Summary of Carbon Management Canada Stakeholder Feedback and Reservoir Containment Team (RCT) Response on Technical Reports				
Section	**Stakeholder Feedback - Issue**	**Possible Solution or Recommendation**	**Rationale to Support Solution or Recommendation**	**RCT Response**
Section 4 p 3	Glacial loading	Better understanding of burial history of the entire Clearwater – McMurray Fm history.	Glacial stresses will also have affected the caprock and reservoir system. The glacial history of the area means that during ice retreat time, which can occur very rapidly (15,000 years), upwards of 20 MPa of pressure could have been quickly removed from the reservoirs during ice sheet retreat. This would likely have resulted in overpressure and possibly fracturing of the caprock. This issue is not restricted to just the glacial sediments which will post-date glacial loading and unloading.	The RCT acknowledges the probability of the Clearwater caprock being fractured due to glacial loading and unloading stresses. This is one of the reasons why the RCT has decided to utilize a conservative MOP formula that utilizes the fracture closure pressure and a safety factor.
Section 6 p 4	3D seismic	Prescribe minimum acquisition parameters	Obtaining high quality 3D seismic images of the caprock at depths of 150 m or less is very challenging. This would require very tight shot and receiver line spacings (e.g. 25 m) which would result in a significant environmental footprint. Even then, it might not be possible to image the top and base of the caprock.	The RCT is not in a position to specify the 3D acquisition geometry and resolution. Notwithstanding, the RCT expects companies to use appropriate practices when acquiring 3D data.
Section 6 p 4		All penetrations of the caprock should be examined for evidence of leaked oil in the caprock section. If caprocks have already leaked fluids, it is likely they will leak fluids again. There is little or no work that has been done on the seal properties of failed seals - if the pore system already contains all there is no capillary pressure barrier. This is an area that CMC could get into. Petroleum geochemical methods are very effective at picking up leaked oil.	Biodegradation work by Larter and others over the last decade suggests that immense volumes of methane and carbon dioxide were produced during the biodegradation of the oil that resulted in the oil sands bitumen. They estimate up to as much as seven reservoir volumes of gas were produced, and has leaked off over time.	The RCT is not convinced that the learnings obtained from an analysis of the geochemical profile of the overburden which occurred over geological time, would be applicable to determining the sealing capacity of the caprock during the time period of a SAGD project.
Section 6 p 5 paragraph 3		As well as lithology and mineralogy of the caprock, a full geochemical profile of fluids through overburden, caprock and reservoir should be required.	Petroleum geochemical methods are effective at picking up leaked oil.	The RCT is not convinced that the learnings obtained from an analysis of the geochemical profile of the overburden which occurred over geological time, would be applicable to determining the sealing capacity of the caprock during the time period of a SAGD project.

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Section 6 p 5 paragraph 4		Qualify requirement with respect to features that can be resolved. Critical features may be sub-seismic in magnitude.	The ability of 3D seismic to identify all faults, incised channels or localized subsidence features is overstated. There may by many leakage pathways through small faults and fractures that are below seismic resolution	The RCT acknowledges that not all geological features maybe resolved using 3D seismic, however at this time this is the best available tool for identifying these features.
Section 6 p 8 paragraph 7		Include porosity and permeability data from the full caprock section, not just the base.	Better caprock characterization is required to mitigate capillary flow and identify higher permeability zones in the caprock section.	This section was not intended to apply to the caprock. Rather it was intended to apply to the next adjacent formation below the caprock where porosity and permeability are present. The RCT believes that clay rich bedrock with a gamma ray value greater than 75 API units has sufficiently low permeability to prevent steam and reservoir fluids from
Section 3, p 2	Information requirements	Change wording to 'best efforts' to identify faults, incising channels, or localized subsidence features. Acquisition geometry to properly image the caprock should be specified and not left to the operator to decide.	3D seismic is a powerful tool, but has resolution limits. The current wording overstates the ability of 3D seismic to identify features of interest at all scales. Leakage pathways through the caprock may well be subseismic in scale, and this limitation must recognized. The ability to image the caprock at all may not be possible in all surveys, depending on near-surface conditions. Acquisition geometry for seismic reflection surveys to properly image the caprock section will have a significant environmental footprint dues to closely spaced shot and receiver line intervals.	The RCT is not in a position to specify the 3D acquisition geometry and resolution. Notwithstanding, the RCT expects companies to use appropriate practices when acquiring 3D data. The RCT acknowledges that not all geological features maybe resolved using 3D seismic, however at this time this is the best available tool for identifying these features.
