



Sellafield Ltd

Groundwater Management at Sellafield

**Presentation to
Geological Society of London
14 January 2009**

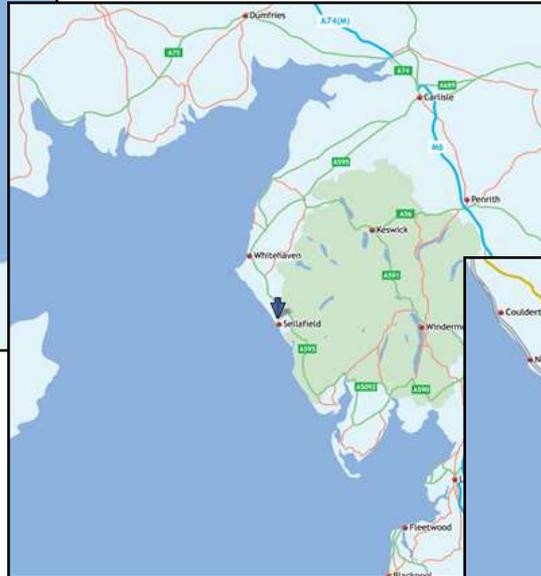
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Presentation Objectives

- Background on Contaminated Land at Sellafield
- Overview of groundwater management at Sellafield
- 2008 groundwater monitoring review

Sellafield Site



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History of Sellafield Operations

- 1941 – 1946: WWII Royal Ordnance Factory for production of TNT
- 1947: Site adopted to support production of atomic weapons materials
- Early 1950's: Development of world's first power generation reactors (Calder Hall)
- Two further generation of plants have followed for the reprocessing of commercial reactor Magnox and Oxide fuels
- Current Status
 - Reprocessing Operations
 - Waste management
 - Decommissioning
 - Potential nuclear new-build site

Sellafield in 1946



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Sellafield Today



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Legacy Contamination

- 1950s - radioactive waste disposal in trenches (pre-Low Level Waste Repository)
- 1970s – silos major leak
- 1950s and 1970s - medium active leakage from Magnox reprocessing facility
- Miscellaneous spillages, leakages and disposals since 1951

History of Contaminated Land Investigations

- Date back to BGS investigations of Drigg and Sellafield in late 1970s
- Sellafield Contaminated Land Study (2001 -2004). Characterised ground and groundwater contamination outside Separation Area
 - Conceptual models of geology, hydrogeology and contaminant transport developed
 - Network of groundwater monitoring boreholes installed
 - Concluded that few sources of ground or groundwater contamination located outside Separation Area
 - Groundwater plumes observed extending towards, and beyond, site boundary
- Sellafield Contaminated Land & Groundwater Management Project (2007 – 2010): characterisation of Separation Area and “next generation” conceptual models

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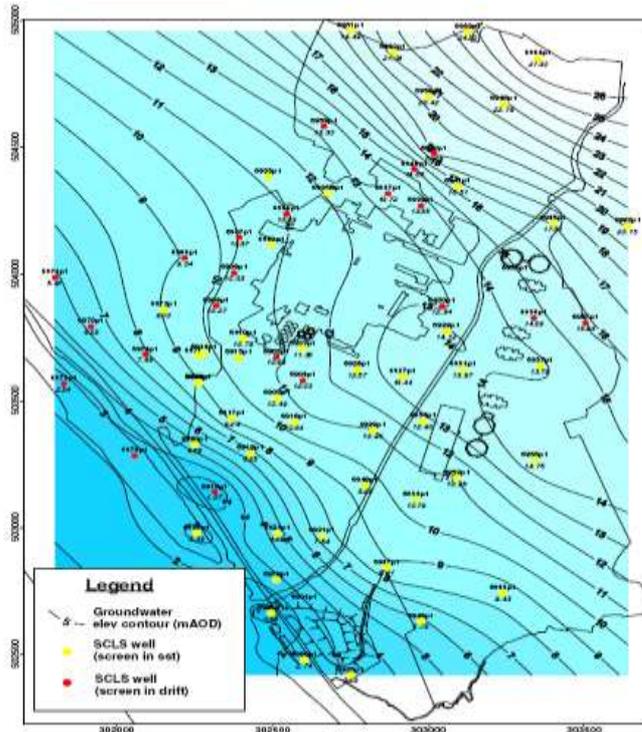
- Combined and integrated programme organisation in 2006
- Provides for the integrated management of the Sellafield site contaminated land and groundwater
 - Understand, control and manage the legacy contamination to ensure protection of the work force, the public and the environment
 - Prevent an increase to the contaminated land inventory (leak detection)
 - Provide the technical bases for effective remediation strategies

