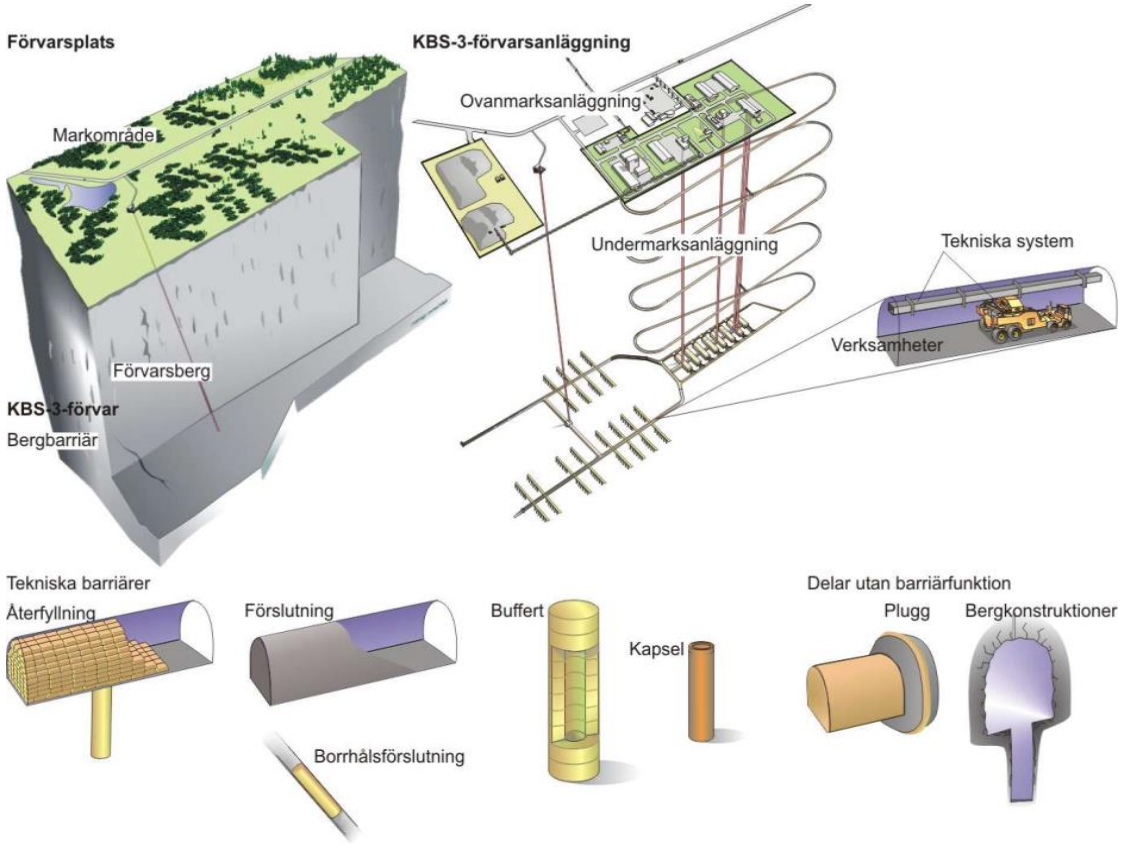
GEOLOGICAL DISPOSAL:
Site selection and characterisation

14 September • Johan Andersson, SKB

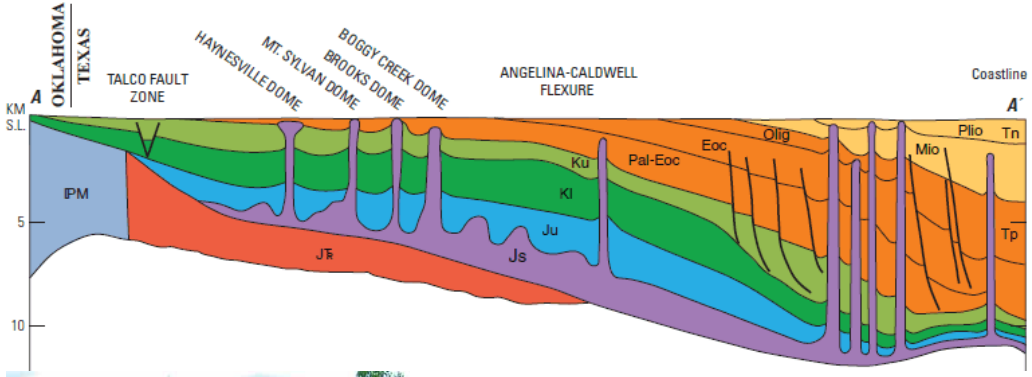
OBJECTIVES OF SITE CHARACTERIZATION

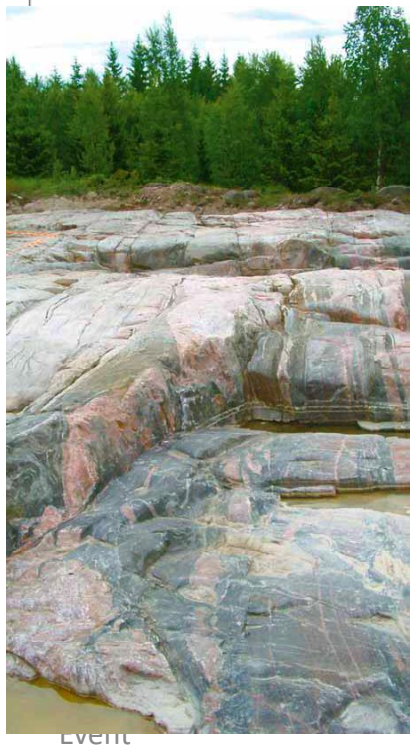
- **Explore whether site is potentially suitable for a repository**
  - Safety
  - Constructability
  - Space
- **Provide information for**
  - Selection of repository concept
  - Safety Assessment
  - Design and layout

