## SECTION 5.0 – DRILLING AND COMPLETION

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5.0  DRILLING AND COMPLETION

5.1  Overview

Cenovus TL ULC (Cenovus) proposes to develop a total of 90 steam assisted gravity drainage (SAGD) well pads located in Townships 93, 94, and 95, Range 3 W4M, as shown in Figure 5.1-1, over the approximately 40 year operational life of the Telephone Lake Project (Project). Of the total SAGD well pads, 54 well pads will include up to seven dewatering wells each while the 36 remaining well pads will have only SAGD wells. Also there will be 10 separate dewatering only pads which will have up to five dewatering wells per pad. Four disposal well pads will be required for process water disposal and for excess dewatering water disposal. In total, 104 well pads will be installed over the life of the Project.

Typically, the SAGD well pads will contain 12 SAGD wells on 67 m horizontal well spacing plus seven dewatering wells where required. The surface layout design for a typical well pad is shown on drawing number TL1-44-PLT-00-002-01 (Volume 1, Attachment 4). All SAGD wells will be about 800 m in the horizontal section and will be thermally completed. The dewatering wells will be thermally completed, but may require various horizontal section lengths depending on the local dewatering requirements. Over the life of the Project, the current plan includes 961 SAGD well-pairs and 378 dewatering wells.

All new wells will be applied for through the Energy Resources Conservation Board (ERCB) licensing process and all necessary approvals for well licensing will be obtained as per normal procedures before any surface disturbance occurs. Applications for surface land requirements (well pads, well pad access roads, etc.) will be submitted to Alberta Sustainable Resource Development (ASRD). Cenovus will attempt to use existing clearings wherever practicable to minimize surface disturbance. Consultation with ASRD regarding the proposed infrastructure and development is ongoing.

5.2  Well and Pad Layout

Figure 5.1-1 shows the well pad layout and interconnecting infrastructure of the Project.

The design of the Project footprint incorporates both engineering and environmental considerations to minimize the overall footprint. Criteria used for locating and routing the various Project components include the following:

- select Project well pad sites that are a minimum distance of 100 m from the high water mark of all water bodies;
- consider the suitability of existing topographical (slopes, breaks), biophysical (soil, vegetation, wildlife) and hydrological conditions;
- avoid steep slope areas (slopes greater than 45%).
Legend

- Proposed Project Area
- Open Water
- Watercourse

Project Layout
- Borrow Pit
- CPF
- Camp
- Dewatering
- Disposal
- Laydown
- Main Access ROW
- Project ROW
- SAGD Only
- SAGD/Dewatering

Source: Cenovus, Spatial Data Warehouse Ltd.

Layout of Project Facilities
as outlined in the Historical Resources Act conduct an appropriate assessment of potential construction and operations effects on historical resources identified in the Historical Resources Impact Assessment completed for the Project;

- locate sites that maximize subsurface oil sands resource target;
- locate pipelines, roads and power lines on existing disturbance, where practical;
- incorporate mitigation features when engineering and designing pipelines and Project components;
- avoid wetlands where practical; and
- locate sites that minimize watercourse crossings.

For the well pads, the cleared area will vary depending on the well pad size. The well pad size is determined by the number of well-pairs that are to be drilled from each pad. The more well-pairs on a well pad, the greater the well pad size and disturbance area. All the SAGD well pads are shown sized for 12 well-pairs plus seven dewatering wells and will be approximately 335 m by 200 m as shown on the Typical Well Pad Plot Plan (Volume 1, Attachment 4). Each individual well pad surface disturbance area will be surveyed and submitted, as required, to ASRD for approval before any disturbance occurs.

Where practicable, and when authorized by regulatory agencies, Cenovus will combine the road, power line and pipeline rights-of-way into one corridor to optimize cleared areas and minimize surface disturbance.

### 5.3 Dewatering Wells

The dewatering process (Volume 1, Section 4.3) will start about one to two years prior to the SAGD operations at a given pad; however, all the wells will be drilled at the same time and, if possible, from common pads. Typically, the SAGD pads that have dewatering wells will likely have one air injection well, three water production wells and up to three water reinjection wells. Based on the location of the top water and its thickness, separate dewatering well pads for the water reinjectors may be required to optimally place wells for dewatering purposes prior to SAGD operations. In areas where the top water is less than 5 m thick, dewatering is not planned.

