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International Centre for Theoretical Physics**



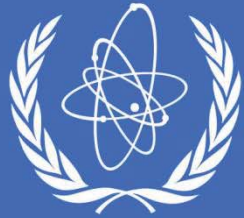
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Joint ICTP-IAEA School of Nuclear Energy Management

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Group activity on the Development of Policy and Strategies for Managing Spent Fuel

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IAEA

EXERCISE

SITING A RADIOACTIVE WASTE REPOSITORY

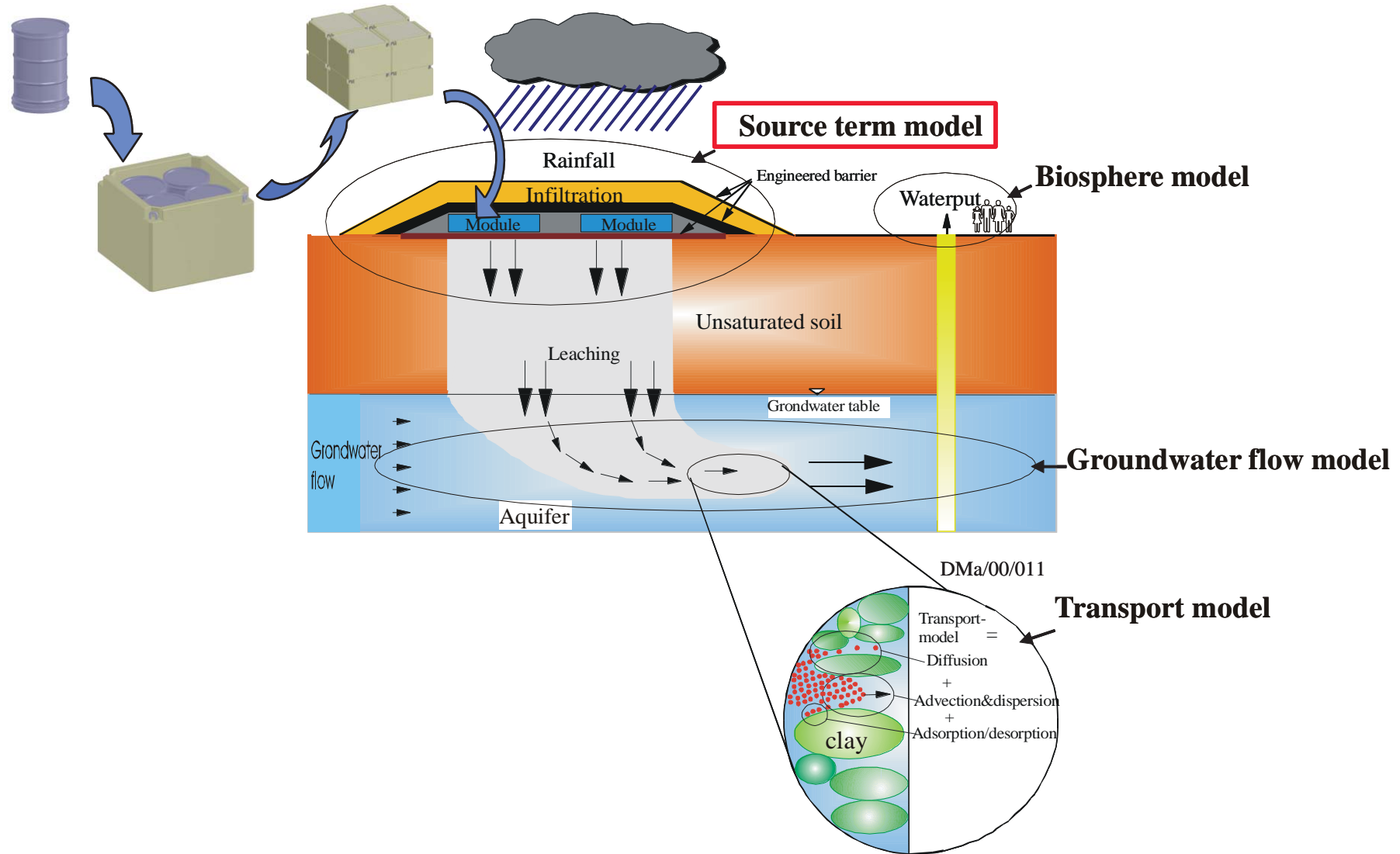
12th August 2011
ICTP School, Trieste, Italy