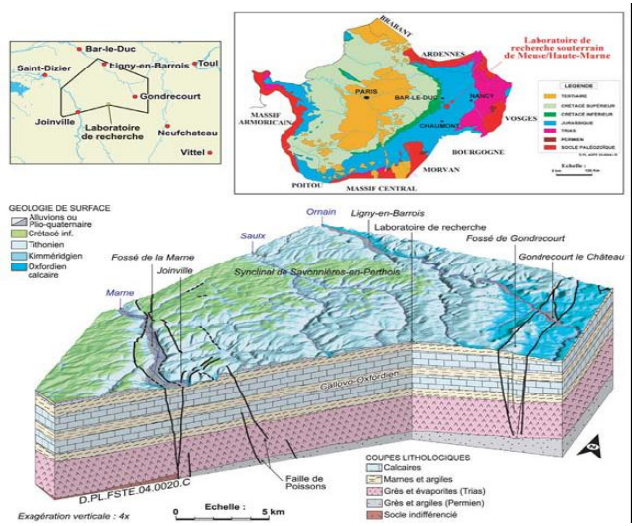


ASPECT TO SEARCH FOR - DEPENDS ON HOST ROCK

- **Clay, crystalline, salt,…?**
- **Low permeability?**
  - Limits impact on EBS and limits release
  - Low groundwater flow – retention
- **Favourable and stable groundwater composition?**
  - Limits impact on EBS and limits release (solubility limited)
- **Mechanically stable?**
  - Limits impact on EBS
  - Constructability
- **Enough space/flexibility?**

