

North Shore Environmental Consultants Inc. (North Shore) and Waterline Resources Inc. (Waterline) are pleased to provide Petroleum Technology Alliance Canada (PTAC) with a review of Phase 2 Environmental Site Assessment (ESA) data from past drilling waste disposal locations to better understand the effectiveness of the Alberta Energy Regulator (AER) document “Assessing Drilling Waste Disposal Areas: Compliance Options for Reclamation Certification” (ADWDA, AER 2014).

The intended outcome of this work program is to evaluate the conditions and calculation triggers for drilling waste disposals completed prior to November 1, 2012 and determine if the Compliance Option 2 (CO2) criteria: 1) are appropriate as currently written; 2) require adjustment to reduce false positive or false negative triggers during Phase 2 ESAs; or 3) require other changes. The primary focus of the evaluation is concentrated on petroleum hydrocarbons (PHC), salinity and drill stem test (DST) endpoints as these conditions/calculations occurred in the highest frequency.

A total of 1681 sites were reviewed with 510 candidate sites identified for statistical evaluation. A summary of the results are noted below:

- PHC condition triggers in CO2 were a good indication of Tier 1 PHC exceedances during the Phase 2 ESA. All individual condition triggers accurately predicted a Tier 1 PHC exceedance on  $\geq 50\%$  of the sites.
- Overall, meeting or exceeding the post disposal total PHC concentration in CO2 was not a good predictor of actual Tier 1 exceedances during the Phase 2 ESA. While it correctly identified Tier 1 exceedances 67.1% of the time when the calculation exceeded the CO2 endpoint, 56.9% of the sites exceeded Tier 1 when the CO2 calculation met the required  $<0.1\%$  total PHC endpoint.
- Overall, meeting the Salt Calculation in CO2 (mud products and DST returns combined) was a good predictor of meeting Tier 1 during the Phase 2 ESA. When the salt calculation met the CO2 endpoint, 77.3% of the sites passed Tier 1/D50 for disposals pre-October 22, 1996 and 66.7% for disposals post-October 22, 1996.
- Exceeding the Salt Calculation in CO2 (mud products and DST returns combined) was a relatively fair to poor predictor of actual Tier 1/D50 exceedances during the Phase 2 ESA. It correctly identified Tier 1/D50 exceedances 40.5% of the time for disposals pre-October 22, 1996 and 29.2% for disposals post-October 22, 1996. This is an indication that the CO2 endpoints for the salt calculation could be increased.
- Overall, meeting the salt calculation in CO2 (mud products only) was a good predictor of actual Tier 1 exceedances during the Phase 2 ESA. When the salt calculation met the CO2 endpoint, 75.6% of the sites passed Tier 1/D50 for disposals pre-October 22, 1996 and 66.7% for disposals post-October 22, 1996.



- Exceeding the Salt Calculation in CO<sub>2</sub> (mud products only) was a poor predictor of actual Tier 1 exceedances during the Phase 2 ESA. It correctly identified Tier 1 exceedances 50.5% of the time for disposals pre-October 22, 1996 and 18.8% for disposals post-October 22, 1996.
- Exceeding the salt calculation in CO<sub>2</sub> (where DST returns contributed >50% to the CO<sub>2</sub> endpoint) was a 'Poor' to 'Very Poor' predictor of actual Tier 1 exceedances during the Phase 2 ESA. It correctly identified Tier 1/D50 exceedances 17% of the time when the 350,000 mg/L chloride default was used and 27% when the 215,000 mg/L chloride default was used. In contrast, the use of site specific chloride values (tested concentration or resistivity) were shown to be 'Fair' predictors of actual Tier 1 exceedances at 40%.

A summary of the general recommendations for CO<sub>2</sub> are listed below:

- When known volumes of hydrocarbons are added to the drilling fluid, AER should consider accepting compliance with the post-disposal hydrocarbon concentration in the final soil-waste-mix (not to exceed 0.1%, dry weight basis, for land treatment on subsoil, landspreading and mix-bury-cover OR 0.5%, dry weight basis, for land treatment on topsoil).
- When an unknown mud product is added to the drilling fluid and the specific quantity is known (number of sacks or pails), AER should consider accepting compliance through inclusion of the unknown mud product quantity in all CO<sub>2</sub> calculations.

A summary of the specific PHC, Salinity calculation and default chloride concentration for DST returns are listed below:

Compliance Option 2 – Petroleum Hydrocarbons	Recommendation
PHC/Invert Mud System (no disposal records)	No Change
Kick or Flow	No Change
Horizontal Oil Well (no disposal records)	No Change
Under Balanced Drilling	No Change
PHC Added to Mud	No Change
Post-Disposal Total PHC Value (0.1% total PHC endpoint)	No Change to Endpoint. Consider Modified Wording Under CO <sub>3</sub> .

Compliance Option 2 – Salt Calculation and DST Returns	Recommendation
Salt Calculation Pre-October 22, 1996 Disposals	22.5% Increase Revise endpoint from 0.026 to 0.032
Salt Calculation Post-October 22, 1996 Disposals	22.5% Increase Revise endpoint from 0.035 to 0.043
DSTs – Default Chloride Concentration 215,000 mg/L	Reduce to 125,000 mg/L (interim) and/or investigate regional formation chloride concentrations. Consider modified wording to include use of regional data.