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NEFW, IAEA

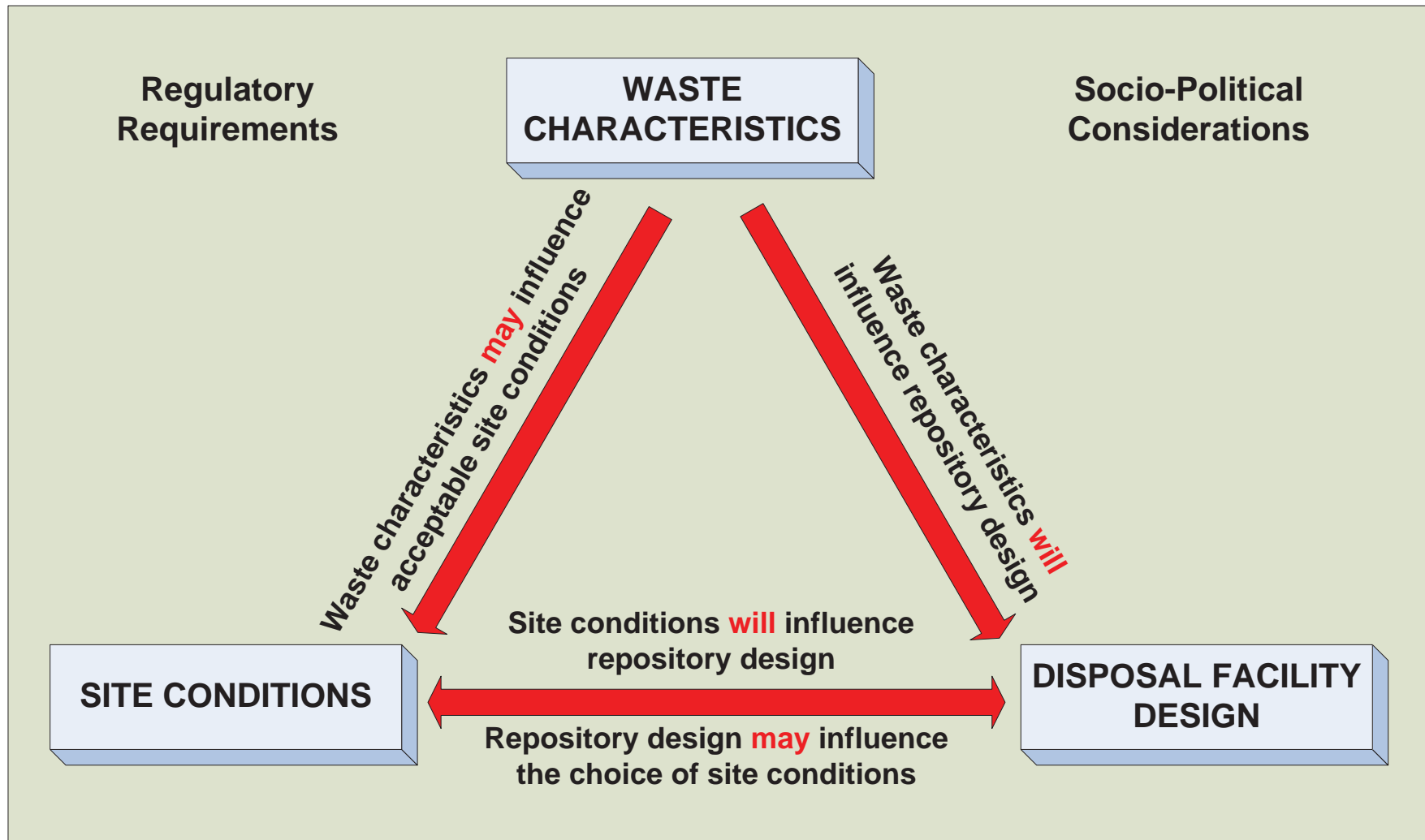
Key Objectives

- The overall objective of disposal is to isolate and contain the waste so that there is no undue radiation exposure to humans or the environment.
- The basic objective of the siting process is therefore to select a suitable site for disposal and to demonstrate that this site has characteristics which, when combined with the facility design and waste package, provide adequate isolation of radionuclides from the biosphere for desired periods of time.