In the dewatering process, three types of horizontal wells are needed: air injectors, water producers and water reinjectors. The air injectors and water producers will likely be drilled from the SAGD well pads where possible and have horizontal sections in the range of 600 to 1,000 m or more. All the wells will be drilled into the clean water sand facies of the McMurray Top Water Zone, as described in Volume 1, Section 3.6.1. The air injectors will be located near the top of the clean water sand facies, while the water producers will be located near the bottom of the Top Water Zone about 1 m above the top water-bitumen contact. The water injection wells will be located near the top of the McMurray Top Water zone in the clean water sand facies. The orientation of the water injection wells will depend on local geological characteristics of the top
water and the underlying bitumen pay. In order for these wells to be optimally placed, separate well pads may occasionally be required to drill these water injection wells. The proposed locations of the 10 dewatering-only well pads are shown on Figure 5.1-1.

It is anticipated that all wells will be slant drilled, although in deeper areas, conventional drilling rigs could be used. All wells will be drilled with water-based muds and the surface and intermediate casing strings will be cemented with thermal cement. The horizontal sections in the water sands will be directionally drilled with a combination of resistivity and gamma-based steering tools. The horizontal sections will be completed with either slotted liner or a mesh type liner for sand control.

Figure 5.3-1 shows the planned completion details for both the air injectors and water injection wells. Figure 5.3-2 shows the planned completion details for the water producer. The water producers will be equipped with bottomhole electrical submersible pumps (ESPs) that will be controlled by variable speed drive at surface. The performance of each pump will be monitored at the central processing facility (CPF). Water production will be measured continuously at the wellhead. Bottomhole pressures will be monitored.

If a production wellhead or casing failure were to occur, pressure and flow rate fluctuations would activate out-of-range alarms in the control room. In this event shutting down the bottomhole pump would halt all production from the wells. Also routine operator attendance at the well pads will monitor for surface casing, wellhead and piping leaks.

### 5.4 SAGD Well-Pairs

The planned horizontal SAGD well pads needed for the Project are shown in Figure 5.1-1. The SAGD well-pairs are laid out on 67 m well spacing and each well pad will have up to 12 SAGD well-pairs. Over the Project life, a total of 90 SAGD well pads, with approximately 961 well-pairs, are planned.

The planned well pad drilling sequence is described in Volume 1, Section 4.5. Each individual well pad location and surface disturbance will be applied for through the appropriate regulatory bodies for approval before licensing any of the well-pairs.

The well pad locations and planned wells described herein are based on Cenovus’s current understanding of the reservoir. As further details are learned, the actual locations may shift; however, individual detailed plot plans will be issued to the local authorities for approval before any surface disturbance occurs.
339.7 mm 71.43 kg/m
H-40 ST&C Surface Casing landed at 90 m TVD

244.5 mm 59.53 kg/m
L-80 QB2 Production casing landed ~ 520 m MD

114.3 mm J55 tubing

Instrument String
31. mm coil

Tubing Packer

Liner Hanger ~ 500 m MD

Slotted Liner 177.8 mm  L-80 QB2
~ 1325 - 1525 m M.D.

Source: Cenovus

Dewatering Injection Well Completion Diagram
339.7 mm 71.43 kg/m
H-40 ST&C Surface Casing landed at 90 m TVD

244.5 mm 59.53 kg/m
L-80 QB2 Production casing landed at ~ 520 m MD

114.3 mm J55 tubing with ESP

Pressure Gauge & 48.3 mm tubing

Liner Hanger ~ 500 m MD

Slotted Liner 177.8 mm  L-80 QB2
~ 1325 to 1525 m MD
5.4.1 Production Wells

Each well-pair includes a horizontal production well and a horizontal steam injection well. The production well is the lower of the two wells that make-up the SAGD well-pair. The production well is drilled before the injector, and the horizontal section is located near the bottom of the reservoir to contact as much oil as possible for drainage from the reservoir. Water-based muds will be used to drill the wells. The surface and intermediate casing strings are cemented with thermal cement. The horizontal section will be completed with slotted liners in order to control sand production. There are two different configurations for the SAGD production well design, one for the circulation start-up as shown on Figure 5.4-1 and one for normal production operations as shown on Figure 5.4-2. After circulation start-up, the 2” coiled tubing string will be removed and the well equipped with a high temperature ESP. The ESP will be capable of pumping fluid from the well into the production gathering facilities and then to the CPF. Each well’s pump will be controlled by a variable speed drive system and the performance of each pump will be monitored at the CPF. Fluid production will be measured continuously at the wellhead. Bottomhole temperatures and pressures will also be monitored continuously via thermocouples and pressure gauges.

