Background
The Sellafield nuclear site lies above the Sherwood Sandstone groundwater aquifer. Decades of on site leaks have contaminated the Separation Area with anthropogenic radionuclides. The more soluble of these are polluting the groundwater as they migrated towards the sea (e.g. technetium and tritium, figures 1 and 2). Traditionally contaminated groundwater is extracted, treated and returned to the aquifer. However, the cost of this method can be prohibitive especially for legacy sites.

Permeable Reactive Barriers
In many non-nuclear sites in-situ sorbent materials in the form of permeable reactive barriers (PRB) have been successfully used to treat polluted groundwater. PRBs provide a porous medium through which groundwater can flow but removes contaminants (figure 2). PRBs can be modified in some cases to improve engineering and/or recovery properties (e.g. using surface modified barrier materials or environmentally resilient magnetic particles).

Remediation Mechanisms
The removal mechanism depends on the material used in the PRB and can occur via redox induced precipitation, mineral precipitation, ion exchange or chemical adsorption. PRBs therefore have the potential to remove specific target contaminants from groundwater (e.g. isotopes of technetium, caesium, strontium or uranium).

Fig 1. Locations of groundwater monitoring wells at Sellafield showing from left to right the total beta, technetium-99 and tritium activities. The Separation Area is outlined in red and the site boundary in blue. Source: Groundwater Annual Report 2011, Sellafield Ltd

Fig 2. Conceptual model of the Sellafield site. Adapted from Sellafield Ltd

Fig 2. Plan view of a Permeable Reactive Barrier.

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