Fact sheet 3

Assessment of groundwater quality from a possible leak of a flowback storage tank from shale gas operations

Flowback water from shale gas operations is known to contain a mixture of metals, radionuclides, and organics. While accidental releases of flowback waters from storage tanks into the environment are unlikely due to multiple containment barriers, leak detection, and routine inspections, they cannot be entirely excluded.

In this study, the natural attenuation potential of soils, deep unsaturated zones and their underlying surficial groundwater was explored using predictive modelling for a scenario involving a possible leak (0.1 megalitre) from a storage tank. Actual chemical concentrations in flowback water collected from the Tanumbirini-1 and Kyalla-117 shale gas wells in the Beetaloo Sub-Basin (Northern Territory, Australia) served as input with exposure volumes and concentrations to the one-dimensional HYDRUS model for simulating chemical transport through unsaturated soil and the deep unsaturated zone. Simulations accounted for the long-term effects of typical dry/wet seasonality of the Beetaloo GBA region. To assess attenuation in groundwater in case chemicals reach the watertable, subsequent transport in groundwater involved use of a three-dimensional analytical transport model.

For a total of 63 chemicals studied, the natural attenuation due to dilution and dispersion in soil and groundwater was predicted by combining the unsaturated zone model and the groundwater model. Predicted environmental concentrations for a groundwater receptor were then compared with default guideline values for freshwater organisms to derive a risk quotient (RQ) (i.e. RQ<1 = chemicals of low concern; RQ≥1 to <10 = chemicals of potential concern; RQ>10 = chemicals of potentially high concern). In addition, modelling included the use of direct toxicity assessment (DTA) data (safe dilutions to protect 95% freshwater organisms) derived from flowback storage tank waters to assess the impact of chemical mixtures.

