low Capability)
- Class 4 (Conditionally Productive)
- Class 5 (Non-Productive)

1:30,000

0 0.2 0.4 0.8 1.2 1.6 2 km

NAD 83 UTM Zone 12

Title:

PRE-DISTURBANCE LAND CAPABILITY FOR FOREST ECOSYSTEMS ON CORNER INITIAL DEVELOPMENT AREA FOOTPRINT

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:
SC/DH/LZ	July 30, 2007

File: Figure. C 5.3-1 Corner Ini Dev Area Pre-Dist LCC_Forest_30k_TL_20070730

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TR/JC/LZ	LZ/SC	C 5.3-1

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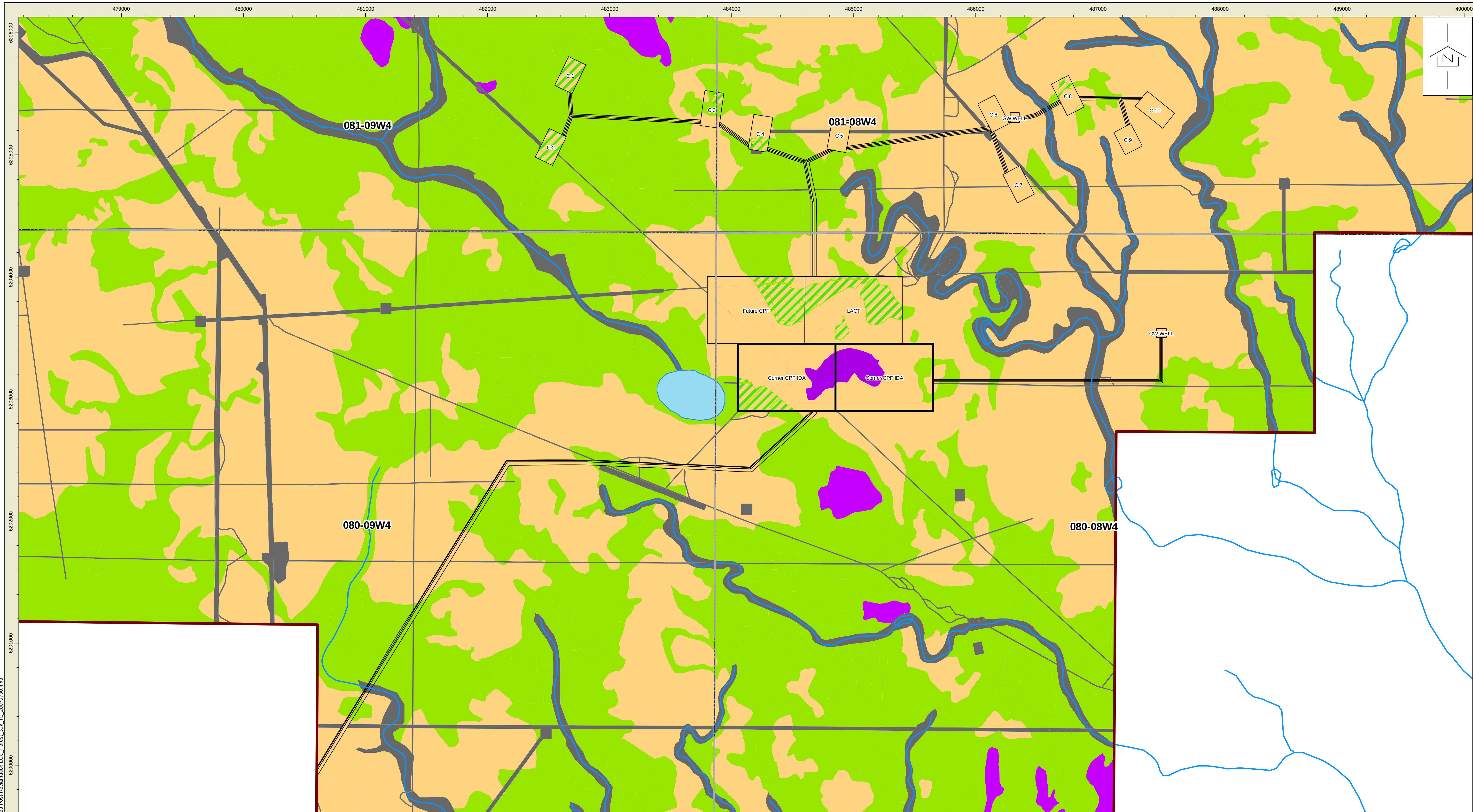

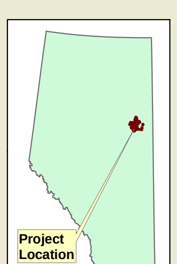

Legend

- North American Soils LSA
- Lake
- River / Stream
- C1-C10: Corner Initial Development Production Well Site
- CPF IDA: Corner Initial Development Area Central Plant Facility
- GW Well: Groundwater Well Site

Land Capability for Forest Ecosystems

- Unclassified (Baseline Disturbances, Lakes, Stream Channels, Rough Broken)
- Class 2 (Moderate Capability)
- Class 3 (Low Capability)
- Class 4 (Conditionally Productive)
- Class 5 (Non-Productive)
- Class 3/5 Complex (Low Capability/Non-Productive)

1:30,000

0 0.2 0.4 0.8 1.2 1.6 2 km

NAD 83 UTM Zone 12

Title:

POST-RECLAMATION LAND CAPABILITY FOR FOREST ECOSYSTEMS ON CORNER INITIAL DEVELOPMENT AREA

NORTH AMERICAN OIL SANDS CORPORATION

Approved:	Revision Date:	
SC/DH/LZ	July 30, 2007	
File: Fig. C 5.3-2 Corner Ini Dev Area Post-Reclamation LCC_Forest_30k_TL_20070730		
Drawn by: TR/JC/LZ	Checked: LZ/SC	Fig. No.: C 5.3-2

14455-514_NAOSC\FINAL_Maps\C&R\Fig. C 5.3-2 Corner Ini Dev Area Post-Reclamation LCC_Forest_30k_TL_20070730.mxd

C5.4 Hydrology

Mitigation measures to prevent impacts on surface water are presented in the conceptual C&R (Volume 1, Section 8.6.2.2) and Hydrology (Volume 3, Section 6) and Fish and Fish Habitat (Volume 3, Section 8) sections of the EIA.

C5.5 Soils Handling Plan

The objective of soil salvage and management is to provide valuable topsoil for reclamation purposes by stripping and storing topsoil in a manner that will minimize loss until it is required for future replacement and reclamation. Through proper handling and conservation, the degradation of topsoil by erosion, compaction, rutting, loss of viable plant material and soil mixing is reduced. For the purposes of salvaging, stockpiling, and replacing soil during reclamation, soil-handling activities have been recommended for the dominant soil series encountered.

C5.5.1 Topsoil and Subsoil Salvage

A professional soil scientist will direct, monitor and document all soil salvage activities according to all applicable regulatory guidelines. All areas of surface disturbance on the Corner Initial Development footprint will have surface soils salvaged as detailed in Table C5.5-1 (based on average topsoil depths for soil series). Where present, colour change from A to B horizons can also be used to guide topsoil stripping. North American will document the volumes and locations of all salvaged topsoils at the time of salvage. Future PDAs on the Corner Initial Development facility areas will provide additional detailed information on soil depths for soil salvage.

Table C5.5-1 Recommended Topsoil Salvage Depths by Soil Series

Soil Series	Recommended Soil Salvage Depth (cm)
Firebag Fort Kinosis Mildred	LFH and/or shallow peat plus 15 cm topsoil (or to bottom of topsoil if deeper)
Livock Surmont	LFH and/or shallow peat plus 18 cm topsoil (or to bottom of topsoil if deeper)
Algar Lake Dover Steepbank	peat plus 10 cm of underlying mineral soil
McLelland Hartley Mariana	Minimum 40 cm of peat

Where topsoil is being stripped, activities will be suspended immediately if soils become excessively wet, or if any other field conditions or operations occur that will result in the degradation of topsoil quality, e.g., rutting, high winds. Where the development area occurs within wet terrain, stripping will occur during frozen conditions.

Up to 30 cm of suitable subsoil (i.e., subsoil rated as good, fair or poor for reclamation suitability according *to* the *Soil Quality Criteria Relative to Disturbance and Reclamation (Revised)* (Alberta Agriculture, 1987)) will also be salvaged from mineral soil sites. No subsoil will be salvaged from wet (i.e., Organic or Gleysolic) soils. Access roads on mineral soils will have surface duff/peat and surface mineral soil (topsoil) salvaged only.

Salvage and stockpile information will be presented in the Annual Conservation and Reclamation Report.

C5.5.2 Stockpile Management

The mineral topsoil, peat from the Organic soils, and the subsoil will be stored in separate, stable stockpiles on site. Stockpiles will be located such that they will not interfere with on site activities. They will be accessible and retrievable for reclamation. North American has included sufficient stockpile area on the CPFs and each pad to accommodate the material volume. In general, the stockpile locations for the Corner Initial Development CPFs and pads will be as illustrated in Figures 8.6-2 and 8.6-1, respectively (Volume 1 Section 8); locations will be finalized when the PDAs are done.

Stockpile sites will be documented in the Annual Conservation and Reclamation Report submitted to AENV and staked or marked in the field.

The stockpiles locations will have stable foundations and will also be stabilized to control water and wind erosion. The requirement for immediate erosion control measures, such as erosion control matting, or tackifiers will be determined on a stockpile-specific basis. An ASRD-approved seed mix suitable for the Central Mixedwood Subregion will be used to provide a protective vegetation cover where required. Soil stockpiles will be monitored and additional erosion control measures adopted, as necessary, where seed germination and plant growth have been poor.

C5.6 Reclamation

C5.6.1 End Land Use Objectives

As discussed in Volume 1, Section 8, the disturbed upland mineral soil areas will be reclaimed to an ecosite phase and land capability equivalent to the pre-disturbance conditions. The central areas of the well pads developed on peatland areas will be reclaimed to a target g1 Labrador tea - subhygric Black spruce-Jack pine ecosite phase with a land capability for forest ecosystems of Class 3 to 4. The edges of the pads will be reclaimed to a wetter peat surface area providing a transition between the reclaimed upland area and the existing wetland area. The transition area will have a target ‘transitional g1’ ecosite phase, with an anticipated land capability for forest ecosystems of Class 5 (to 4) as described in Volume 1, Section 8 and illustrated in Figures 8.6-3 and 8.6-4.

The ‘transitional g1’ ecosite phase will have similar target species as the g1 Labrador tea - subhygric Black spruce-Jack pine ecosite phase (black spruce, bog cranberry, bunchberry, blueberry and Labrador tea); however, there will be a decrease in tree species density and an increase in shrub species density. The prescribed vegetation for reclamation is considered to be best suited for the moisture and drainage conditions that will occur in the transition zone, and which will also most closely resemble adjacent existing wetland vegetation.

C5.6.2 Site Reclamation

Reclamation for all the Corner Initial Development facilities will be carried out as discussed in the conceptual C&R plan (Volume 1, Section 8) and section C5.6.1; the Corner Initial Development Central Plant Facilities, LACT Unit and well pads are further discussed below. Site preparation for soil replacement will follow the guidelines presented in section 8.6.5 (Volume 1, Section 8).

The C&R procedures for the sites in the Corner Initial Development Area are based on the current information. Future Pre-Development Assessments (PDAs) will be done on the Corner Initial Development facility areas to provide additional detail on soils and terrain, and revised site-specific C&R procedures.

C5.6.2.1 CPFs and LACT Unit

The two southern, adjacent, initial development Corner CPFs are dominated by upland Kinosis till soils, with a central area of Mildred glaciofluvial soils. Minor areas of Steepbank soils (east boundary) and McLelland Organic soils (southwest corner of the area) occur; drainage (e.g., culverts and/or rock drains) will be utilized in construction of the southwest corner of the CPF area to maintain water flow in the McLelland fen unit.

The dominant soil series on the adjoining LACT Unit is Kinosis, with a McLelland soil unit in the northeast with Muskeg (and minor McLelland) soil units in the northwest. Peat depths encountered in these Organic soil units varied from about 80 cm to 160 – 220 cm or more. A small, separate Organic Hartley soil unit occurs in the central south part of the LACT Unit with shallow peat (approximately 50 cm encountered); additional information obtained in the future PDAs will be used to determine the reclamation for this small, shallow peat unit.

The dominant mineral soil will be reclaimed to upland areas with similar soils, terrain, and land capability and target ecosite phases as the pre-disturbance conditions as described in Volume 1, Section 8. The terrain will be re-contoured so slopes and local drainage will be compatible with the adjacent terrain, including the fen area.

Volume 1, Section 8, describes reclamation of peatland areas partly to a reclaimed upland area with a target ecosite phase of g1, and to the wetter, transitional peat surface area, though this may be adjusted for site specific conditions. For the McLelland fen and Muskeg soil units, the reclamation goal would be to reclaim much of these areas to a peat surface 'transitional g1' ecosite phase, and the remaining areas of the pre-disturbance peatland reclaimed with the pad in place with a target g1 ecosite phase, depending on additional information on soils from the PDAs, site specific conditions at the time, and logistics.

Surface soil stripping on the dominant mineral soils will include the surface LFH and approximately 15 cm of the surface soil, or to depth of topsoil if deeper; the upper lift soil salvage from small inclusions of shallow (< 40 cm) peat that may occur on the Steepbank soil can be included in this upper lift. The McLelland fen and Muskeg areas with peat > 40 cm thick will have a minimum of 40 cm salvaged for replacement.

The upper lift of LFH/shallow peat/mineral soil A horizons will be replaced where salvaged. The peat salvaged from the McLelland and Muskeg units will be replaced back in the 'transitional g1' zone (to the elevation of the adjacent undisturbed peatland) and mixed into the surface soil of any areas of pad reclaimed in place.

In the mineral soils, up to 30 cm of suitable subsoil as defined in the *Soil Quality Criteria Relative to Disturbance and Reclamation* (Alberta Agriculture, March 1987) will also be salvaged from mineral sites. No subsoil will be salvaged from wet (i.e., Organic or Gleysolic) soils. The salvaged subsoil will be replaced over the part of the lease not included in the transition zone. Salvaged soil will be stored on the CPF areas.

C5.6.2.2 Well Pads

Well pads C5 to C10 are located dominantly on upland Kinosis till soils. Pad C3 is dominantly upland Kinosis and Steepbank soils. Pad C3 also has a small area of Terric Organic soil (Mariana) series in the northeast corner and Pad C8 has minor inclusions of Hartley Organic soils. For the dominant mineral soil areas on these pads, the standard conservation and reclamation procedures for the mineral upland soils will apply as described in Volume 1, Section 8 (e.g. gravel removal, decompaction, re-contouring to match adjacent upland terrain, replacement of topsoil and subsoil salvaged from the upland, and revegetation to the pre-disturbance upland ecosite phase). The Ecological Land Classification indicates a small peat unit on Pad C9; the future PDA will further assess this unit.

Surface soil stripping on the dominant mineral soils will include the surface LFH and approximately 15 cm of the surface soil, or to depth of topsoil if deeper; any small inclusions of shallow (< 40 cm) peat that may occur will be included in this upper lift. In the mineral soils, up to 30 cm of suitable subsoil will be salvaged as previous described for mineral soils.

Pads C3 and C8 have small areas of Organic Mariana and Hartley soil, respectively. A soil inspection in the Organic soil map unit on Pad C3 indicates a peat depth of about 75 cm. Drainage (e.g., culverts and/or rock drains) will be utilized in construction of these pads as required to maintain water flow. If these peat areas are confirmed by the PDAs, the peat will be salvaged and separately stored from the upper lift. In reclamation of these peatland areas, the pad will be excavated to the extent allowed by abandoned wells, and the peat replaced to create a wetter, surface peat transitional zone ('transitional g1' ecosite phase) in these areas.

Pads C1 and C2 are located in an area dominated by Terric Organic soils (Hartley series) with nearby soil inspections indicating peat depths of 65 to 90 cm. A minimum of 40 cm of peat will be salvaged for these sites. For these sites, the central areas of well pads will be reclaimed to upland areas while the outer portions of the pads will be reclaimed to a poorly to very poorly drained surface peat area which is transitional to the undisturbed peatland as described in the conceptual C & R plan (Figures 8.6-3 & 8.6-4; Volume 1, Section 8).

Pad C4 has Kinosis till in the north and Organic (Mariana series) soil in the south of the pad with soil inspections indicating peat depths of 110 cm or more in the area. As described in the conceptual C & R plan, the general upland reclamation measures would apply to the part to be reclaimed back to upland (e.g. gravel removal, decompaction, re-contouring to match adjacent upland terrain, replacement of topsoil and subsoil salvaged from the upland, and revegetation to the pre-disturbance upland ecosite phase). The reclamation of Organic soil will be as previously described; the peatland area will be reclaimed partly to a reclaimed pad with a target ecosite phase of g1, and to a wetter, transitional surface peat area ('transitional g1' ecosite phase).

Prior to construction, any existing disturbed areas will be assessed for contamination through visual inspections. Any noted contamination will be remediated as appropriate. All clean topsoil, and up to 30 cm of suitable subsoil will be salvaged, under the direction of a professional soil scientist. The PDAs will provide additional information on the baseline soils conditions on these areas.

C5.6.3 Material Balance

Table C5.6-1 presents the material balance volumes for the topsoil (including shallow peat and LFH), deep peat, and subsoil material available for salvage and replacement for the Corner Initial Development. All salvaged soil will be replaced on the site of origin wherever possible; therefore, the target replacement value is shown equivalent to the soil available for salvage. The actual replacement values may be slightly less than the target due to soil loss that may occur during salvage activities. Access roads developed on mineral soils will have surface LFH/peat and surface mineral soil salvaged only.

Table 5.6-1 Surface Soil and Subsoil Available for Salvage and Replacement

Topsoil Volume Available (m^3)	Topsoil Volume Replacement Target (m^3)	Peat Volume Available (m^3)	Peat Material Replacement Target (m^3)	Subsoil Volume Available (m^3)	Subsoil Volume Replacement Target (m^3)
282,200	282,200	145,600	145,600	389,700	389,700

Underground pipeline construction has direct replacement of salvaged soil at the end of construction and powerlines and above-ground pipelines have minimal soil disturbance; therefore these areas are not included in the material balance volumes.

C6 LITERATURE CITED

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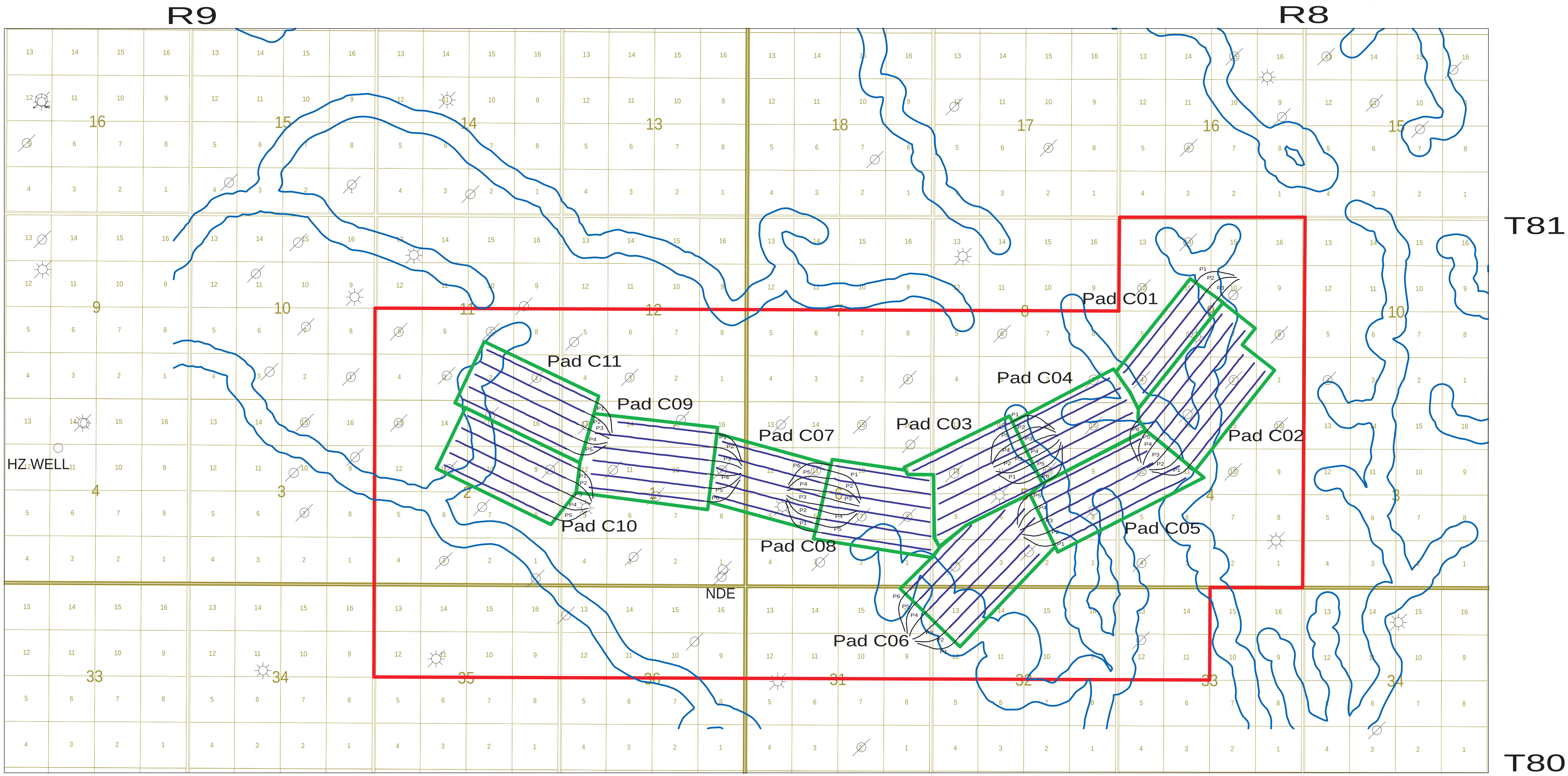
C7 CORNER HUB HORIZONTAL PRODUCER WELL PLOTS

The following figures present individual plots for each horizontal producer well in the Corner Hub development area with a depth converted 3D seismic profile and key horizons.

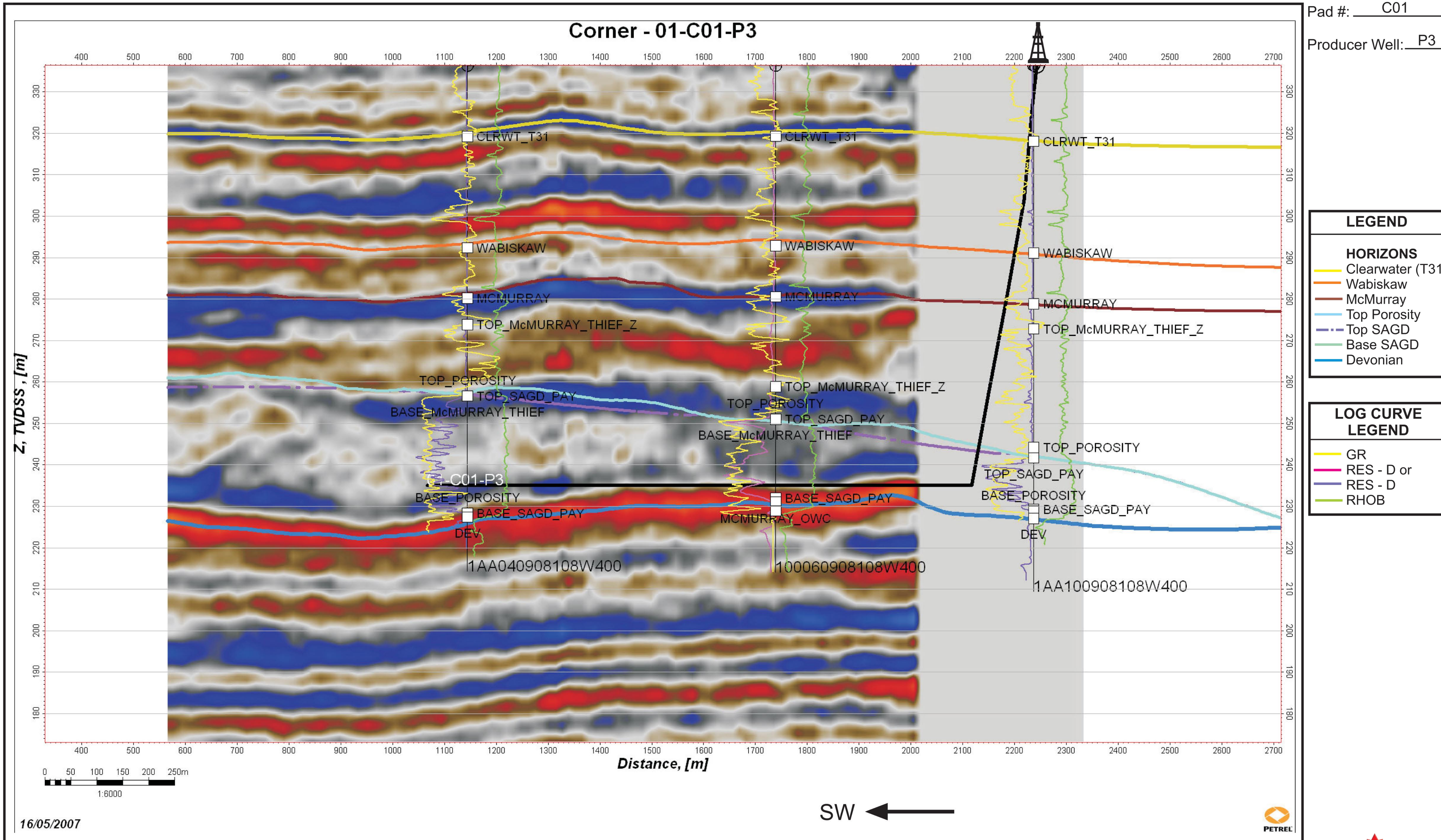


Pad C05 Pad Name
P4 Well Number
Horizontal Well Pads
Pad Area
Corner Initial Development Area
HZ WELL Horizontal Well
NDE Not Deep Enough
100 m Stream Buffer Line