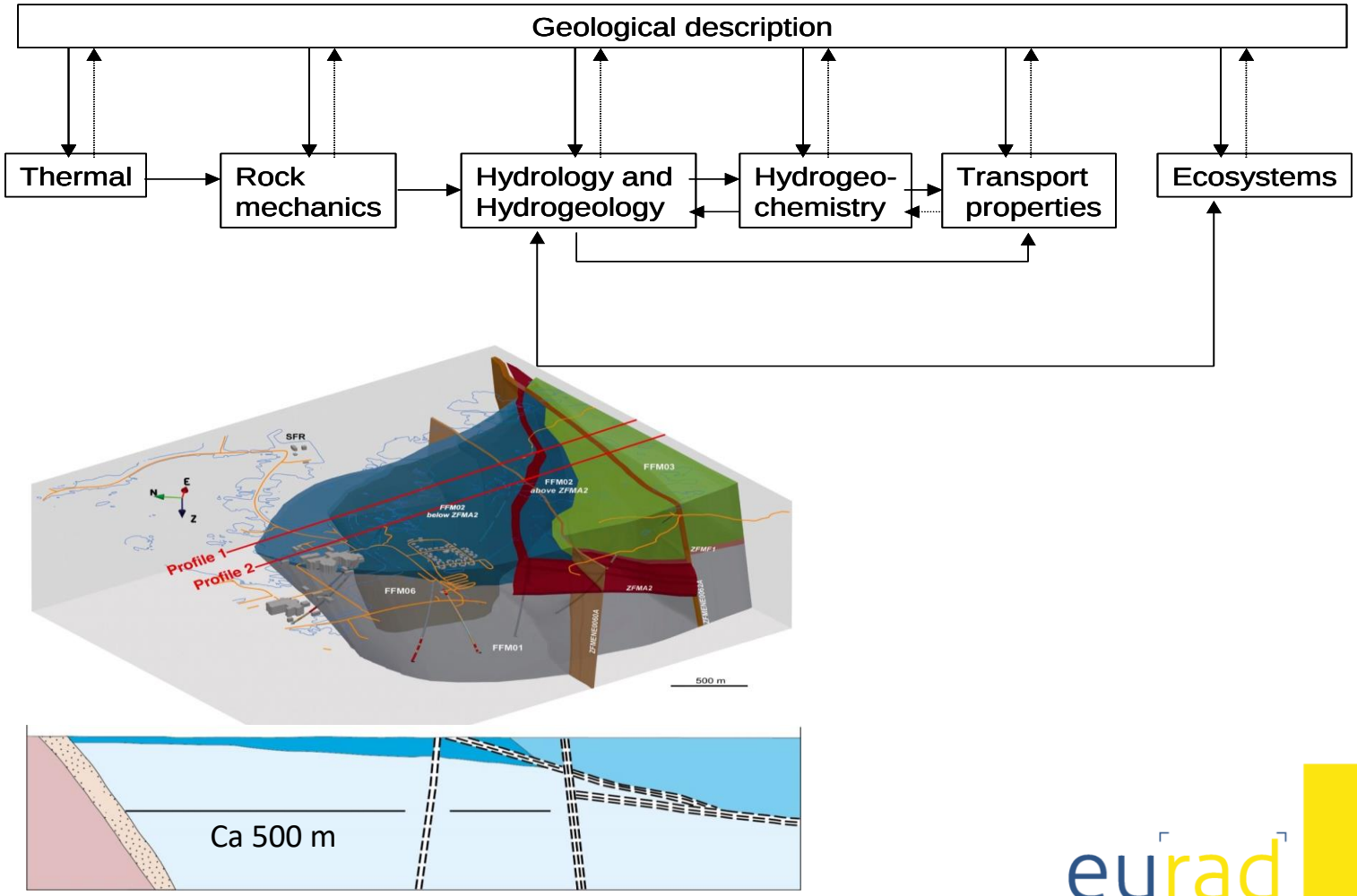






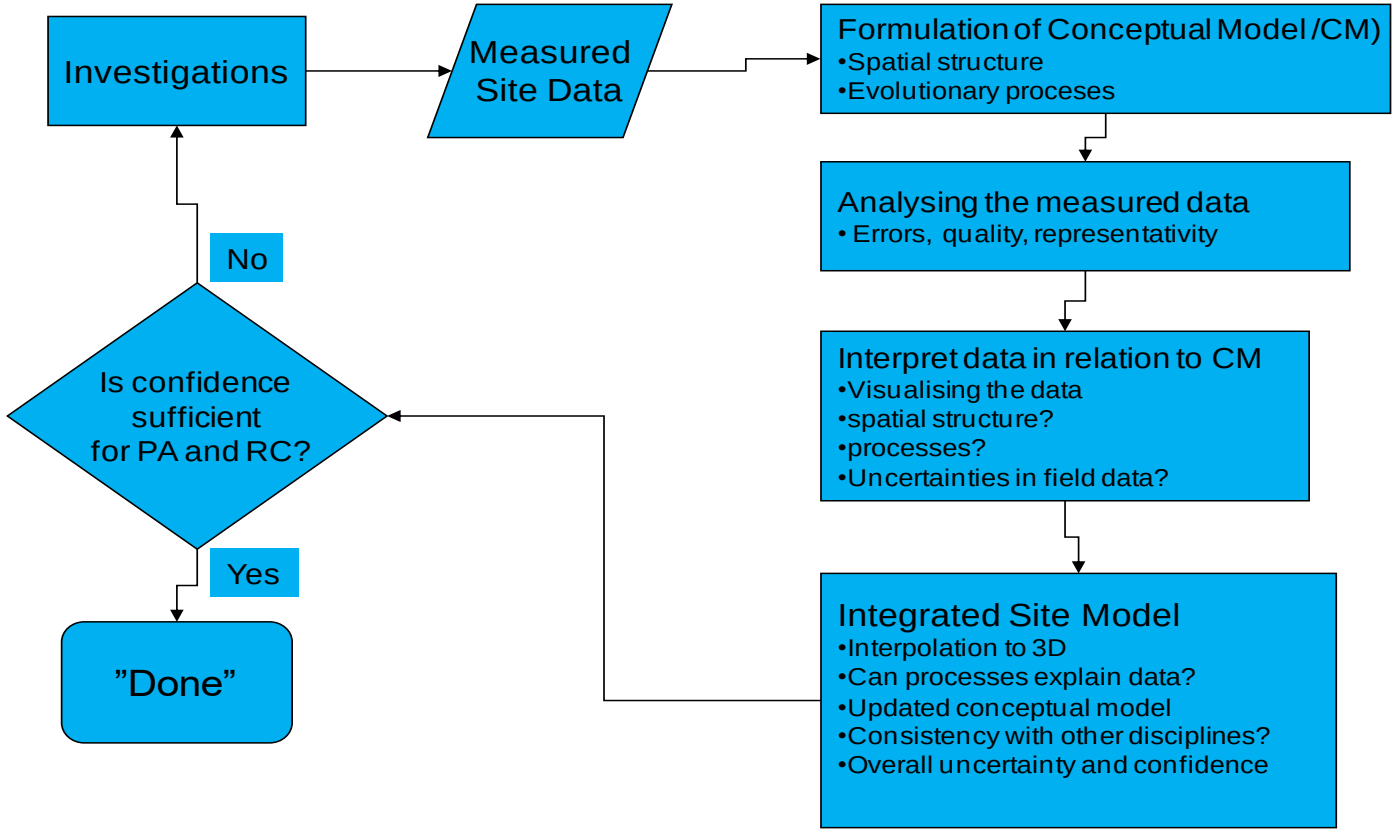
EVALUATION OF FIELD DATA – SITE DESCRIPTIVE MODEL

- **Synthesis**
  - geology, rock mechanics, thermal properties, hydrogeology, hydrogeochemistry and surface system
- **Traceability**
  - From field investigation to 3D interpretation
- **Assessment of uncertainties and confidence**
- **Used by Design and Safety Assessment**
- **Usually a new version after each data freeze**
- **See e.g. SKB TR-08-05**