Overall conceptual model for groundwater pathway from a NSR



Influences on the Choice of Site and Design of the Disposal Facility



Stages in the Siting Process

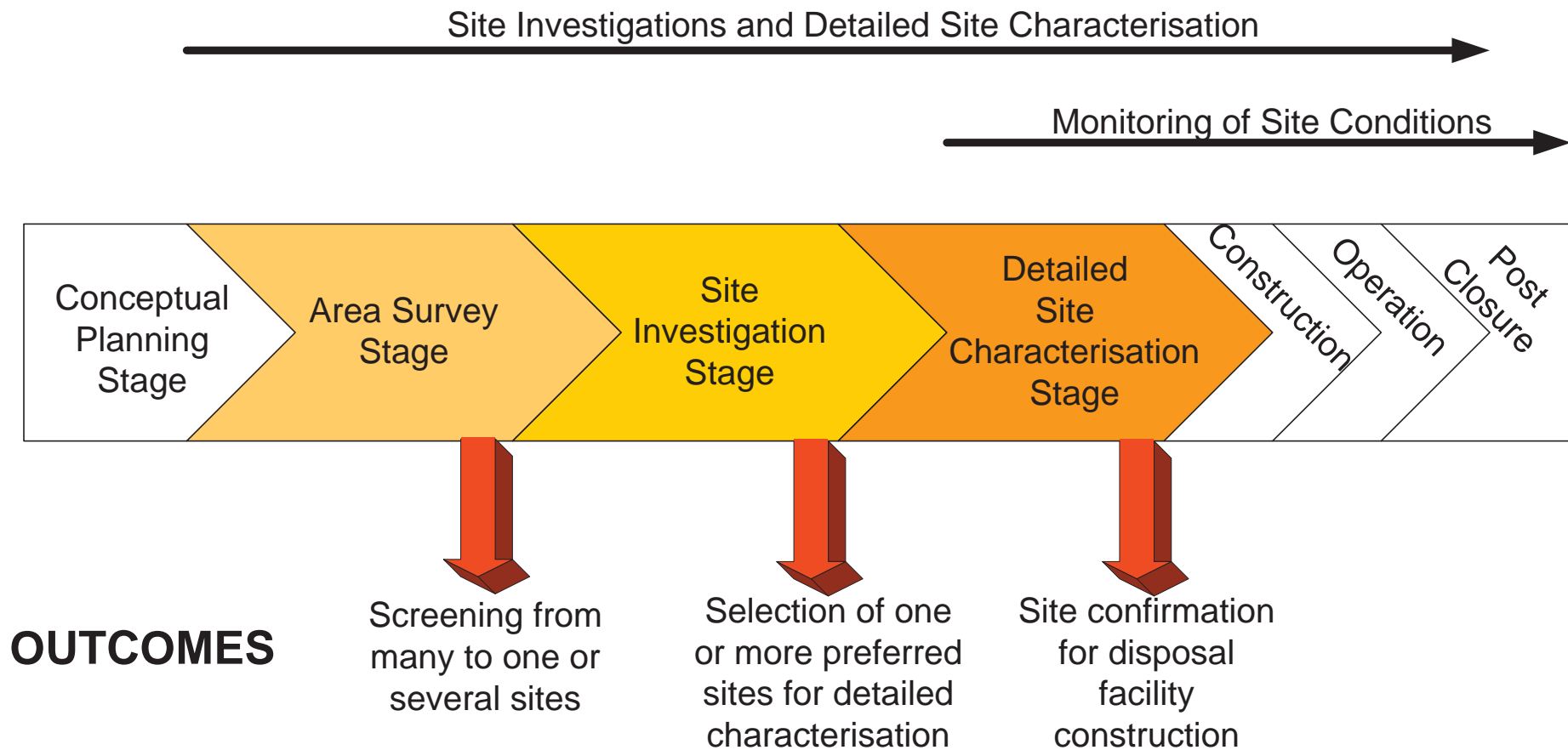
In many national RWM programmes a typical siting process for a disposal facility would involve the following 4 stages:

- Conceptual and Planning Stage
- Area Survey Stage
- Site Investigation Stage
- Detailed Site Characterisation Stage



Site Confirmation

Stages in a Siting Process



What Makes a Good Site?