Location of Pads and Horizontal Wells

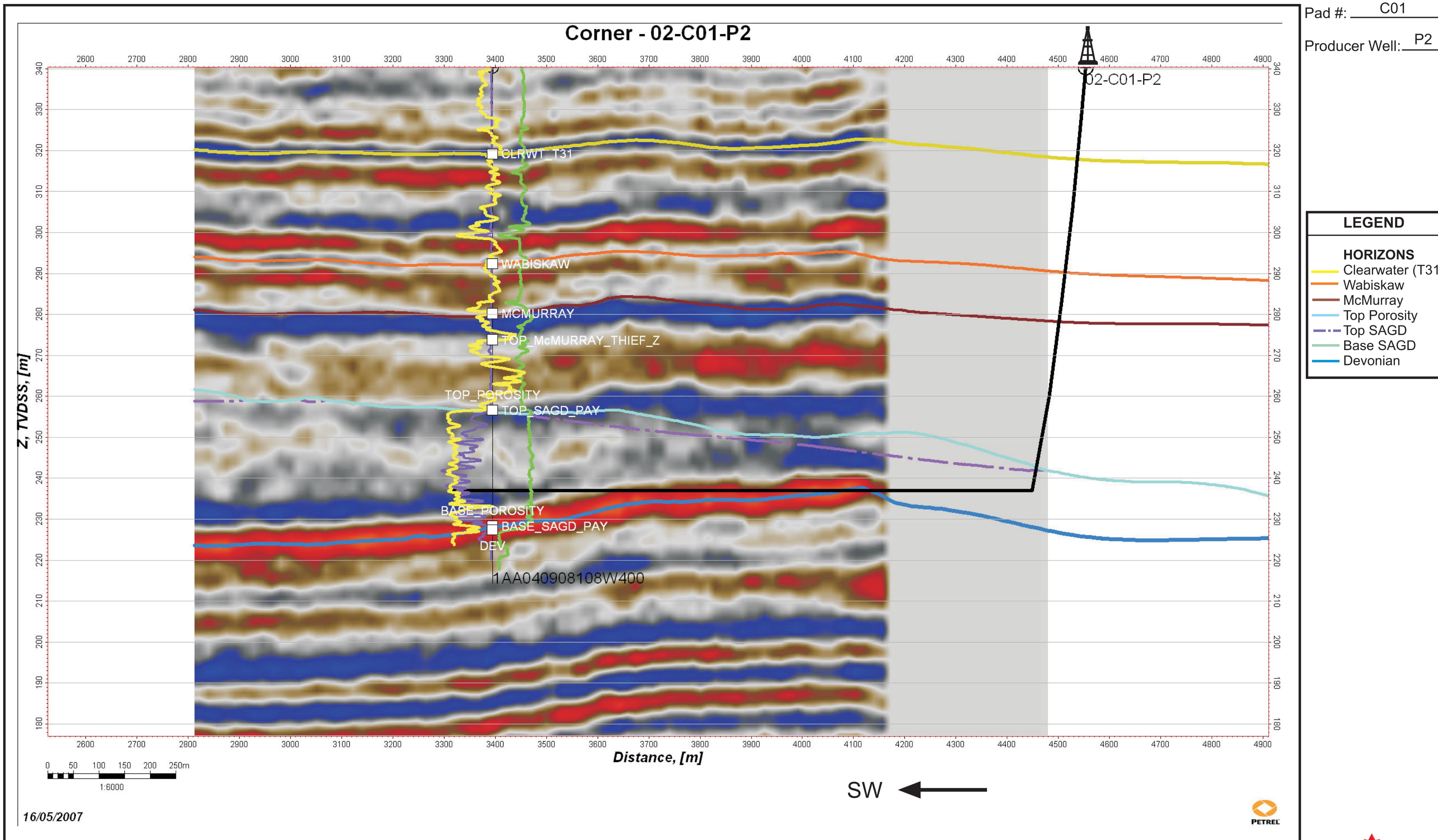
Pad #: C01

Producer Well: P3



CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

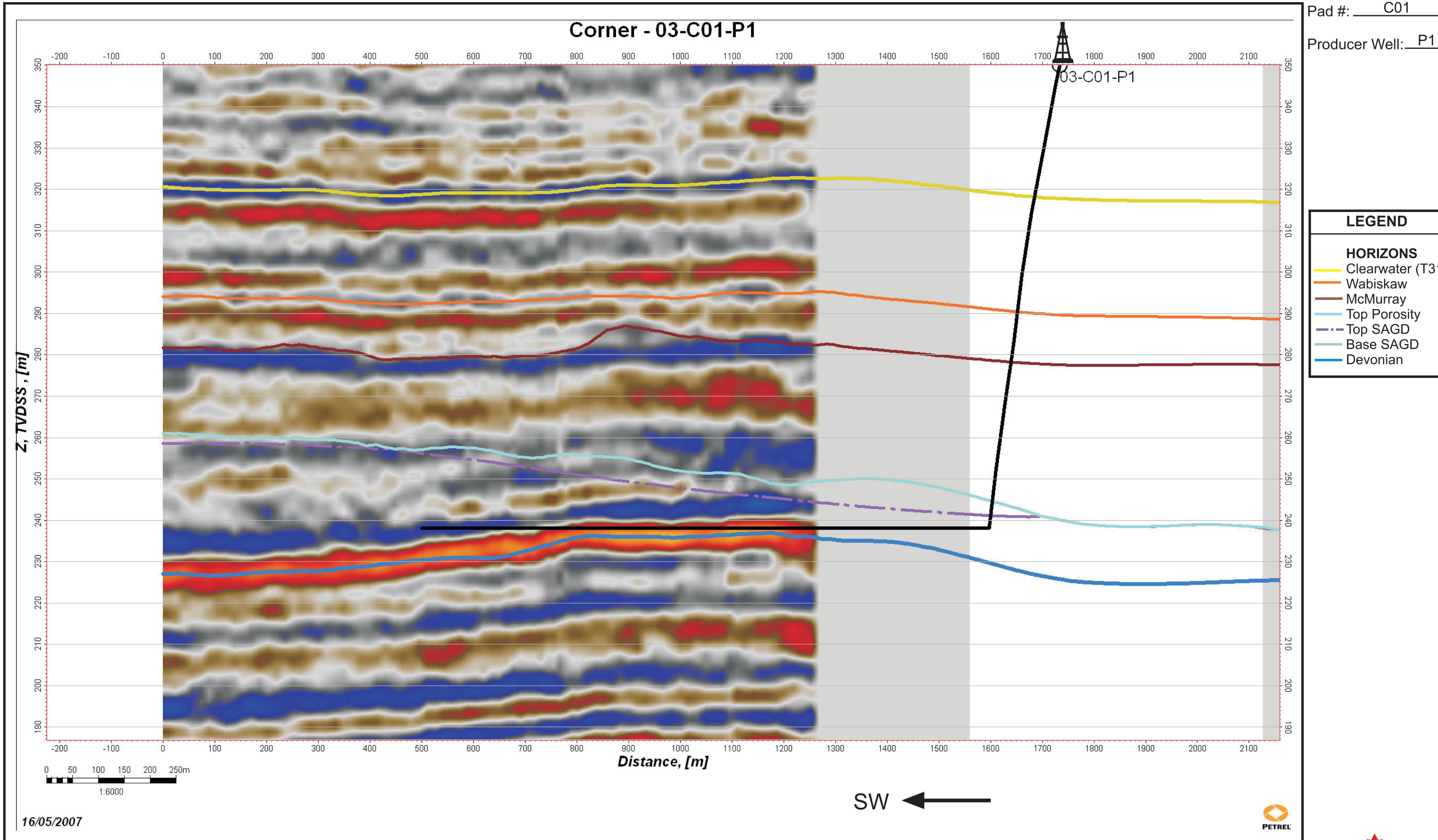


CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C01

Producer Well: P1

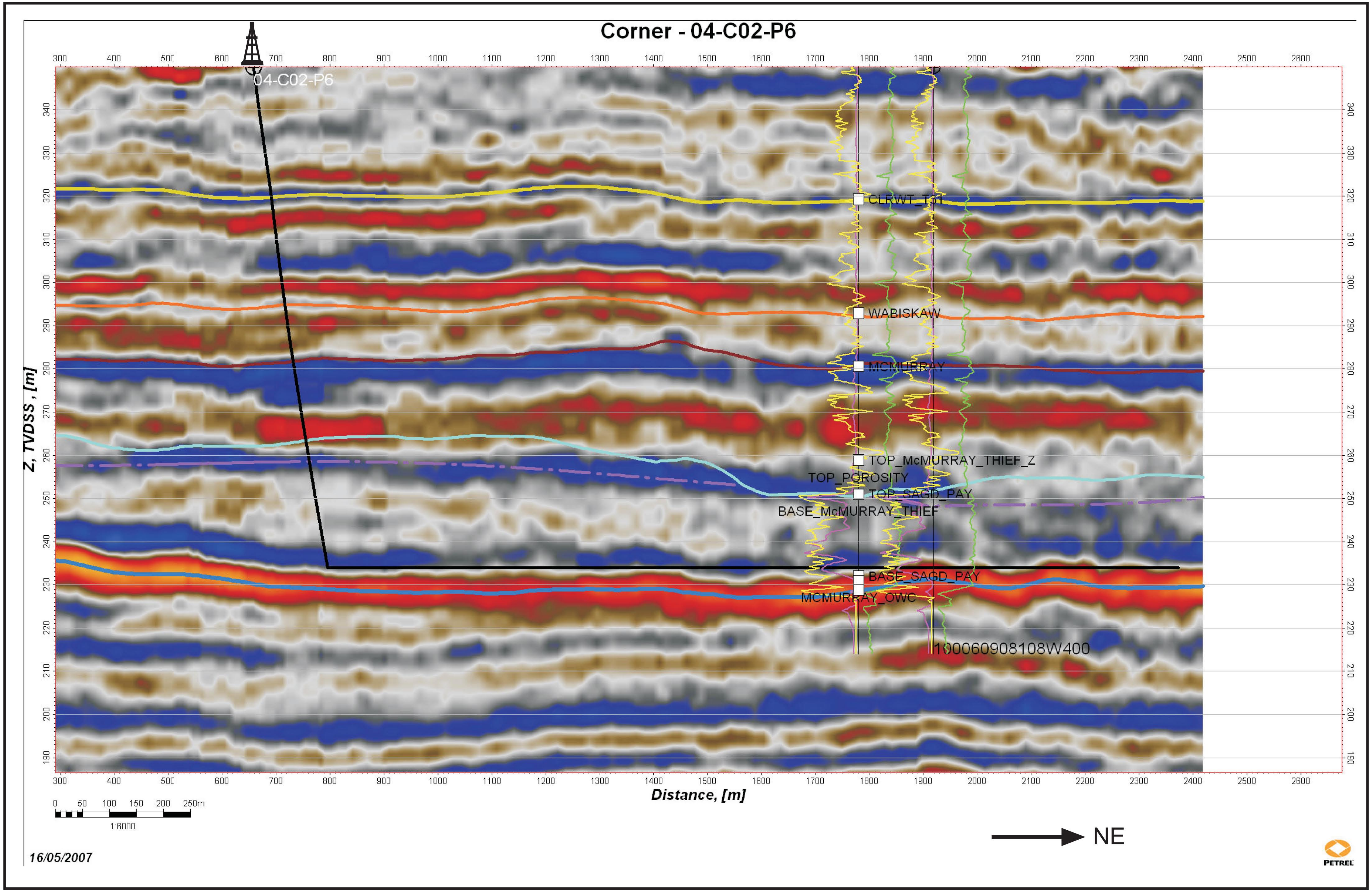


CORNER AREA

North American Oil Sands Corporation

Pad #: C02

Producer Well: P6



LEGEND

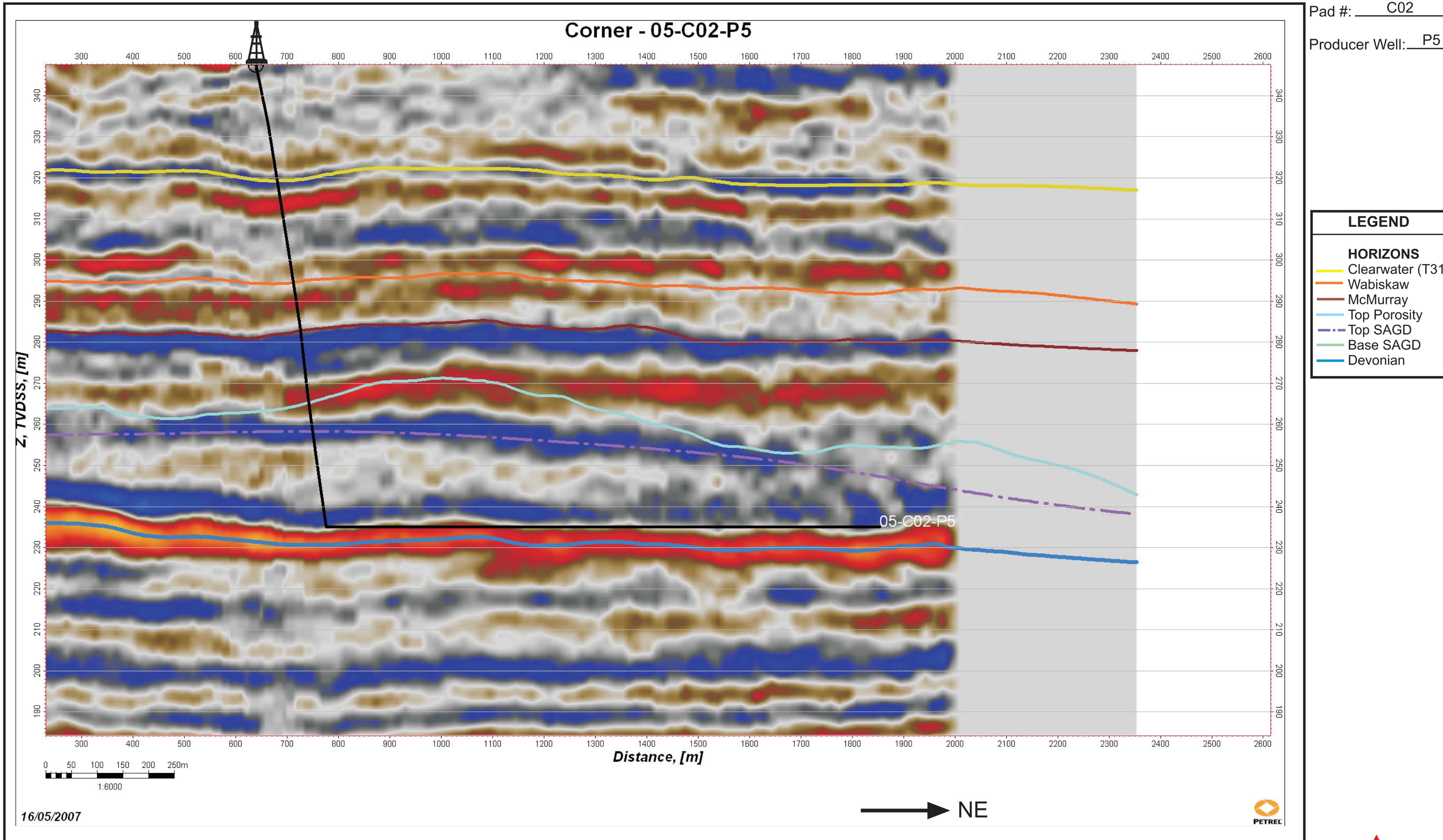
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C02

Producer Well: P5

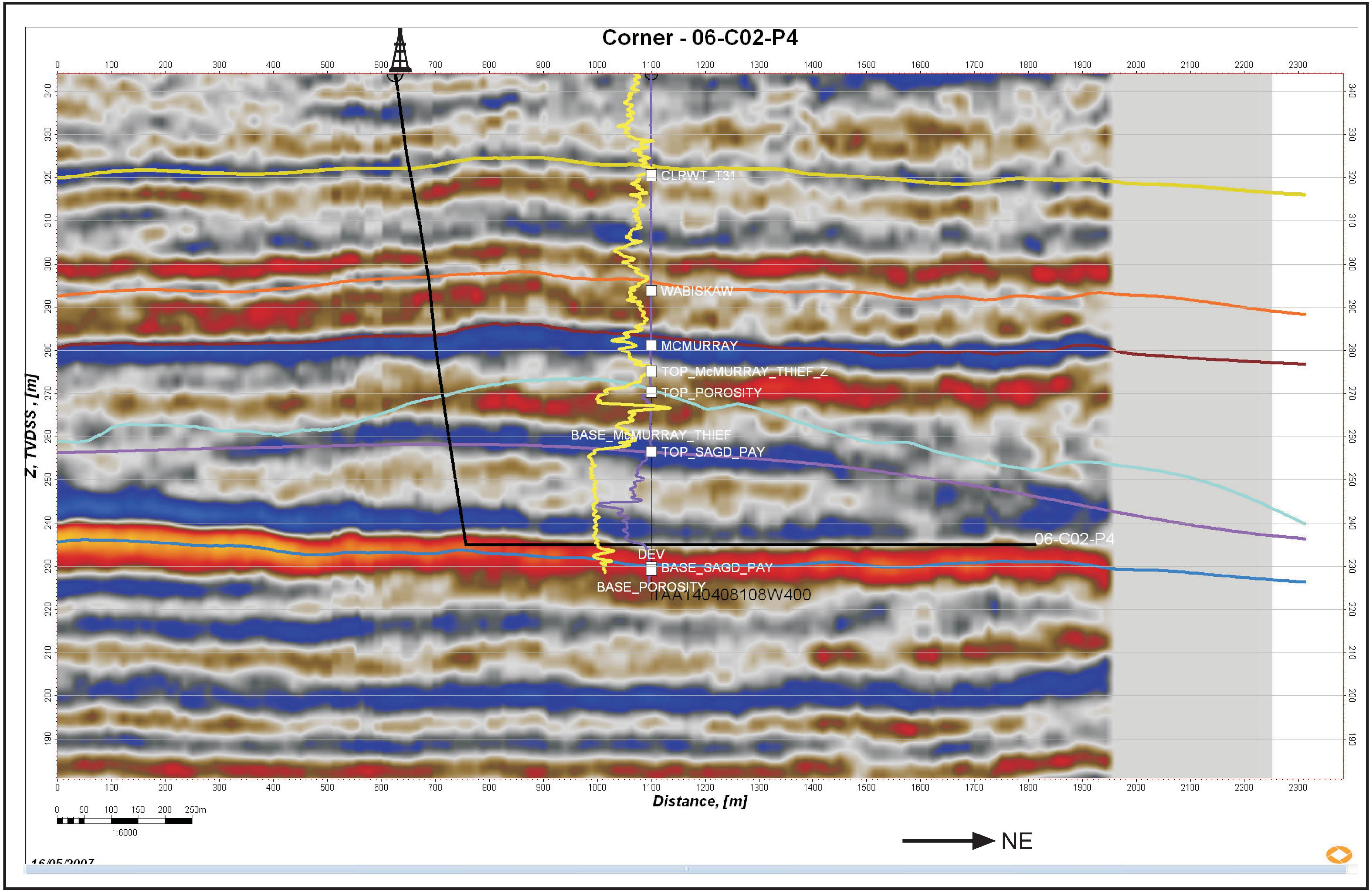


CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C02

Producer Well: P4



LEGEND

HORIZONS

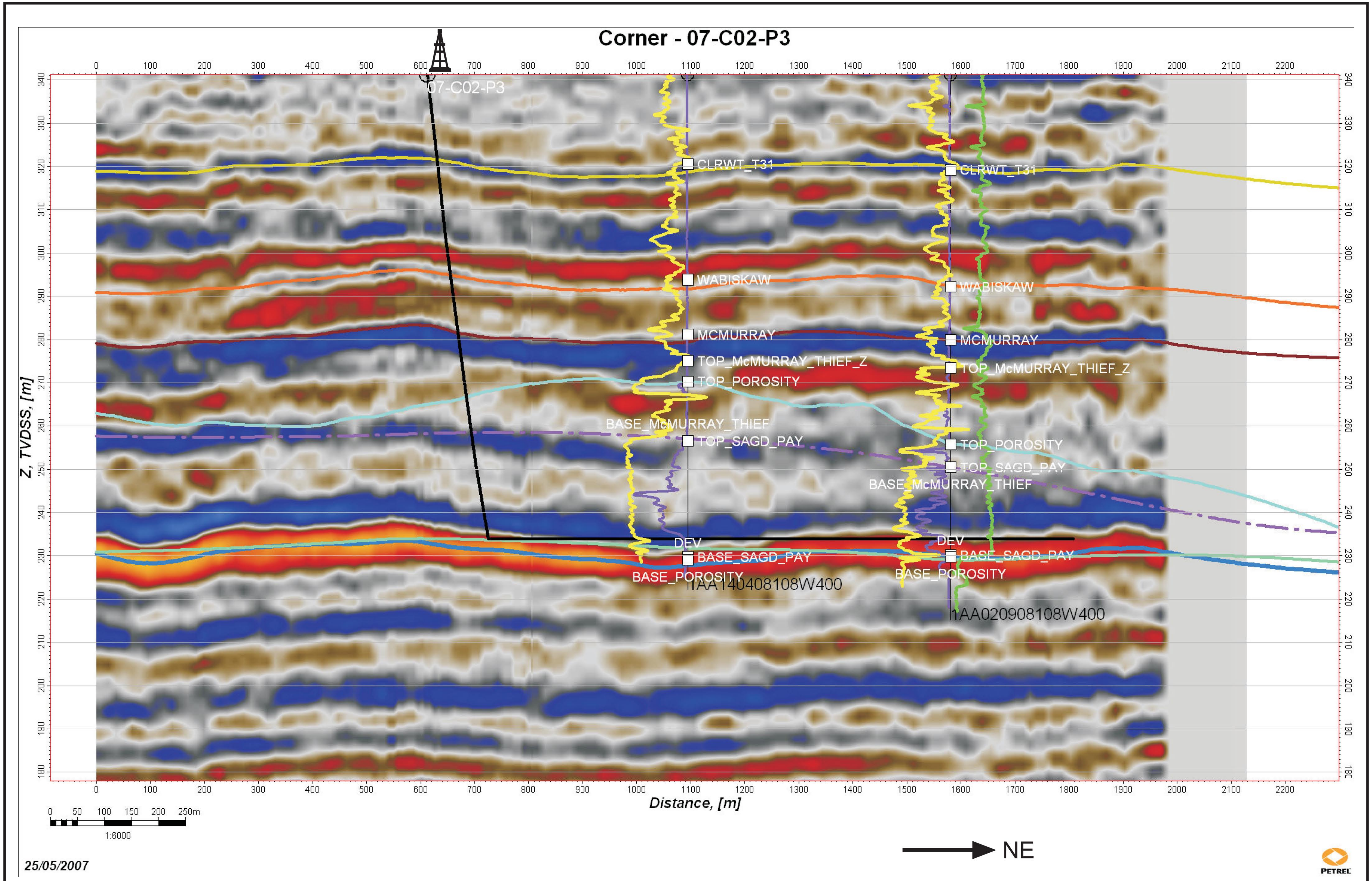
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C02

Producer Well: P3



LEGEND

HORIZONS

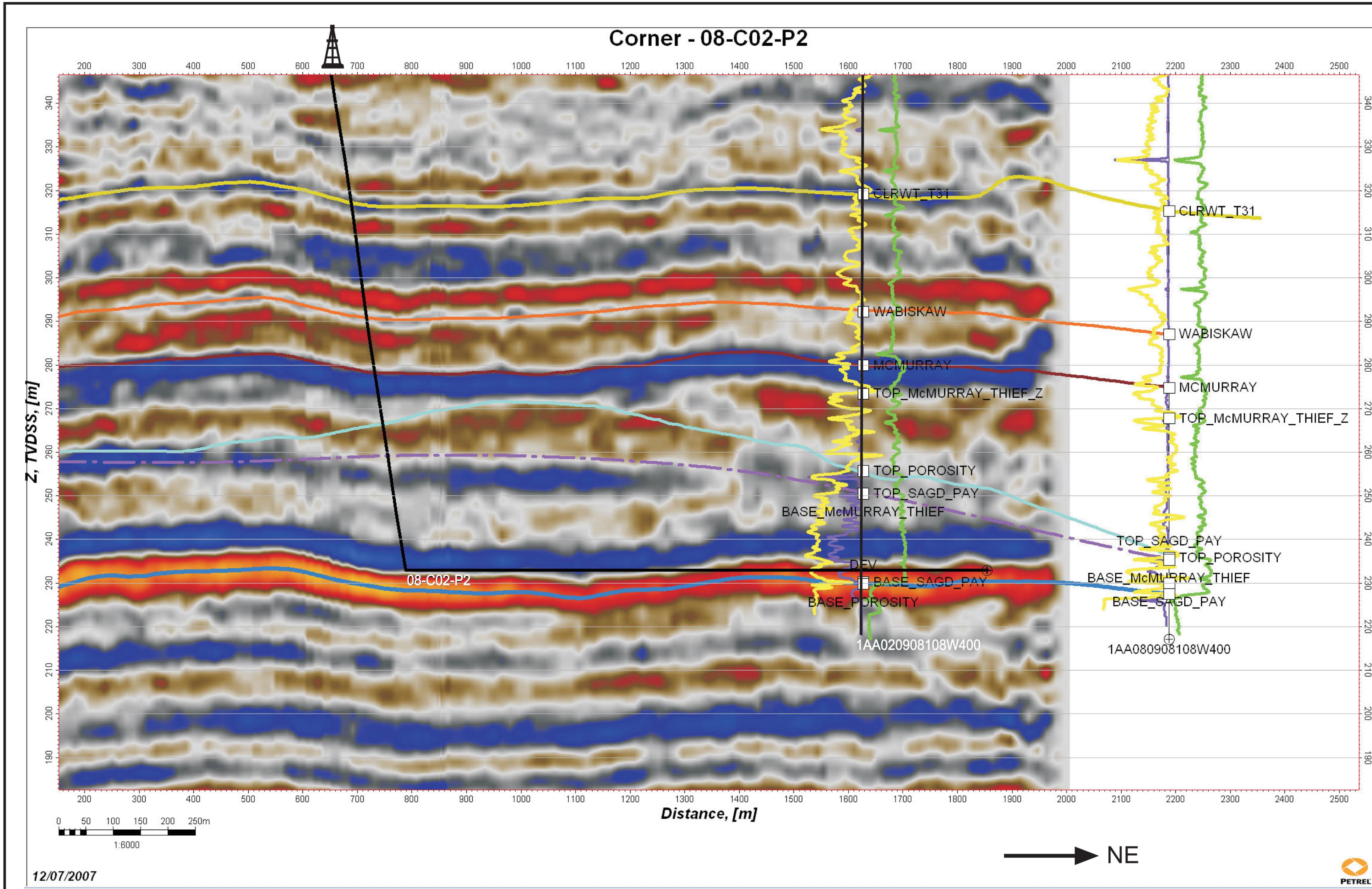
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C02

Producer Well: P2



LEGEND

HORIZONS

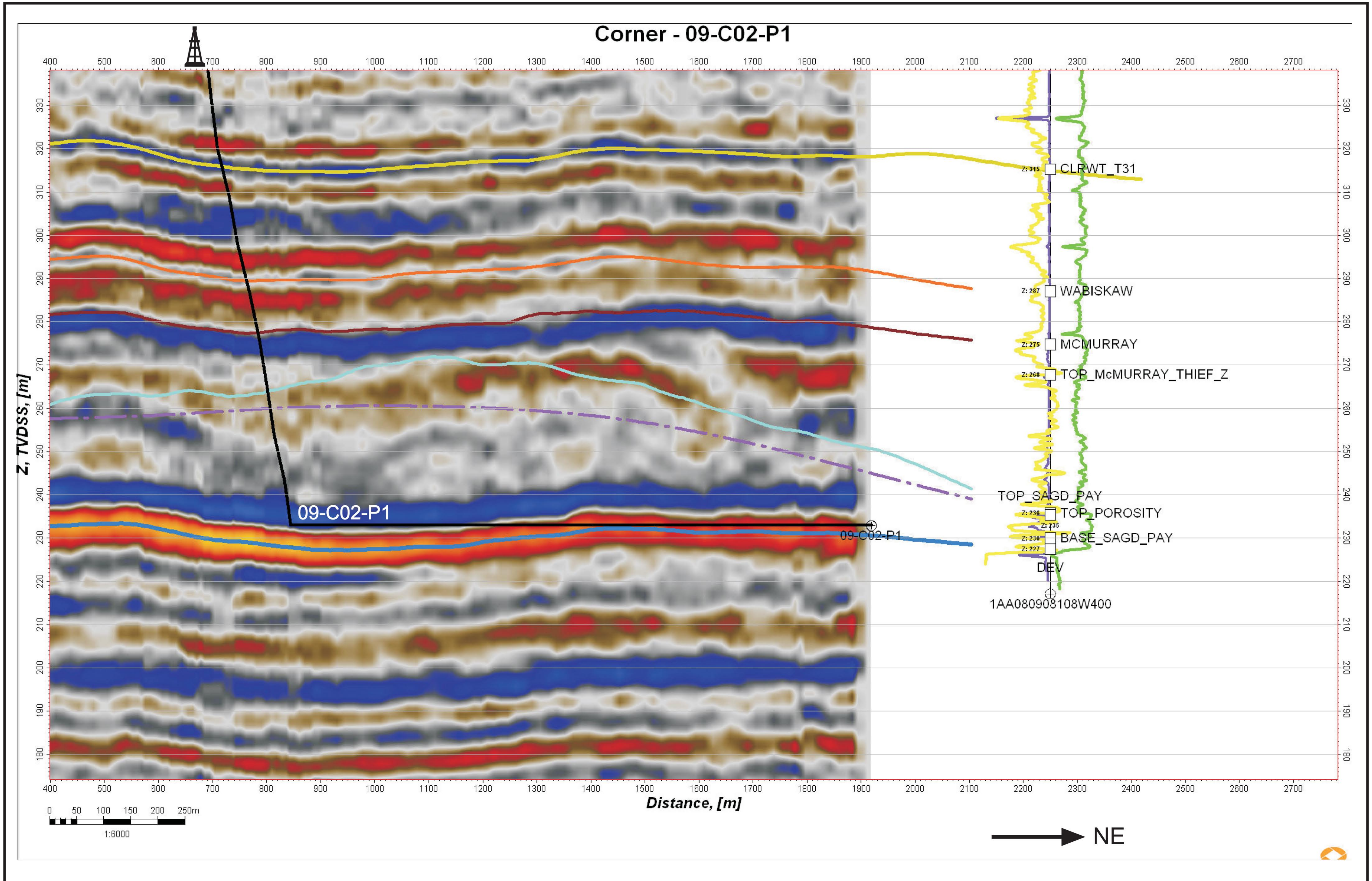
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C02

Producer Well: P1



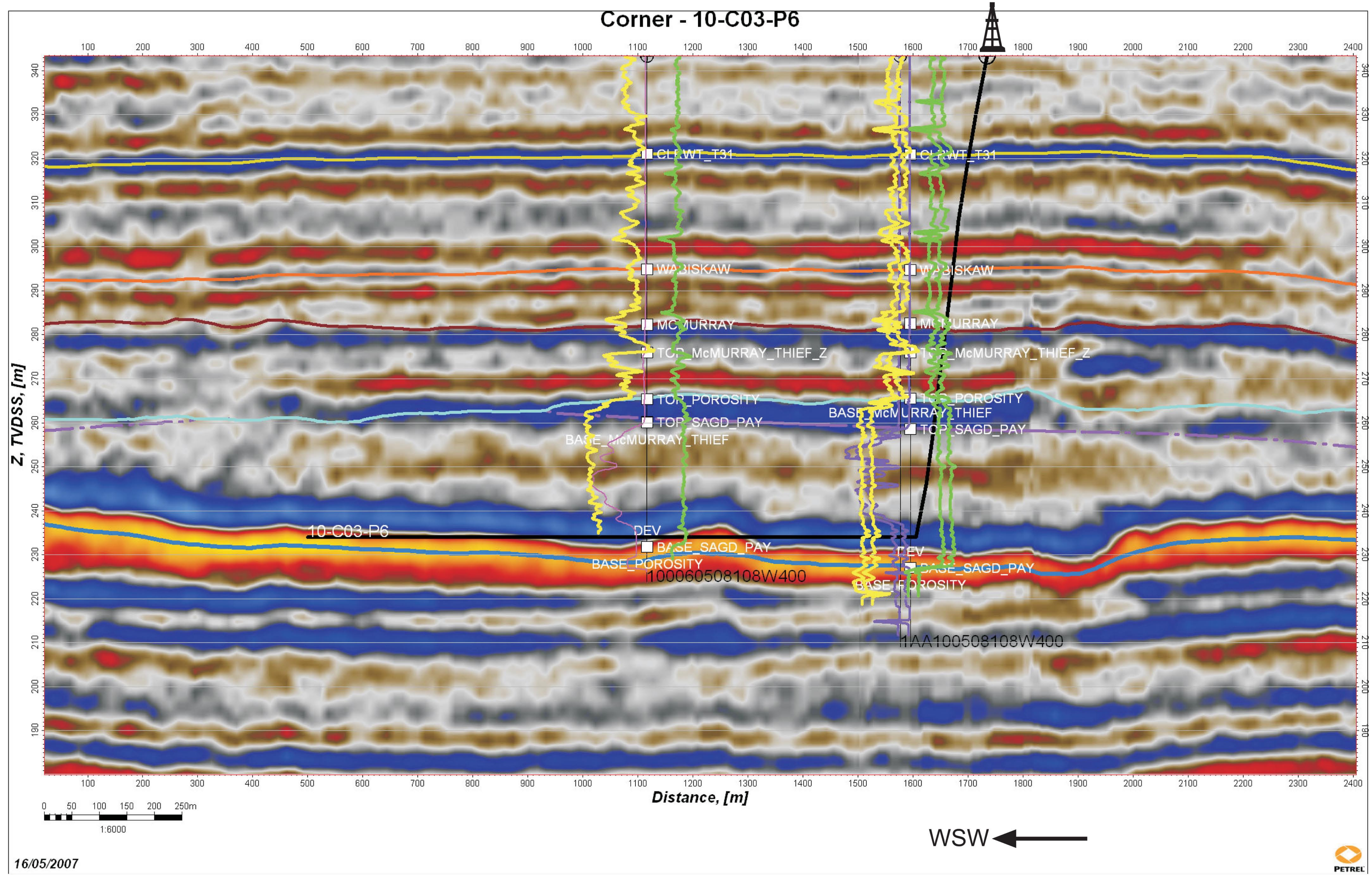
LEGEND
HORIZONS
Clearwater (T31)
Wabiskaw
McMurray
Top Porosity
Top SAGD
Base SAGD
Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C03