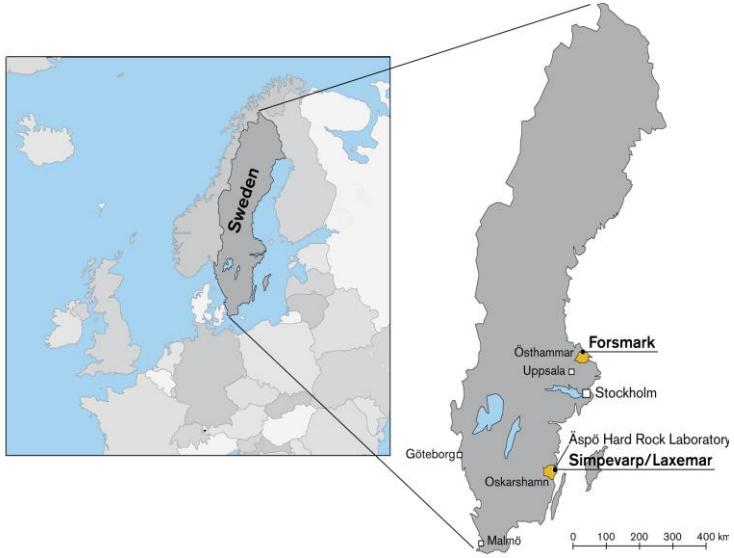
SITE DESCRIPTIVE MODELLING STEPS

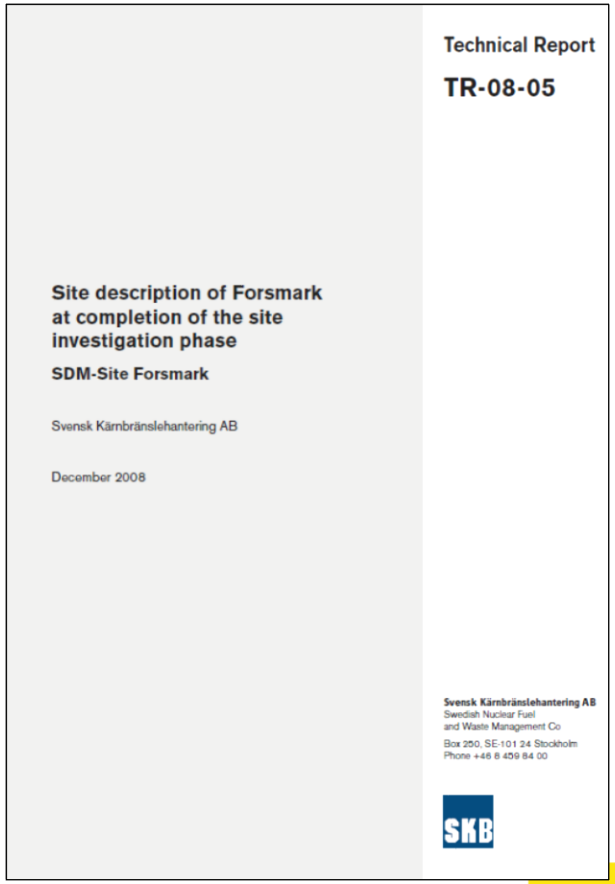
- **Conceptual model**
  - Hypotheses on spatial structure and processes based on experience, previous iteration
- **Analysing the measured data**
  - Quality, errors, representativity of the data
- **Interpreting data in relation to conceptual model**
  - Visualising the data in 3D and/or in relation to other data
  - Support for conceptual model?
  - Uncertainties (field data and interpretation)
- **Integrated site model**
  - Interpolation/extrapolation into 3D
  - Processes – can measured data as a result of identified evolutionary processes?
  - Updated conceptual model
  - Consistency with other disciplines?
  - Overall uncertainty and confidence in the model



SKB SITE INVESTIGATIONS CONDUCTED IN CAMPAIGNS

- **Five "data freezes"**
- **After data freeze 1.2**
  - Preliminary site descriptive models used to develop preliminary repository layouts and input to a full safety assessment (SR-Can)
  - Feedback factored into the final program for the completion of the site investigation phase
- **After completion final SDM (SKB TR-08-05 and SKB TR-09-01) developed**
  - Input to revised repository layouts
  - Basis for the safety case (SKB TR-11-01) being the core of the application for the repository for spent fuel