- **Technical Suitability**
 - Geological Containment – Long-Term Safety
 - Low Environmental Impact
- **Practical Workability**
 - Accessibility
 - “Investigatability”
 - Constructability
 - Operability
- **Societal and Political Acceptability**
 - Local Acceptance
 - National Approval

How much weighting to put on these factors?

Selecting a Near-Surface Repository Site: General Criteria

- Availability of favourable geology, hydrogeology and topography
 - Geology – geological structures and stratigraphy, thickness and lateral extent of units.
 - Hydrogeology – data on existing and projected water uses, major discharge and extraction points, estimates of groundwater flow velocities and direction.
- Absence of natural resources
- Avoidance of areas of special cultural, scientific or ecological interest
- Availability of local infrastructure, including utilities, human resources, transportation routes and basic services

Site Characterisation Data Requirements (1)

- *Surface Conditions**
 - *Topography,*
 - *Geomorphology,*
 - *Surface water hydrology (drainage),*
 - *Pedology (soils),*
 - *Ecosystems (flora & fauna) and agriculture,*
 - *Surface processes causing potential hazard (erosion, flooding, landslide),*
 - *Meteorology and climate (rainfall, temperature, wind speed and direction, actual and potential evapotranspiration)*

Site Characterisation Data Requirements (2)

- Subsurface Conditions
 - *Geology (Lithostratigraphy, regional structure, local structure, petrology, mineralogy, facies analysis),*
 - *Hydrogeology (groundwater units, groundwater pressures & depth to water table [seasonal variability], hydraulic gradients, hydraulic conductivity, porosity, storativity, unsaturated flow conditions, groundwater recharge locations and rates, groundwater discharge locations and rates, groundwater residence times, relationships between different hydrogeological units and local vs regional flow)*
 - *Geochemistry (hydrochemistry – major and trace elements, pH, eH, TDS, TOC, DOC, isotopes (O-18, H-2, C-14, Cl-36), etc, radionuclide retardation potential – Kd, diffusion coefficient, etc.)*
 - *Tectonics and seismicity (Proximity to active faults, frequency, location, intensity & magnitude, stress regime).*
 - *Geotechnical Properties – for regolith and basement (rock hardness Q/RMR, in situ stress*

Site Characterisation Data Requirements (3)

- Social Environment and Infrastructure
 - *Demographics*
 - *Current Land use and ownership*
 - *Areas of special scientific or archaeological interest*
 - *Local industry & dominant occupations*
 - *Behaviours and consumption habits*
 - *Transportation Links*
 - *Powerline routes, sewers, etc*

The Exercise - Area survey stage

- The purpose of this stage is to identify one or more potential sites. It will be necessary to consider technical, engineering, operational, socioeconomic and environmental constraints.
- The stage can be split into two phases;
 - Regional mapping to identify areas with potentially suitable sites.
 - **Screening to select potential sites for further evaluation.**

Area survey stage

- Regional mapping should focus on large areas that contain lands having favourable geological, structural, hydrological, hydrogeological and climatic features.
- In the screening phase, potential sites are identified within the suitable areas. The screening process would result in the identification of a few candidate sites for further site characterisation.

General Scenario

In this exercise, you will play the role of the operator responsible for the siting of a disposal facility on an island nation with one soon to be operational NPP. Assume that the inventory of waste to be disposed of will be well characterised at the NPP and that the Waste Acceptance Criteria and procedures will be comprehensive and therefore will ensure that only wastes suitable for disposal in a near-surface facility (LLW and short-lived ILW) will be accepted. A disposal facility is needed due to the very large volumes of LLW that will arise from NPP operation. The repository area will have a footprint of approximately 1km². The general population is in favour of nuclear power generation, but there is likely to be some strong local opposition for the siting of waste facilities.

