Hydrodynamics of the karstified Grosmont aquifer system, Alberta, Canada

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Summary

The hydrogeology of bitumen extraction from the Cretaceous layers north of Fort McMurray is fairly well understood and has been the subject of mining activity for more than 40 years. Since about 2000, subsurface extraction methods like SAGD have commenced operations first in the areas north and then south of Fort McMurray. Subsequently, the Cretaceous Wabasca oil sands area (the area between the canyon of the Athabasca River and the Wabasca River) became the focus of intense development. Current bitumen extraction also targets the Devonian Grosmont Formation, as indicated by development applications by two operators put forward in February and April 2013.

The development of the Wabasca oil sands imposes new challenges which were not encountered in the SAGD operations north and south of Fort McMurray. Therefore much of the experience from that region cannot be transferred without re-assessment of their validity, in particular with respect to regional groundwater flow, water production and waste water disposal.

The special groundwater conditions in the area of the Wabasca oil sands have been created and maintained by the unusually high karstic permeability of the Grosmont Formation which is absent in the other bitumen extraction areas. Hitchon (1969) indicated the presence of a low fluid potential drain within the Devonian layers extending west-southwest from the Athabasca oil sands. Weyer et al. (2013) have shown that this drain is caused by the Grosmont Formation which receives groundwater from the Quaternary, Cretaceous and the Paleozoic layers above, as well as the Paleozoic and deeper layers below. The Grosmont Formation subsequently transmits much of the groundwater from the area of the Wabasca Oil Sands towards the Athabasca canyon and discharges it there into the Athabasca River. The hydraulics of this formation has a direct hydraulic effect on the overlying layers (to the groundwater table) and on the layers below.

Conclusions

Water production from the Grosmont Formation has already created a depression cone of drawdown extending from west of the Wabasca River to the Athabasca River, underlying the area of the Cretaceous Wabasca oil sands (Figure 1). The drainage and drawdown by the Grosmont affects both water production and waste water disposal. The concept of groundwater and waste water underflowing the Birch Mountains in a northwesterly direction towards the Peace River has been quoted by some of the operators with respect to their wastewater disposal. This concept is, however, not applicable as, within the area of the Wabasca Oil sands,

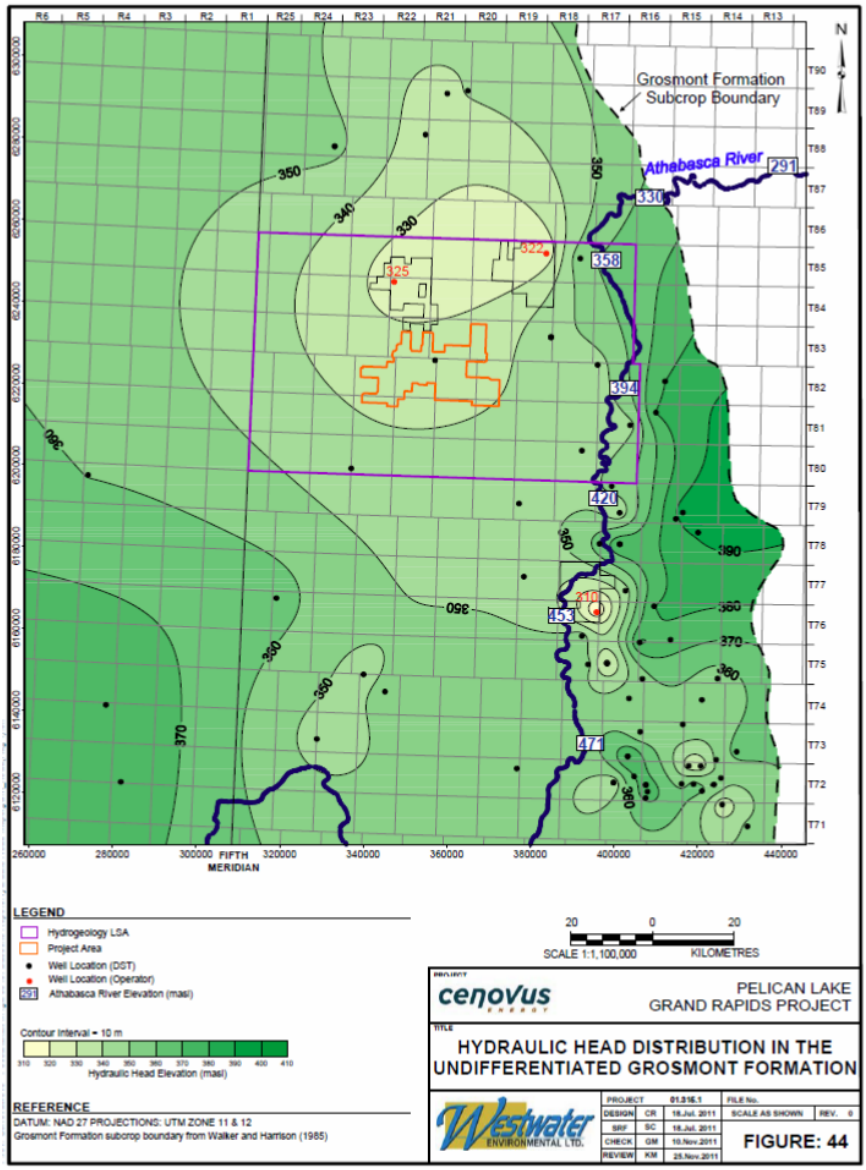

Figure 1 . Hydraulic head distribution in the undifferentiated Grosmont formation. From Cenovus, 2011, Volume 4, Appendix 4-IV, Figure 44.

natural groundwater flow in the Grosmont Formation has been directed towards the Athabasca River (Weyer et al., 2013) and possibly the Wabasca River.

The special groundwater conditions of the Wabasca oil sands need to be incorporated into the boundary conditions and parameters of mathematical groundwater flow models to cover the entire geologic domain (from the groundwater table down to the Paleozoic containing the Grosmont Formation with unusually high karstic permeability).

References

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