Section 3, p 2	Information requirements	Add geochemical profiling of entire section to required database.	Baseline geochemical surveys of overburden, caprock, reservoir and underburden should be required in order to identify petroleum content of caprock and fluid flow (petroleum and groundwater) over geological time.	The RCT believes that the most practical approach for determining whether a caprock has sufficiently low permeability to prevent steam and reservoir fluids from escaping through porous media flow is by ensuring that it has a gamma ray value greater than 75 API units .
Section 6, p 4	Monitoring	AER should coordinate and fund a research program into alarm, short-term and long-term monitoring technology development.	MOP monitoring is inadequate to ensure that caprock failure will not occur. A comprehensive research program on fast and responsive monitoring technology development must be undertaken.	The RCT would be supportive of this type of research but is not in a position to fund it.

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General	Alarm timelines	Revise definition of alarm timeline	The 'alarm' timeline for containment failure is somewhat arbitrary at < 24 hours. A leakage path through the caprock may occur quickly, but flow to surface may take longer than a day. This could evaluated by modelling studies and field experience. Defining an 'alarm' at < 24 hours may not be feasible or realistic.	The RCT acknowledges the 24 hour period is arbitrary. However the RCT continues to believe that this is an appropriate time period for alarm purposes. The RCT's primary goal is to ensure that all fluids remain contained within in the steaming reservoir, and acknowledges that once a loss of containment begins it may transpire as a near instantaneous event to an event that may take weeks to manifest.
Summary and content later in report.	Pressure monitoring	Monitor pressure (and temperature) in shallow aquifers, rather than just within the caprock	In the report, monitoring pressure outside the steam chamber is viewed as not being viable because the pressure monitor may be not located near a failure point. However the pressure front should spread laterally more quickly in a permeable aquifer that lies about the caprock. This zone should be considered from pressure (and temperature) monitoring	The RCT acknowledges that there is still risk however, does not believe that any type of currently available monitoring can prevent a failure. The RCT believes that once an anomaly has been detected the energy present in the steam chamber would make the event irreversible no matter what actions the operator took at surface.
Summary and content later in report	Geophysical monitoring	Closer integration between monitoring technologies	The report identifies ERT (electrical resistivity tomography) as a potential alarm monitor, but this is untested at this time (but should be tested). However, ERT alone is unsuitable as the initial model for the inversion of ERT data must be detailed. Such a model may be obtained from 3D seismic surveys.	The RCT is uncertain on the potential for ERT to provide accurate and timely data at this time due to the unproven technology.
Summary and content later in report.	Geochemical monitoring	Monitoring wells deeper than shallow groundwater monitoring wells.	The report suggests that groundwater monitoring has no role in early detection of caprock integrity impairment. This is true, but no monitoring method will detect incipient failure except perhaps micro seismic methods. However, loss of containment is more than just the failure instant of the caprock. Early detection of reservoir fluids and or steam into overlying aquifers would still be an early warning signal. Geochemical analytical methods would be able to quickly detect fugitive leakage from the steam	The RCT is not convinced that the use of geochemical testing is a practical means of obtaining and "early" warning to a leak. Data acquisition would be lengthy and would need to be performed on a very frequent basis. The determination of a baseline and how much of a variation from that baseline denoted a problem would be subjective. The RCT is of the view that pressure and temperature are transmitted and may be measured in a much quicker and meaningful manner.