13.2 **Carbon dioxide emissions and water consumption from oil shale production: A second look**

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In a previous analysis, Boak (2008) concluded that the CO_2 emissions from in-situ oil shale production would be dominated by the contribution from burning of fuel in a power plant providing electricity for heating to pyrolysis temperatures. Mitigation of this emission level would largely depend upon reduction of the power plant emissions, or substitution of alternative means of heating the rock. At that time, proponents of in situ methods generally planned to remove evaporitic minerals (nahcolite, dawsonite) by solution mining prior to heating of the rock. Such a process adds to the potential water consumption of the process, which already may use substantial quantities of water for power plant steam condensation and post-retort water/steam cleaning of the rock (Boak and Mattson, 2010).

ExxonMobil has proposed to heat the rock in the saline section of the Green River Formation (GRF) prior to removing the bicarbonate evaporitic minerals. Nahcolite will react to natrite, releasing water and CO_2, at temperatures in the vicinity of 150°C by the following reaction:

$2\ NaHCO_3 = Na_2CO_3 + H_2O + CO_2$.

This release of volatile constituents may be sufficient to fracture the rock, but it will certainly be released when the additional volume increase from pyrolysis occurs in the range of 300-400°C. Nahcolite constitutes as much as ~30 wt% of the rock in the saline sections of the GRF, and this large additional CO_2 output has not been accounted for in our earlier analyses. Mitigation of this release, which should occur in a restricted temperature window, may be expected to add to the cost of recovery.

At the same time, the much larger volume of water released from the rock will mitigate use of water elsewhere in the process for recovery of oil shale. ExxonMobil appears to consider using water both to recover the transformed nahcolite and to remediate any contaminants of concern in the retorted block as a single step. This paper will provide an estimate of the additional CO_2 and water released and uncertainties in the estimates, and discuss its potential impact on oil shale production.