Current Key Areas of Work

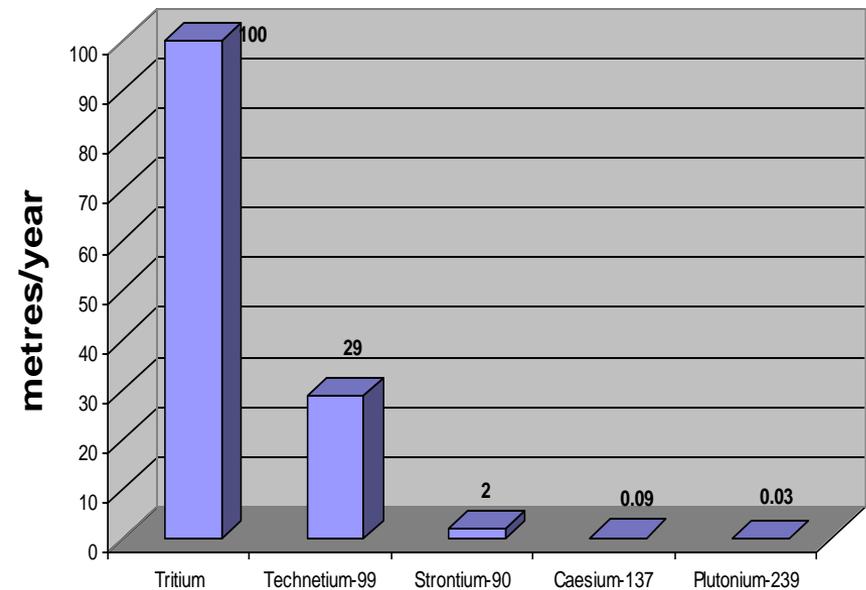
- Phase 2 Characterisation Project
- Groundwater Management
 - Groundwater monitoring
 - Data analysis
 - Develop “Next Generation” conceptual models
 - Numerical modelling
 - Risk assessment
- Data management