Technical Report
TR-08-05

Site description of Forsmark at completion of the site investigation phase

SDM-Site Forsmark

Svensk Kärnbränslehantering AB

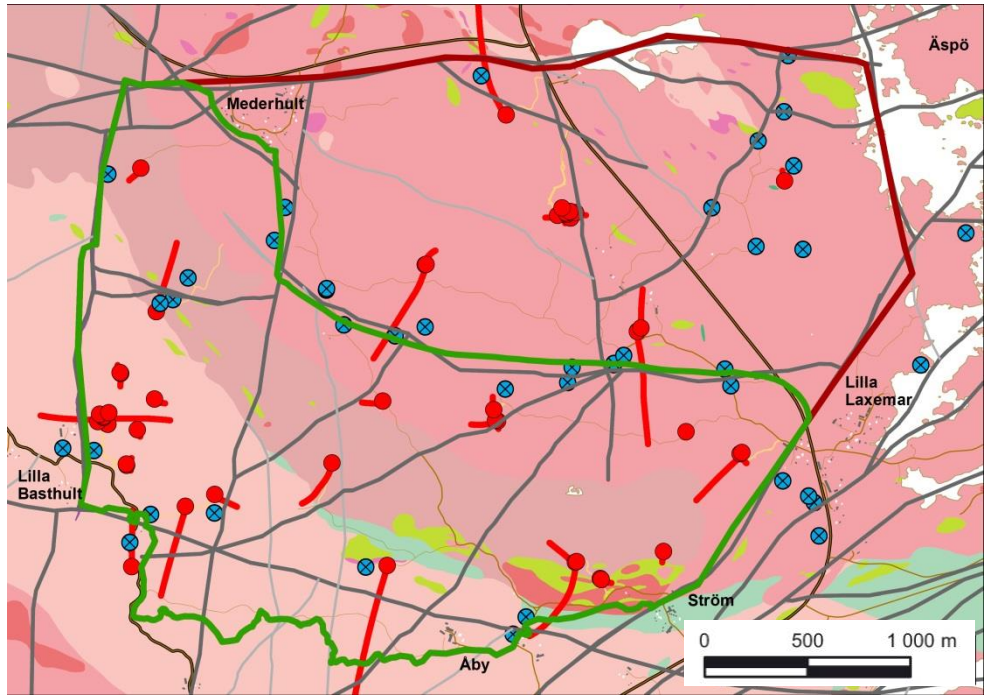
December 2008

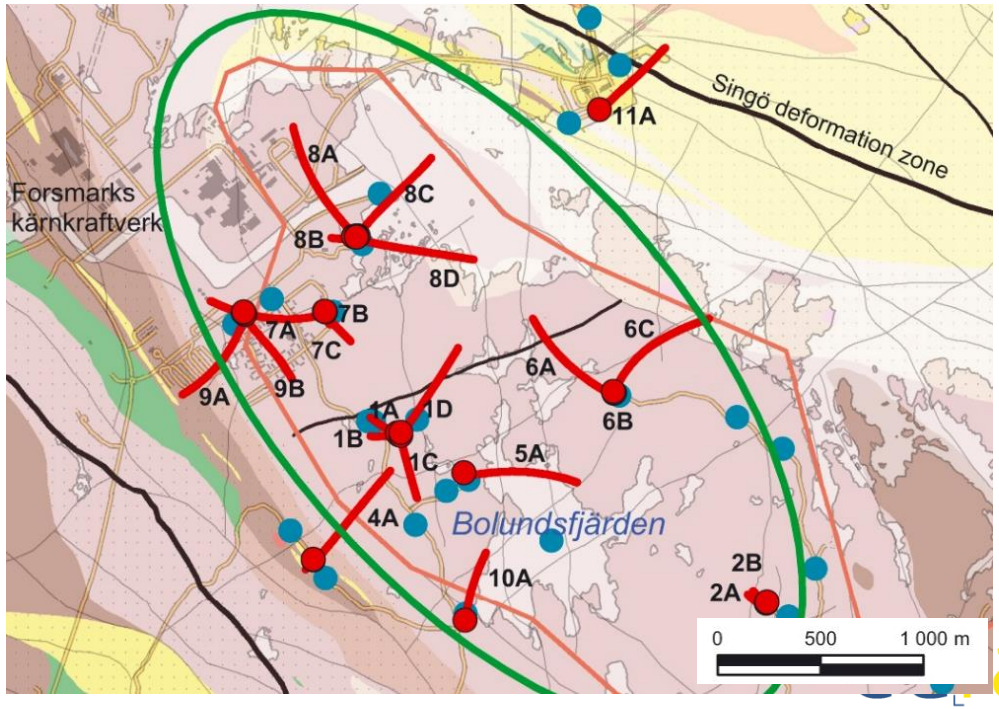
Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel and Waste Management Co
Box 250, SE-101 24 Stockholm
Phone +46 8 459 84 00

SKB

SKB SITE INVESTIGATIONS IN LAXEMAR AND FORSMARK 2002–2007

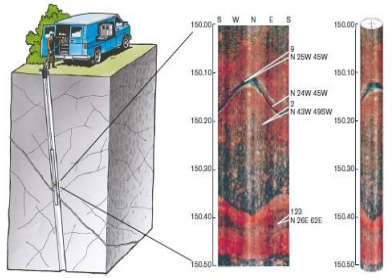
- 6 years of investigation
- About 20 core drilled boreholes down to 1000 m depth per site
- About 40 percussion drilled borehole per site
- Geoscientific and ecological surface mapping and airborne surveys
- About 600 reports per site





DATA QA AND HANDLING

- **Data base needed**
  - Should be able to handle the measurement ('raw') data produced by the planned investigation.
  - If measured data are interpreted from the actual measured data, both the measured data and the interpretation should be entered into the database and there must be a clear distinction between raw data and data derived from interpretation.
- **Strict QA and version control procedures are needed when storing the data in the database.**
  - Data should be retrieved using purpose-designed software and procedures for retrieval.
  - Ensure that everyone uses the same data and that corrections to the data reach all users.
  - It is not acceptable for users to develop their own version of (parts of) the database, or to exchange data between users.
  - Different users may have different access rights and privileges for data input and data use.