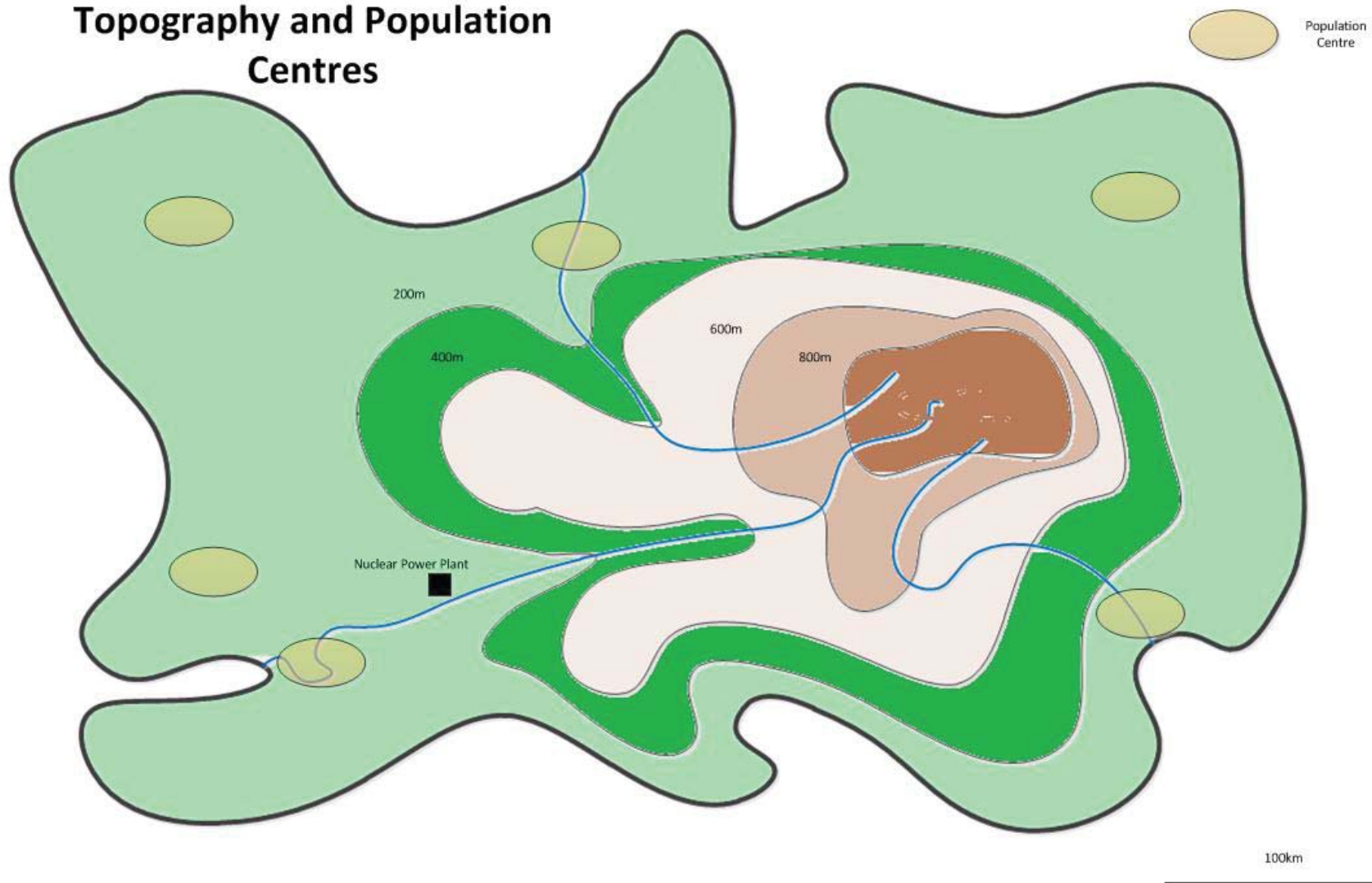
Surface and Social Characteristics:

- Regional investigation area is approximately 300 x 100 km
- Variable topography, from 1500m to sea level.
- Population centres with high population density, much less outside
- National parks and sites of scientific interest
- Agriculture and forest
- Desert area in west
- Stable population with increasing energy demands
- Sparse transport infrastructure in some areas