General Groundwater Flow and Nuclide Transport at Sellafield

Regional Groundwater Elevation Surface

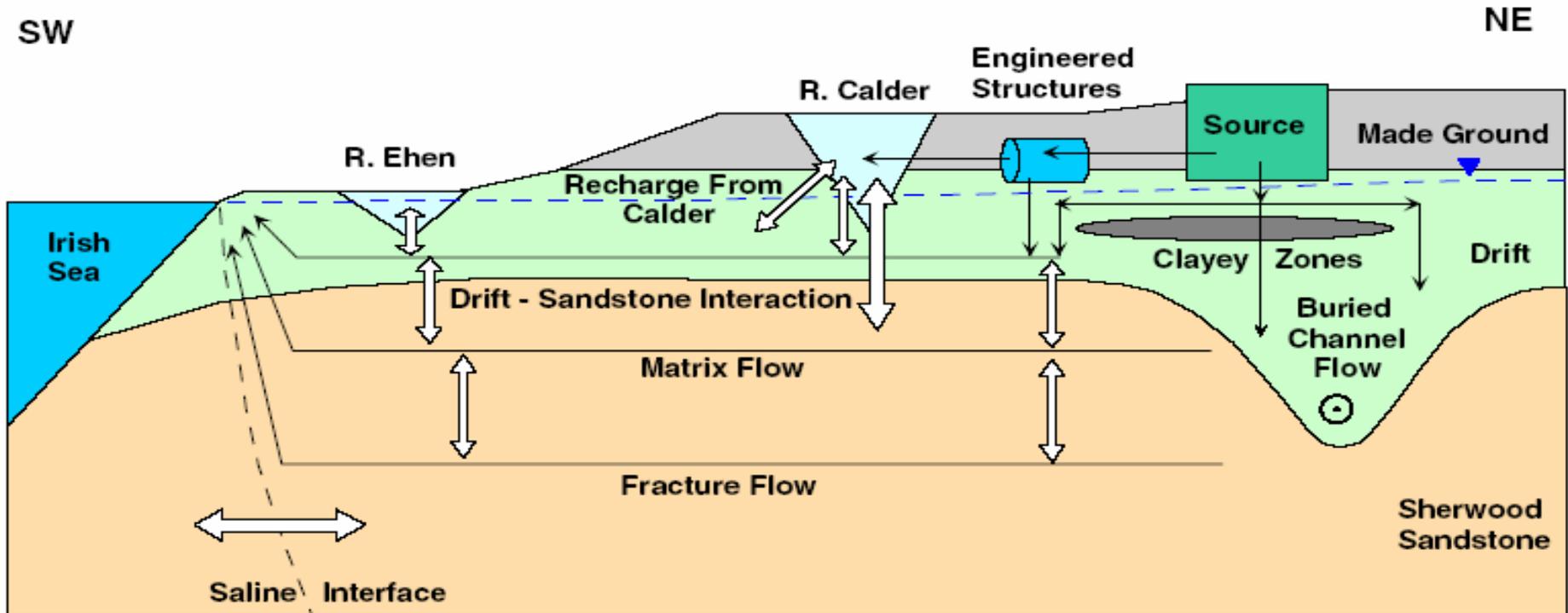


Speed at which radionuclide contaminants migrate through groundwater



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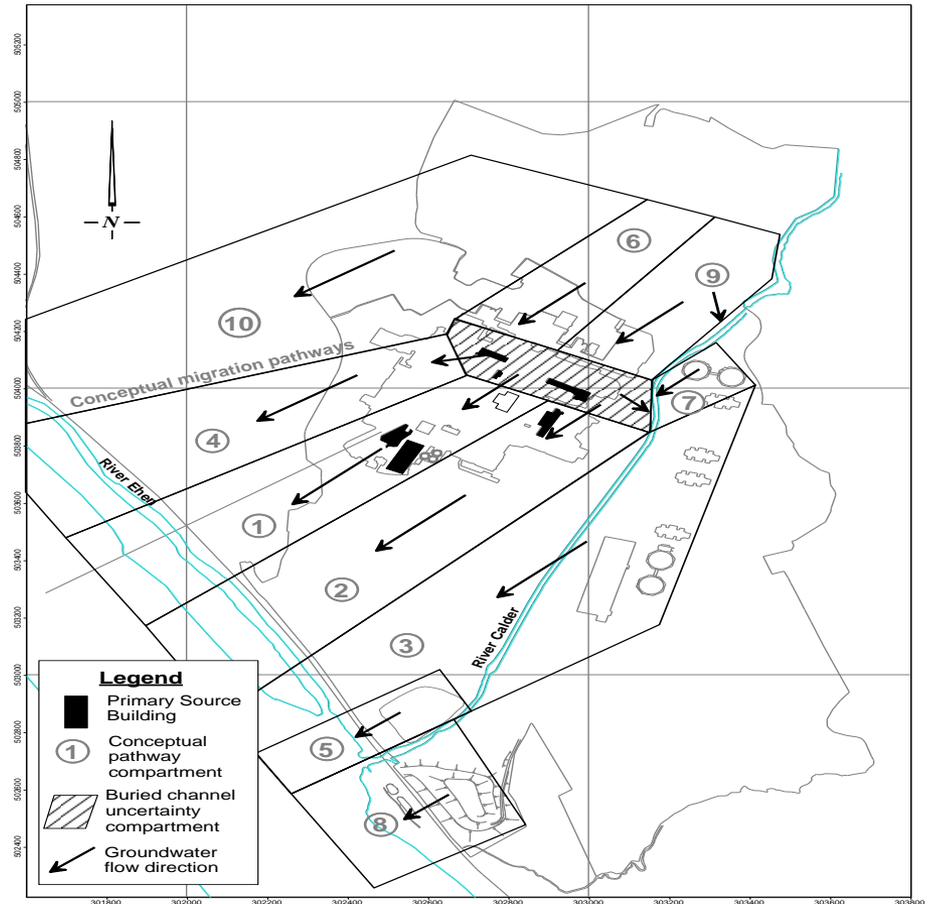
Sellafield Site Conceptual Model Cross Section



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Sellafield Groundwater Flow Path Compartments