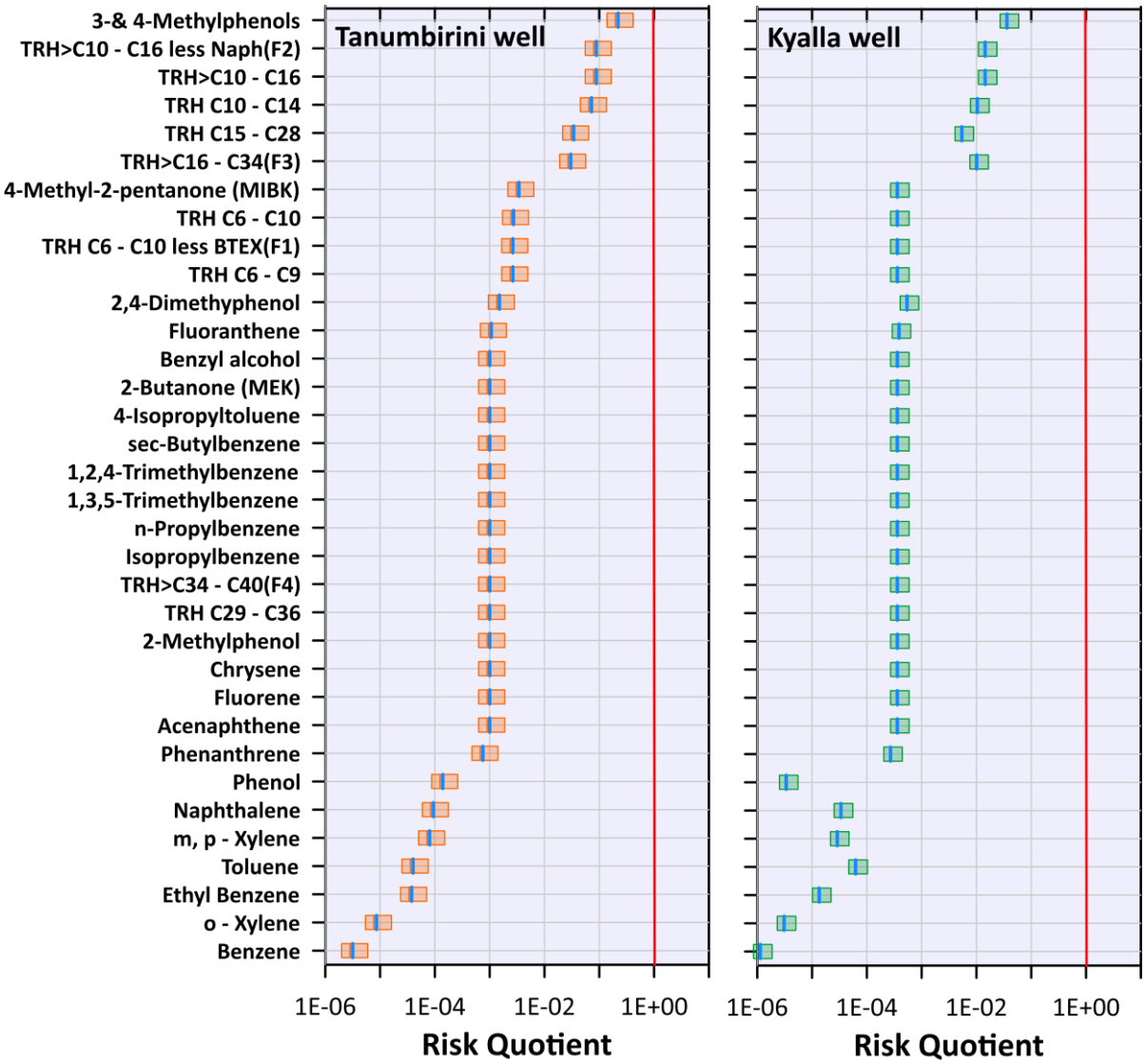
Results

Predictive modelling of a possible leak scenario from a flowback water storage tank demonstrated that physical attenuation by dilution and dispersion through a 50-m (at the Tanumbirini-1 site) or 100-m (at the Kyalla-117 site) deep unsaturated zone followed by 500 m transport in surficial groundwater was sufficient to decrease concentrations for most chemicals to below their predicted no-effect concentrations (RQ<1 (Figure 1)). The finding was in the absence of intervention or controls such as the removal of contaminated soil, that would be required in accordance with an approved environmental management plan (spill management plan and emergency response plan, if applicable) and the *Code of Practice: Onshore Petroleum Activities in the Northern Territory*, that would significantly have reduced chemical exposure concentrations.

Additional natural attenuation processes such as sorption, biodegradation and radioactive decay were shown to further decrease chemical and radionuclide concentrations to below their respective default guideline values for freshwater organisms. Moreover, these concentrations reached natural background levels for surface soils using data from other regional surveys in Australia. The modelling also demonstrated that the combination of all attenuation processes was sufficient to provide a DTA-based ‘safe dilution’ to groundwater to protect 95% of freshwater organisms.

Figure 1 Risk quotients in groundwater at 500 m from a possible leak for organic chemicals in a flowback storage tank accounting for variability in dilution factors

(Blue line is site-specific value; box-whisker plots show 25th, 50th and 75th percentiles)



The GBA Program

The $35.4 million Geological and Bioregional Assessment (GBA) Program is assessing the potential impacts of shale and tight gas development on water and the environment to inform regulatory frameworks and appropriate management approaches. The geological and environmental knowledge, data and tools produced by the GBA Program will assist governments, industry, land users, and the community by informing decision-making and enabling the coordinated management of potential impacts.

How to cite

Geological and Bioregional Assessment Program (2021) Fact sheet 3: Assessment of groundwater quality from a possible leak of a flowback storage tank from shale gas operations [online document]. Fact sheet for the Geological and Bioregional Assessment Program.

Find out more

Datasets that support this work are available at data.gov.au:

- Geological and Bioregional Assessment Program (2021) Contaminant screening modelling [data].

More information is available at bioregionalassessments.gov.au/gba.