Producer Well: P6



LEGEND

HORIZONS

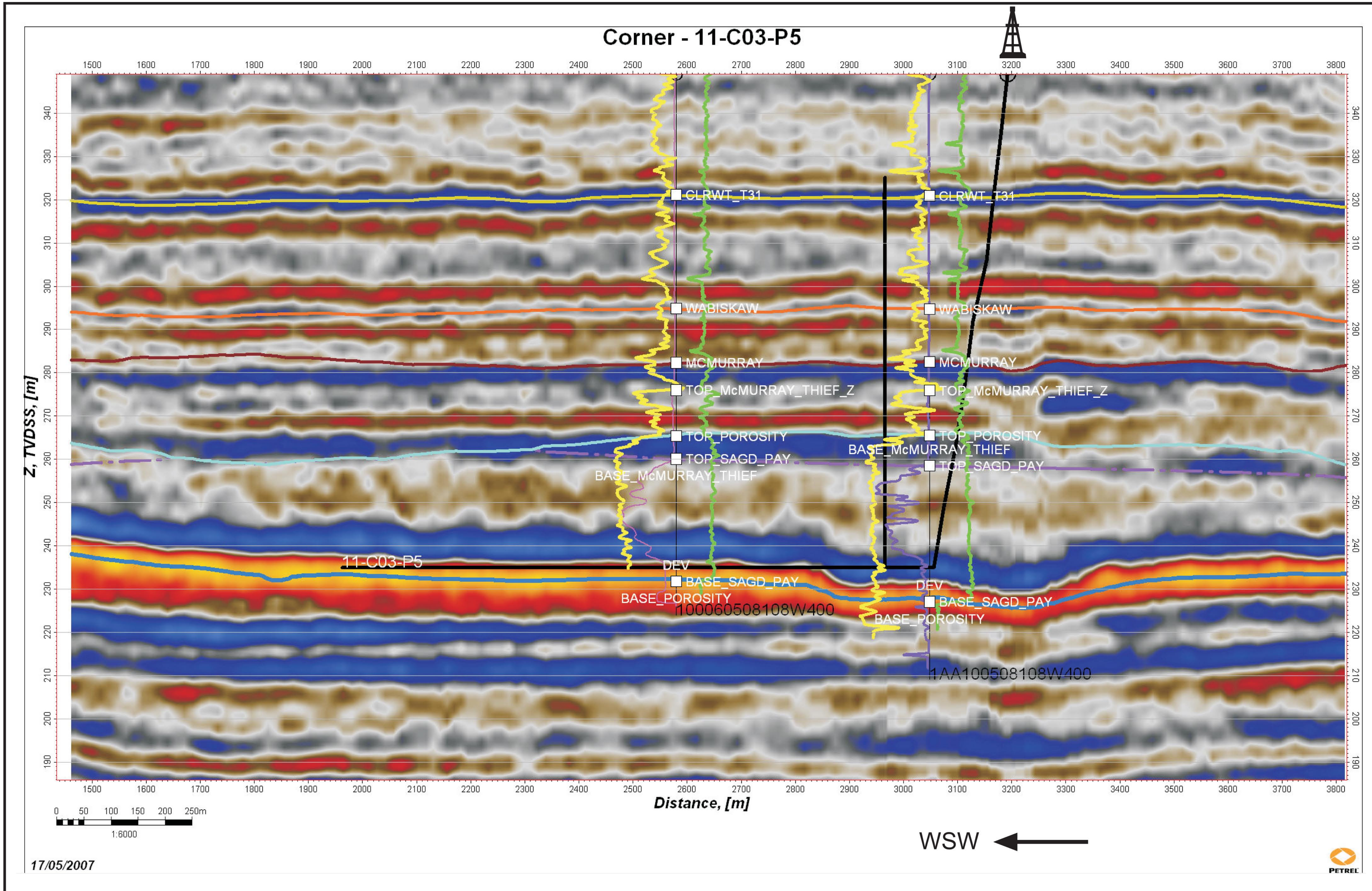
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C03

Producer Well: P5



LEGEND

HORIZONS

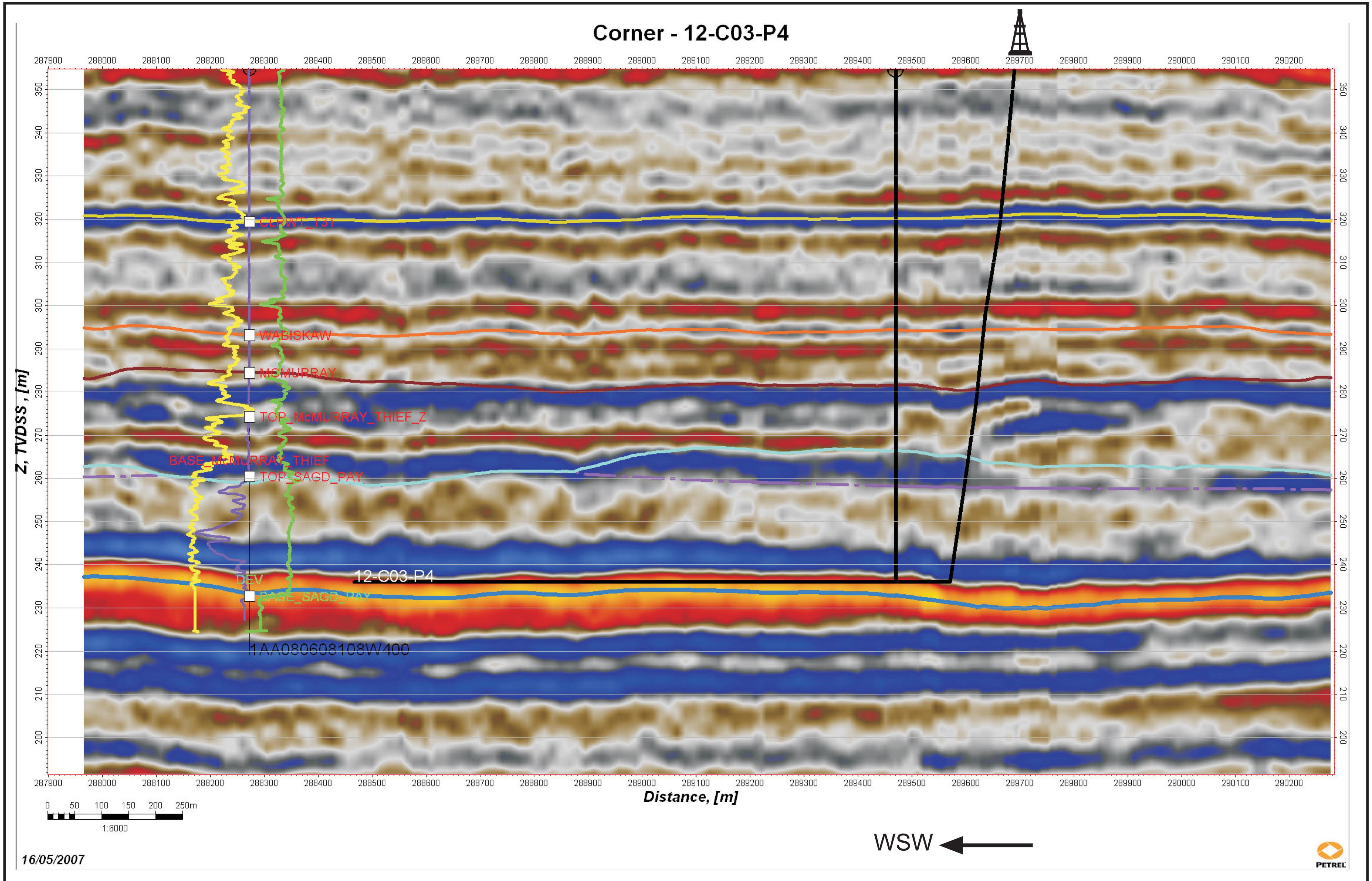
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C03

Producer Well: P4



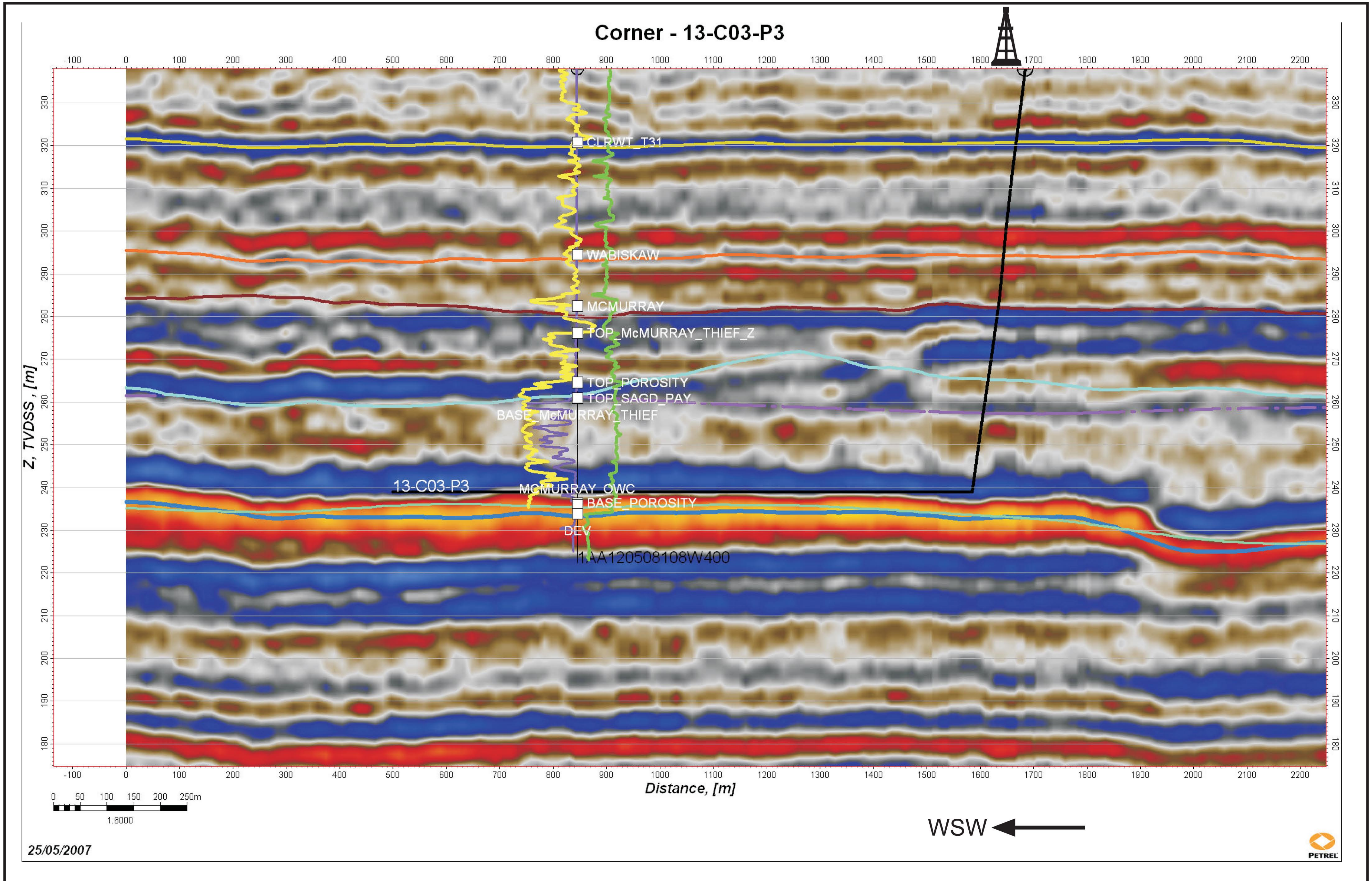
LEGEND
HORIZONS
Clearwater (T31)
Wabiskaw
McMurray
Top Porosity
Top SAGD
Base SAGD
Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C03

Producer Well: P3



LEGEND

HORIZONS

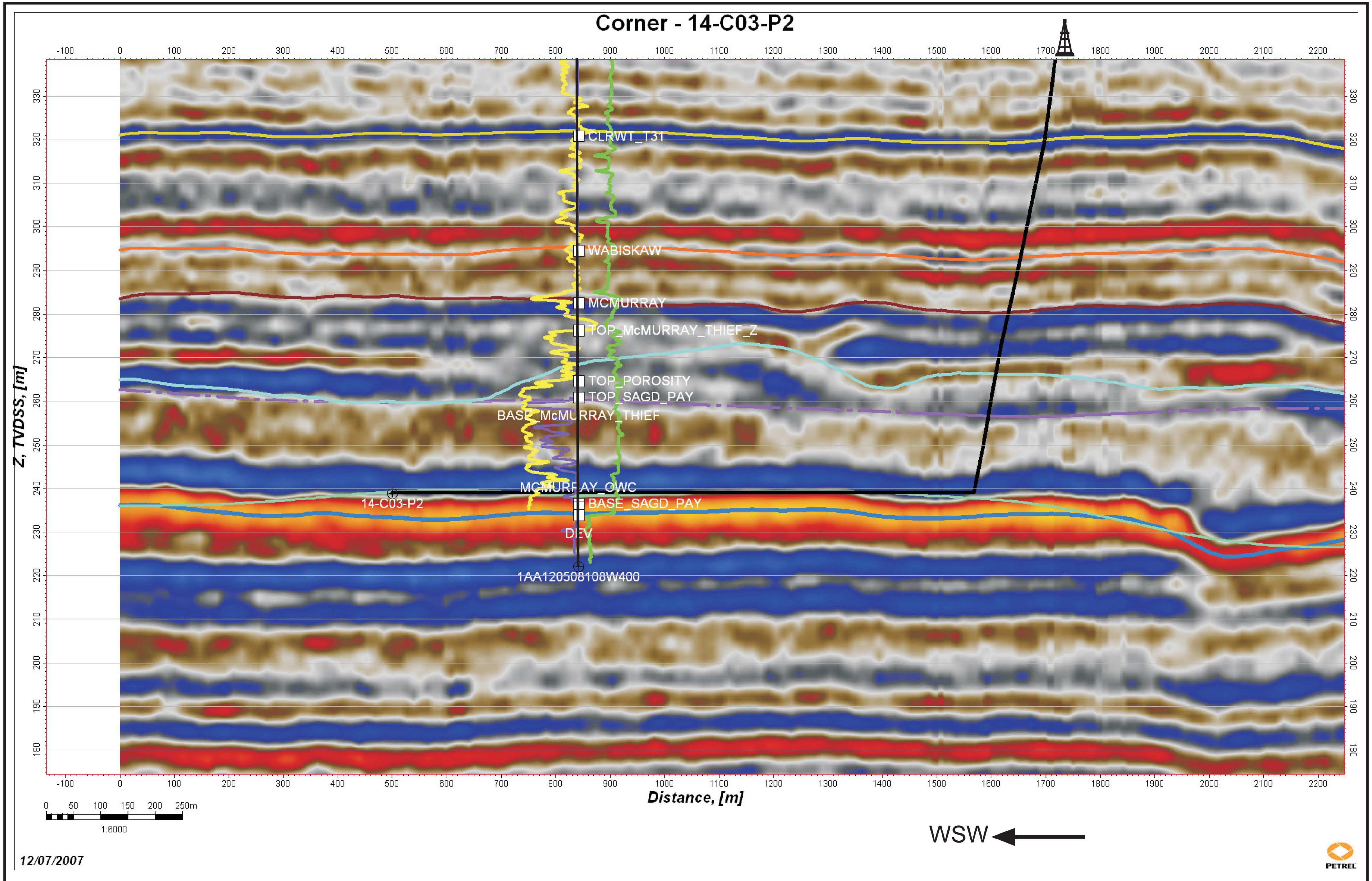
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C03

Producer Well: P2



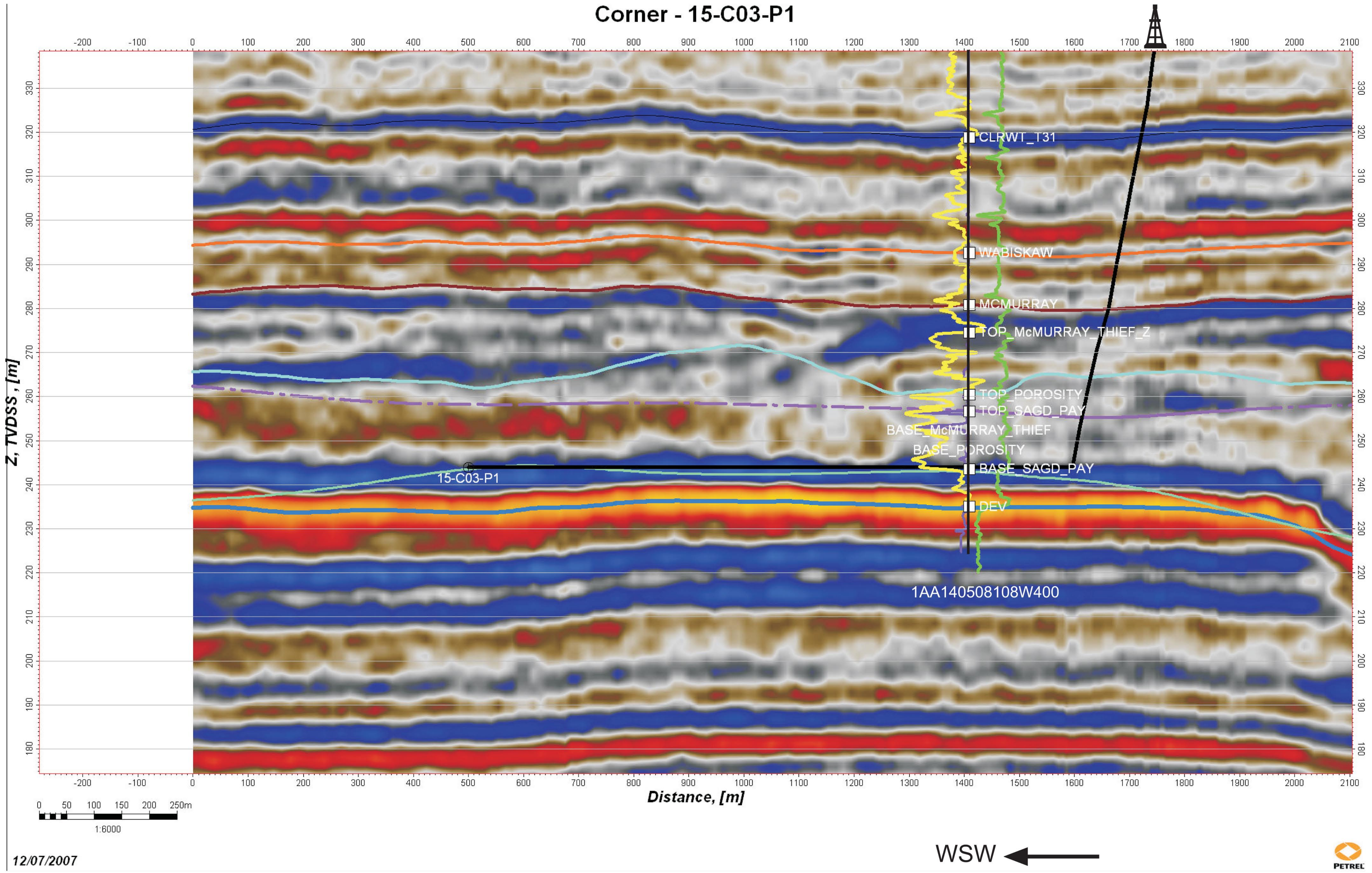
LEGEND

HORIZONS

- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION



Pad #: C03

Producer Well: P1

LEGEND

HORIZONS

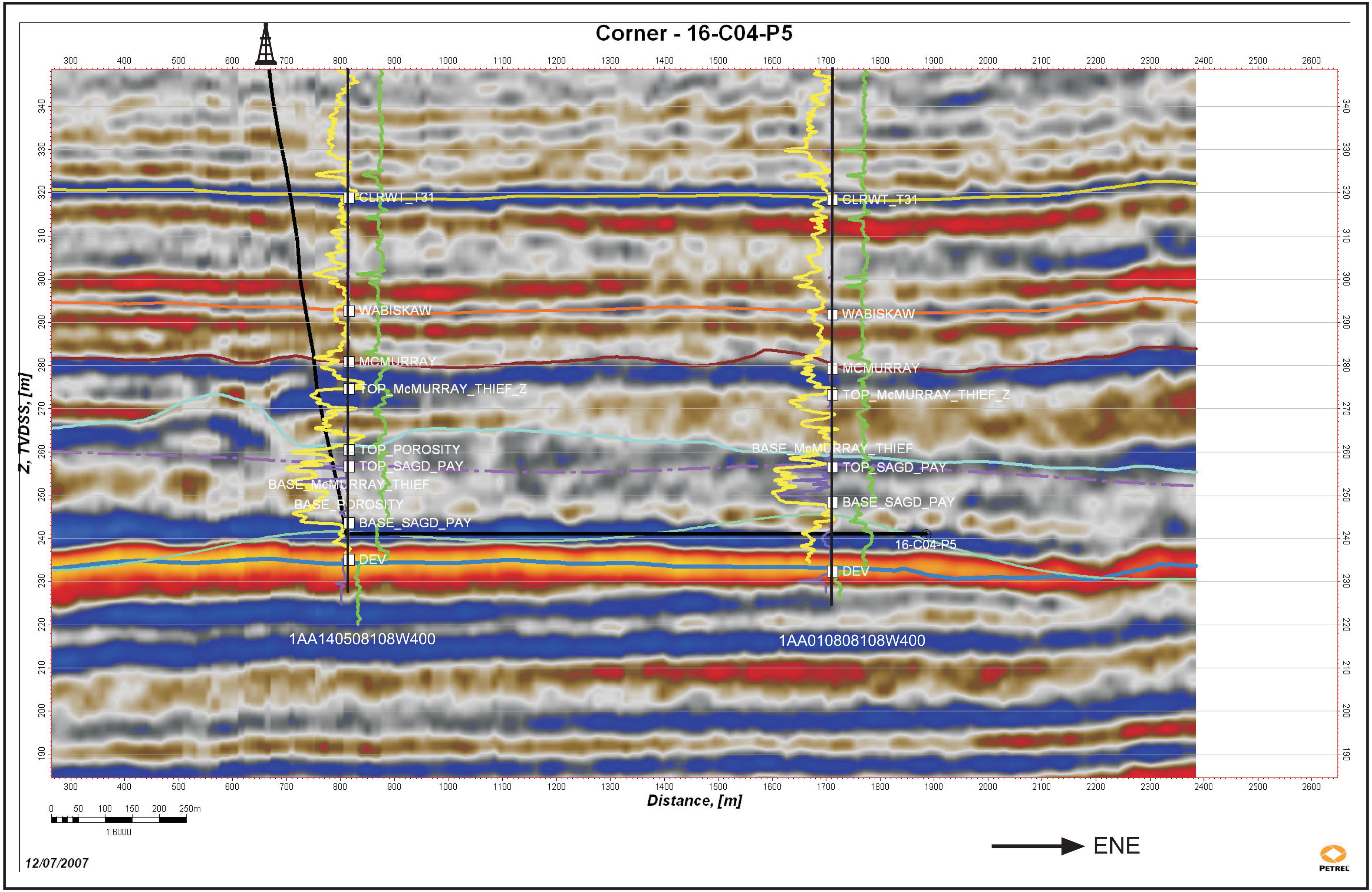
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C04

Producer Well: P5



LEGEND

HORIZONS

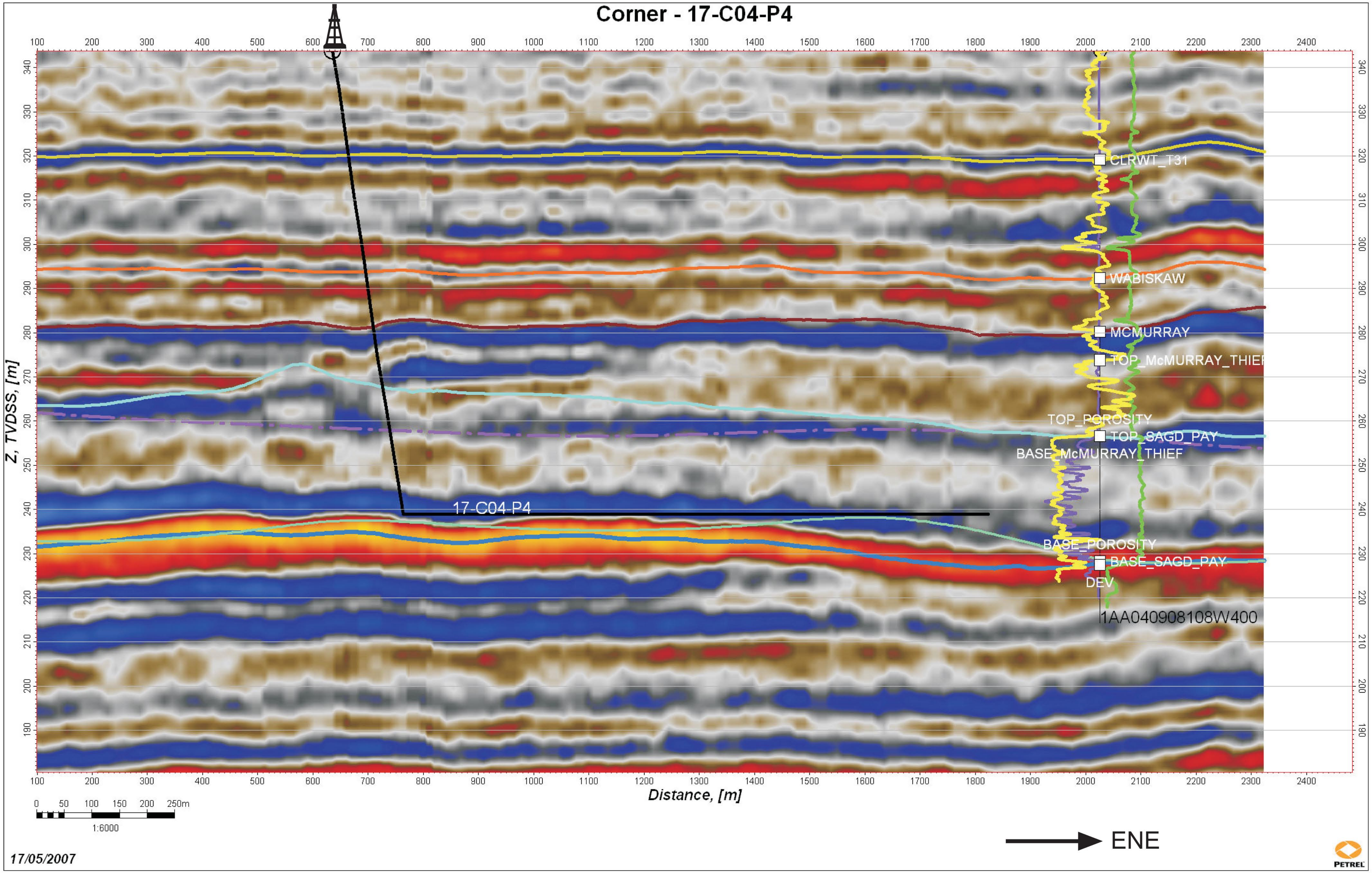
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C04

Producer Well: P4



LEGEND

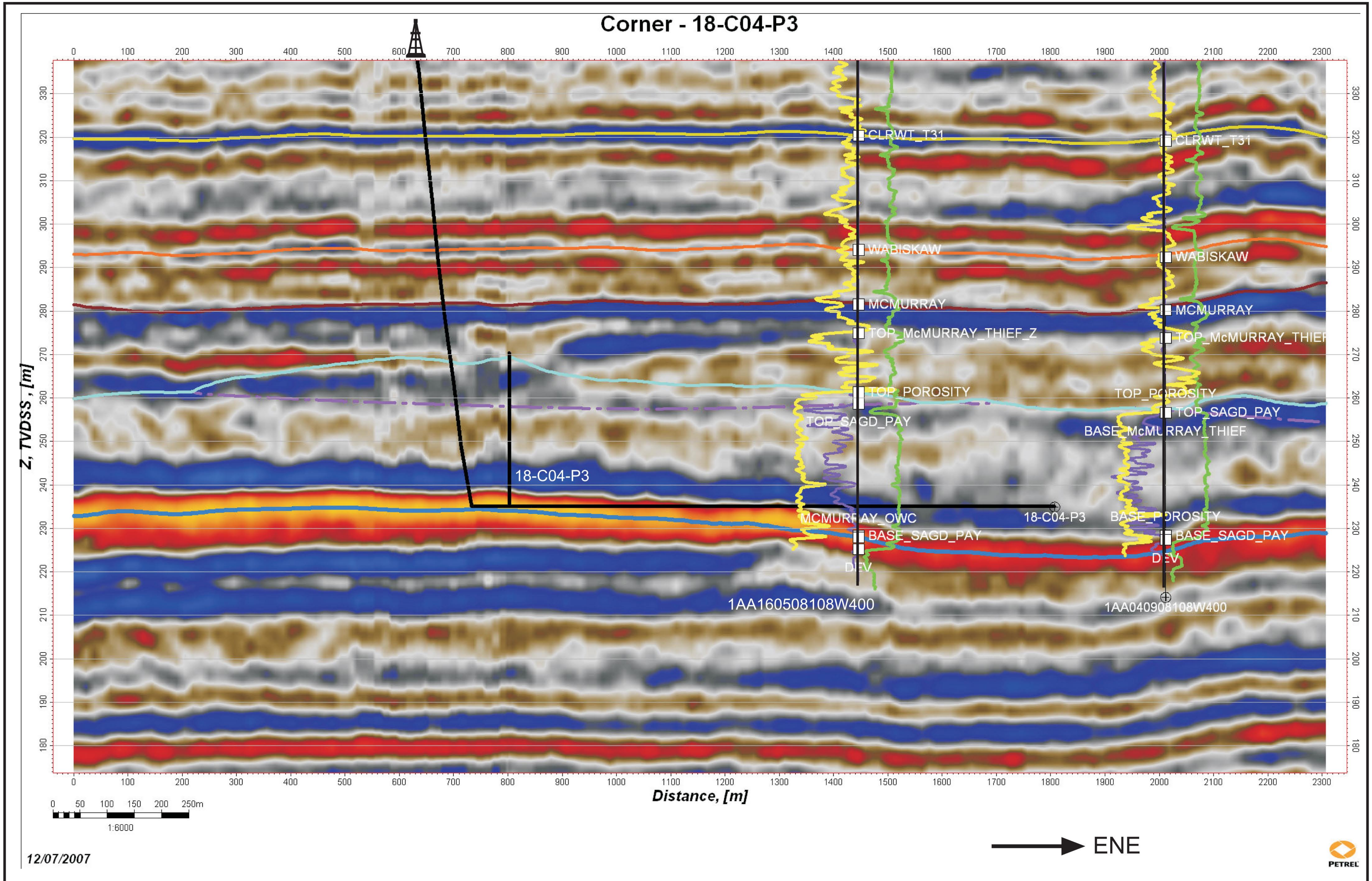
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American
Oil Sands Corporation