Conceptual model of
contaminant migration
pathways



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Groundwater Risk

- 2005 risk evaluation for off-site risk:
 - utilised the most current site conceptual models (hydrogeology, source term, and biosphere)
 - incorporated consistently conservative assumptions (e.g. assumptions that would lead to increased risk)
 - assumed no on-site intervention
 - risk was calculated for the most exposed critical groups – exposure is from groundwater discharge along the coastal area adjacent to Sellafield (fisherman and bait-diggers)
- Calculated peak risk was significantly below the recommended intervention level and occurs approximately 3,000 years into the future

Groundwater Monitoring Requirements and How Requirements are Met

- **Site License Requirements**

- Radioactive Substance Act (RSA) Certificate of Authorisation
- 'Compilation of Environment Agency Requirements' (CEAR)
- Pollution Prevention and Control (PPC) regulations and permit to monitor for non-radiological polluting substances
- HSE/NII Safety Assessment Principals under the Nuclear Installations Act to insure the safe management of radioactively contaminated land

- **Meeting the Requirements**

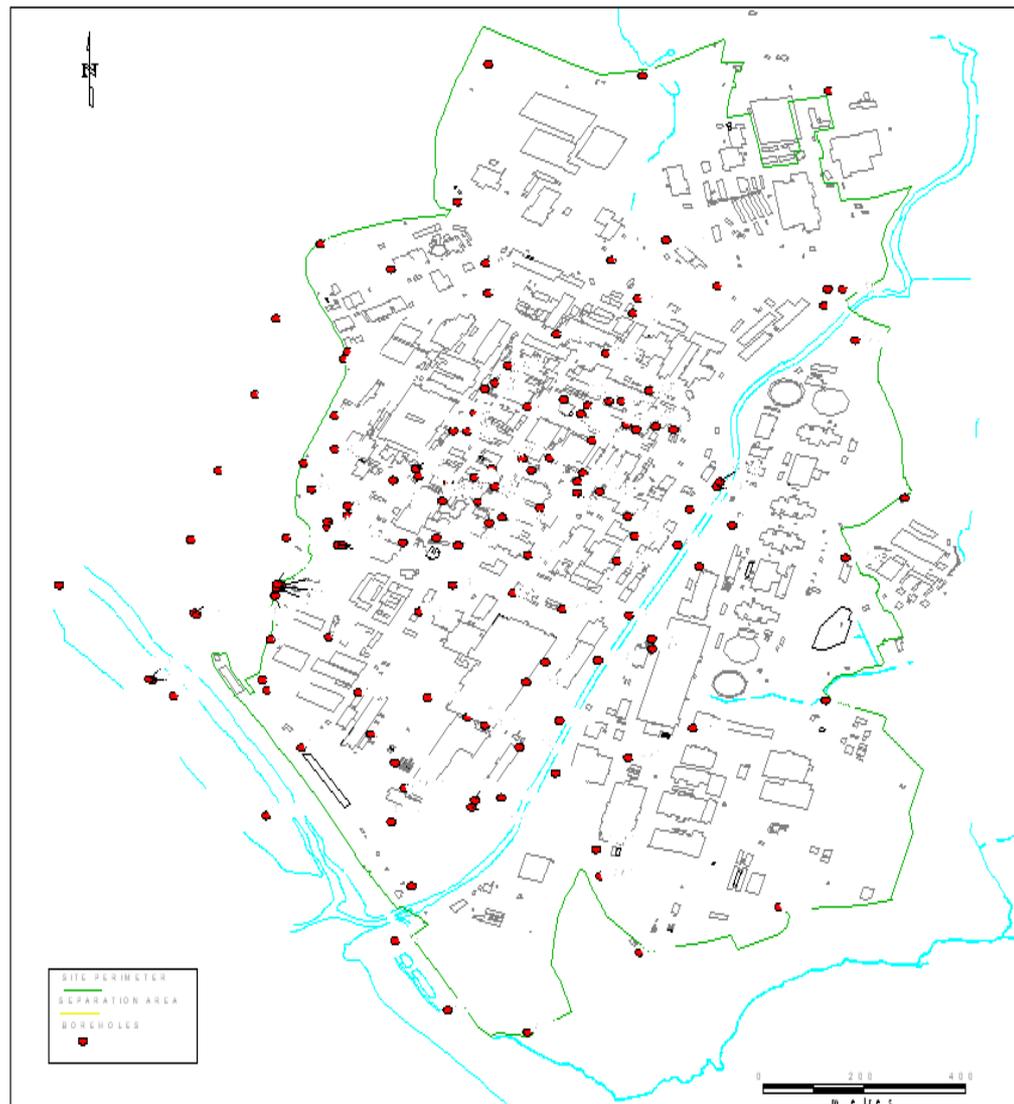
- Annually scheduled groundwater sample collection
- Data analyses to:
 - determine the nature, scale and location of contaminants in the groundwater underlying the Sellafield site
 - confirm the current concentration of contaminants
 - monitor changes in groundwater quality between the points that groundwater enters the site to the points it leaves the site
 - Identify any significant changes to on-site and off-site risks
- Annual publication of monitoring results