Subsurface Characteristics

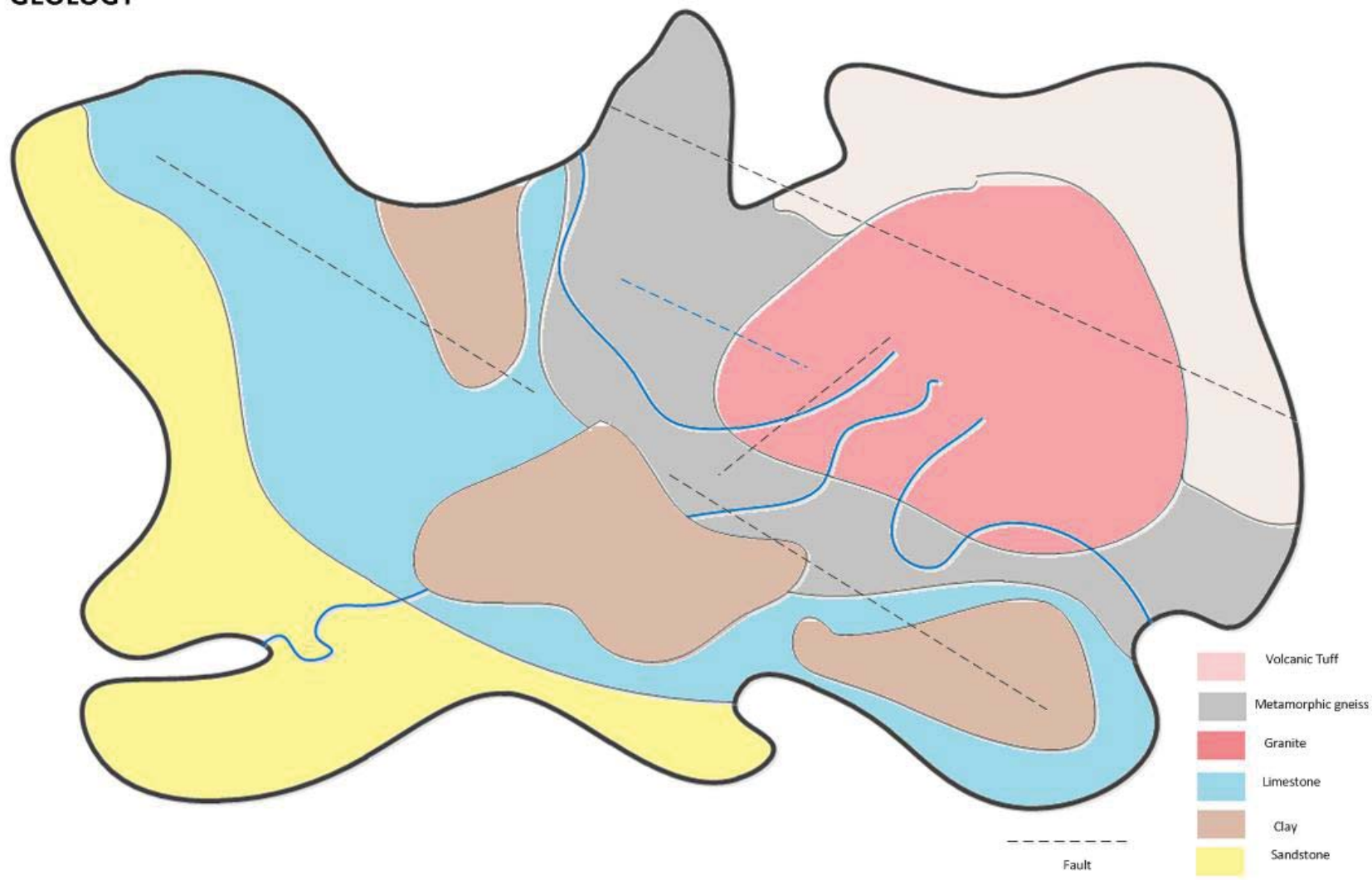
- Variable near-surface geology
- Variable deep geology
- Region has experienced moderate earthquakes in the geologically recent past. The historical records indicate these are concentrated along known major faults.
- Mining and oil extraction activities are carried out in certain rock formations