If a production wellhead or casing failure were to occur, pressure and temperature fluctuations would activate out-of-range alarms in the control room. In this event, shutting down the bottomhole pump would halt all production from the well. Also routine operator attendance at the well pads will monitor for surface casing, wellhead and piping leaks.

5.4.2 Steam Injection Wells

The steam injection well is drilled approximately 5 m higher in the reservoir than its associated production well. Ranging/survey technology is used to determine the relative proximity of the two wells. The well design follows the same specifications as the producers with respect to mud, cement and grades of steel and couplings (Figure 5.4.3). The injection well provides the steam needed to heat the bitumen to drain to the production well below. The injection well is drilled from an adjacent surface location on the well pad.

Cenovus’s experience at the Foster Creek Thermal Project and the Christina Lake Thermal Project leads to a high degree of confidence, based on the following, that well casing failures will not occur:

- the sealing feature of the premium couplings does not allow thread jump during casing expansion and contractions; and
- with the exception of the 90-day start-up stage, the operating pressures of the injection and production wells are well below the McMurray fracturing pressure (Volume 1, Section 4.5.3.2).
339.7 mm 71.4 kg/m
H-40 ST&C Surface Casing landed at 90 m TVD

244.5 mm 59.5 kg/m
L-80 QB2 Production casing landed at ~ 525 m MD

Liner Hanger ~ 505 m MD

Slotted Liner 177.8 mm L-80 QB2  
~ 1325 m MD

Instrument String
31.7 mm coil

Inner Tubing 89.0 mm tubing

Coil for Circulation
50.8 mm coil

Outer tubing
139.7 mm tubing

PROJECTION/DATUM: Cenovus
PROVIDED BY: AMCE H EH
DATE: 11-12-11
KW
QA/QC: Cenovus TL ULC
Telephone Lake Project

production Well Completion Diagram
(Start Up Configuration)

Source: Cenovus.

Figure 5.4-1

CE0339901
December 2011
KW KW EH EH

Fig05.04-01 SAGD Producer 11-12-11
PROJECTION/DATUM: NA
ANALYST: KW
PROVIDED BY: Cenovus
FINAL MAPPING BY: AMEC
Production Well Completion Diagram (ESP)

339.7 mm 71.40 kg/m
H40 ST&C Surface Casing set 90 m TVD

244.5 mm 59.53 kg/m
L80 QB2 Production casing landed at ~ 525 m MD

Retrievable Liner
114.3 mm tapered to 88.9 mm

Instrument String
48.3 mm landed @ heel

177.8 mm slotted Liner
L80 QB2 ~ 1325 m MD

Liner Hanger @ ~ 505 m MD
339.7 mm 71.43 kg/m
H-40 ST&C Surface Casing landed at 90 m TVD

244.5 mm 59.53 kg/m
L-80 QB2 Production casing landed at ~ 525 mKB

139.7 mm J55 tubing tapered to 114.3 mm

Steam Subs

Coil for Circulation
50.8 mm coil

Liner Hanger ~ 505 m MD

Slotted Liner 177.8 mm  L-80 QB2
~ 1325 m M.D.
If an injection wellhead or casing failure occurred, the flow rate, pressure and temperature fluctuation would activate alarms. The wells would be shut in at surface, stopping the steam injection. Quench water would be pumped down the annulus to kill the well. In addition, routine operator attendance at the well pads will monitor for surface casing, wellhead and piping leaks.

5.5 Water Injection and Disposal Wells

Cenovus will utilize two types of wells, one for the injection of excess non-saline top water from the dewatering operations and another type for the disposal of process wastewater. The excess top water will be injected into the Lower McMurray Water Zone while the process wastewater will be injected into the Keg River (Methy) Formation.