Additional Uses of Groundwater Monitoring Data

- Provide information to improve the conceptual hydro-geological model of the Sellafield site
 - Time-series water level data
 - Geochemical information impacting contaminant transport (e.g. colloids studies)
- Facilitate planning and prioritisation for future remedial actions

2008 Groundwater Monitoring Programme

- CEAR Sampling
 - **145 boreholes and 226 individual piezometers**
 - 49 radionuclide analysis groups
 - variable sample schedule
 - approximately 1,300 samples collected
- PPC Sampling
 - **28 boreholes**
 - 21 non-radiological contaminant analysis groups
 - quarterly sample schedule
 - 2008 start with 3 rounds of quarterly sampling completed



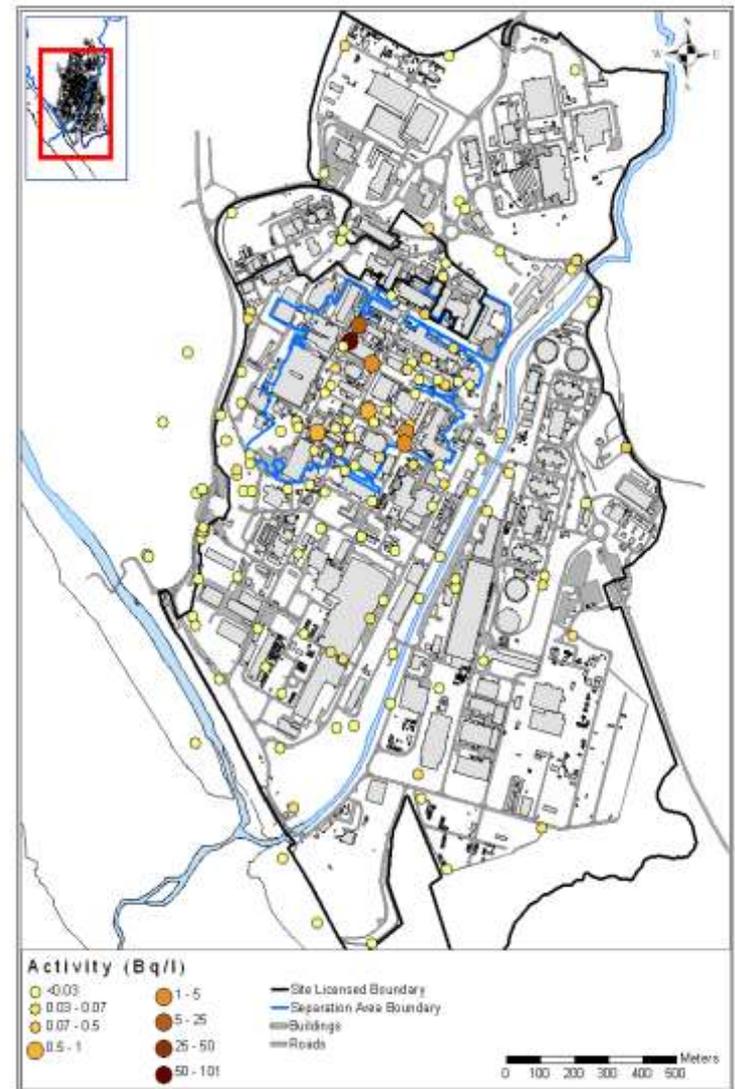
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Analysis of Groundwater Sample Data