Pad #: C04

Producer Well: P3



LEGEND

HORIZONS

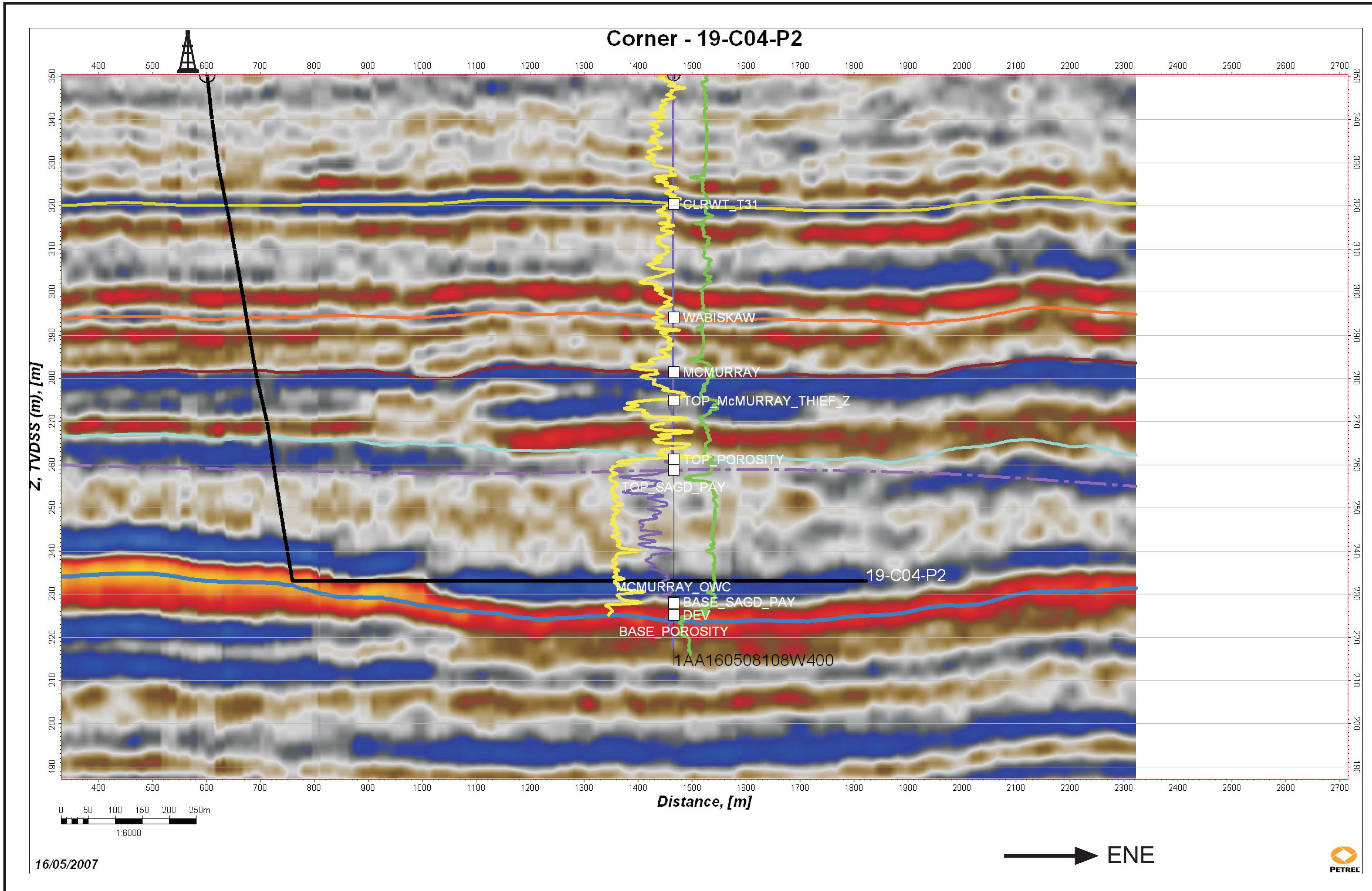
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C04

Producer Well: P2



LEGEND

HORIZONS

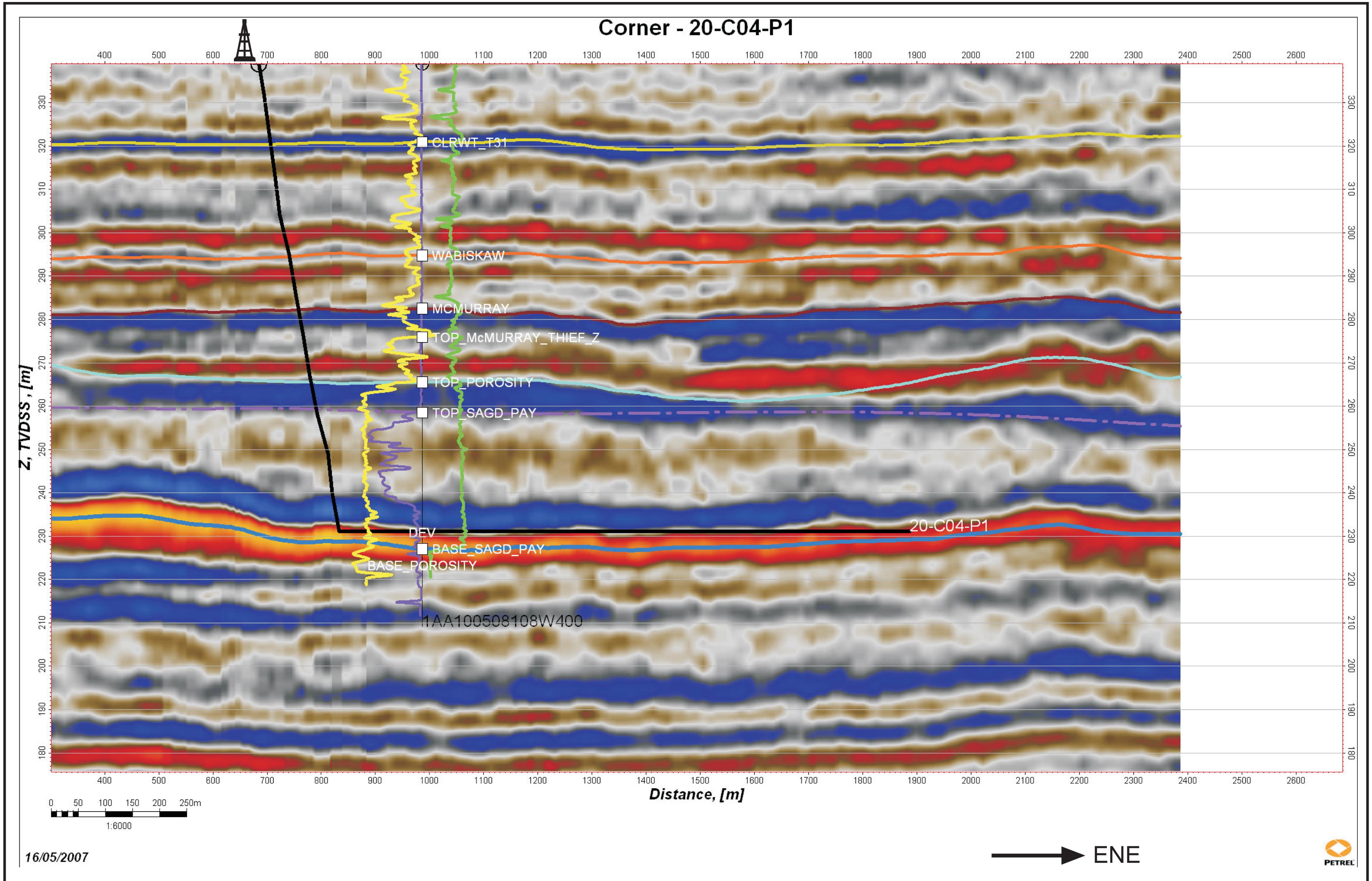
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C04

Producer Well: P1



LEGEND

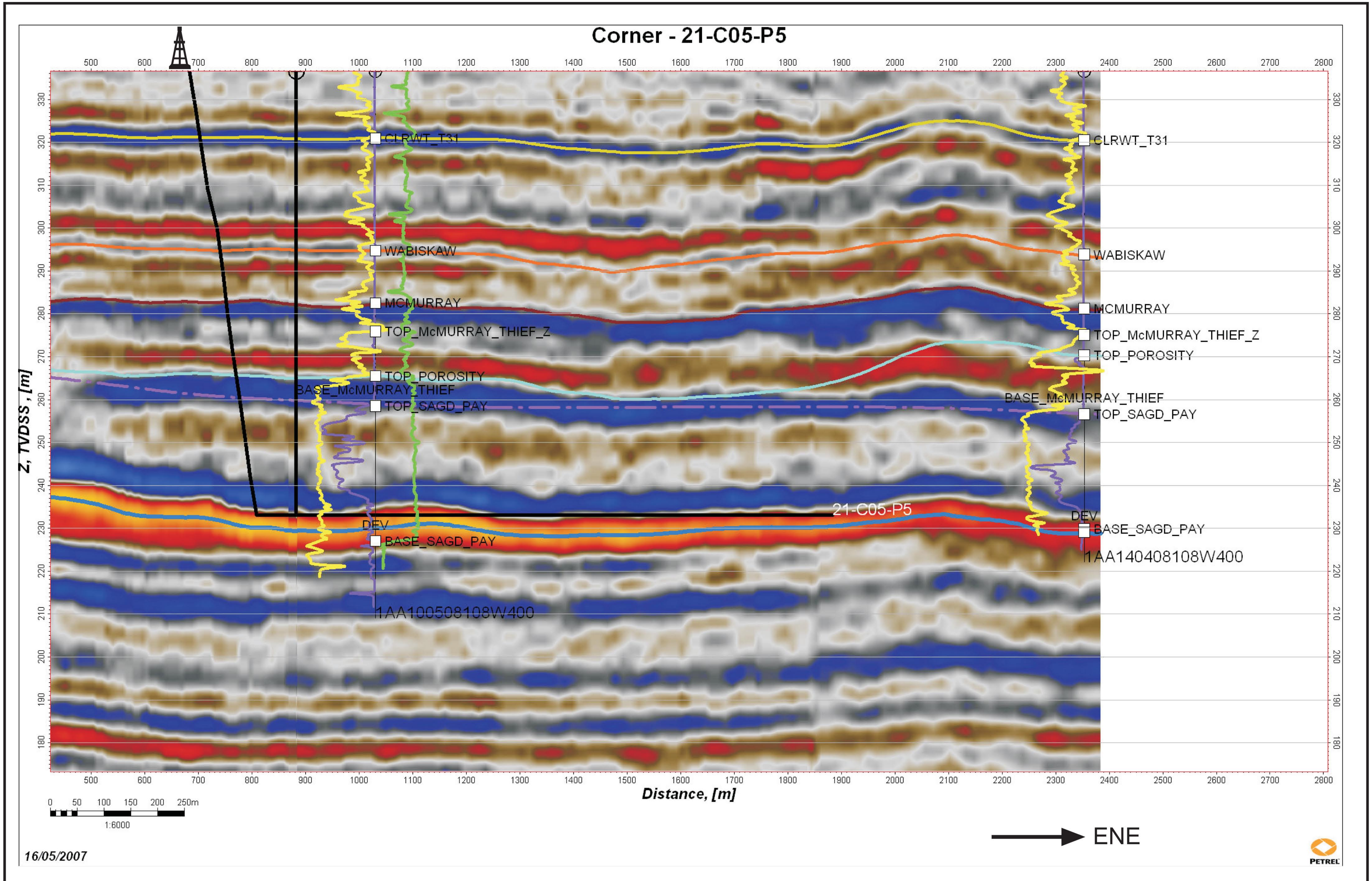
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C05

Producer Well: P5



LEGEND

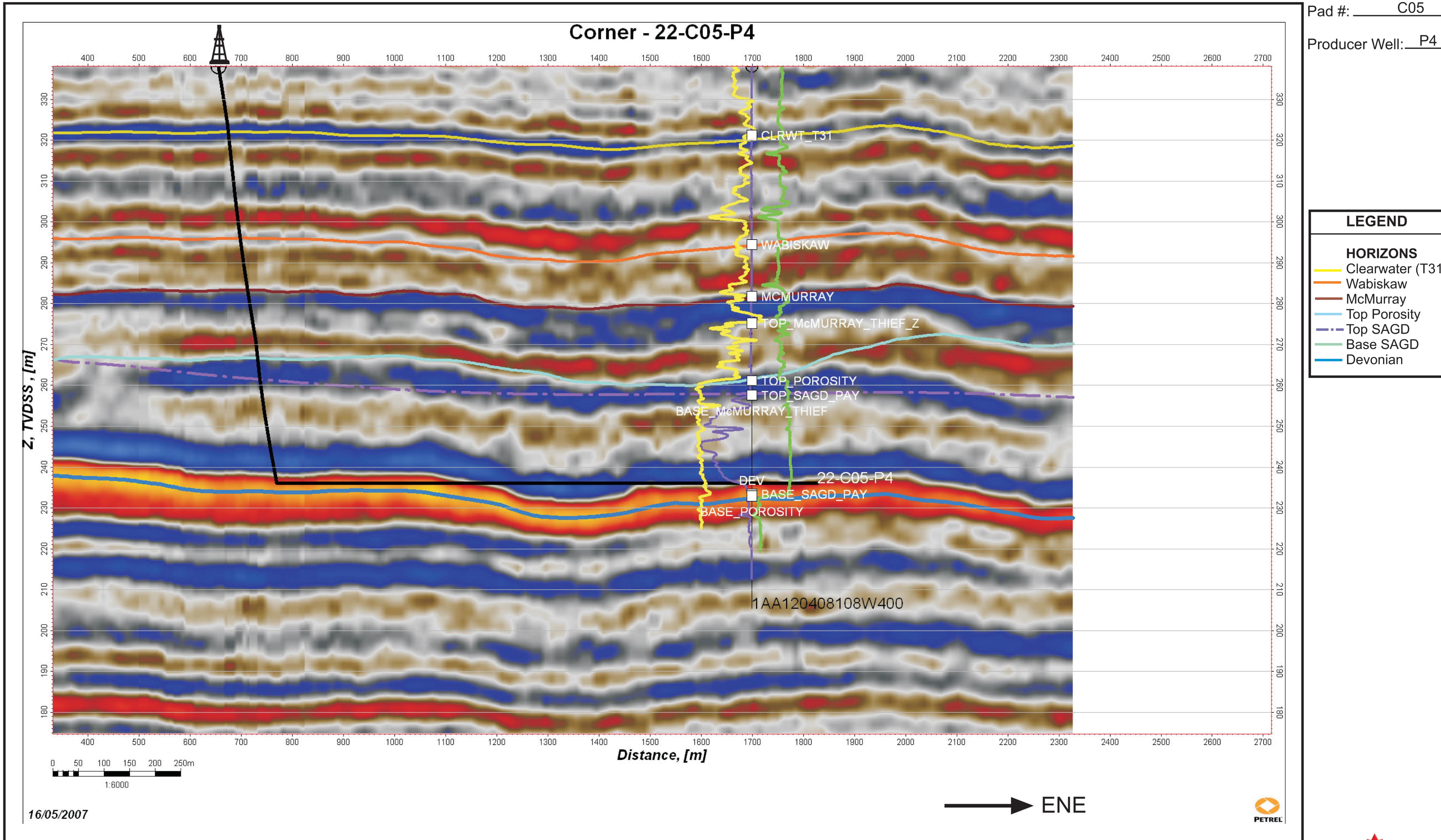
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

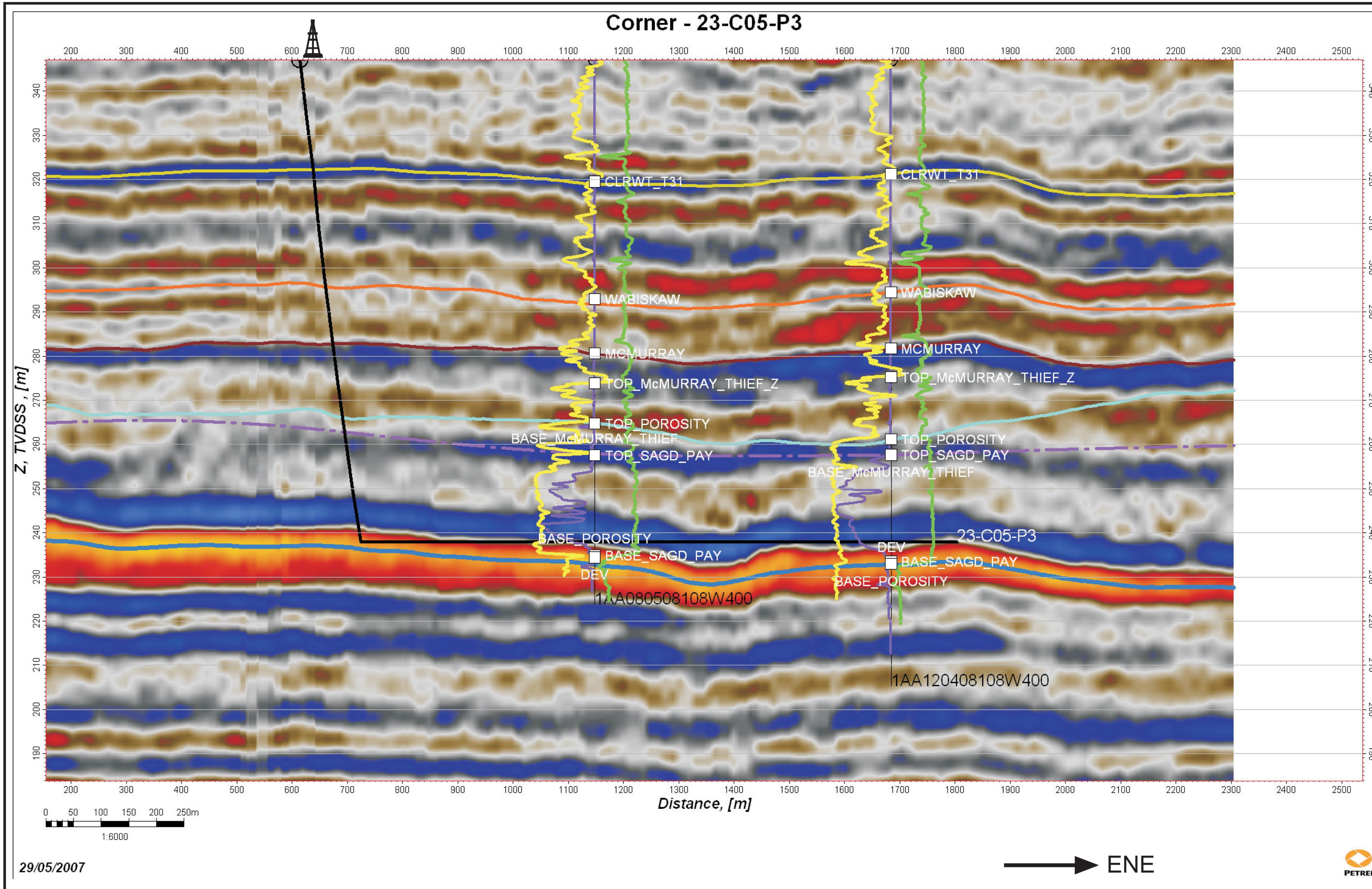
Pad #: C05

Producer Well: P4



CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION



Pad #: C05

Producer Well: P3

LEGEND

HORIZONS

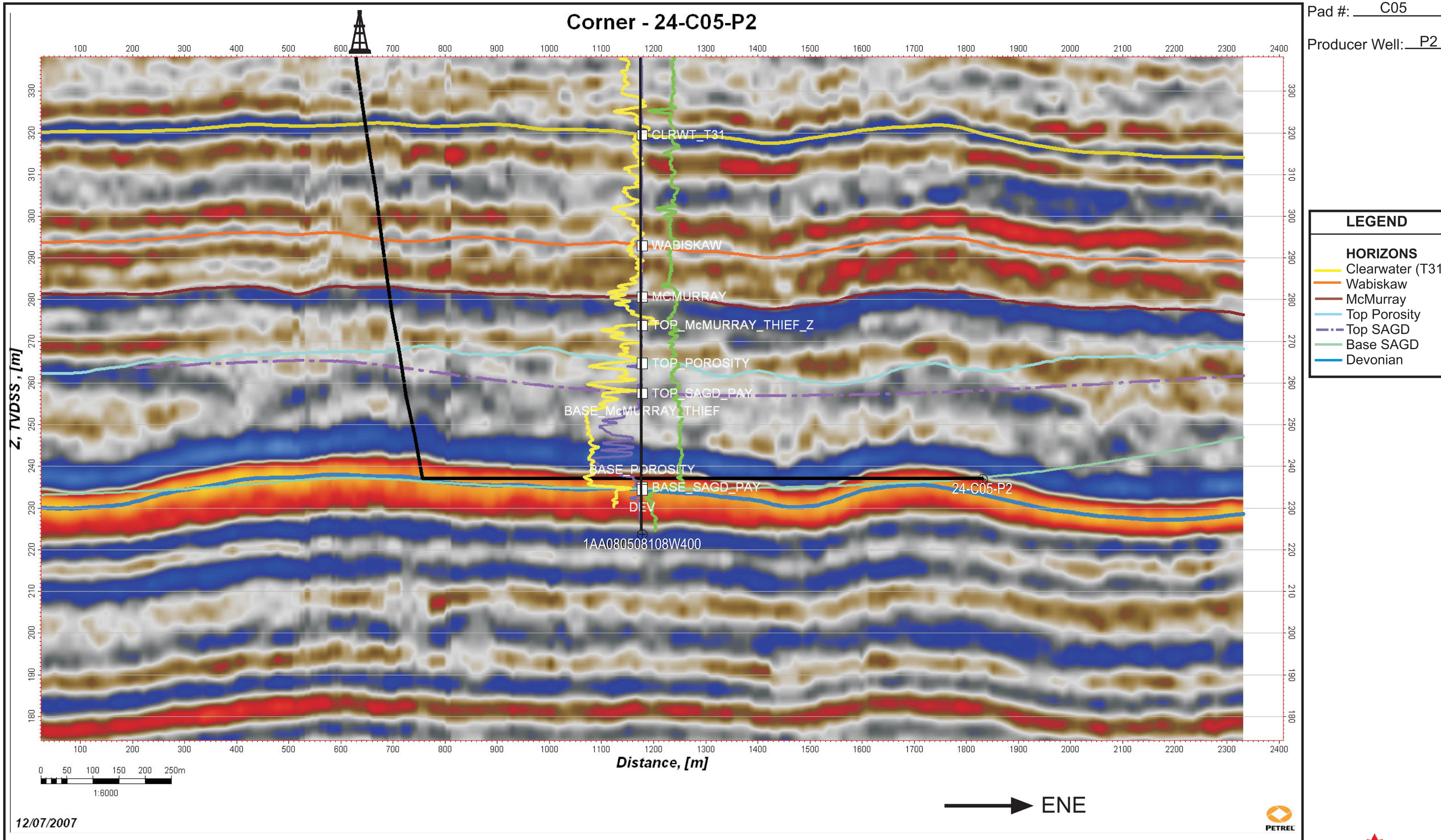
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C05

Producer Well: P2

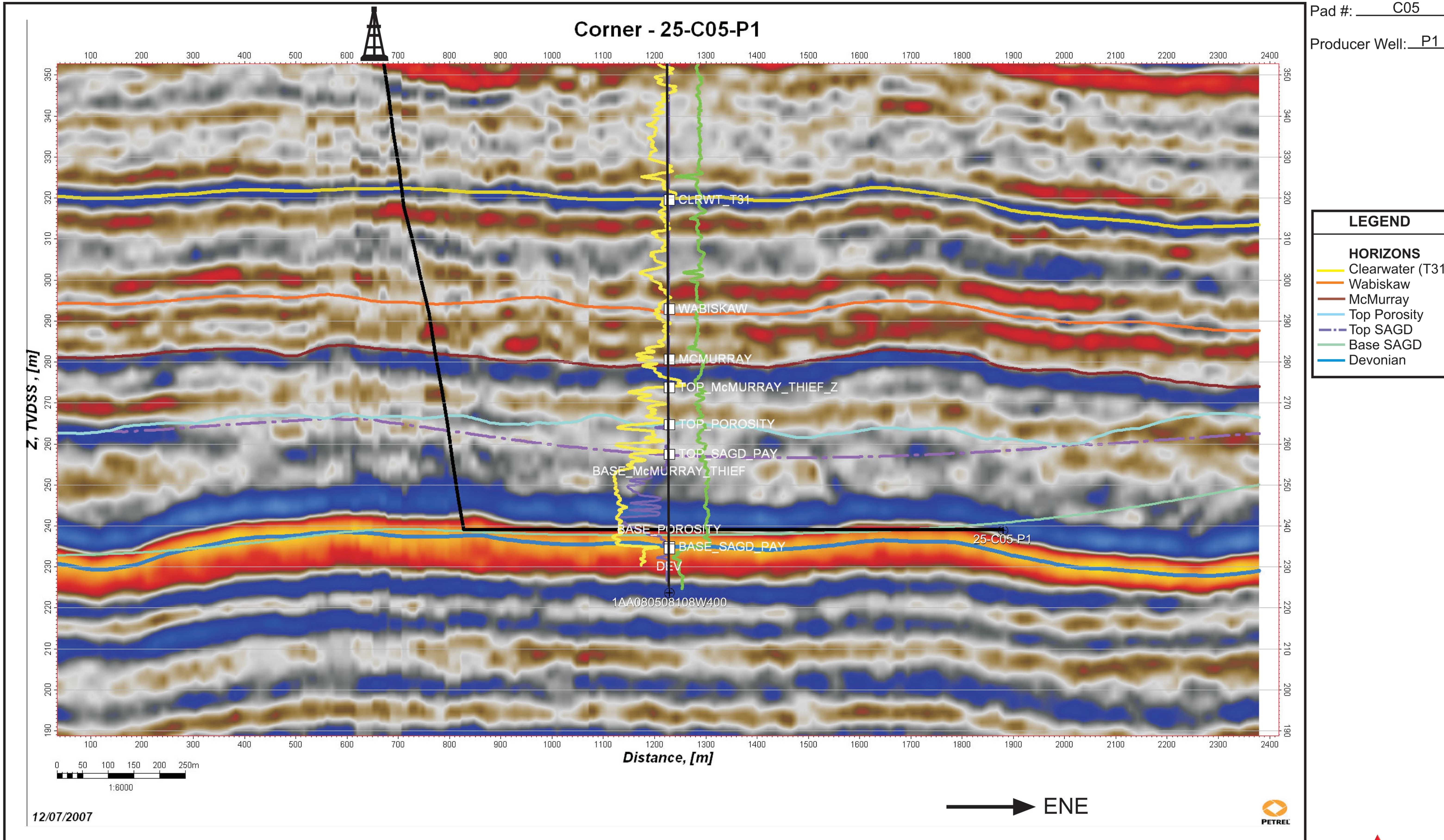


CORNER AREA

North American Oil Sands Corporation

Pad #: C05

Producer Well: P1

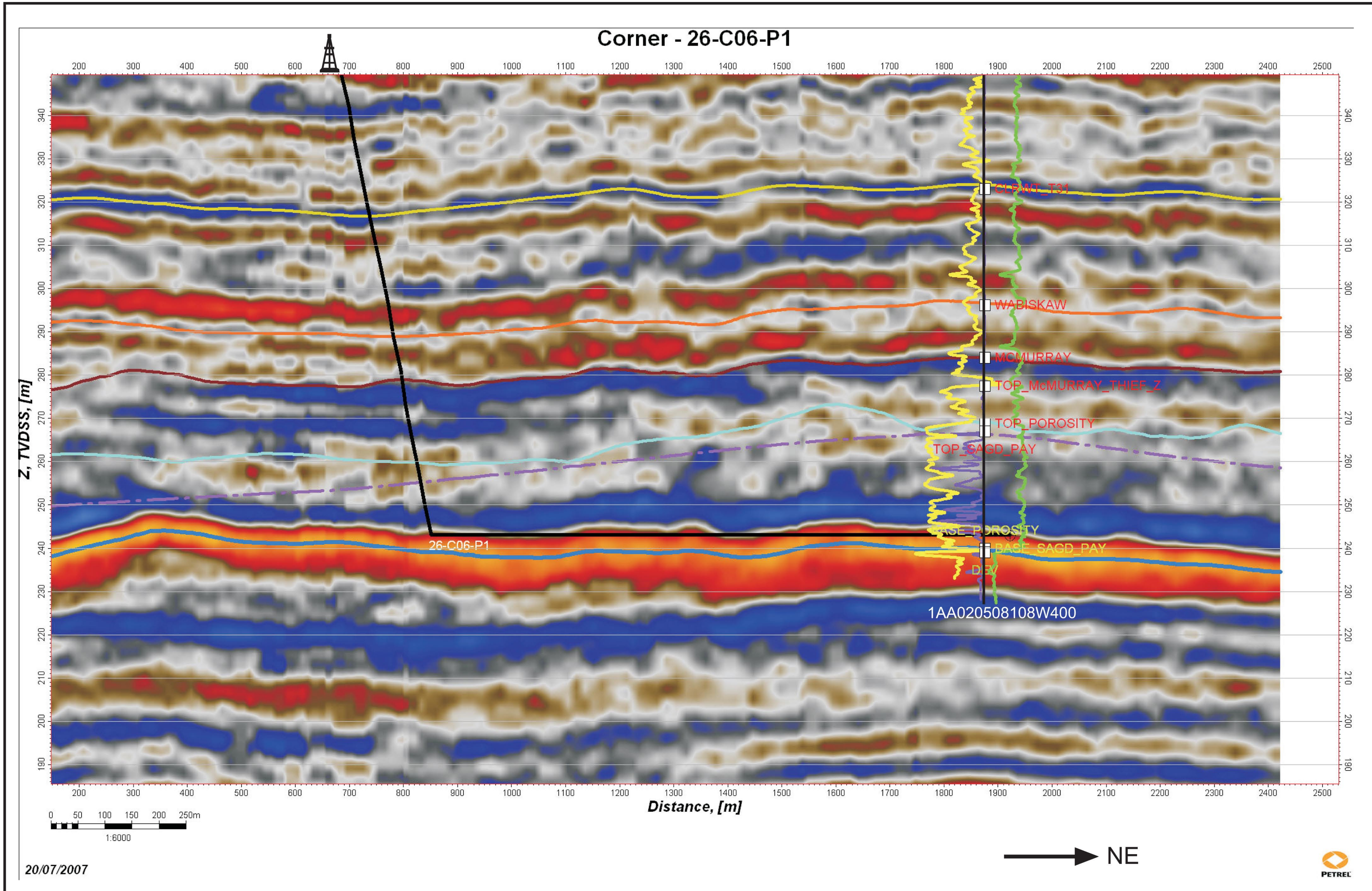


CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C06

Producer Well: P1



LEGEND

HORIZONS

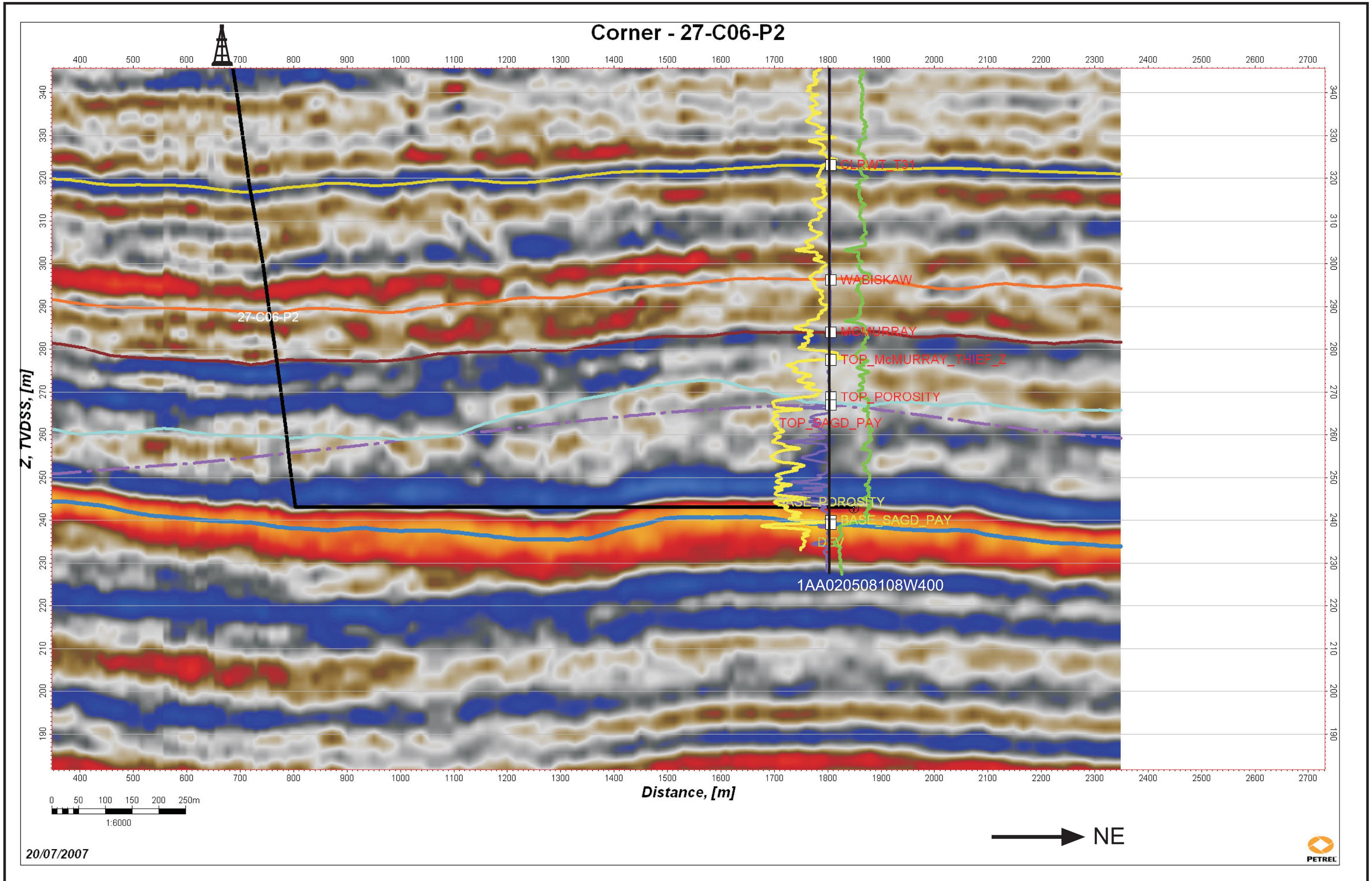
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C06

