Table 1: Recommendations that NRCan suggests be incorporated into the EA Report for the Central Ridge Exploration Drilling Project

EIS Section	Context	Comment	Recommendations
2.5.3	Produced water within oil and gas reservoirs is often brackish and commonly contains chlorine salts such as sodium chloride (NaCl). Given the explicit reference made by the Proponent that produced water will be flared if formation flow testing with flare is employed, this provides some possibility of having chlorine in the flare stream. Chlorine is a necessary component for the formation of dioxins and furans, but their formation is also contingent upon other enabling conditions, and the presence of chlorine alone is not a guarantee of dioxin and furan formation. Dioxins and furans are chemicals that are identified as toxic under the Canadian Environmental Protection Act (CEPA-1999), and are tracked under the National Pollutant Release Inventory (NPRI). Dioxin is a term commonly used to refer to an entire group of chlorine containing compounds more correctly known as polychlorinated dibenzo-p-dioxins (PCDD). In some cases, the term dioxin may also be meant to include related chemicals called furans, which themselves are properly called polychlorinated dibenzofurans (PCDF). The mechanisms of formation of PCDD and PCDF are complex and are only partially understood. In general, formation may occur through homogeneous reactions in the vapour phase or in heterogeneous reactions on solid surfaces such as small soot or ash particles [1]. For each of these primary pathways, there is a preferred temperature window for formation of PCDD/PCDF, which is approximately 500-800°C for the homogeneous route and 200-400°C for the heterogeneous route. Although the heterogeneous reactions are most effective in the presence of metal oxides that catalyze the	The Proponent indicates that, if flaring is employed during formation flow testing, produced water will be carried over into the flare, and that they will use third-party well testing contractors for the described formation flow testing. The Proponent also indicates that "most suppliers for well testing equipment / services have their own burner technology that has been tested and quantified for liquid fallout (i.e., oil phase) and emissions (e.g., carbon monoxide [CO], CO2, nitrogen oxides [NOX], hydrocarbons)", and that "documented fallout and combustion efficiencies for burners on the market from major suppliers are typically 99.9%". The Proponent does not however explicitly state that the third-party well testing contractor they will employ will utilize burner technology that has been tested and quantified for liquids fallout and emissions, or has a documented fallout or combustion efficiency of 99.9%. Additionally, the Proponent does not indicate whether the burner technology that will be deployed has been evaluated for toxic emissions of non GHG or criteria air contaminant (CAC) substances that could be harmful to marine habitat, fish, marine birds and marine mammals. The Proponent indicates that they have the technical ability to control the amount of produced water that will be flared, and that they can separate and treat produced water	There is growing domestic and international awareness and sensitivity regarding the environmental and health impacts associated with the potential for GHG, CAC, and toxic emissions from intentional (and often technically and economically avoidable) practices such as flaring within oil and natural gas exploration and production. In the context of the formation flow testing described in Section 2.5.3, the potential for environmental and health risks and impacts associated with GHG, CAC or toxic emissions, or the fallout of oil phase liquids into the environment, is entirely linked to whether the Proponent determines to intentionally undertake formation flow testing with flaring. In specific regard to the potential for fallout of oil phase liquids into marine or terrestrial environments from flow testing with flaring, the atmospheric fate of oil phase fallout is that volatile constituents of any crude oil will evaporate. These volatile organic compounds (VOC) are characterized as CAC emissions. Notwithstanding that deposition of liquid hydrocarbons can also contribute to deleterious impacts upon marine and terrestrial habitats and wildlife, and that residual crude oil solids that do not evaporate can persist in the environment, the NRCan OERD is assessing only the air emissions impact(s). The Proponent can eliminate the environmental and health risks and impacts associated with GHG, CAC or toxic emissions, or the fallout of oil phase liquids associated with formation flow testing, by opting to employ an available "alternative to formation flow testing with flaring" process, such as formation testing while tripping, which the Proponent identifies in Section 2.5.3.