SKB'S SITING PROCESS FOR A REPOSITORY FOR SPENT NUCLEAR FUEL

1993 - 2000

2001 - 2008

Älvkarleby
Hultsfred
Tierp
Oskarshamn
Östhammar
Nyköping
Malå
Storuman

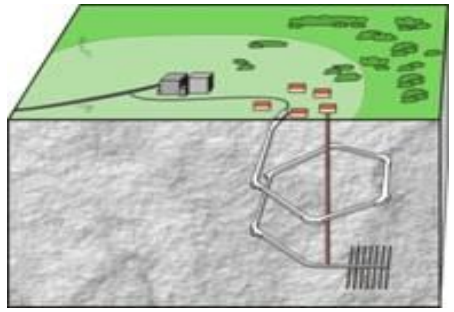
Feasibility studies (5–10)

Siting decision

Forsmark
Oskarshamn

Site investigations (at least 2)

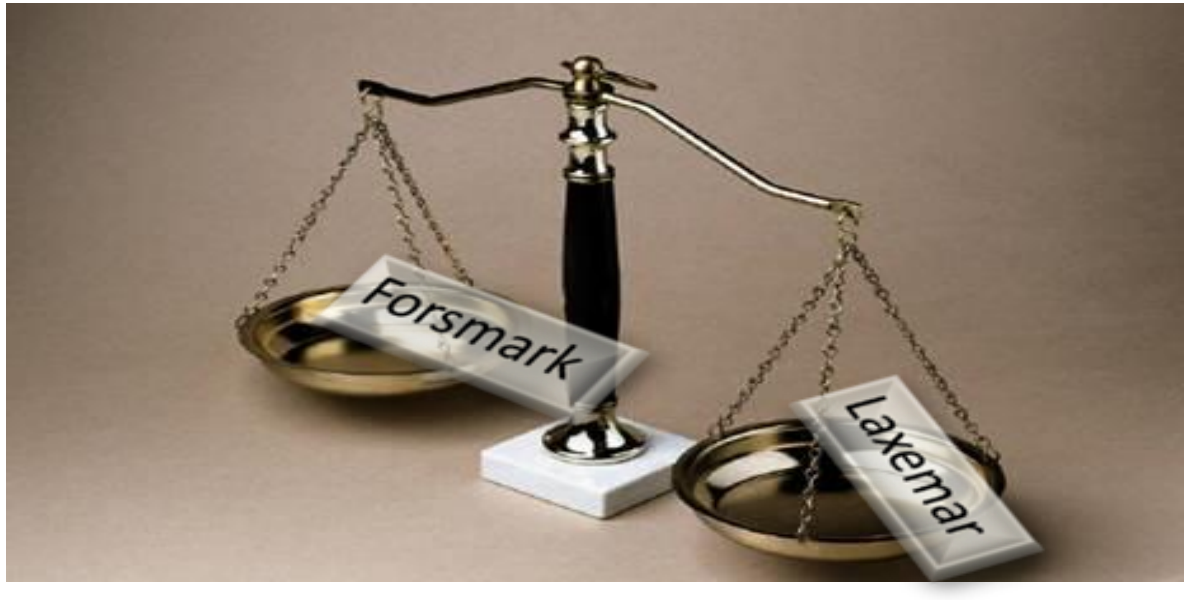
Detailed characterization and construction (one site)