Producer Well: P2



LEGEND

HORIZONS

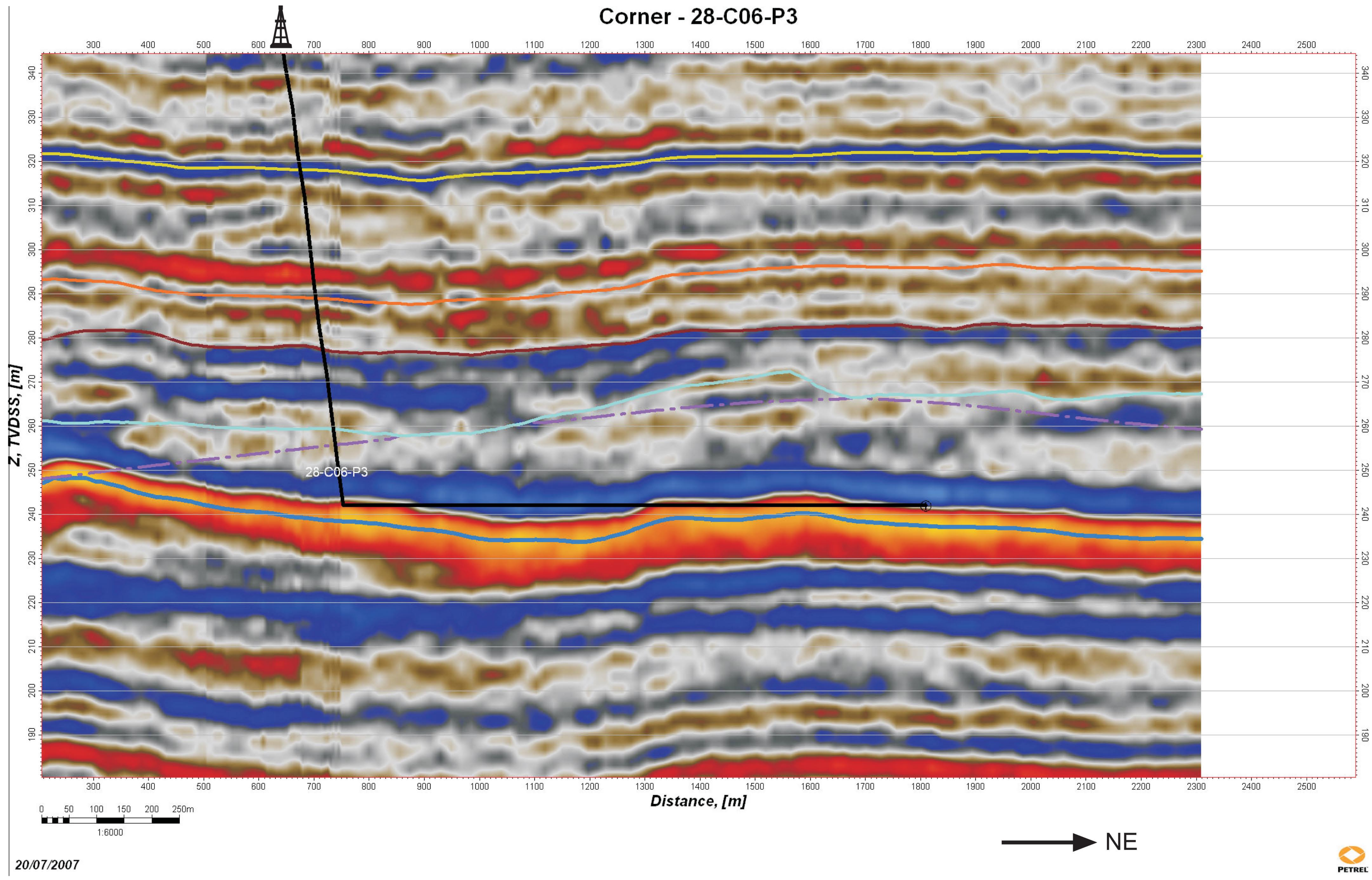
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C06

Producer Well: P3



LEGEND

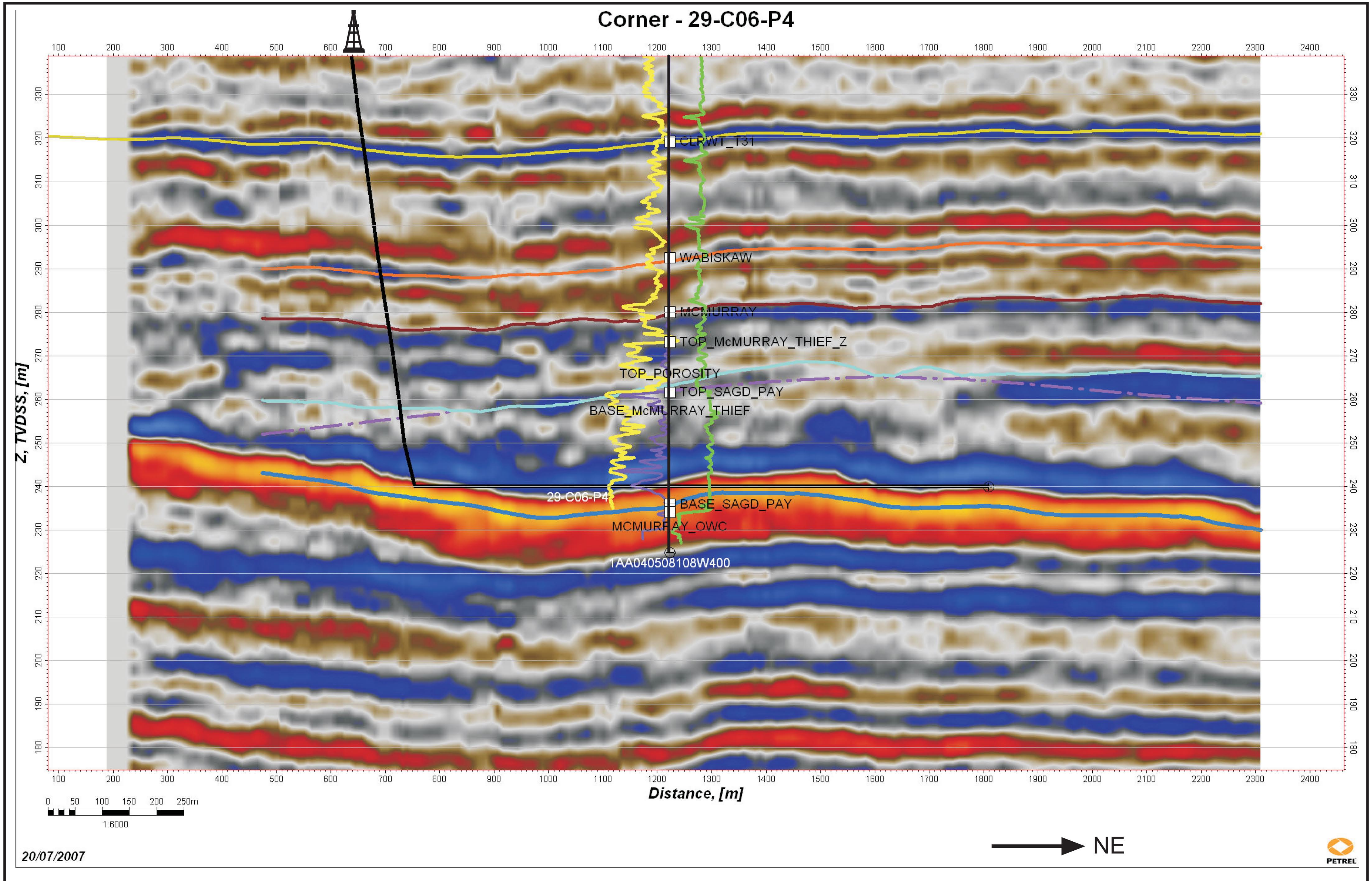
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C06

Producer Well: P4



LEGEND

HORIZONS

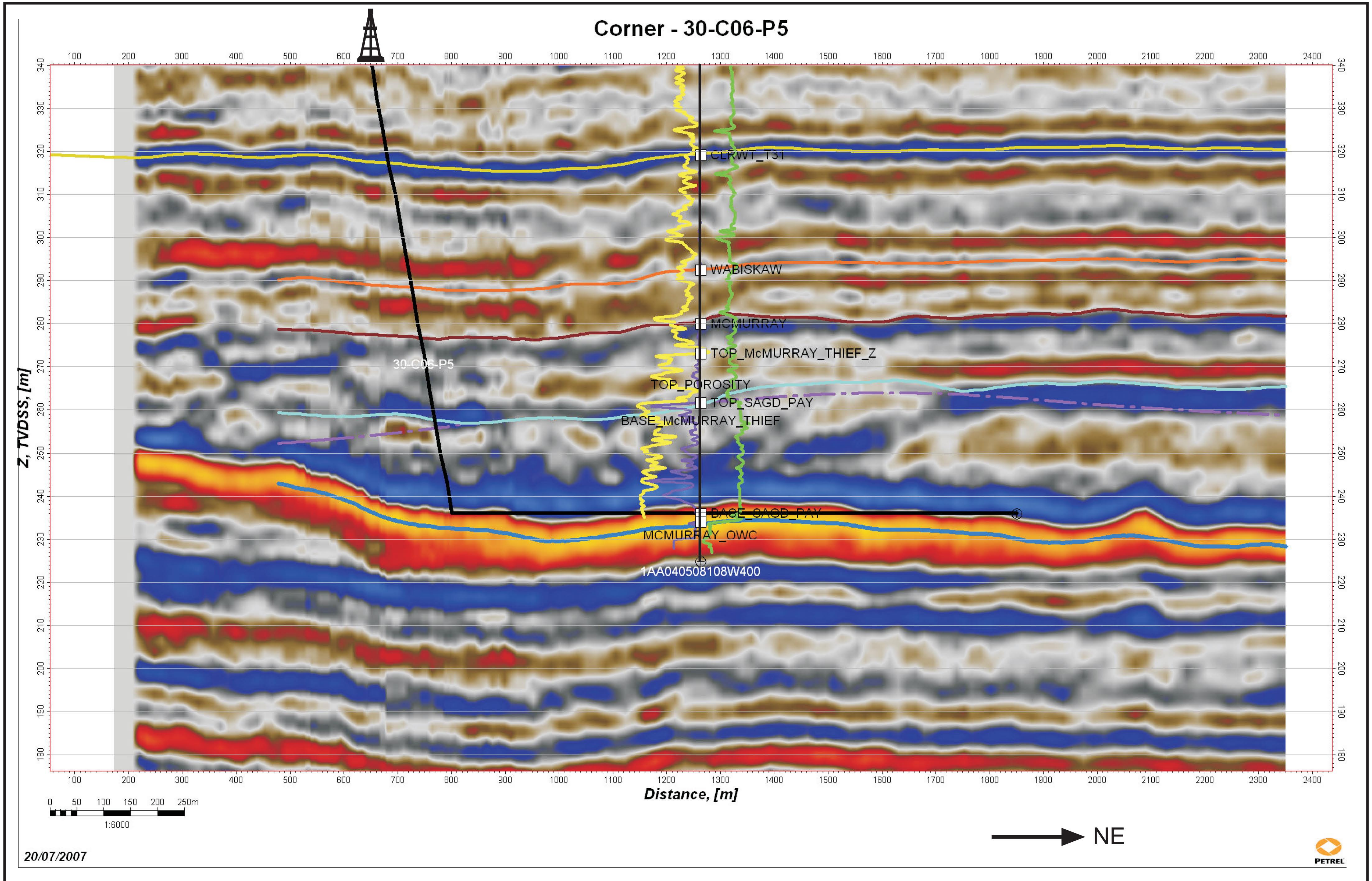
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C06

Producer Well: P5



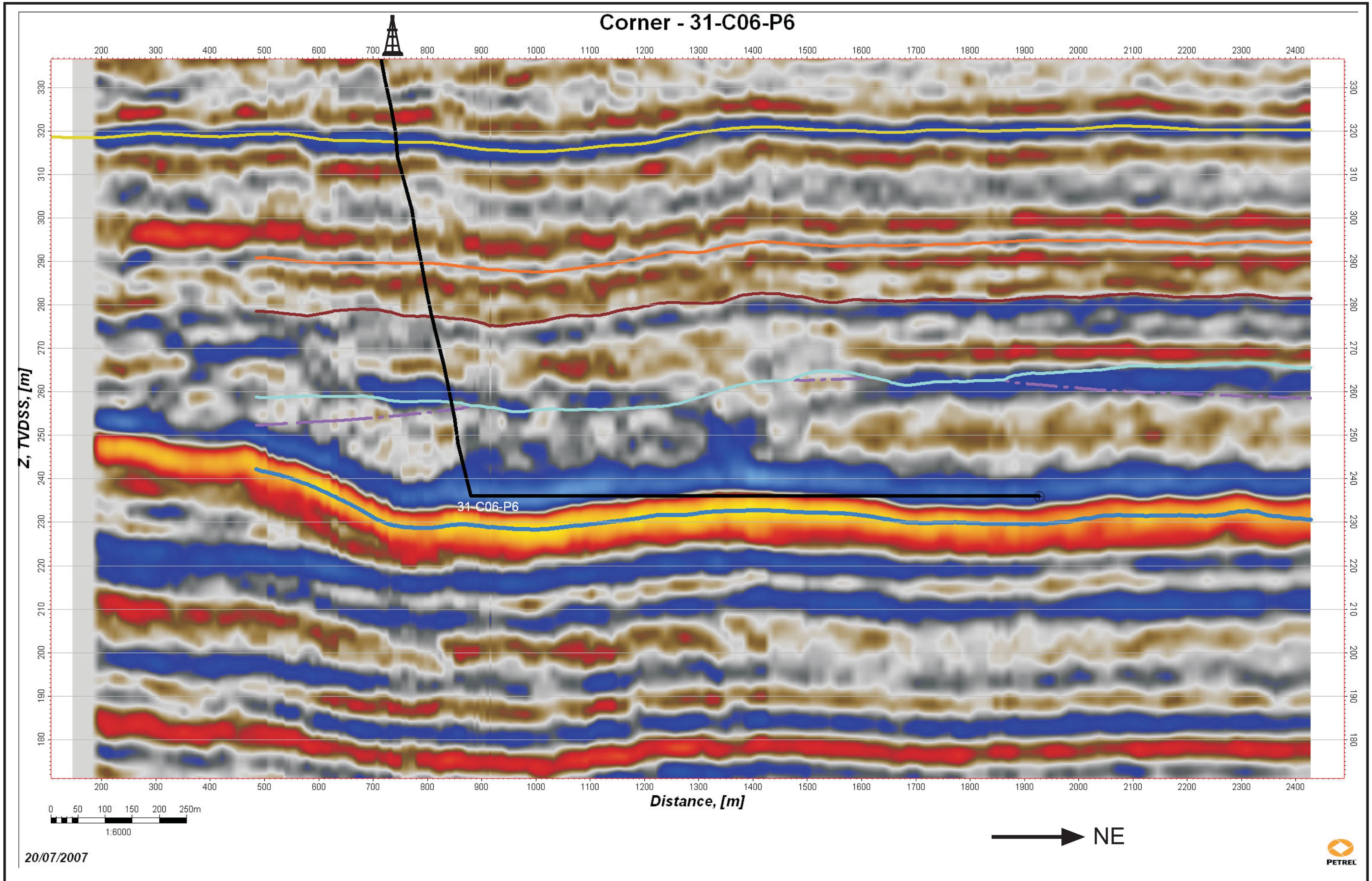
LEGEND
HORIZONS
Clearwater (T31)
Wabiskaw
McMurray
Top Porosity
Top SAGD
Base SAGD
Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C06

Producer Well: P6



LEGEND

HORIZONS

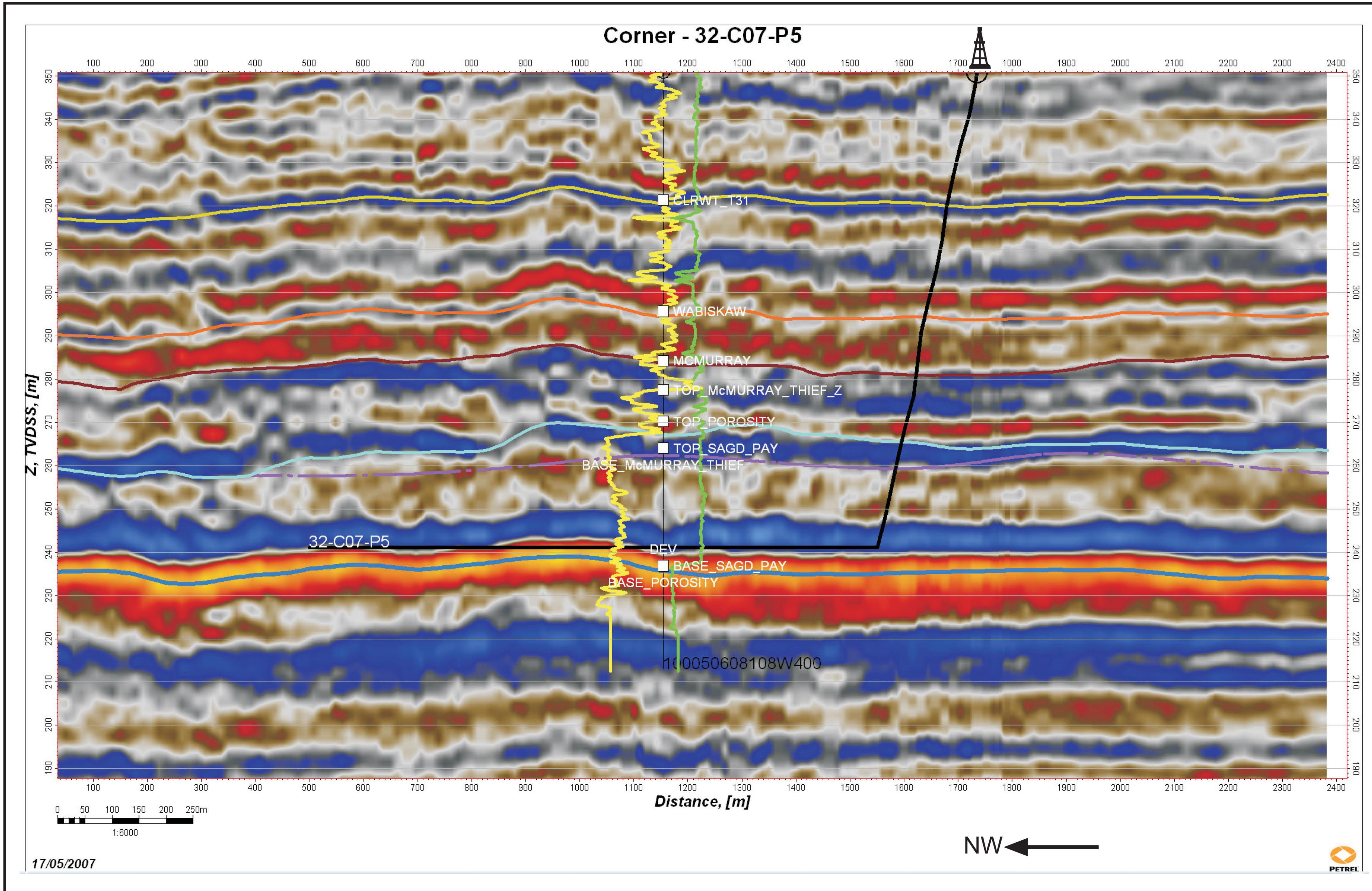
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C07

Producer Well: P5



LEGEND

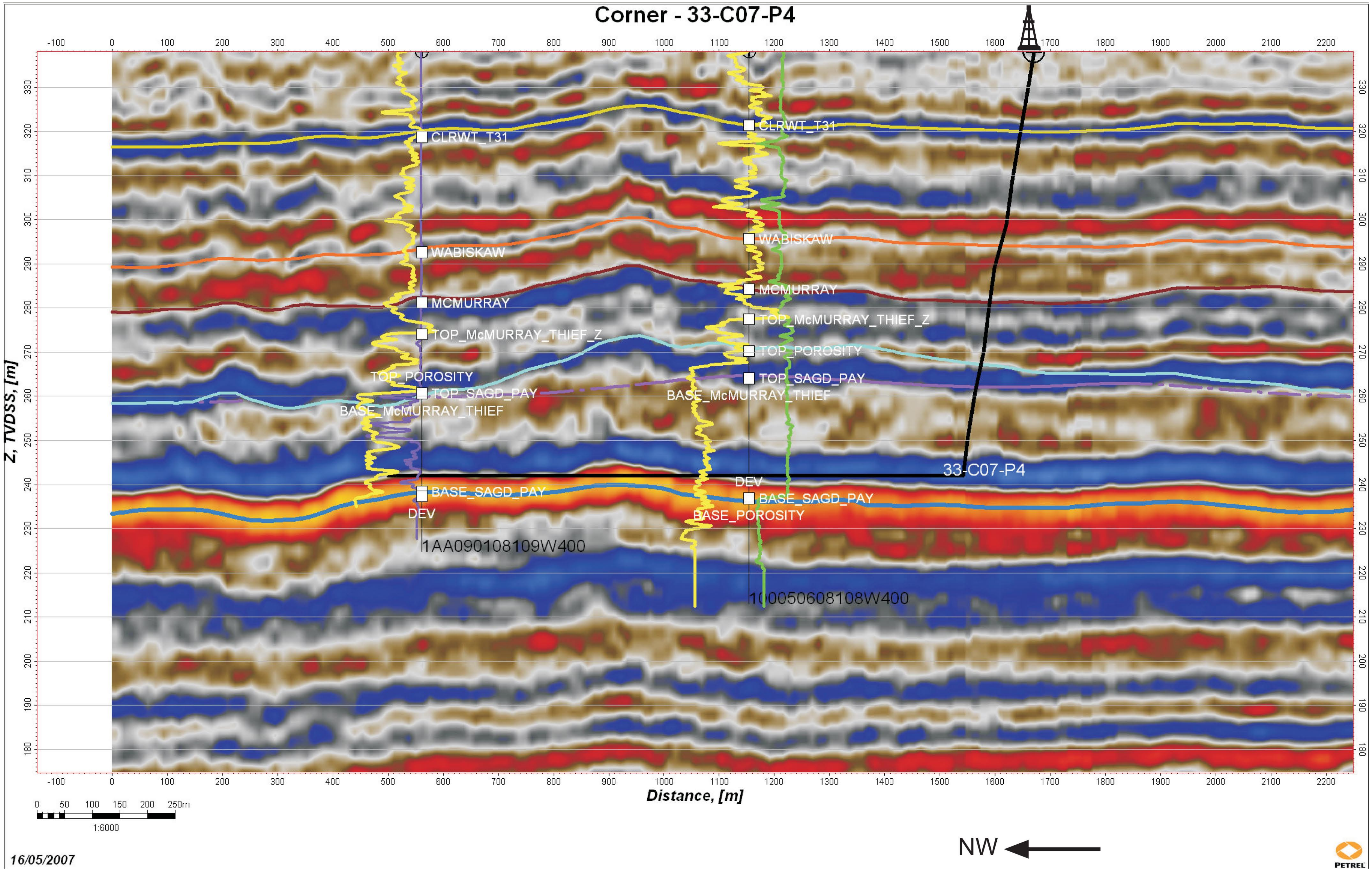
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C07

Producer Well: P4



LEGEND

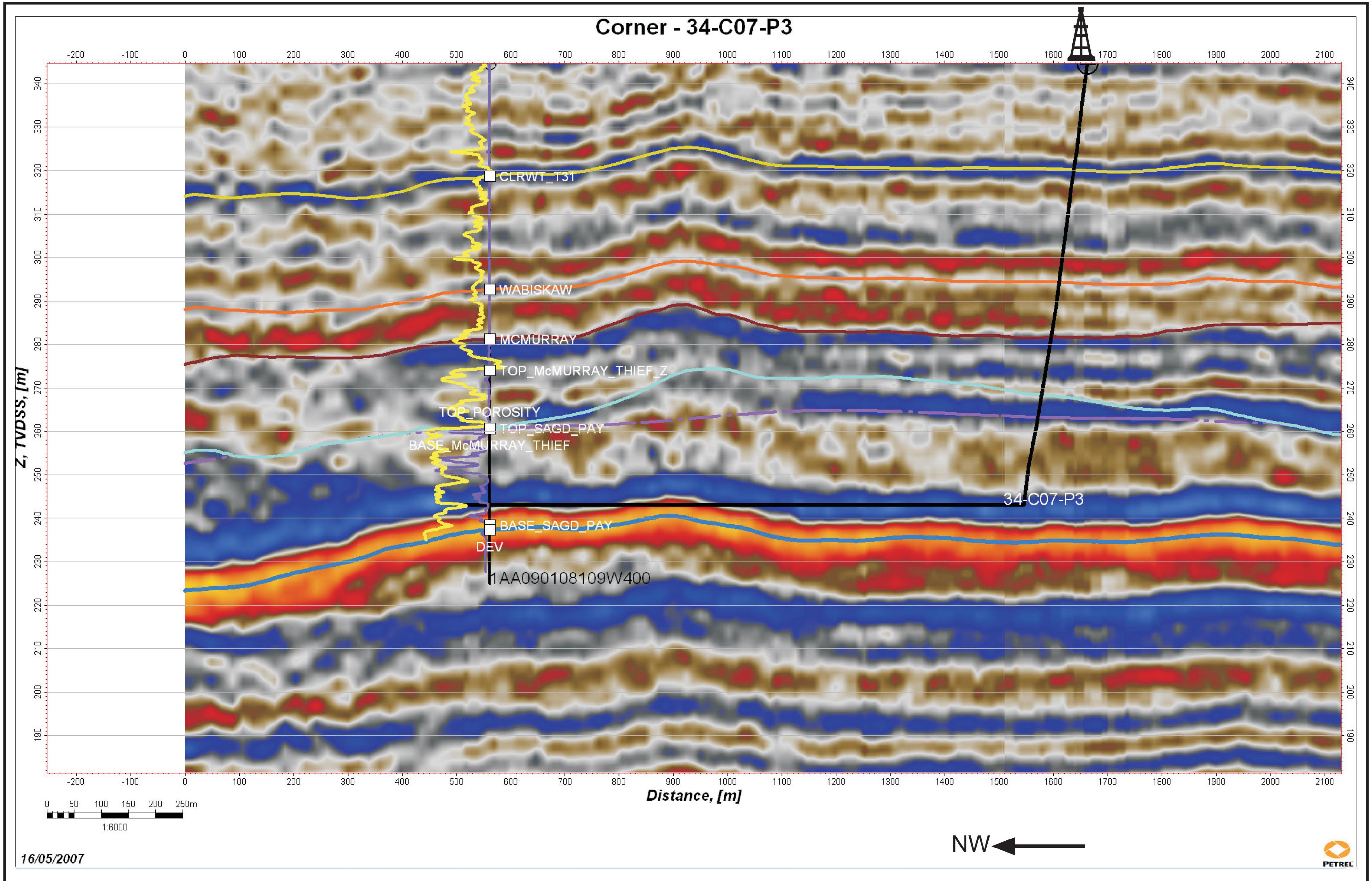
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C07

