

MCM Environmental Services Ltd Experience in Geological Disposal Facility Siting and Site Evaluation

Selecting a suitable location for a geological disposal facility involves a wide range of knowledge and expertise. The location that emerges from a siting process must be technically capable of hosting the wastes concerned, should allow sufficient technical flexibility to optimise repository design to the site characteristics, and must be recognised by all stakeholders as an appropriate choice. Many technical and non-technical factors have to be balanced to the satisfaction of groups with differing views. Environmental impacts, transport of materials, societal impacts, costs and regulatory constraints are all prime issues for consideration. In the case of a volunteering siting approach, site characterisation has to be intimately coupled to the process of tailoring the repository design and the associated safety case to any proposed location that can be shown to satisfy the diverse technical and socioeconomic constraints.

In addition, the siting and design of critical infrastructure (nuclear power stations, reprocessing plants, interim storage facilities, or geological disposal facilities), or facilities that are considered to have high hazard potential, need to consider the long-term natural hazards to which the site might be susceptible. The importance of the requirement to assess and endeavour to quantify natural hazard risk was emphasized by the 2011 Tohoku earthquake and associated tsunami, where several sensitive facilities were affected (most publically, the Fukushima Dai-ichi nuclear power plant, but also some petrochemical and industrial sites). Assessing hazards is particularly important when siting a new facility.

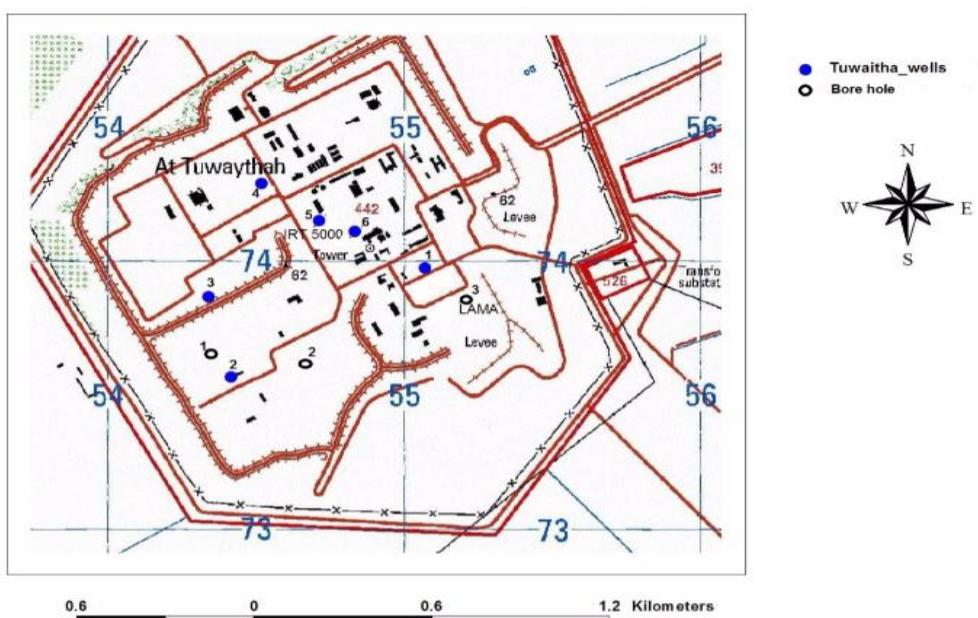
The MCM team has the expertise needed to address this complex activity. It has extensive direct experience in the planning and execution of programmes for identifying and evaluating repository sites, taking all these factors into account. The capabilities of MCM are based on relevant siting work stretching over four decades and involving several national programmes.

The following case studies outline MCM's most relevant experience.

Direct Experience in National Siting Programmes

Iraq

MCM is currently supporting the Iraqi Ministry of Science and Technology to site, design and licence a facility for low and intermediate level waste as part of a 3 year EC funded project. MCM is leading tasks to characterise the site, site the facility and develop conceptual and detailed facility designs.