Topography and Population Centres

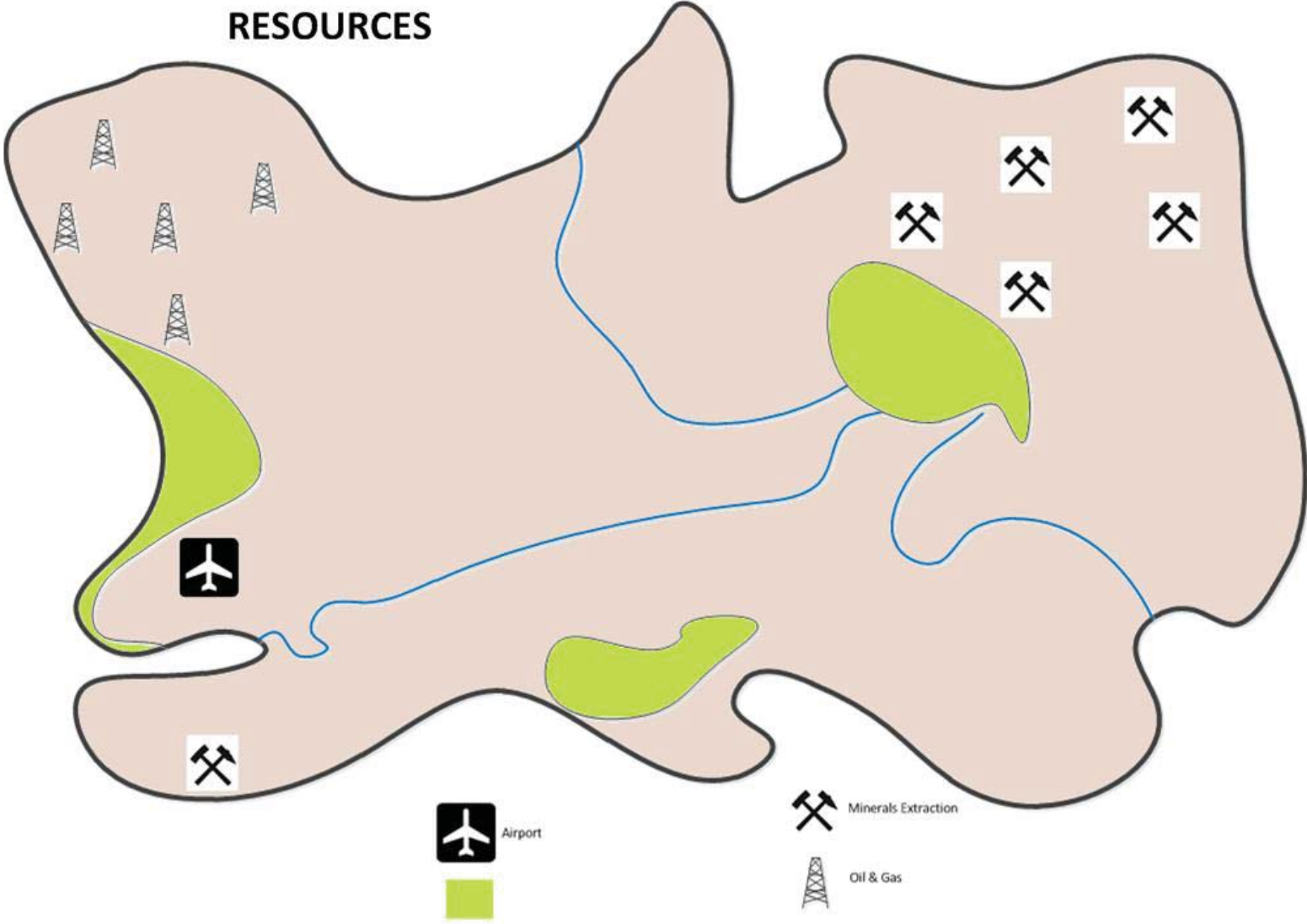




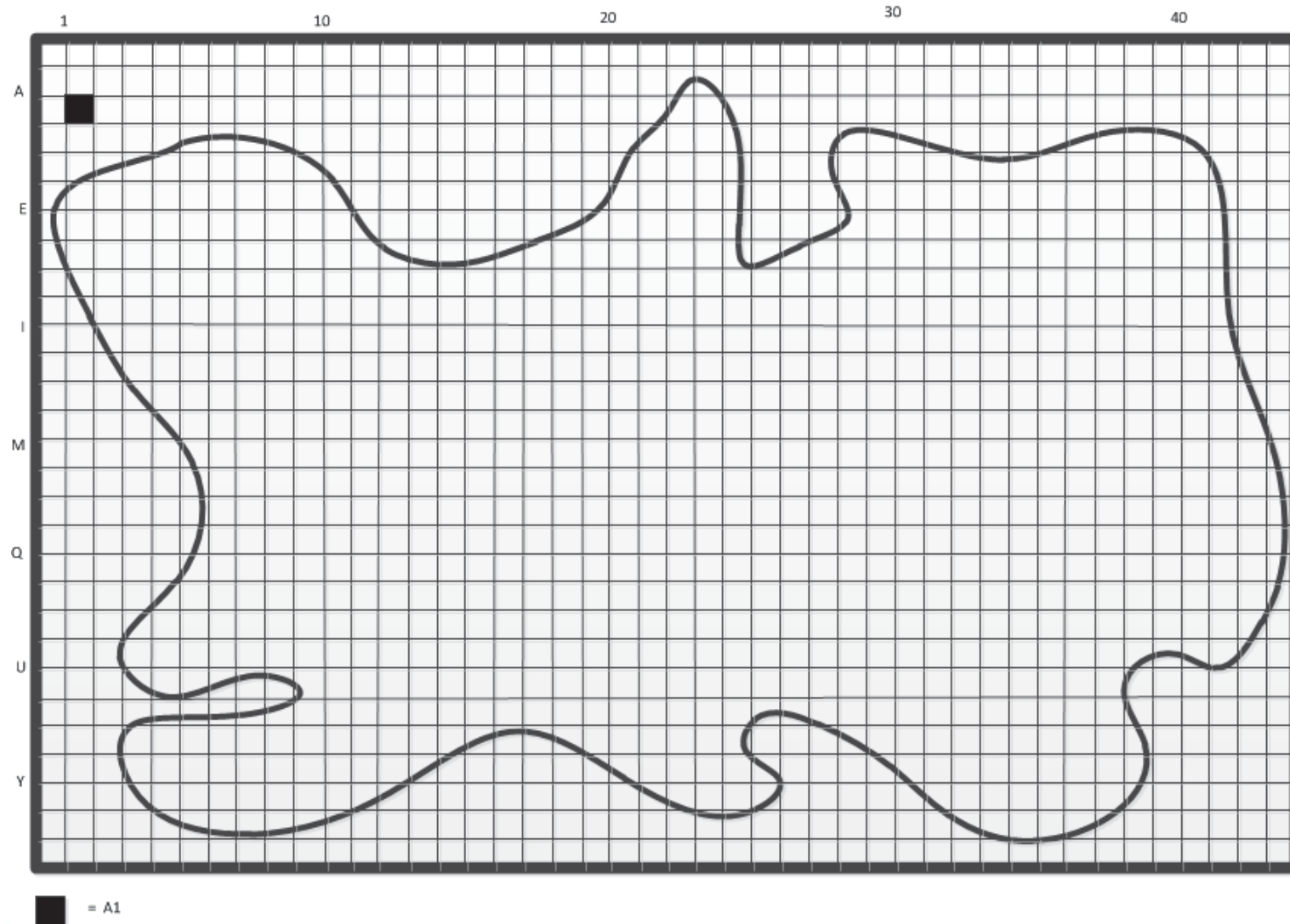
GEOLOGY



RESOURCES



GRID for preferred investigation area



The Task

- Identify the key selection criteria you consider necessary to include in the siting exercise. Provide structure to the criteria. (e.g. exclusion or preferable, technical and other)
- Decide on the weighting, if any, you will assign to these criteria.
- On the basis of an analysis of information provided and reasonable assumptions, propose a potential area that should be investigated in more detail for siting a repository and justify your choice.
- Suggest a possible repository design concept suitable for the area and the waste type. Briefly mention the main barriers and safety functions and the key pathways for any possible radionuclide transfers.
- Choose a key stakeholder group as a target group to “pitch” your presentation towards.

References and useful background reading

- IAEA. Technical considerations in the design of near surface disposal facilities for radioactive waste. IAEA-TECDOC-1256. (2001).
- IAEA. Siting of Near Surface Disposal Facilities. Safety Series No 111-G-3.1. (1994).