- Evaluation of samples that exceed the specified “trigger level”
- Site overview and annual reporting:
 - alpha-emitting radionuclide concentration distribution (uranium-alpha, plutonium-alpha, neptunium-237, americium-241, and radium-226)
 - beta-emitting radionuclide concentration distribution (strontium-90, potassium-40, cobalt-60, ruthenium-106, antimony-125, and caesium-137)
 - weak beta-emitting radionuclide concentration distribution (tritium, technecium-99, carbon-14, chlorine-36, and iodine-129)
- Identification of significant year-to-year changes

Average Total Alpha activities in Sellafield Groundwater from April 2007 – March 2008

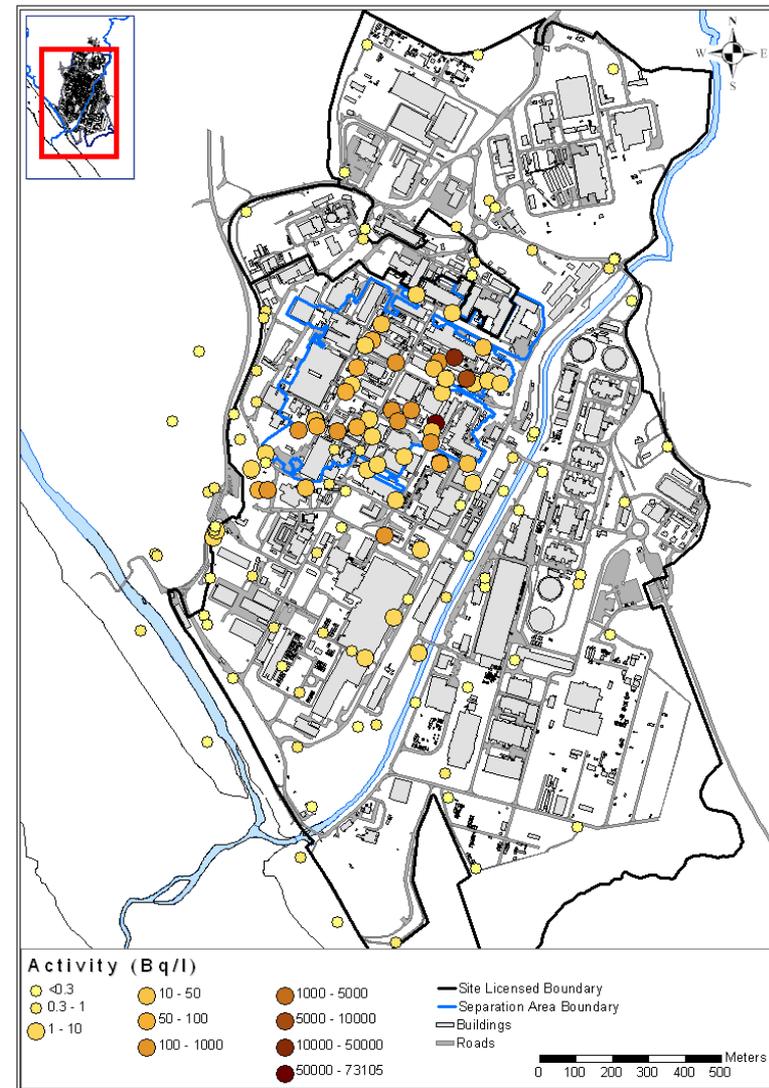
- Mainly concentrated in areas of known historic leaks-to-ground
- Dominated by uranium with much lesser plutonium, neptunium-237, americium-241, and radon-226
- The majority of groundwater samples are below the limit of detection (0.03 Bq/l)
- WHO safe drinking water guideline value for Total Alpha (0.5 Bq/l) was exceeded in 6 boreholes



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Average Beta activities in Sellafield Groundwater from April 2007 – March 2008

- Majority of boreholes that exceed WHO drinking water guideline values are located in areas of known historic leaks-to-ground and disposals.
- A number of boreholes located to the south and south west of Separation Area also exhibit concentrations that exceed WHO safe drinking water guideline values.
- Strontium 90 is the dominant beta emitting nuclide with the distribution across site mirroring Total Beta.