Producer Well: P3



LEGEND

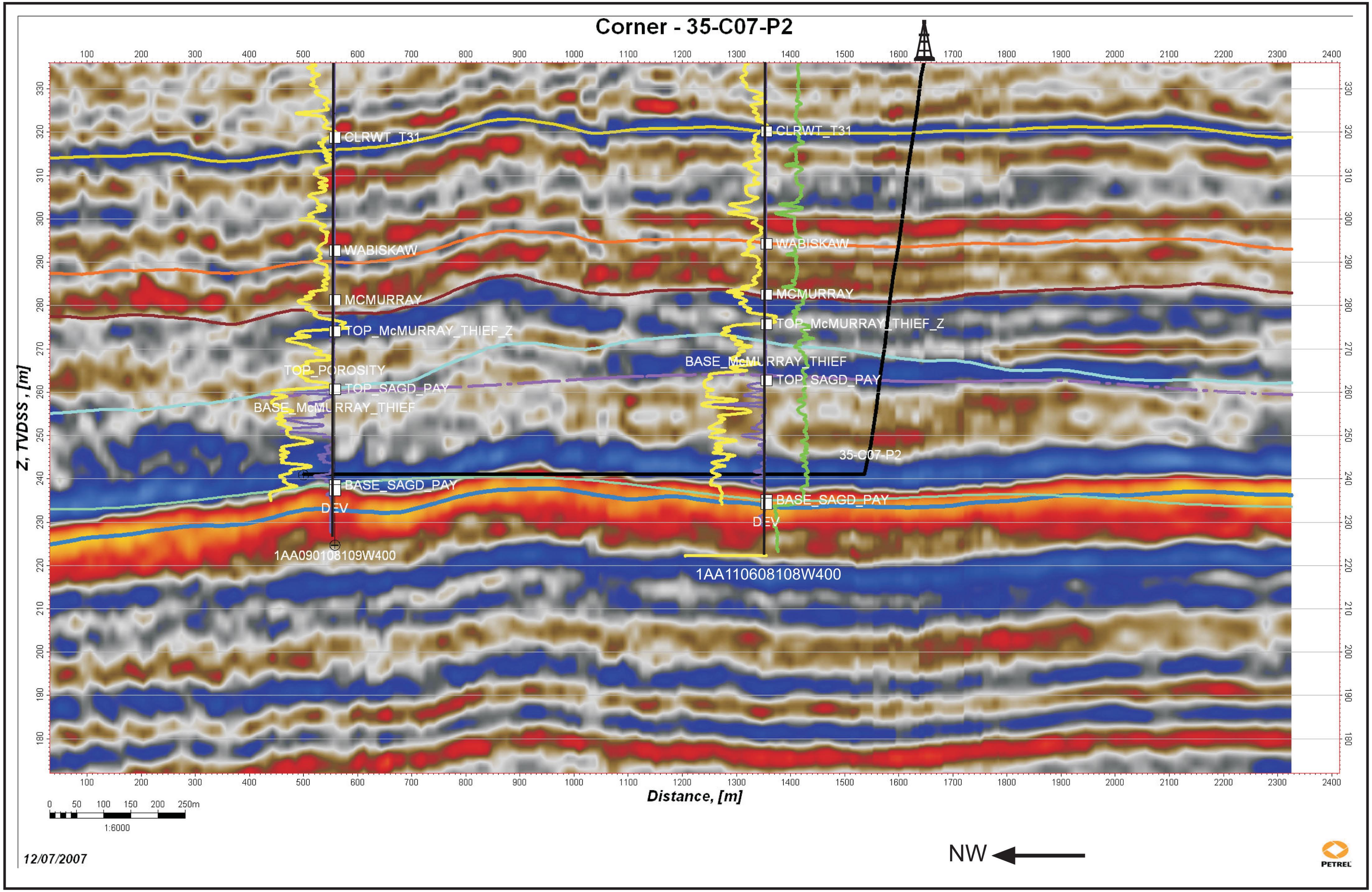
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C07

Producer Well: P2



LEGEND

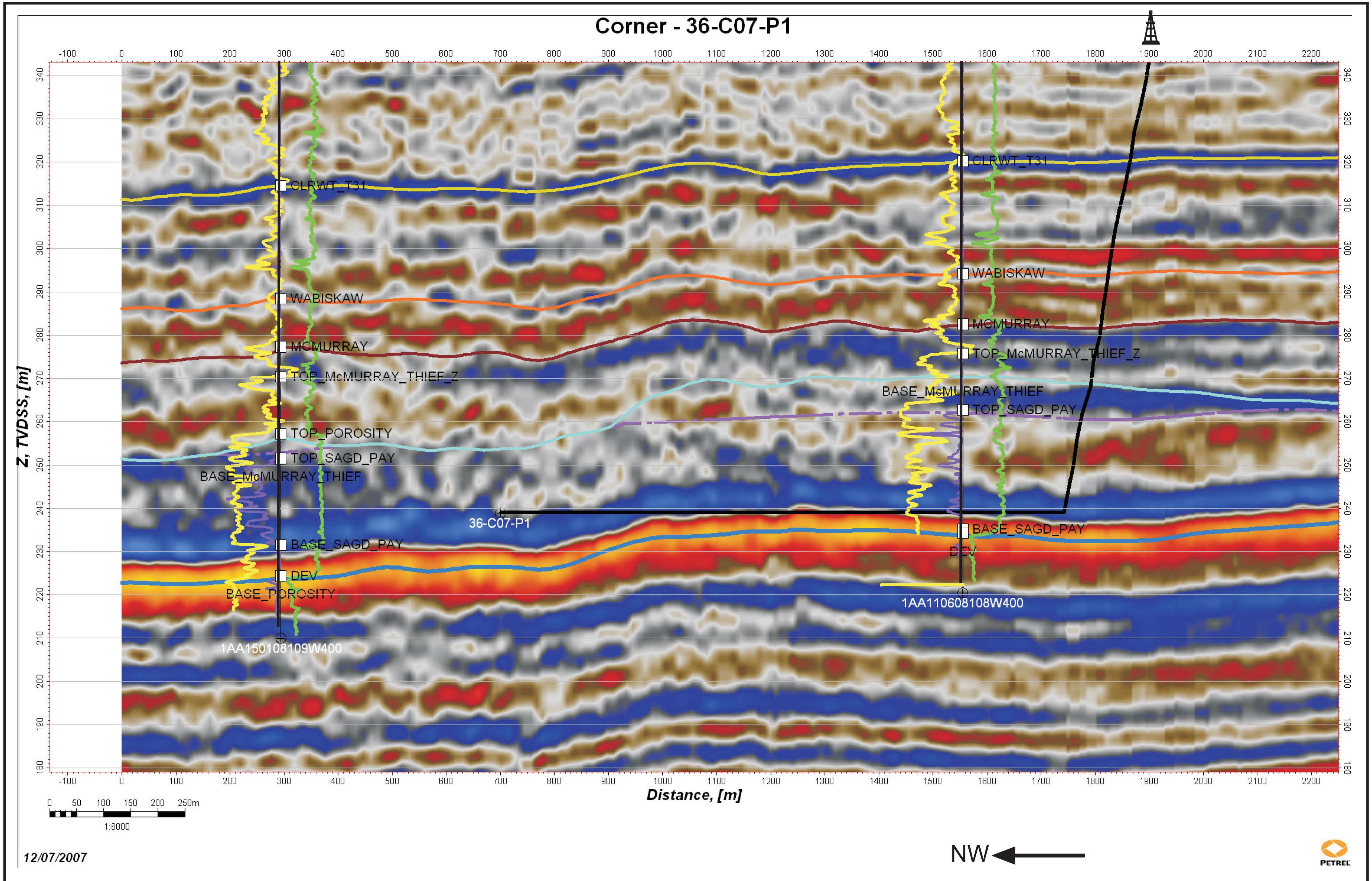
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C07

Producer Well: P1



LEGEND

HORIZONS

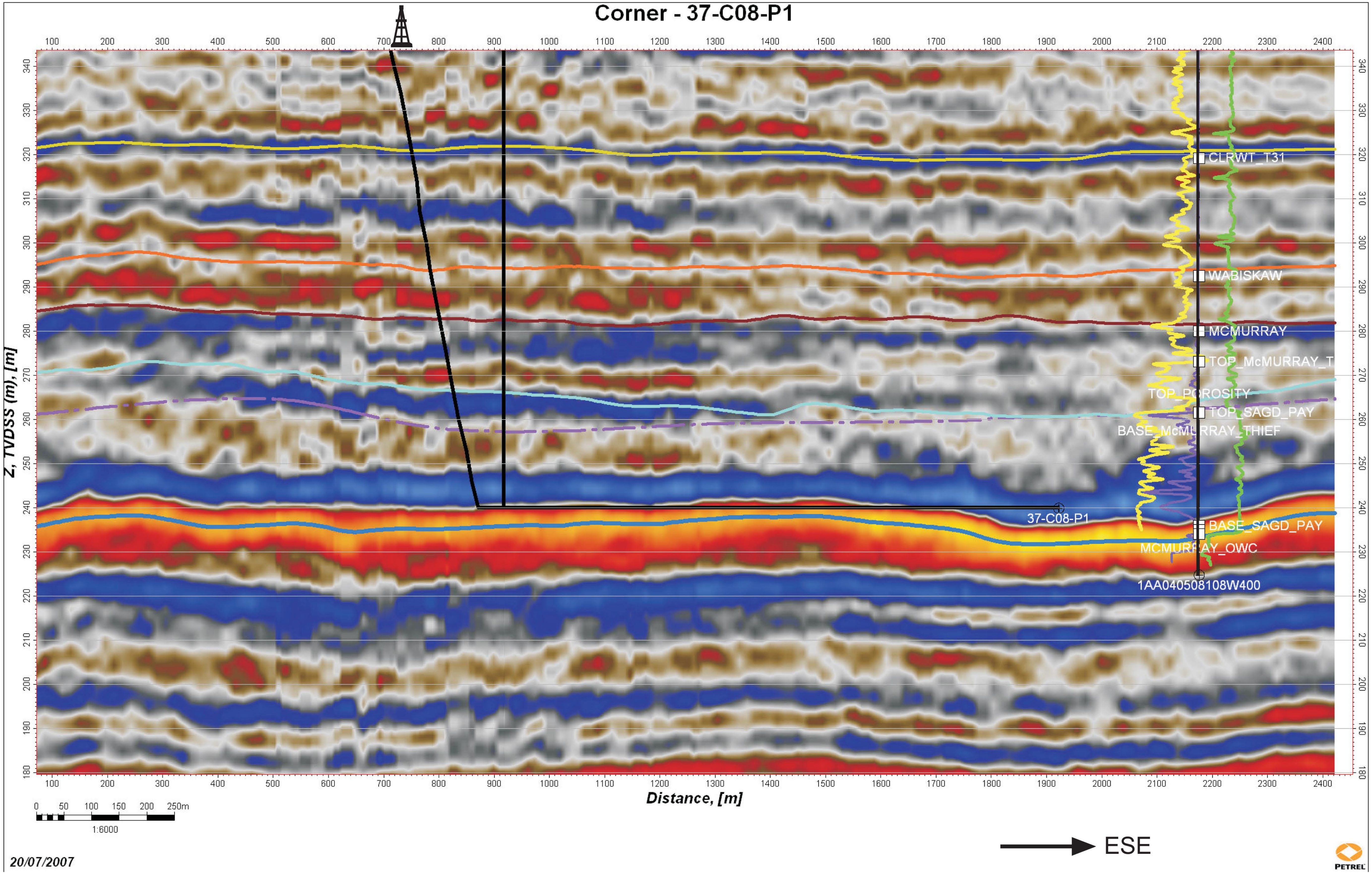
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C08

Producer Well: P1

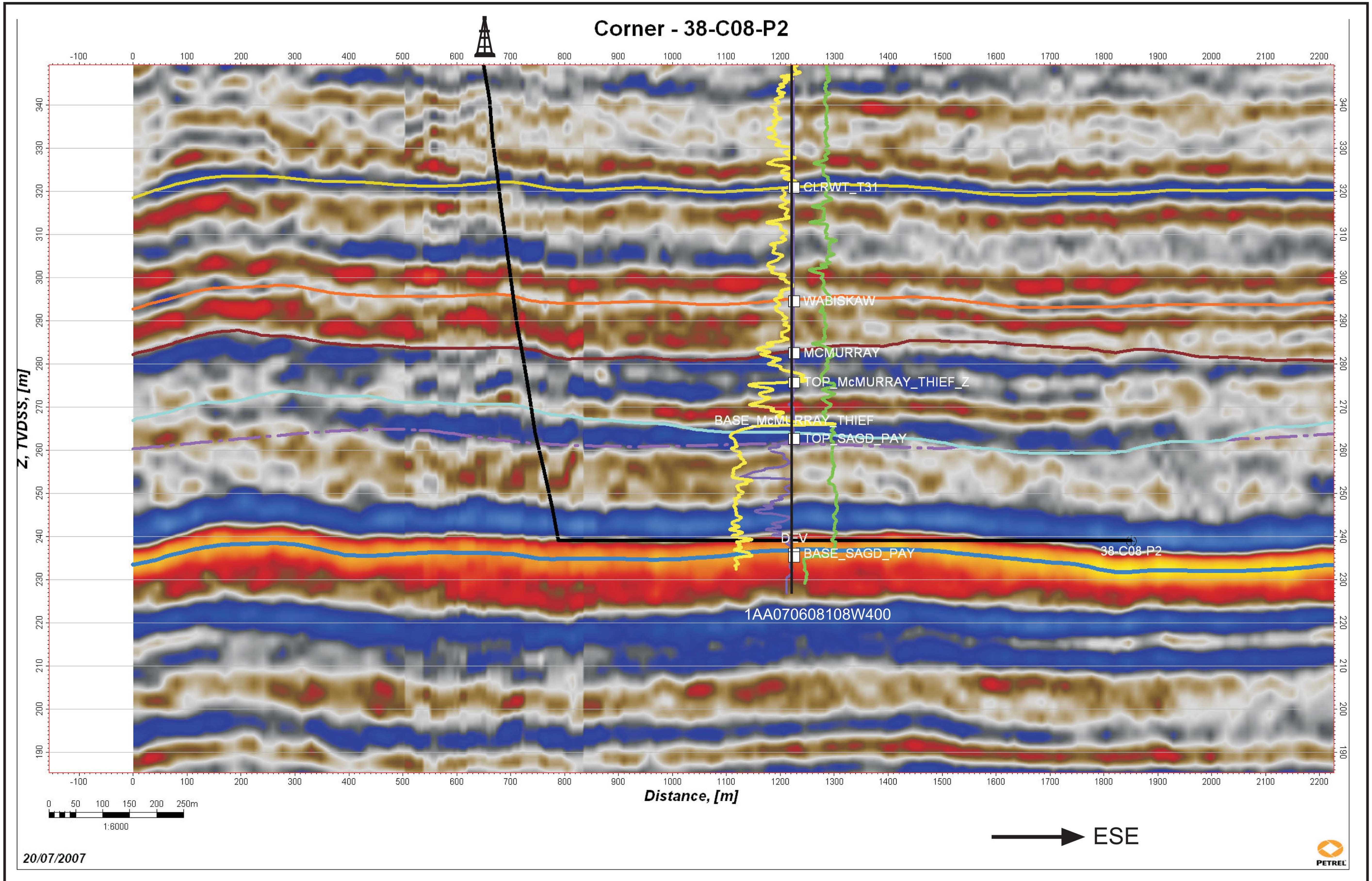


LEGEND
HORIZONS
Clearwater (T31)
Wabiskaw
McMurray
Top Porosity
Top SAGD
Base SAGD
Devonian

CORNER AREA

Pad #: C08

Producer Well: P2



LEGEND

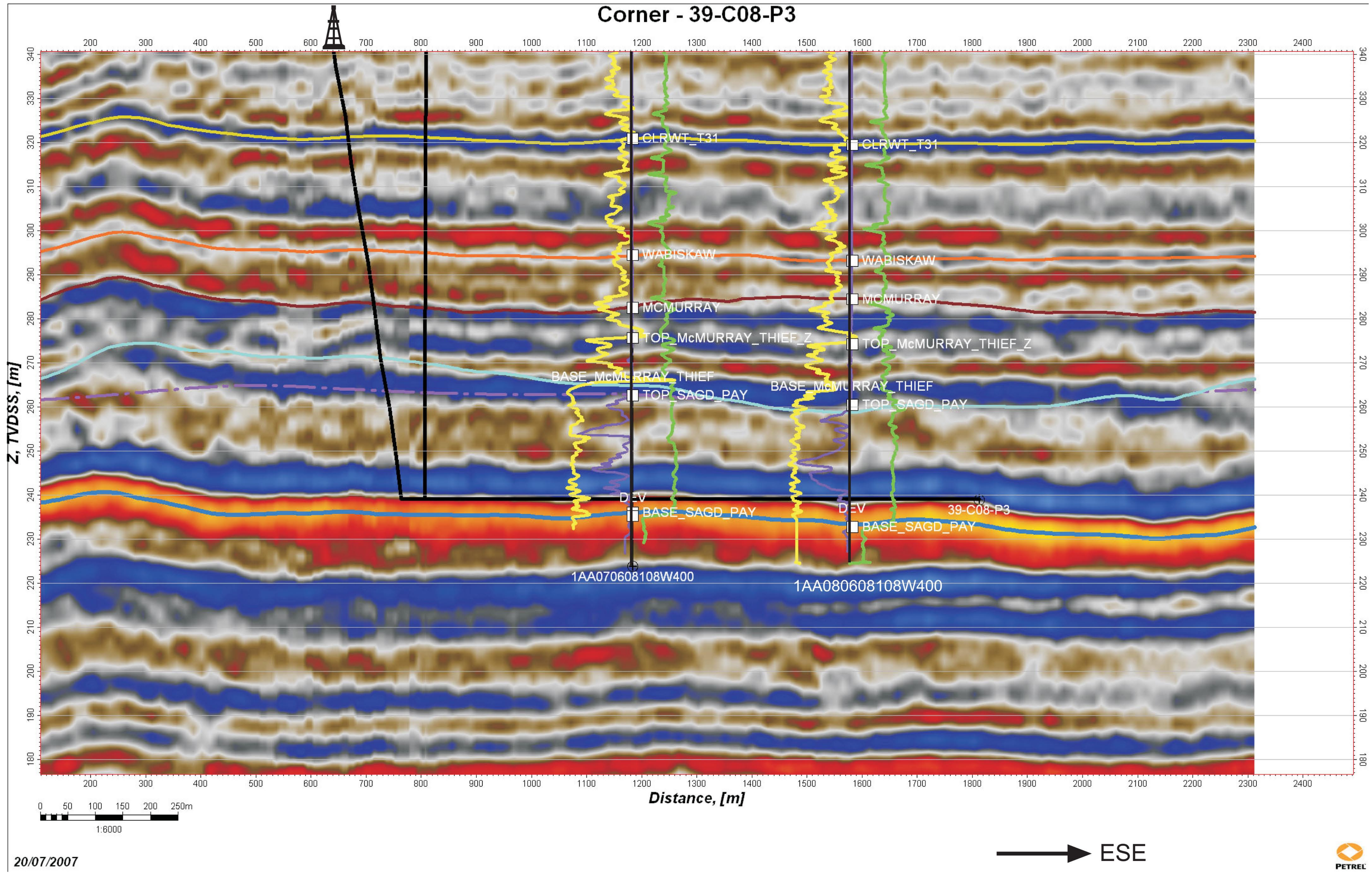
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C08

Producer Well: P3



LEGEND

HORIZONS

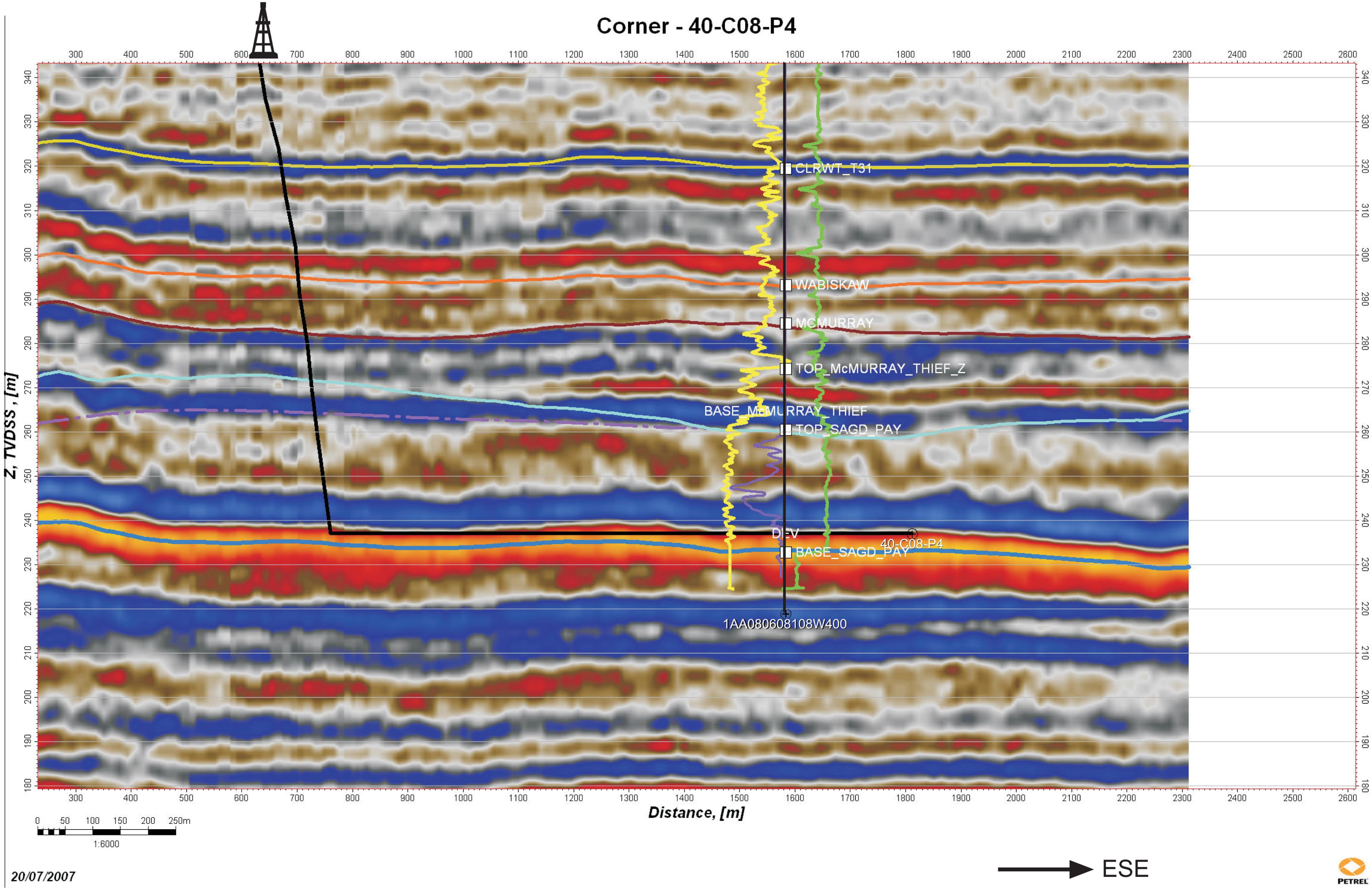
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C08

Producer Well: P4



LEGEND

HORIZONS

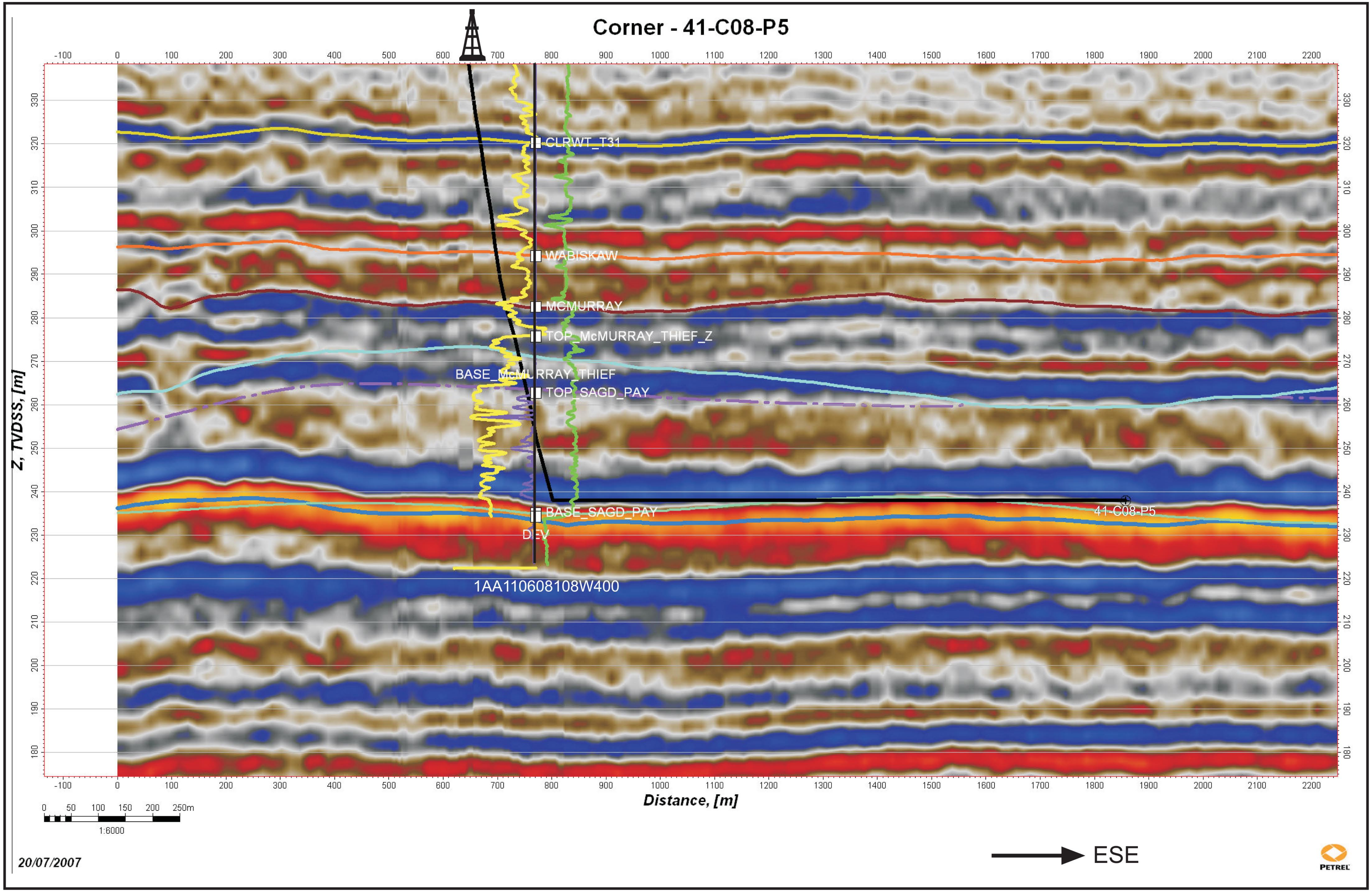
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

