Review of the T4 Environmental Assessment (Groundwater) report for the construction of the T4 terminal near Newcastle (T4)

a) Adequacy of the methodologies described in the Environmental Assessment to accurately identify the potential impacts that the T4 project may have on the hydrogeology of the area

I find the methodologies adequate and effective. Firstly, there is a thorough site investigation focusing soil and water contamination as well as water level monitoring. Secondly, there is a good conceptualisation and modelling of aquifer processes before, during, and after construction. Lastly, modelling is carried out taking into account different scenarios and uncertainty (probabilistic simulation) which leads to sound conclusions. However, in my opinion, there a few issues that would require further consideration and review. These are:

- Maintaining aquifer pressure in the Estuarine Aquifer is important. This aquifer is confined and in direct hydraulic connection to the river system. Because this aquifer is confined, contaminant fluxes from the fill (unconfined) aquifer (e.g. through the clay aquitard) are naturally prevented. However, during T4 project construction it will be necessary to dewater certain areas (e.g. with spears or open pit excavations) which will lead to localized aquifer depressurisation. This depressurisation can extend to the Estuarine Aquifer in areas where the clay aquitard is thin or nonexistent. The MODFLOW model does not model these effects at this local level. This warrant further explanations or detailed modelling work to show the extent of localized depressurisation activities during construction.
- Three licensed water supply bores were identified using an online search. Are there any unregistered bores in the area currently being used? These bores would not show up on an online search.
- A low permeability ($K = 1x10^{-11}$ m/s) GCL cap is proposed for the Delta EMD site. An alternative, a low permeability liner (e.g. $K = 1x10^{-8}$ m/s clay) of 0.5m thick, is also considered and it is suggested it will have the same effect as the GCL cap. GCLs can puncture and leak whereas a 0.5 m clay liner could offer a more "robust" level of protection. No modelling is provided to ascertain the effectiveness of these alternatives. It would be desirable to carry out geotechnical modelling (e.g. using the Hydrologic Evaluation of Landfill Performance, HELP model) to assess the effectiveness of these designs. This type of modelling could be extended to verify the effectiveness of low permeability caps throughout the whole T4 project area.
- The MODFLOW model was calibrated by adjusting hydraulic parameters (e.g. hydraulic conductivity values), recharge (as % of precipitation), and evapotranspiration. Recharge rates were between 6-50% of precipitation for different materials and this analysis also took into account the depth to water level. It is not clear how this was done and whether or not runoff coefficients (e.g. curve number method) were taken into account. Also, the match between original (estimated) recharge rates and recharge rates resulting from model calibration is not explicitly explained.
- A few remediation options are proposed to address specific contaminant sources. These include the construction of soil-bentonite barriers, installation of permeable reactive barriers, and installation of low permeability liners. The MODFLOW model simulates the effectiveness of low permeability liners to prevent saline contamination but does not assess other remediation options. Also, the effectiveness of permeable reactive barriers (e.g.

contaminant adsorbtion) is not being tested. It would be desired to include these management options as model scenarios within the MODFLOW model.

- Contaminant transport was assessed using ConSim and this is a valid approach. However, there seemed to be some confusion regarding the definitions for the distribution coefficient (*Kd*), the fraction of organic carbon (*foc*), and the organic carbon-water partition coefficient (*Koc*). For point-source contaminants being transported through an aquifer system the distribution coefficient (*Kd*) is:

  $$K_d = K_{OC} \times f_{OC}$$

  The fraction of organic carbon (*foc*) is the fraction of the aquifer soil matrix comprised of natural organic carbon in uncontaminated areas. The fraction organic carbon value should be measured if possible by collecting a sample of aquifer material from an uncontaminated zone and performing a laboratory analysis (e.g. ASTM Method 2974-87 or equivalent). If unknown, a default value of 0.001 is often used (e.g., ASTM 1995).

  Throughout the modelling for this project, Total Organic Carbon (TOC) values from contaminated soil samples were directly used instead of *foc* from uncontaminated aquifer samples. As a result, the final *Kd* values used in the contaminant transport modelling were higher than what they should be. This can result in an underestimation of contaminants detected in groundwater at locations downgradient from the source (e.g. at a given time). This effect can be easily observed by setting up simple 1D models (e.g. using HYDRUS or PHREQC) which could be used to complement the ConSim study.

b) The potential of contaminated materials to enter groundwater.

After reviewing the information provided, it is my opinion that a certain amount of contaminants will leach from contaminated materials existing at the site, and these will be transported with groundwater. However, this contamination is not likely to exceed existing background concentrations and effects can be adequately managed with the measures proposed. Nevertheless, it is necessary to re-run the analyses with correct *Kd* values and to complement this with additional modelling work to show patterns of plume migration downgradient from contaminated sites within the project area.

c) Additional mitigation measures that should be undertaken as part of the project to minimise impacts on groundwater.

- The establishment of vegetation around the site and particularly at contaminated sites to maximize evapotranspiration thus minimizing the influx of water.
- Removal of contaminated soil material prior and during construction. This could be followed by further contaminant transport modelling to assess the extent of groundwater contamination.
- Covering contaminated sites with adequate materials and cap (GCL, and clay) modelling to assess the effectiveness of designs. Also, it would be useful to include lateral drainage layers (between the caps and the waste) to divert groundwater before it leaches through contaminated soils.