	reactions, recent experiments have also shown the potential of small in-flame soot particles as a surface site for heterogeneous PCDD/PCDF formation [2]. Since soot is always present within a diffusion flame typical of a flare (even if it does not escape the flame to be emitted into the atmosphere), this raises possibility that PCDD/PCDF could potentially form within the flame of a flare via the heterogeneous reaction path. Notwithstanding the Proponent's reference to documented fallout and combustion efficiencies for burners on the market from major suppliers as typically being 99.9%, visibly detectable emissions of soot particles escaping the flame zone of onshore and offshore flares are common. Although the application of combustion efficiency promoting technologies such as turbulence and air-to-fuel ratio optimizing flare tip designs, and steam or compressed air assisted combustion can be applied to flaring and can serve to reduce emissions of soot particles, flaring is a well known source of soot particles. The temperature ranges necessary for homogenous and heterogeneous PCDD/PCDF formation can also be found under certain flaring operating conditions. Environment and Climate Change Canada identifies fuel burning as a process that can potentially result in PCDD and PCDF formation and emissions into the air, and further identifies that PCDD and PCDF will partition onto small soot particles, which will settle onto the ground or into marine environments. The presence of the above described enabling chemical, thermal and physical conditions identifies the potential for PCDD and PCDF formation, transport and deposition into terrestrial or marine environments, and PCDD and PCDF uptake into food chains. Once introduced into food chains, PCDD and PCDF are well known to accumulate and concentrate in fatty food sources such as fish, meat and	from formation flows for subsequent direct ocean discharge in compliance with regulation(s). The Proponent also identifies the ability to undertake formation flow testing without a need for flaring, using "Formation Testing While Tripping". It is therefore understood that any volumetric rate of carry-over of produced water to hydrocarbon fluid flows being directed to a flare will be intentional and controllable, and are avoidable. The separation of non-hydrocarbon liquids such as produced water, from single phase or two-phase oil and natural gas hydrocarbon fluids during formation flow testing and subsequent production, is a common and well-understood unit operation that can be successfully applied to onshore and offshore oil and gas activity. Complete and sustainably achievable separation of produced water from formation testing and production flows requires the proper engineering design and adequate sizing of single or multi-stage inlet separation vessels that provide sufficient flow disruption(s) and residence time within the vessel(s), in order to eliminate produced water carryover to the flare	Should the Proponent determine to employ formation flow testing with flaring, it is recommended that the following conditions be included into the EA Report by the Agency in order to minimize or eliminate the potential for emissions or the fallout of oil phase liquids. 1. In regard to GHG and CAC emissions, and the potential for fallout of oil phase liquids, and given that the Proponent indicates that documented fallout and combustion efficiencies for burners on the market from major suppliers are typically 99.9%, the Proponent shall be required to document and verify to the CNLOPB that any third-party contractor(s) that will undertake formation flow testing with flaring on behalf of the Proponent, will only use burner technology that ***is*** tested and proven to provide 99.9% fallout prevention and combustion efficiencies. 2. In regard to the potential for dioxin and furan compound emissions, and given that the potential for the formation of these toxic compounds can be technically and operationally eliminated if the Proponent determines not to intentionally direct produced water to the flare for combustion, it is recommended that the Proponent shall not flare any produced water.

	milk, and are therefore transferable to mammals, birds and reptiles in terrestrial and marine environments. Both PCDD and PCDF can be highly toxic to wildlife and have potential to produce a broad spectrum of adverse health effects in humans [3].		
15.1 15.2 15.3 15.4		Further to NRCan's comments in previous exploratory drilling projects, NRCan reiterates that current oil spill models do not adequately consider the fate of the heavier components in the oil. Consequently mass balance estimates shown in Figures 15-7 to 15-14 will give estimates of biodegradation that will be high while those for sedimentation will be low. This would also impact the estimates of the amount of oil that would reach shores because heavier oil components in the water column would be carried towards shores and are less likely to resurface. Consequently this portion of the oil would not be "recoverable" until it lands on shore. However, NRCan acknowledges that this is an ongoing area of research and that other federal departments are of the view that current models provide sufficient information. NRcan will conduct simulations, publish data, and continue ongoing discussions with industry to further advance existing models. As such, there is no need for NRCan to ask further information on this, however we ask that these views be reflected in the EA Report.	NRCan suggest that the following wording be included by the Agency in the EA Report when it is produced: NRCan advises that the current oil spill models do not consider the contents of the persistent portions of the crude oil and that biodegradation rates are therefore over-estimated; however, NRCan agrees that this is indeed on ongoing area of research and has indicated that it will conduct simulations, publish data, and continue ongoing discussions with industry to further advance existing models. Despite the potential shortcomings identified by NRCan, other federal departments are of the view that current models provide sufficient information.

References

[1] Stanmore, B.R. (2004) The formation of dioxins in combustion systems, *Combustion and Flame*, 136:398-427.
[2] Ryan, S., Wikström, E. Gullet, B.K., Touati, A. (2004) Investigation of the Pathways to PCDDs/Fs from an Ethylene Diffusion Flame: Formation from Soot and Aromatics, *Thermal Processes*, 66:1119-1125.
[3] USEPA (2004), NAS Review Draft of EPA's *Exposure and Human Health Reassessment of 2,3,7,8-Tetrachlorodibenzo-p-Dioxin (TCDD) and Related Compounds*