North American Oil Sands Corporation

Pad #: C08

Producer Well: P5



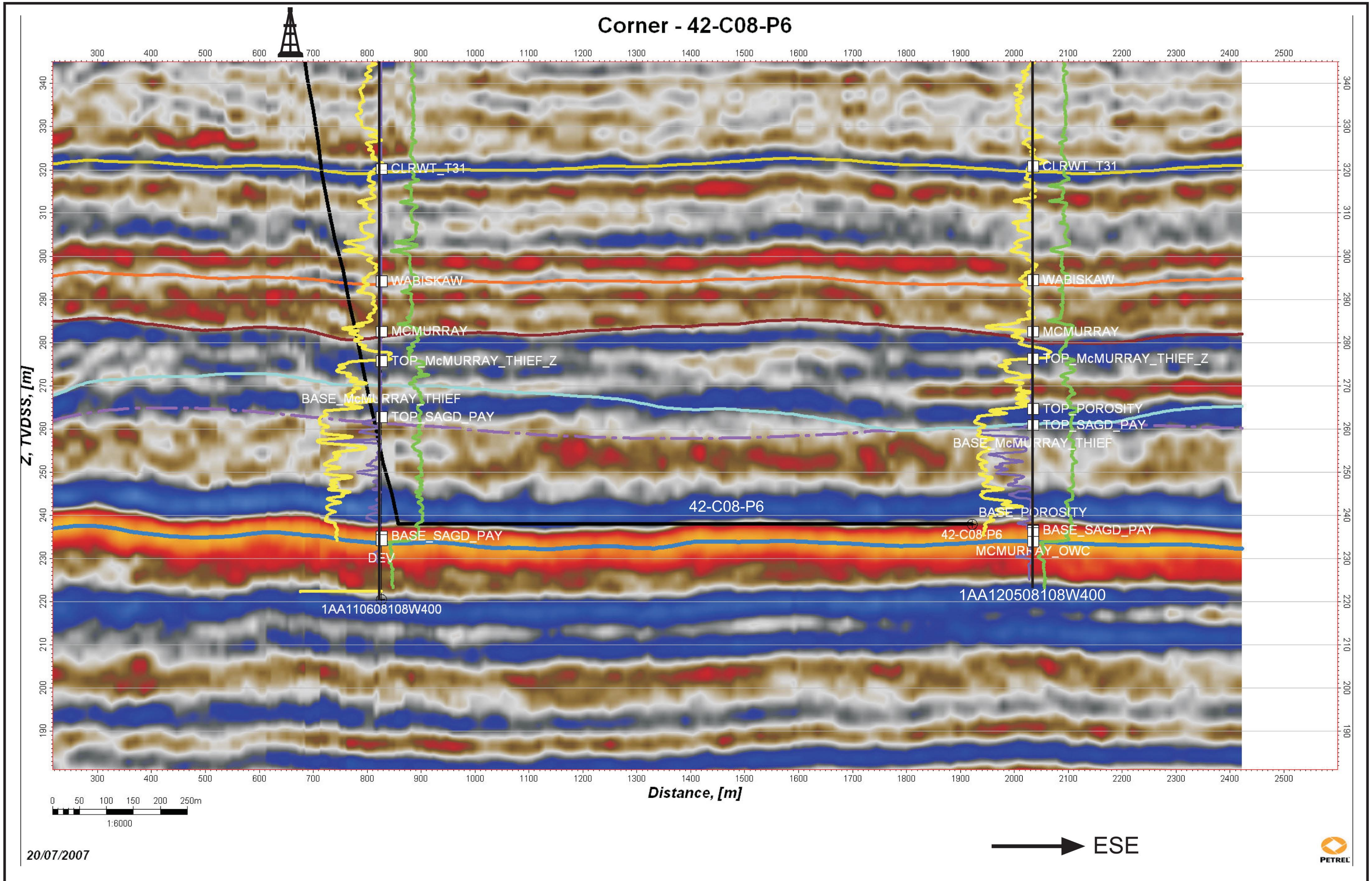
LEGEND

HORIZONS

- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION



Pad #: C08

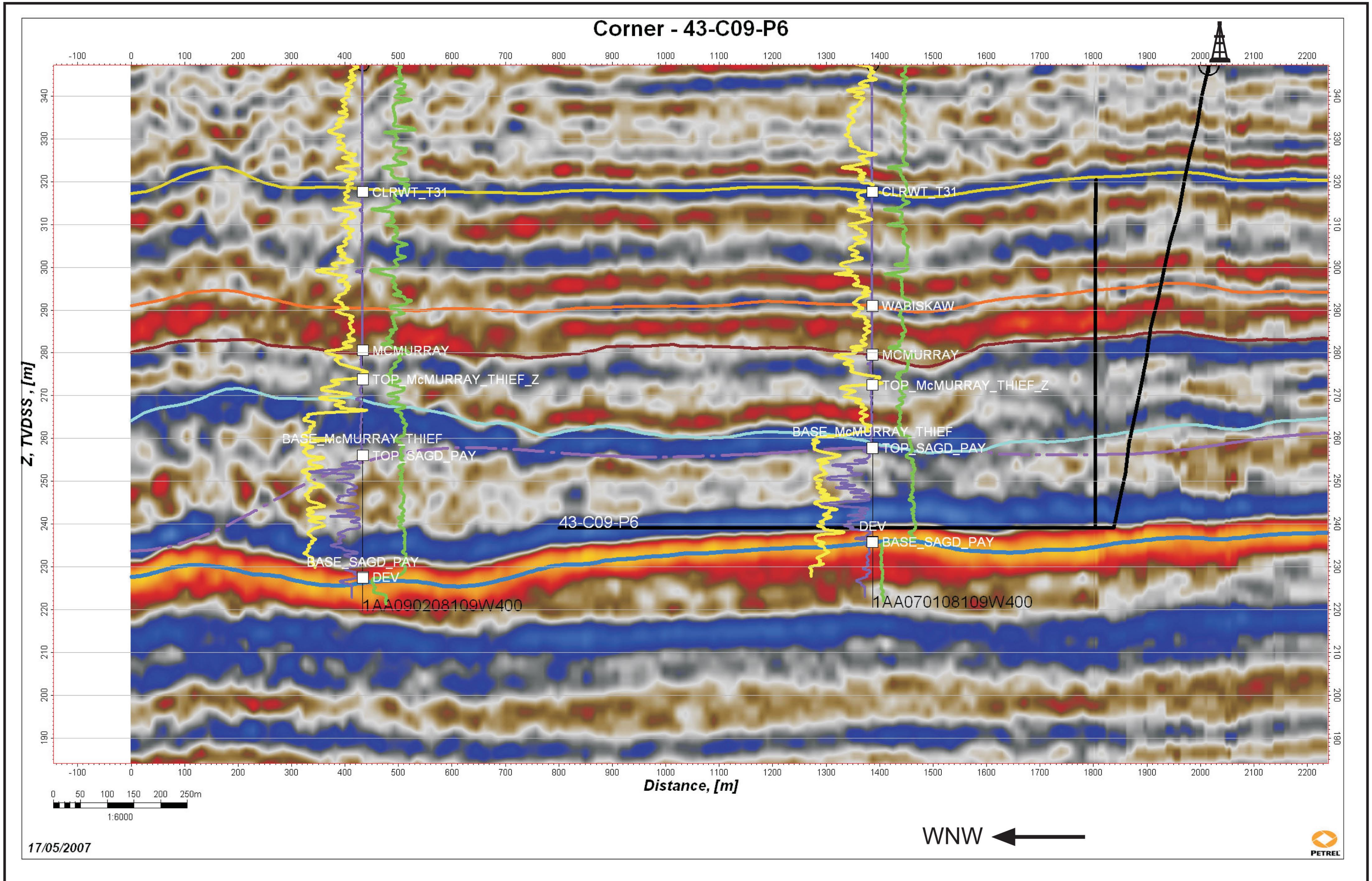
Producer Well: P6

LEGEND

HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION



Pad #: C09

Producer Well: P6

LEGEND

HORIZONS

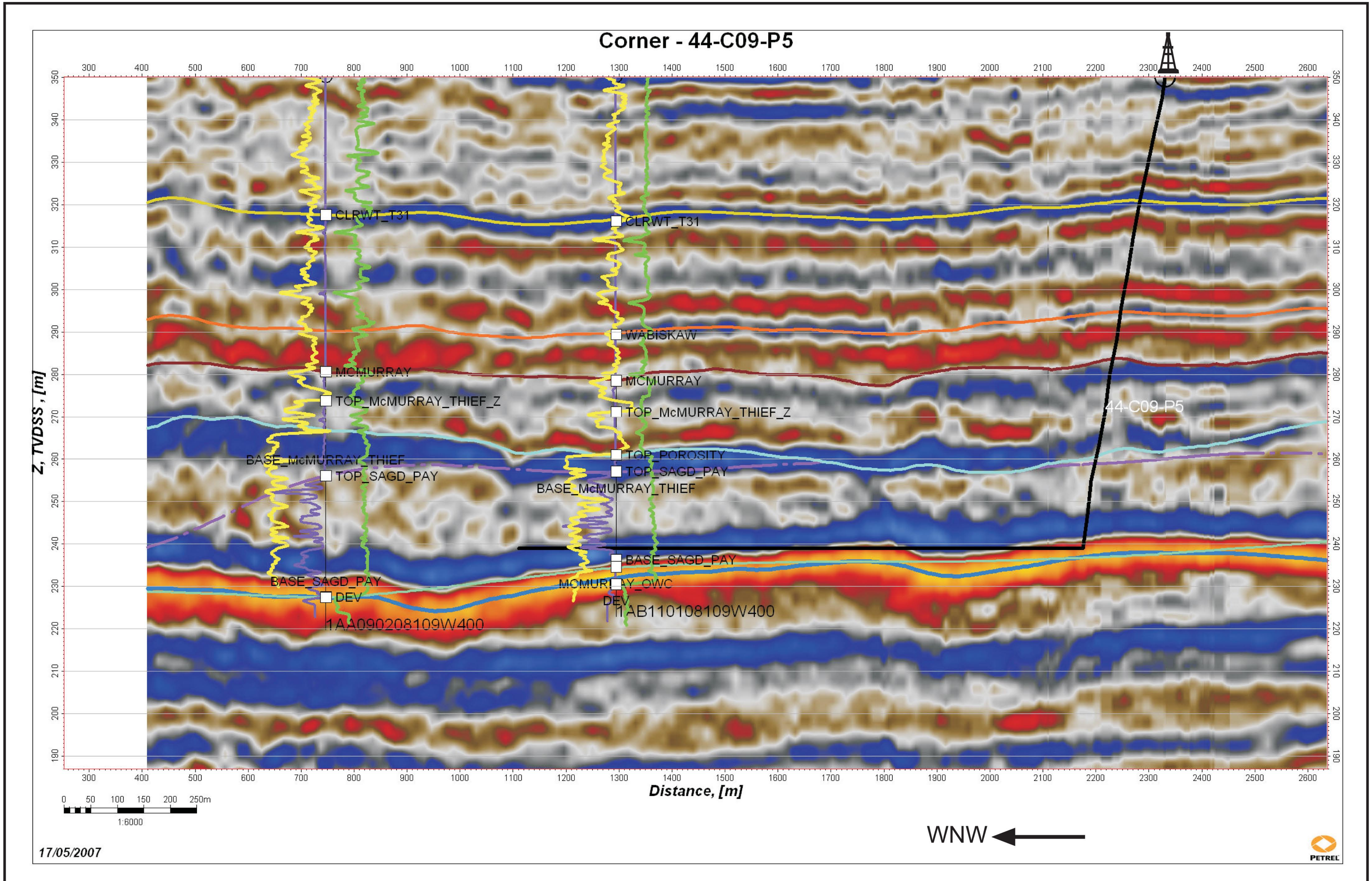
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C09

Producer Well: P5

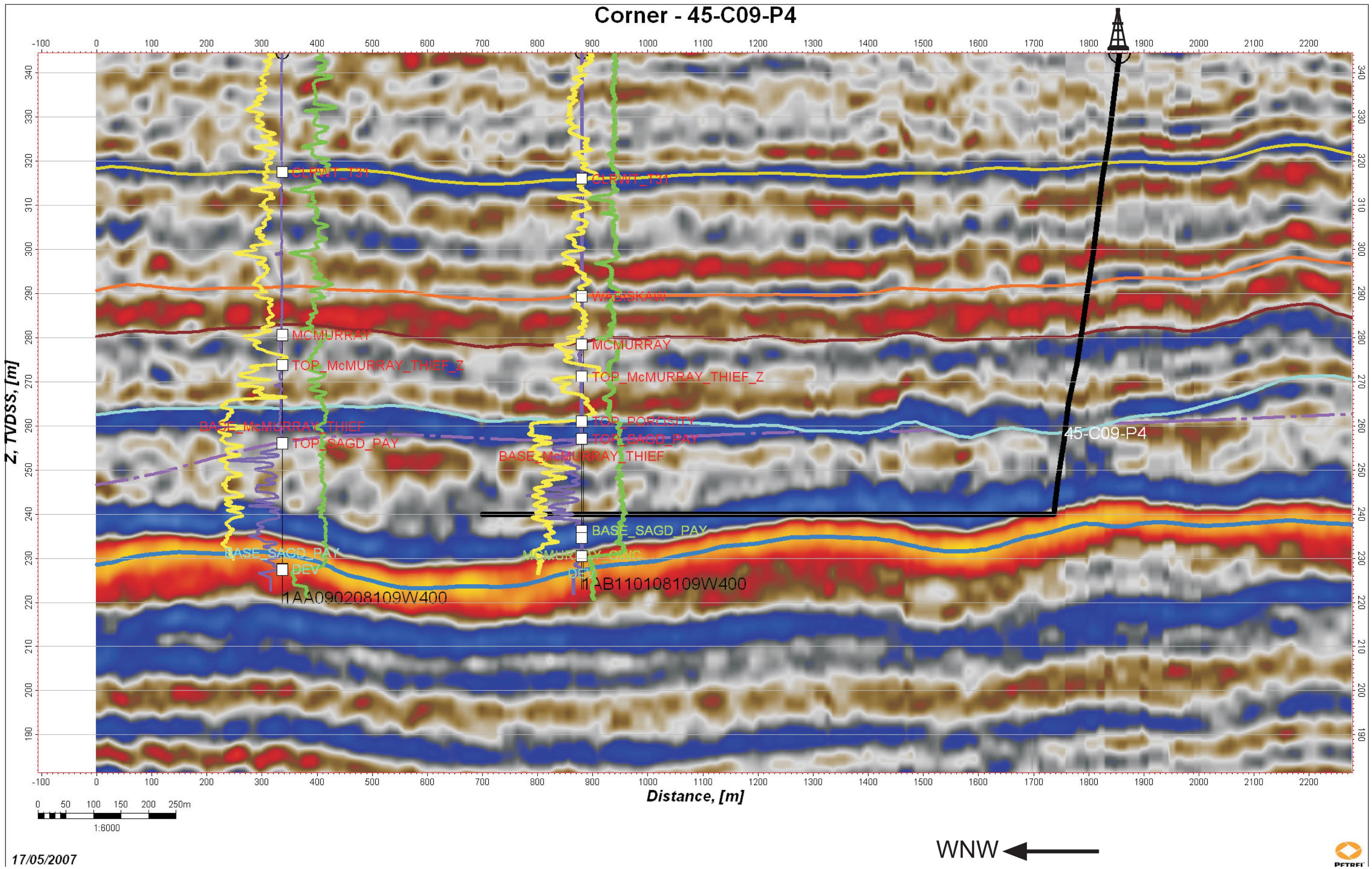


CORNER AREA

North American Oil Sands Corporation

Pad #: C09

Producer Well: P4



LEGEND

HORIZONS

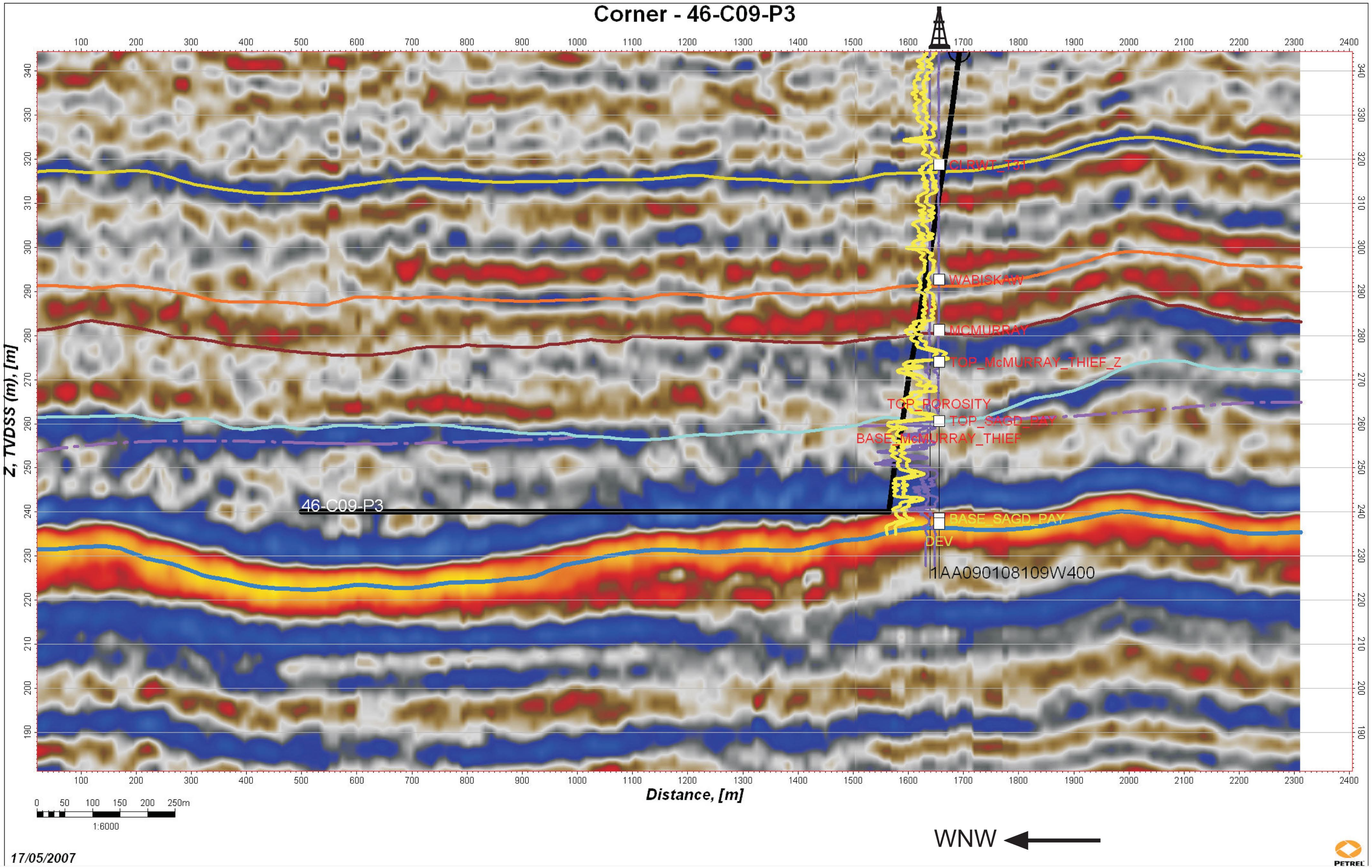
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C09

Producer Well: P3

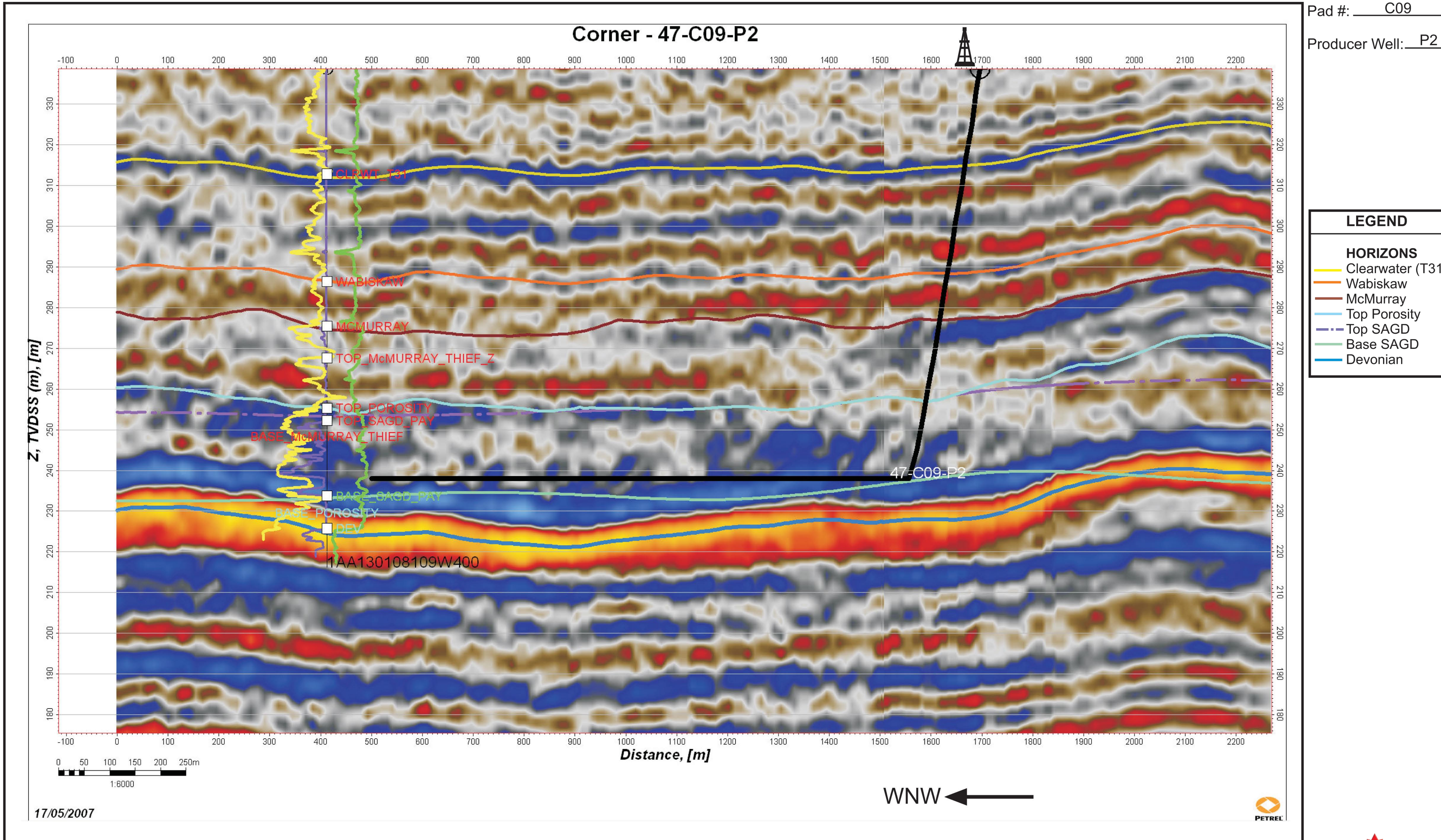


CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C09

Producer Well: P2

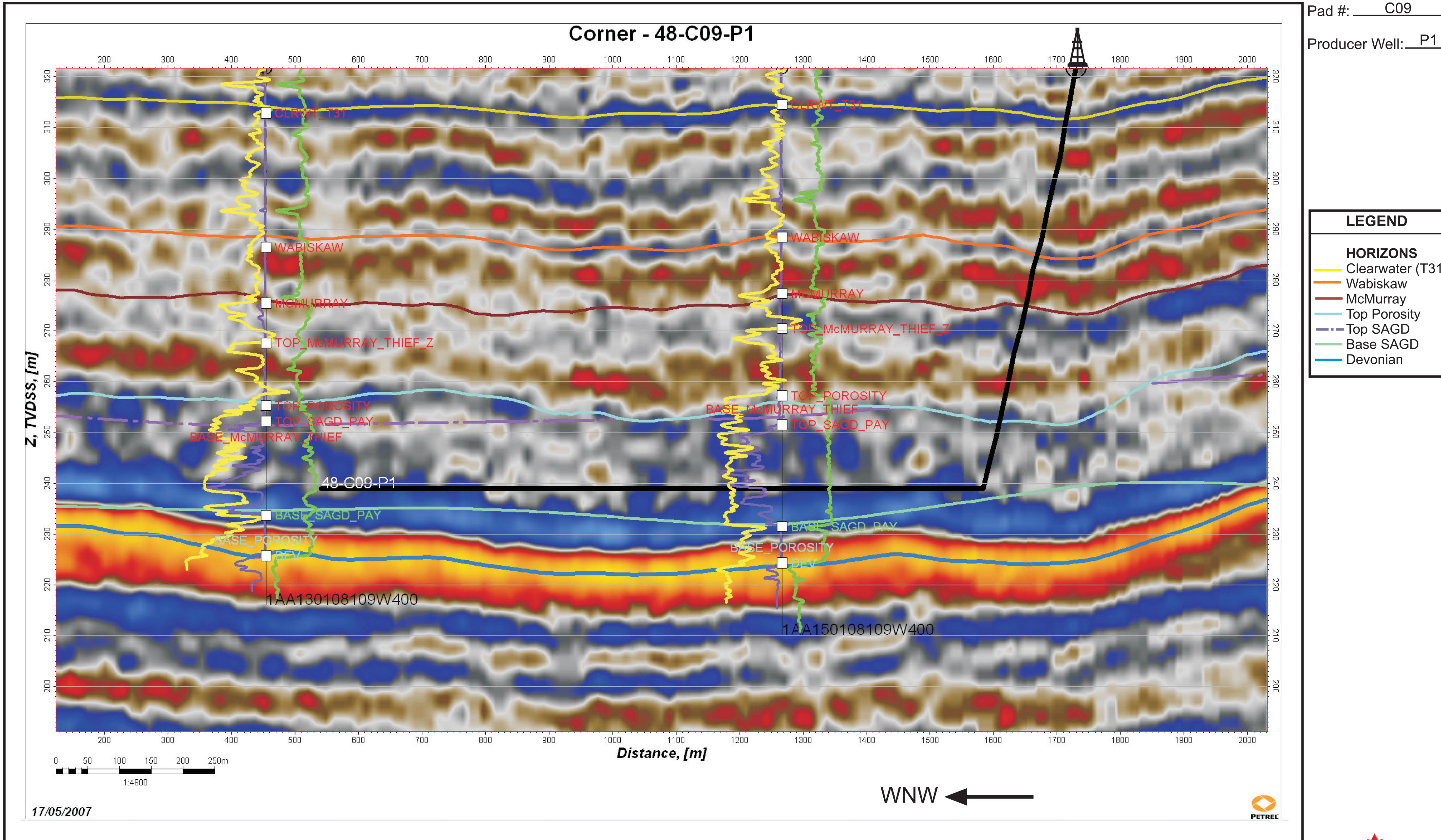


CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C09

Producer Well: P1

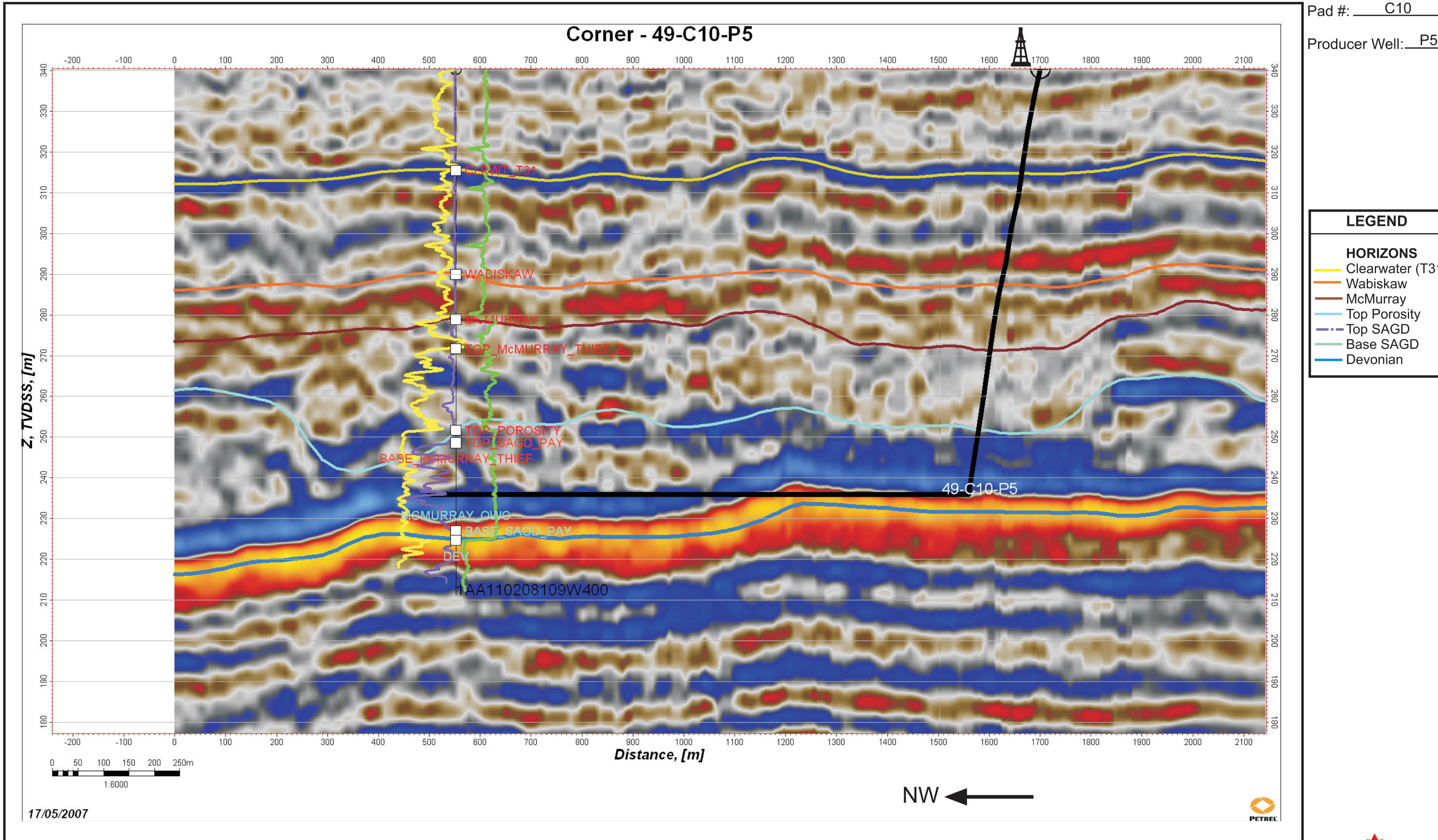


CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C10

Producer Well: P5

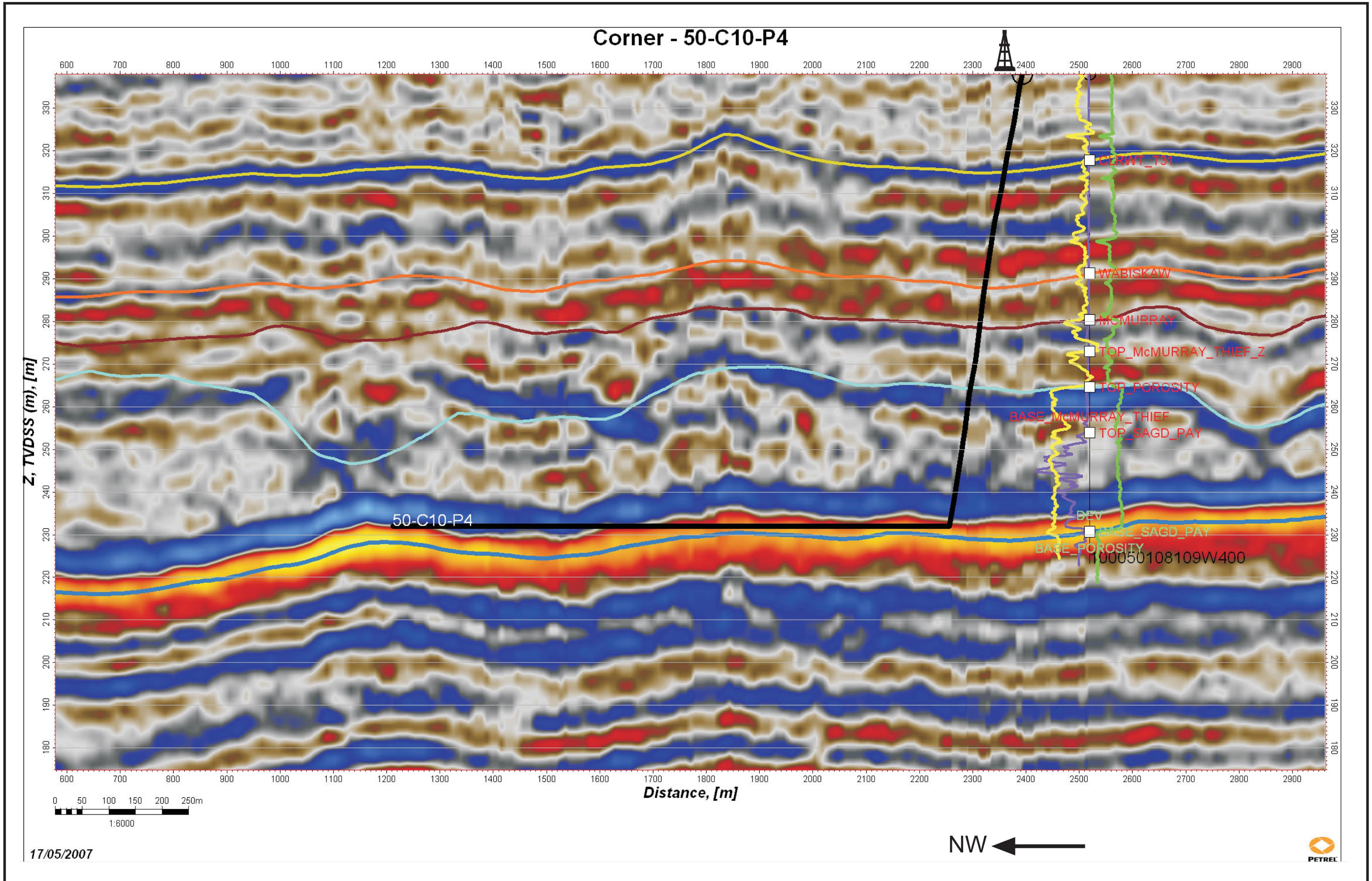


CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C10

Producer Well: P4



LEGEND

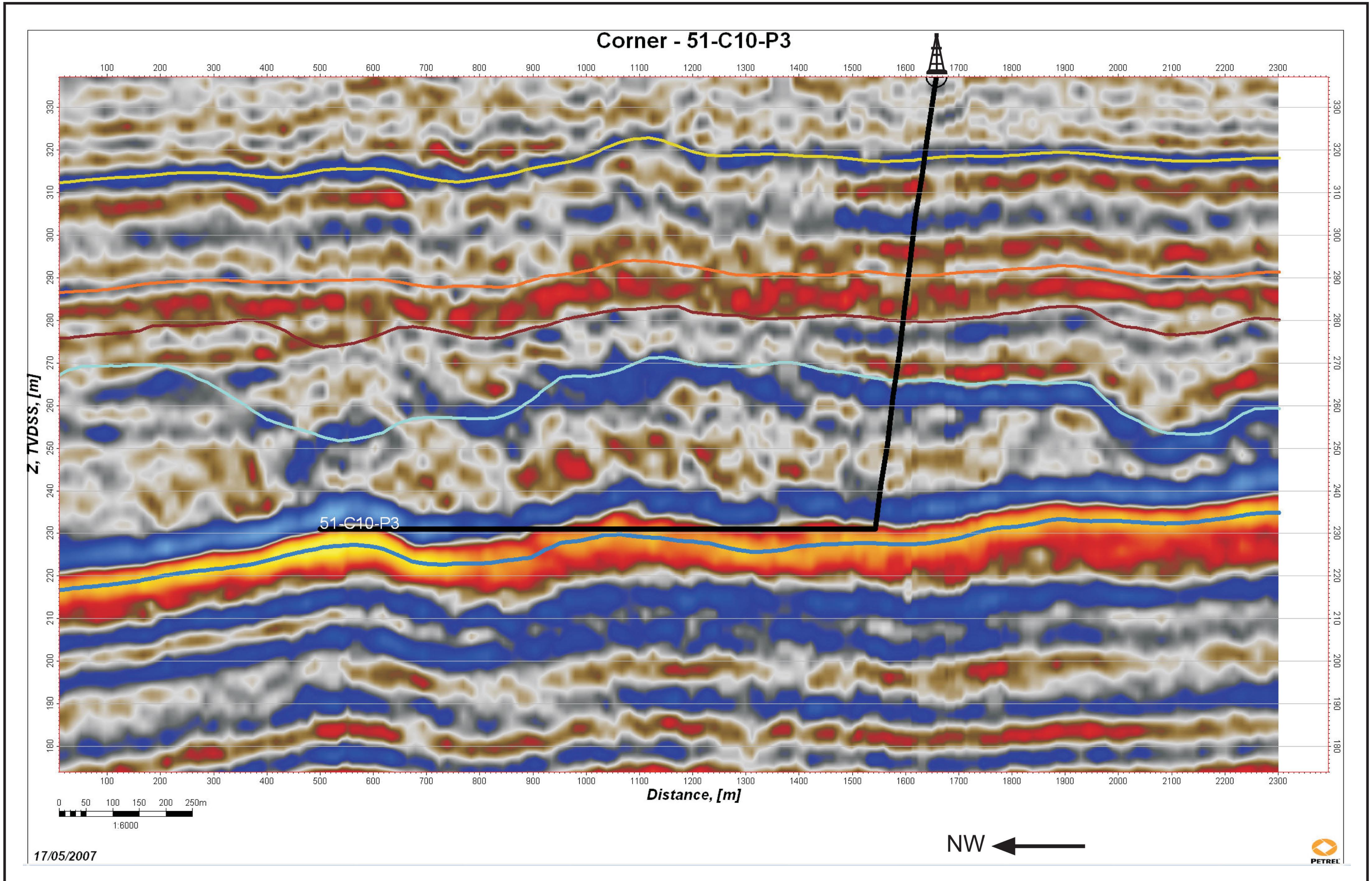
HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C10