5.5.1 Excess Top Water Injection Wells

Excess top water from the dewatering operations will be injected into the Lower McMurray Water Zone, which contains water of comparable quality. Up to 10 water injection wells may be required over the life of the Project. Alternatives to injecting excess top water into the Lower McMurray Water Zone are discussed in Volume 1, Section 10.5.

5.5.2 Process Wastewater Disposal Wells

The excess process wastewater will be disposed into the saline Keg River (Methy) Formation. Up to 10 wastewater disposal wells at two new pads will be required over the Project life. The initial disposal pad is currently planned for the 10-20-093-03W4M location.

5.6 Water Source Wells

Water source requirements for the Project are illustrated on the Block Flow Diagram (Volume 1, Attachment 5) and are briefly summarized below.

5.6.1 Domestic Water Source Wells

For the Project, Cenovus plans to use 60 m$^3$/d of non-saline water from the Quaternary Upper Sand (S2) aquifer for domestic purposes and up to 190 m$^3$/d during construction activities, as described in Volume 1, Section 7.3. One or more new water source wells will be drilled and tested near the CPF.

5.6.2 Top Water Source Wells

During conventional SAGD operations (Volume 1, Section 4.2.3), on a cold water equivalent basis, produced water will exceed steam injected; therefore, source water makeup requirements for steam generation will be limited to Project start-up and upset conditions. During Project start-up, it is anticipated that about 10,000 m$^3$/d of excess non-saline top water from the dewatering operations (i.e., horizontal water producers) will be used as source water, as described in Volume 1, Section 7.4.
5.7 **Delineation Wells**
Further delineation will be carried out to allow for detailed placement of the horizontal well-pairs as they are needed over the life of the Project. Additional delineation wells may be needed to allow for refined placement of recovery well-pairs, in particular where the reservoir has greater variability. Several of these delineation wells may ultimately serve a dual purpose, as many of them may be instrumented as observation wells for SAGD operations and dewatering operations. It is anticipated that approximately one observation well per SAGD pad will be required.

5.8 **Drilling Waste Management**
The ERCB’s *Directive 050: Drilling Waste Management* (ERCB 1996a) outlines allowable management options for the disposal of drilling waste within the province of Alberta. Cenovus’s drilling waste management plan for the Project will be managed with the following objectives:

- compliance with all provincial waste management regulatory requirements;
- promotion of efficient and innovative waste management practices (i.e., investigation of recycling possibilities); and
- minimization of future environmental liabilities.

5.8.1 **Drilling Waste and Cement Storage**
A combination of on-lease tanks and earthen storage systems will be used in conjunction with remote sumps to contain drilling waste and cement returns prior to disposal.

5.8.2 **Drilling Waste and Cement Disposal**
All drilling waste will be managed in accordance with the requirements outlined in the ERCB’s Directive 050 (ERCB 1996a) and the *Oil and Gas Conservation Regulations* (ERCB 2011). The final disposal method for drilling waste will be determined on the basis of the analytical results of waste sampling, with environmental concerns given primary consideration.

Drilling waste will primarily be disposed of on-site or at a remote sump via the disposal methods outlined in the ERCB’s Directive 050 or, alternatively, hauled to an approved landfill or disposal facility. Cement returns will either be buried on-site or at a remote sump as per Directive 050 (ERCB 1996a), incorporated into access roads or well pads as aggregate for aggregate following Directive 058: *Oilfield Waste Management Requirements for the Upstream Petroleum Industry* (ERCB 1996b), or hauled to landfill as detailed in *Volume 1, Section 9.5*. 
5.8.3 Drilling Waste Reuse

Solids control equipment may be used to separate the water portion of the drilling waste from the solids portion and will either be set up at the drilling location or staged at a remote sump location. The primary purpose of separating the water from the drilling waste is for its re-use as drilling fluid make-up water and for the potential beneficial use of the solids for pad construction material. Utilization of solids control equipment reduces the amount of drilling waste requiring disposal as well as reduces total fresh water usage.

Any technology used for solids control will comply with regulatory and Project requirements, will be screened and selected based on such requirements and best practices, and will have practices and procedures established before use.

5.9 Literature Cited