Switzerland:

Charles McCombie, as Director of Science and Technology at Nagra, was directly involved in the selection of potential LLW sites and in their characterisation. He was Project Leader for the Swiss HLW programme during the crystalline and sediment siting phases, up to the selection of the currently favoured clay region in Northern Switzerland. Ian McKinley, as R&D coordinator, reviewed the technical work associated with site characterisation, repository design and associated performance assessment. Ian McKinley and Charles McCombie were also directly responsible for research programmes in the Swiss underground laboratories where many site investigation techniques have been developed and tested. All team members have worked in the Swiss national programme at managerial and technical levels.

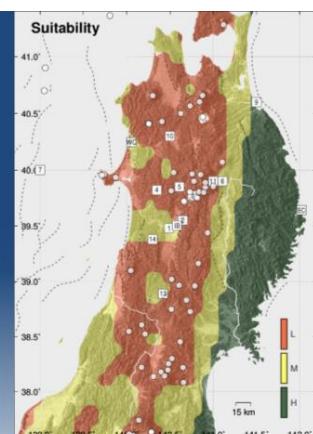
Japan:

Neil Chapman, Charles McCombie and Ian McKinley were members of the NUMO International Technical Advisory Committee that helped develop the siting factors used in the NUMO volunteering approach. Charles McCombie chaired the International Board of Counsellors of NUMO that was specifically designed to address strategic issues, including siting. Ian McKinley is currently co-chair of the NUMO Technical Advisory Group. MCM has organised and run for NUMO “dry runs” on site selection, based on state of the art multi-attribute analysis methodologies and tools. Ian McKinley has played a leading role in developing NUMO siting approaches in which the repository design is tailored to the specific site conditions.

A probabilistic approach to hazard assessment is the only realistic means of addressing the uncertainties in predicting possible hazards, when there is variability in spatial distribution, timing, intensity and style of events being evaluated. MCM International has experience of undertaking a range of probabilistic hazard assessments, predominantly in Japan. This approach utilizes tools to incorporate and manage uncertainties in the assessment and decision making process, for example Expert Elicitation and Bayesian Belief Networks. Neil Chapman and Ellie Scourse managed the ‘TOPAZ’ project - a major international, multidisciplinary project to develop probabilistic methods that will allow potentially disruptive tectonic processes to be accounted for transparently in site selection. The output was used to produce Hazard Maps (an example is shown to the right) of large regions of Japan for different future time periods. Ellie Scourse was involved in both management and technical work for TOPAZ, including the use of expert elicitation to manage the treatment of uncertainty.

Ian McKinley has also been involved in supporting RWMC, JAEA and JNFL, including for the work on design and layout of the new ILW repository planned by JNFL. Neil and Ellie were part of an International Review Group who assessed on-site faulting at the JNFL Rokkasho site in northern Japan, taking into account new ‘active fault’ definitions provided by the NRA (the Japanese regulators). The assessment concluded that the evidence presented to the International Review Group by JNFL on the geology and tectonics of the site was sufficient to demonstrate that the faults on-site were not active, according to the NRA definition.

- **Green** (high suitability): The probability of volcanism is $\leq 1 \times 10^{-8}$ per year for all alternative models
- **Yellow** (moderate suitability): The probability of volcanism is $> 1 \times 10^{-8}$ per year for at least one alternative model and is $\leq 1 \times 10^{-7}$ per year for all alternative models
- **Red** (low suitability): The probability of volcanism is $> 1 \times 10^{-7}$ per year for at least one alternative model



United Kingdom:

Ally Clark led the UK siting project from 2012 to 2013 in preparation for repository site identification and assessment in Cumbria. This included development of a Geographic Information System (GIS) tool, preparation of documentation and collaboration with the British Geological Survey to establish the approach for above and below-ground siting.

Neil Chapman and Ian McKinley were involved in the early stages of the UK programme, including site screening and on-site investigations. Neil Chapman developed the geological siting guidelines and managed the geological input to site selection for the Nirex deep repository project in the 1980s. Neil Chapman has advised the government advisory group, CORWM, on the new siting process and is currently a member of the Environmental Safety Case advisory panel of the NDA that is developing the approach to presenting the repository safety impacts to the public and regulators. He has also advised DEFRA on the development of site suitability criteria, is currently a Member of the NDA Advisory Board which is involved in the present UK siting programme, and provides ongoing advice to NDA-RWM on UK siting strategy for the national GDF via the RWM Technical Advisory Panel.