Producer Well: P3



LEGEND

HORIZONS

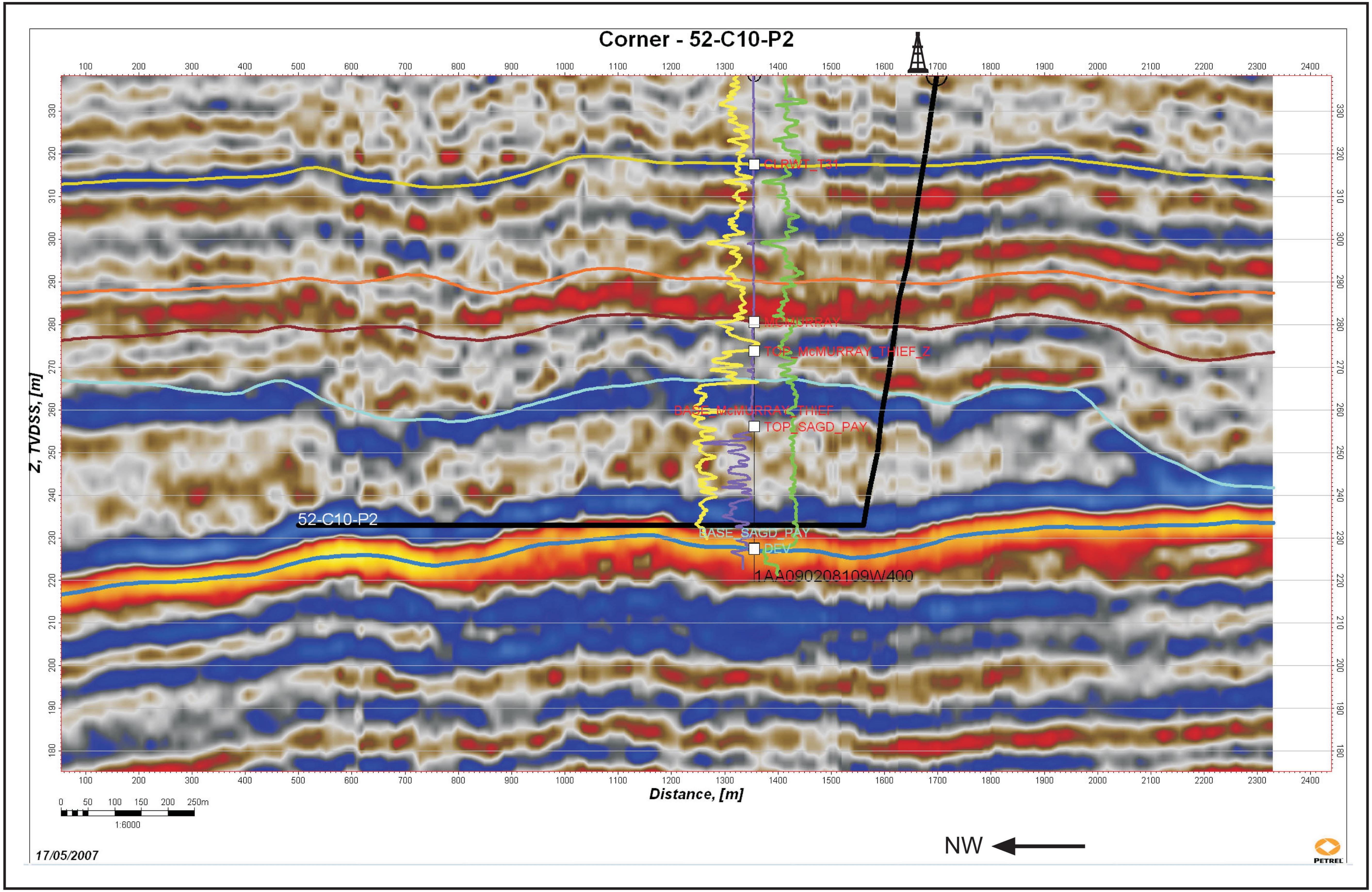
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C10

Producer Well: P2



LEGEND

HORIZONS

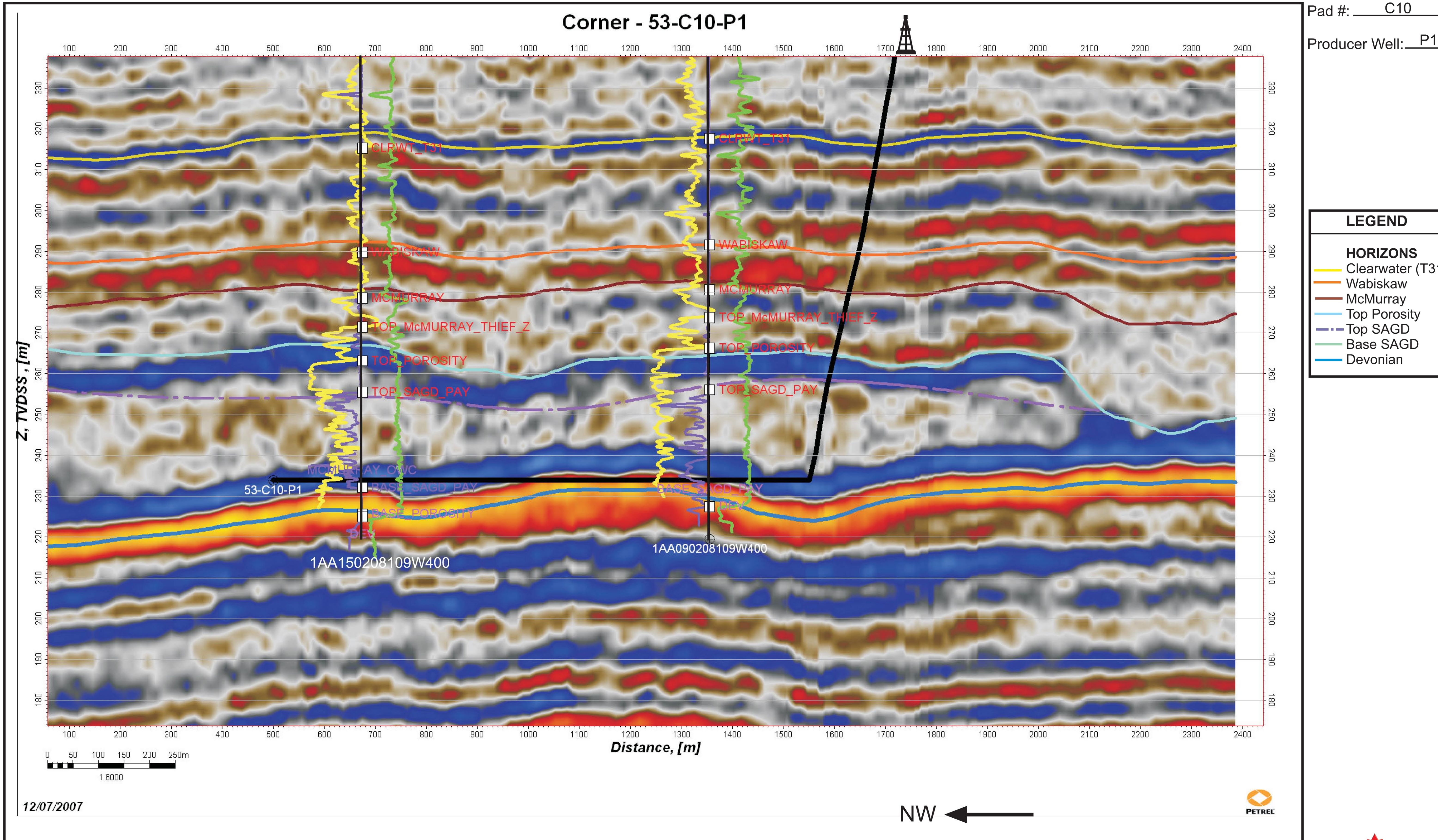
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C10

Producer Well: P1

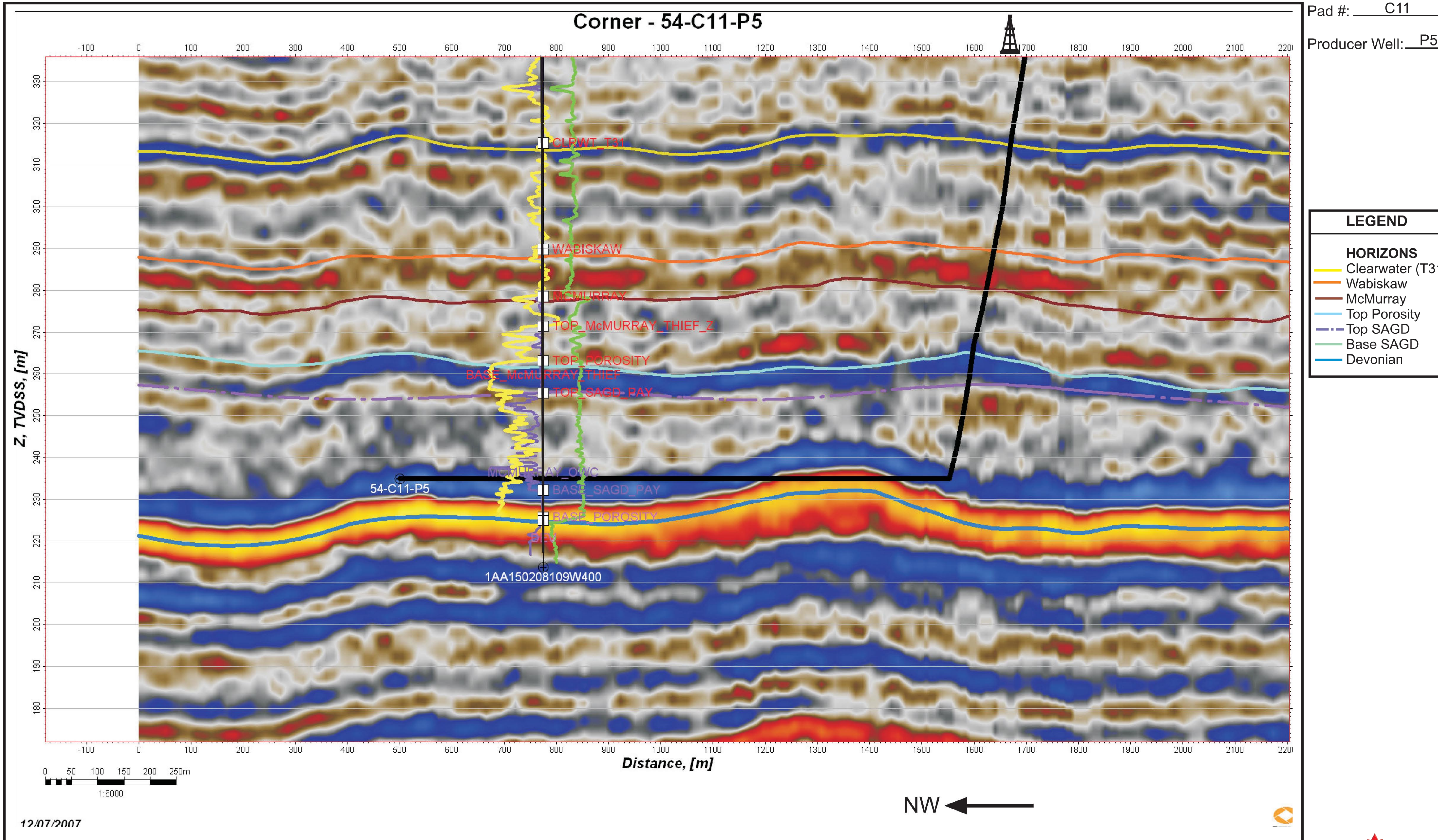


CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C11

Producer Well: P5

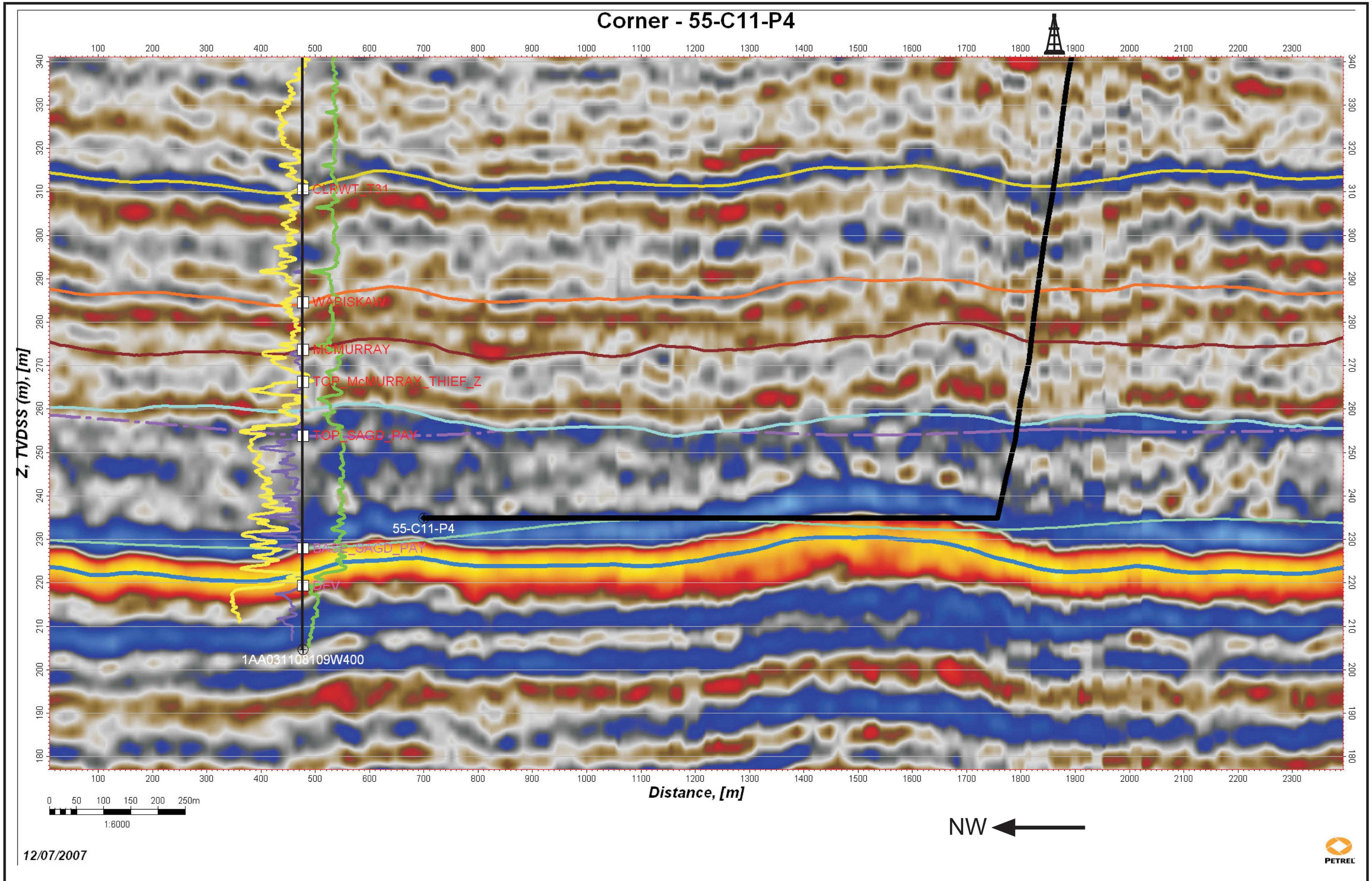


CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C11

Producer Well: P4

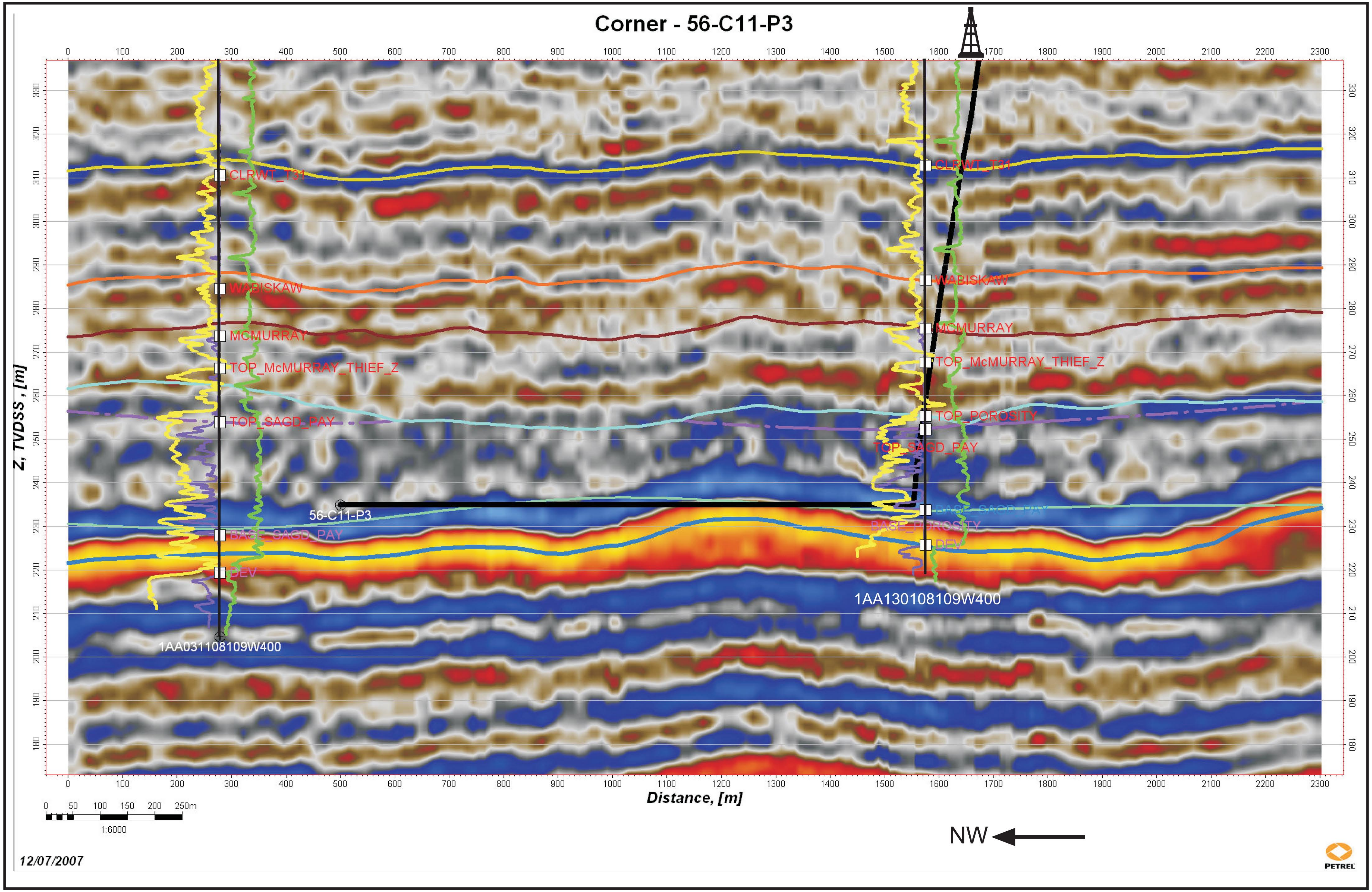


LEGEND

HORIZONS
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION



Pad #: C11

Producer Well: P3

LEGEND

HORIZONS

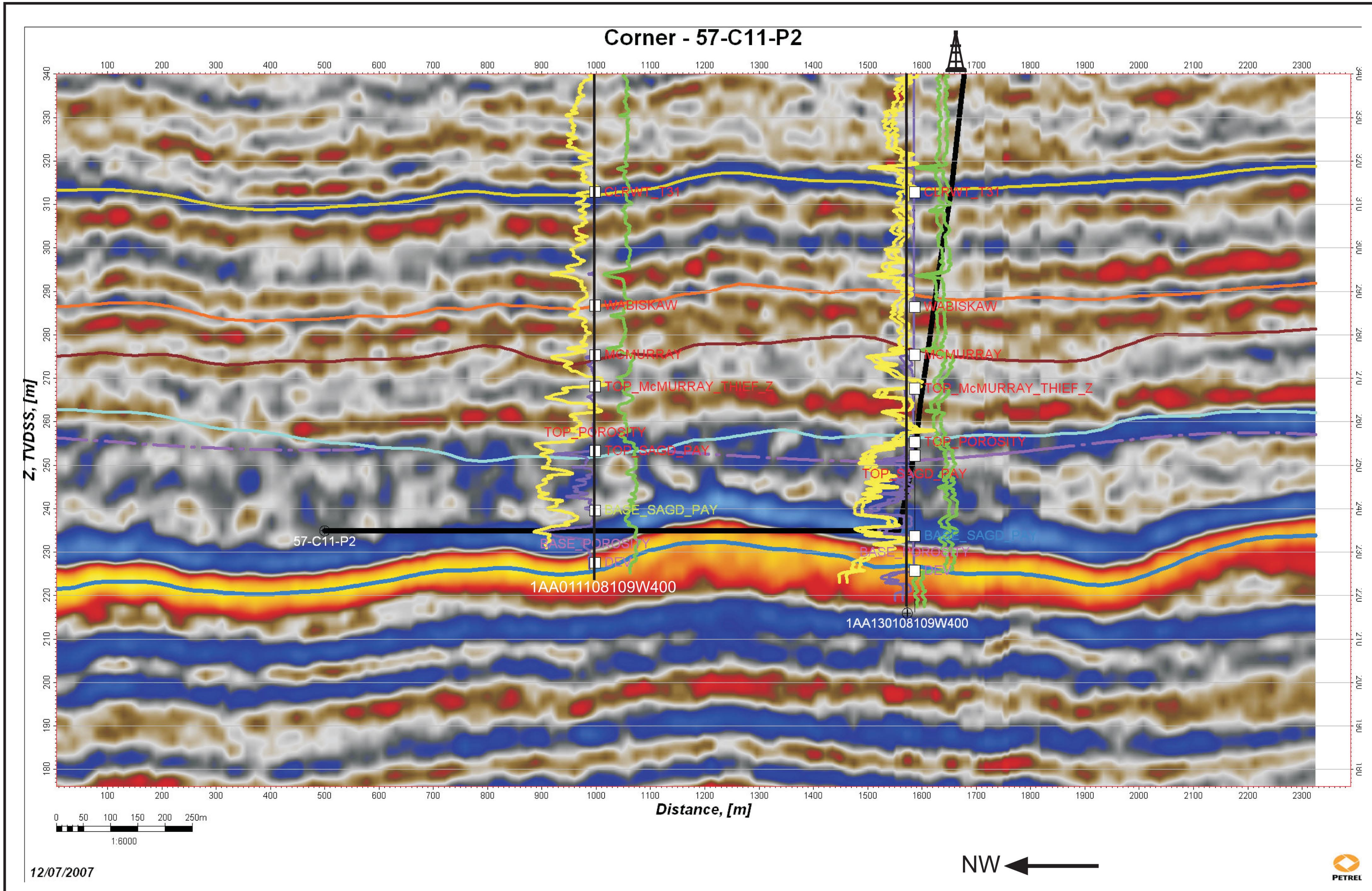
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN
OIL SANDS CORPORATION

Pad #: C11

Producer Well: P2



LEGEND

HORIZONS

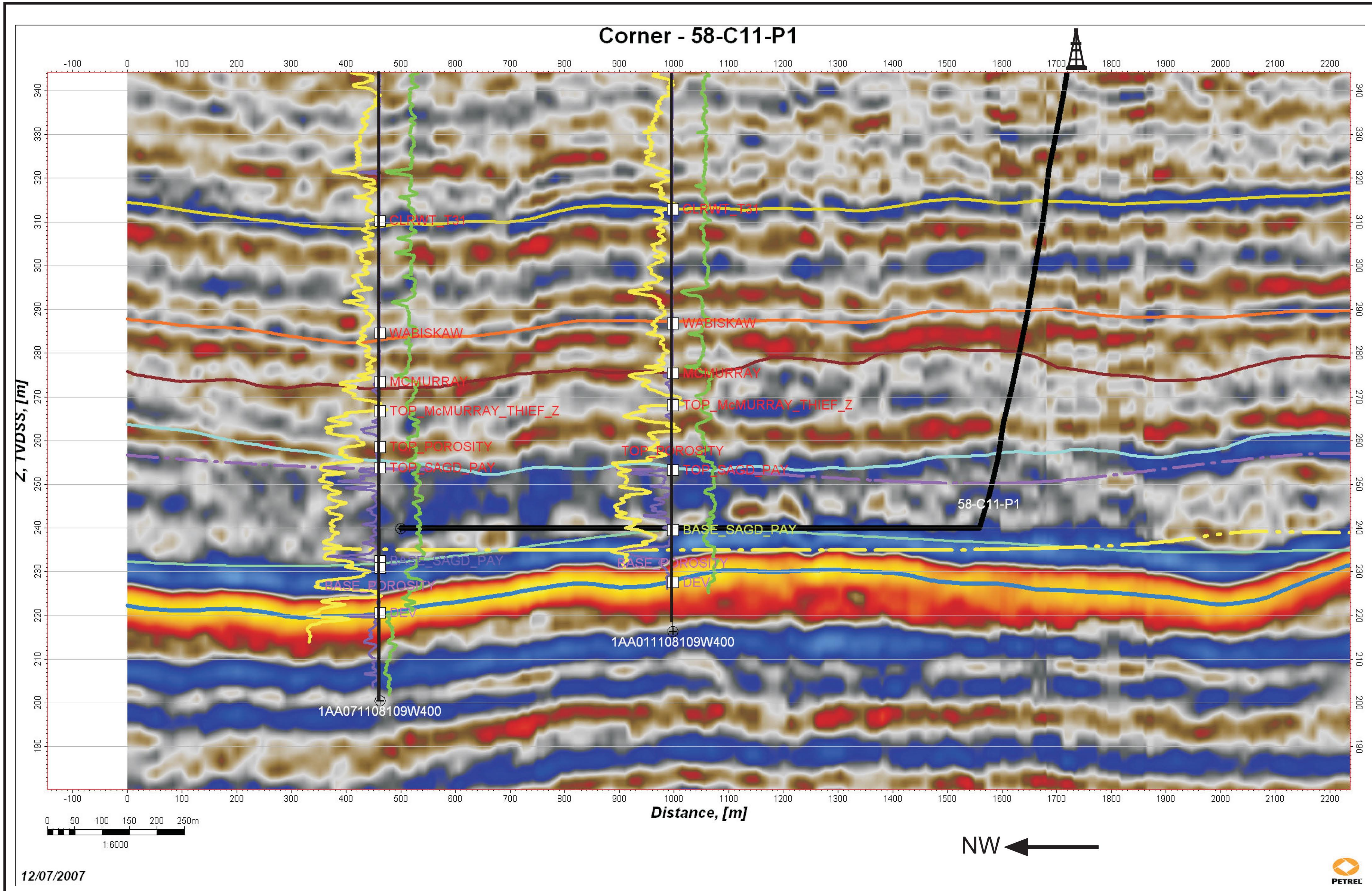
- Clearwater (T31)
- Wabiskaw
- McMurray
- Top Porosity
- Top SAGD
- Base SAGD
- Devonian

CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Pad #: C11

Producer Well: P1



CORNER AREA

NORTH AMERICAN OIL SANDS CORPORATION

Appendix D

TABLE OF CONTENTS

ALBERTA ENVIRONMENT LETTER, FEBRUARY 2006

Alberta [illegible]

Environmental Assessment Program
Regional Services
Northern Region

111, Twin Atria Building
4999 - 98 Avenue
Edmonton, AB T6B 2X3

Telephone (780) 427-5828
Fax (780) 427-9102

February 14, 2006

16 -02- 2006

Mr. Barry Worbets
Senior Advisor
Environment, Safety & Aboriginal Affairs
North American Oil Sands Corporation
Suite 800, 635 – 8th Ave. SW
Calgary, AB T2P 3M3

Dear Mr. Worbets

I am writing in response to your request for confirmation of North American Oil Sands' proposed plans for regulatory submissions (environmental impact assessment (EIA) and *Environmental Protection and Enhancement Act* (EPEA) approval applications) related to the Kai Kos Dehseh Project. The 10,000 bpd commercial demonstration project, Leismer, will require an approval under the *Environmental Protection and Enhancement Act (EPEA)*. The subsequent 165,000 bpd commercial project, Kai Kos Dehseh, is a mandatory activity according to the *EPEA Environmental Assessment (Mandatory and Exempted Activities) Regulation*, and will require an EIA.

Your plan to submit the *EPEA* application for the 10,000 bpd Leismer project, followed by an EIA for the 165,000 bpd Kai Kos Dehseh project which will include the *EPEA* application for the 20,000 bpd Corner commercial project is acceptable to Alberta Environment. Each subsequent commercial project phase up to 165,000 bpd will require an *EPEA* approval application.

If you have any questions or require further direction, please contact James Chen at (780) 415-9628 regarding the EPEA approval application for the Leismer Project and Lisa Nakonnik at (780) 427-2205 regarding the EIA for the Kai Kos Dehseh Project.

Sincerely

Mike Boyd

Mike Boyd
Regional Environmental Manager
Northern Region
(Designated Director Under the Act)

cc K. [illegible] (EUB)
L. [illegible] (CEAA)
K. [illegible] (ASRD)