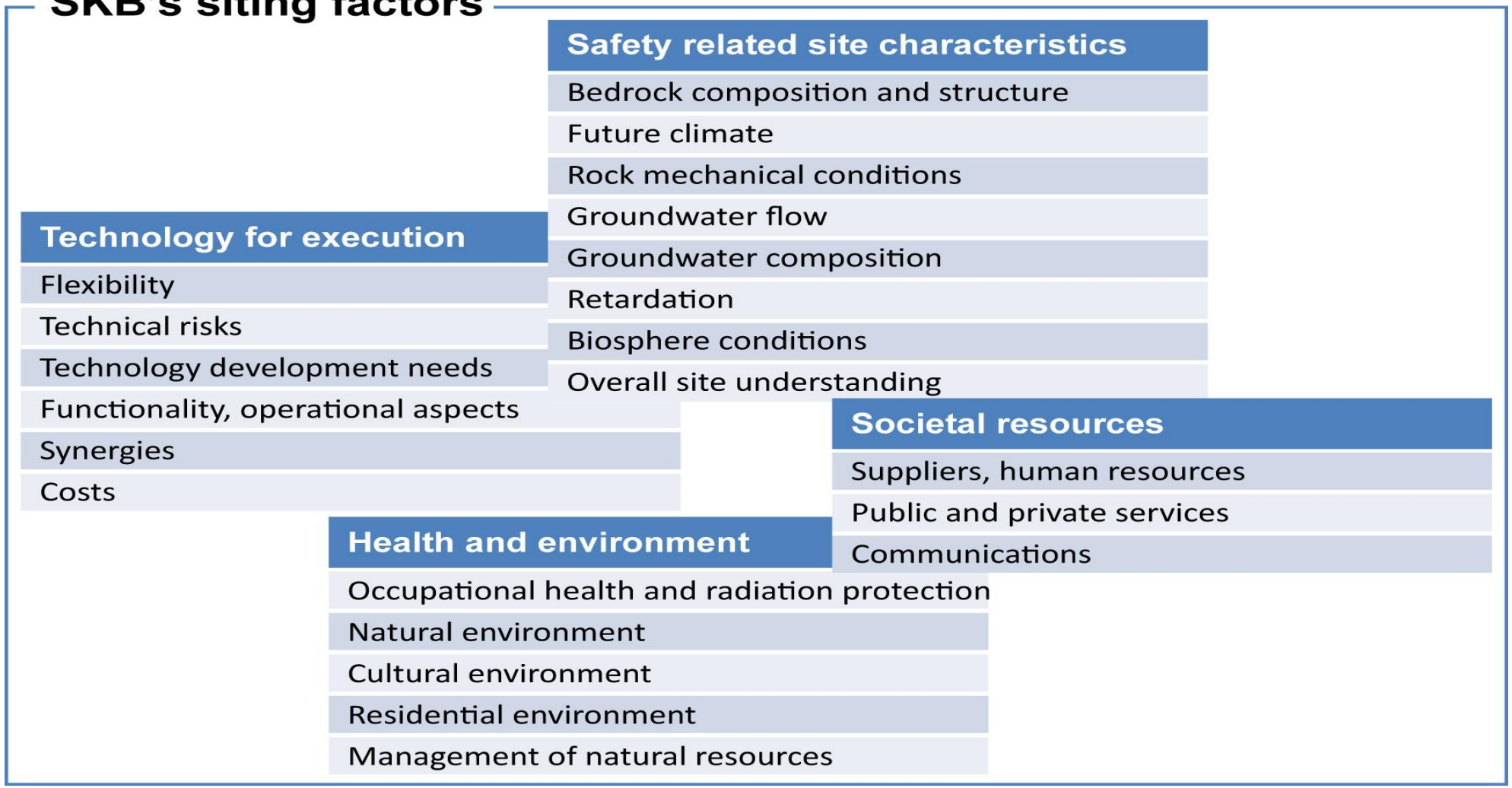
These steps should be similar in any program, but number of sites may differ

SKB'S GENERAL SITING PRINCIPLE

- The site that provides the best conditions for realizing long term safety will be selected
- If there are no significant differences with respect to conditions for realizing long term safety then the site will be selected that from all other aspects is considered most suitable for accomplishing the spent fuel project.