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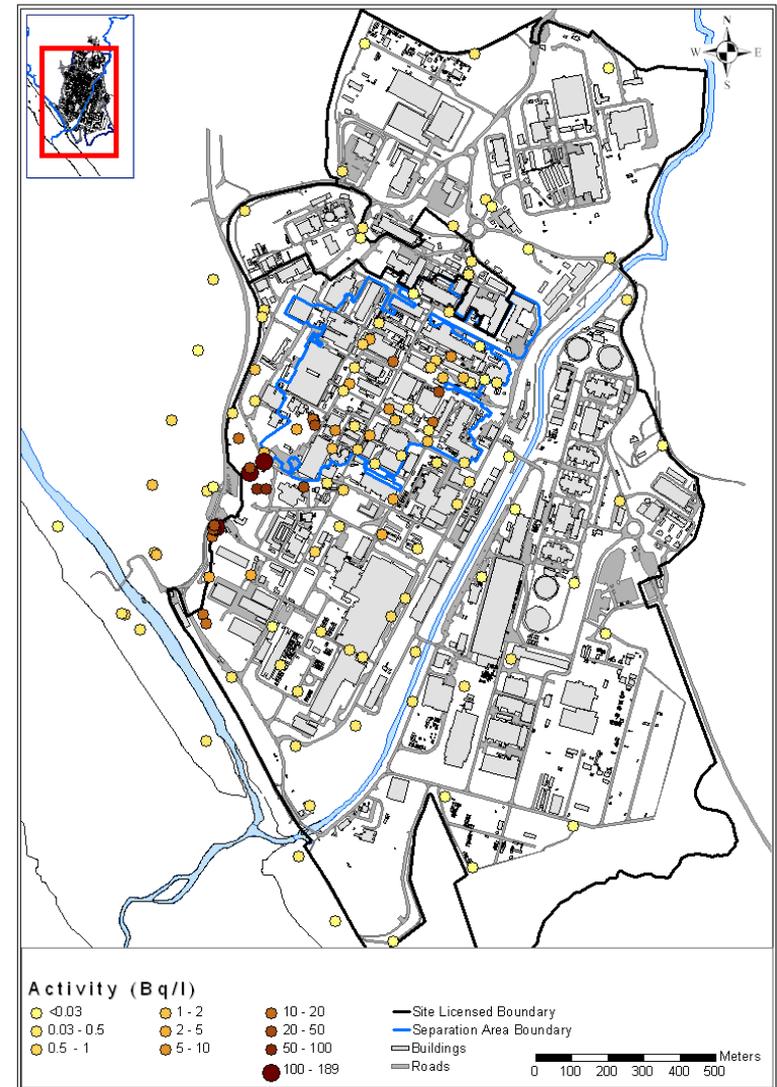
Average Weak Beta-emitting Radionuclides (Tritium / Technetium-99) activities in Sellafield Groundwater from April 2007 – March 2008

Tritium

- Elevated tritium activities are found within Separation Area and in a south westerly direction towards the coast
 - Samples from 3 boreholes located to the south west exceed the WHO safe drinking water guideline value of 10,000 Bq/l

Technetium-99

- The majority of groundwater samples contain average annual concentrations of approximately 0.5 Bq/l
 - Samples from 7 boreholes located to the south west exceed the WHO safe drinking water guideline value of 100 Bq/l



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2008 Groundwater Monitoring Summary

- There have been no significant year-to-year change in the overall distribution of nuclide concentrations in Sellafield groundwater
- Nuclide concentrations from this year's groundwater samples are similar to those reported in previous years
- Nuclide concentrations in key areas are in line with numerical model results that were incorporated in the 2005 off-site interim risk assessment
- Current concentrations of nuclides in groundwater samples collected from offsite are below the WHO safe drinking water guidelines.
- Dedicated PPC sampling programme has started
- The 2008 Groundwater Annual Report will be added to the Sellafield Ltd public website – "<http://www.sellafieldsites.co.uk/land/>"

Land Quality Programme Lifetime Plan

- Site Characterisation 2007 -2009
- Assess data, model potential scenarios and carry out BPEO/BPM studies 2010 – 2015
- Institute line of groundwater management around main area of contamination 2015 – 2020
- Remediate contaminated areas around site as they become available 2020 – 2070
- Land remains in institutional control with de-licensed Outer zone redeveloped / landscaped and ongoing management of Inner zone, possibly involving waste disposal activities