Sweden, Finland:

Neil Chapman is Chairman of the INSITE advisory group working for the Swedish regulator. This group is charged with continuous review of the siting and site characterisation programme of SKB, one of the most successful national waste management organisations. He is also Chairman of the site evaluation group for Finnish SF repository for regulatory authority (STUK), including assessment of Construction License Application.

South Africa:

Neil Chapman and Charles McCombie, working together with the South African national research organisation, NECSA, have developed a siting strategy for South Africa (for the nuclear utility ESKOM), taking into account both technical and societal issues.

USA:

Charles McCombie, as Vice-Chairman of the National Research Council's Board on Radioactive Waste Management for several years, was directly involved in providing strategic advice to the Government on many issues, including those related to siting. He chaired the Committee that produced the study for USDOE entitled "One Step at a Time" which lays out the modern staged approach to developing all aspects a repository programme.

Canada:

The staged approach advocated in the USDOE report was adopted by the Canadian waste management organisation, NWMO, and Tom Isaacs has been an advisor to NWMO during its ongoing siting work based on consensual approach.

Germany:

Charles McCombie, as a member of the Scientific Board of GSF and of the International Expert Group on Gorleben, has reviewed German work on the sites at Asse, Gorleben and Konrad. He was also involved in reviewing siting proposals by the AkEnd Advisory Group of the German Government.

ROC:

Ian McKinley coordinated projects to support site selection and characterisation for a Taiwanese LLW repository based on small island sites. Training courses on site characterisation for deeper repositories were also run.

UAE:

MCM performed a major strategic study for the UAE on radioactive waste management policy and strategy in preparation for their rapidly developing nuclear power programme. This study included analysing the various siting possibilities for all the required waste management facilities and, in particular, examined whether the overall programme could be optimized by judicious choice of sites that could host more than one facility (storage, near-surface disposal, geological disposal, etc.)

Other European Countries:

Due to their long established and ongoing contacts with colleagues in numerous national waste management organisations, MCM experts also have detailed knowledge of the development of siting programmes in France, Spain, Italy, Belgium, Slovenia and the Czech Republic.

International:

Charles McCombie and Neil Chapman were responsible in the Pangea project for developing guidelines for site selection on a global, rather than a purely national basis. Emphasis was on identifying “high-isolation” sites in stable, arid regions of the world. They are also both directly responsible for developing multinational and regional siting concepts for shared repositories in Europe (through the ERDO Working Group) and globally (through the Arius Association). Charles and Neil also recently co-authored a

Generic work:

All team members have co-authored papers and textbooks on waste management in which overviews of siting methodologies are reviewed:

- Scourse E.M., Aspinall, W.P., Chapman, N.A. (2014). Using expert elicitation to characterise long-term tectonic risks to radioactive waste repositories in Japan, *Journal of Risk Research* 18 (3), November 2014.
- “Deep Geological Disposal of Radioactive Waste”, Elsevier, 2007 (Co-editor Alexander; contributors Ian McKinley and Charles McCombie)
- “Principles and Standards for the Disposal of Long-Lived Wastes” Elsevier, 2003 (Authors Neil Chapman and Charles McCombie)
- “The Scientific and Regulatory basis for the Geological Disposal of Radioactive Wastes” J. Wiley and Sons, 1987 (Contributor Neil Chapman)
- “The Geological Disposal of Nuclear Waste”, J. Wiley and Sons, 1987 (Authors Neil Chapman and Ian McKinley)
- “One Step at a Time: the Staged Development of Geologic Repositories for High Level Radioactive Waste”, National Research Council, 2003 (Chairman of drafting committee Charles McCombie)
- Volcanic and Tectonic Hazard Assessment for Nuclear Facilities. Cambridge University Press, Cambridge, 2009. (Connor C.B., Chapman N.A. and Connor L.J. (eds.)

In addition, various members have functioned as advisors to international organisations in their work on siting:

- IAEA Siting documents (Neil Chapman)
- EC SAPIERR project on regional repositories in Europe (Charles McCombie and Neil Chapman)
- ITC School of Underground Waste Storage and Disposal
 - Teaching courses on siting (Neil Chapman, Charles McCombie, Ian McKinley)
 - Siting methodology project for NUMO (Neil Chapman, Ian McKinley)