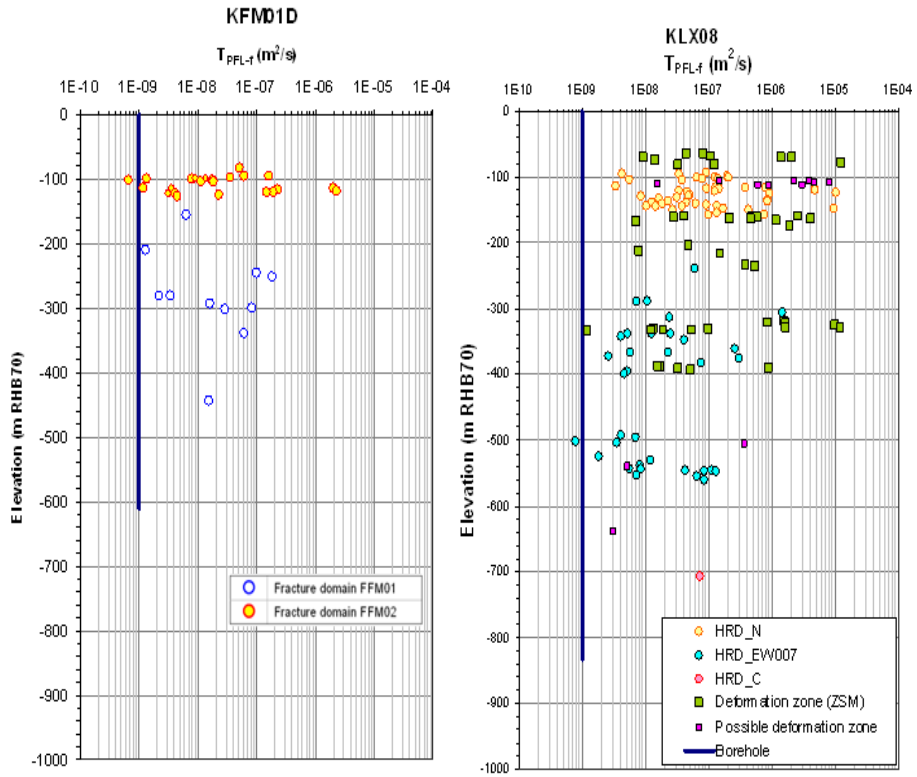


SITING FACTORS



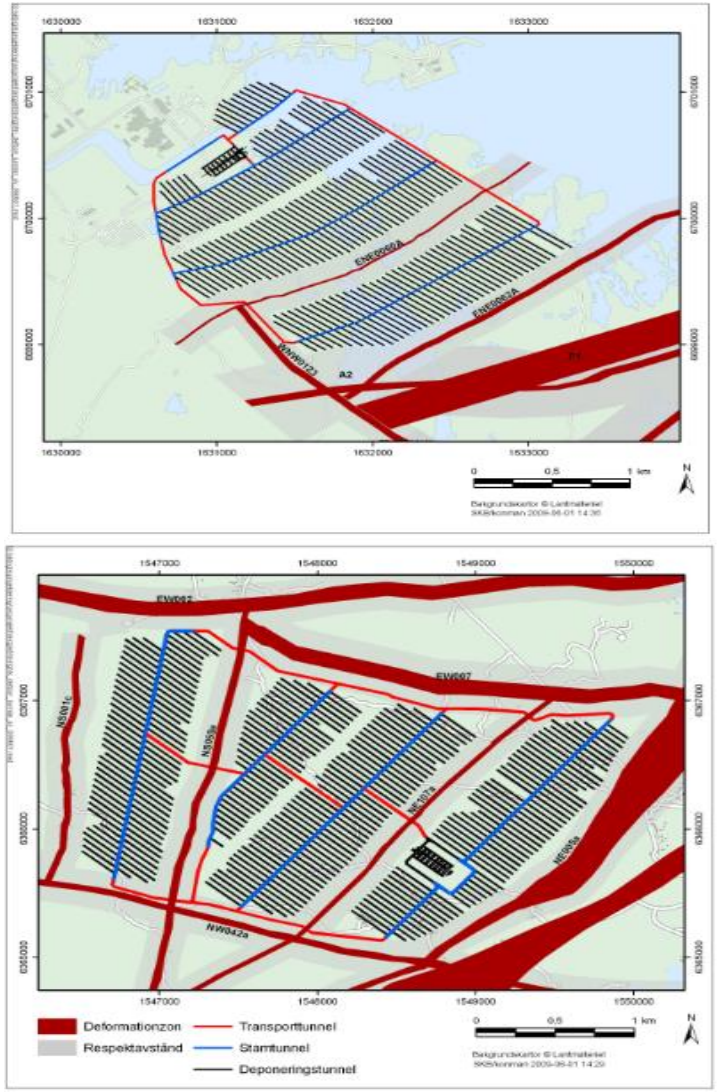
SAFETY RELATED SITE CHARACTERISTICS

- **Assess site specific factors potentially affecting safety functions**
  - Future climate and its impacts
  - Rock mechanics - Thermally induced spalling
  - Hydrogeology
  - Groundwater composition
  - Impact from earthquakes
  - Potential mineral resources
  - Biosphere conditions
  - Calculated risk
- **Forsmark is clearly the preferable option**
  - Frequency of water conducting fractures at repository depth is much larger at Laxemar than at Forsmark. This affects bentonite stability, potential for canister corrosion and RN release and migration
  - For other characteristics no decisive differences between the sites



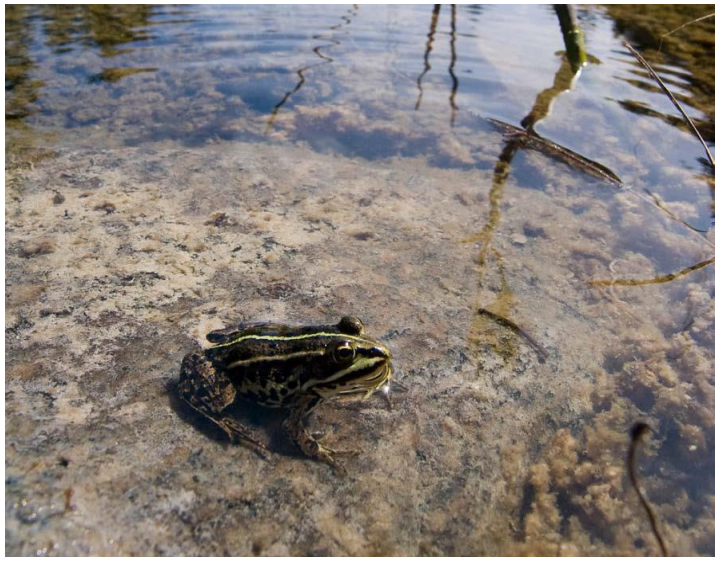
TECHNOLOGY FOR EXECUTION:

- **Adapt design to each site based on requirements from safety and constructability**
- **Consider different aspects**
  - *Flexiblity:* Can the waste be hosted/size of footprint
  - *Technical risk*: Complexity of layout determining features. Need for local adaptation to spatial variability. Rock stability. Groundwater handling
  - *Technical development needs*
  - *Functionality* (operational aspects)
  - *Costs* (correlated to flexibility and technical risks)
- **Forsmark site prefeed**
  - Limited footprint (high thermal conductivity). Room for 6,000 canisters
  - Few layout determining features.Water handing minor issue (low permeability)
  - High rock stresses, but can be handled



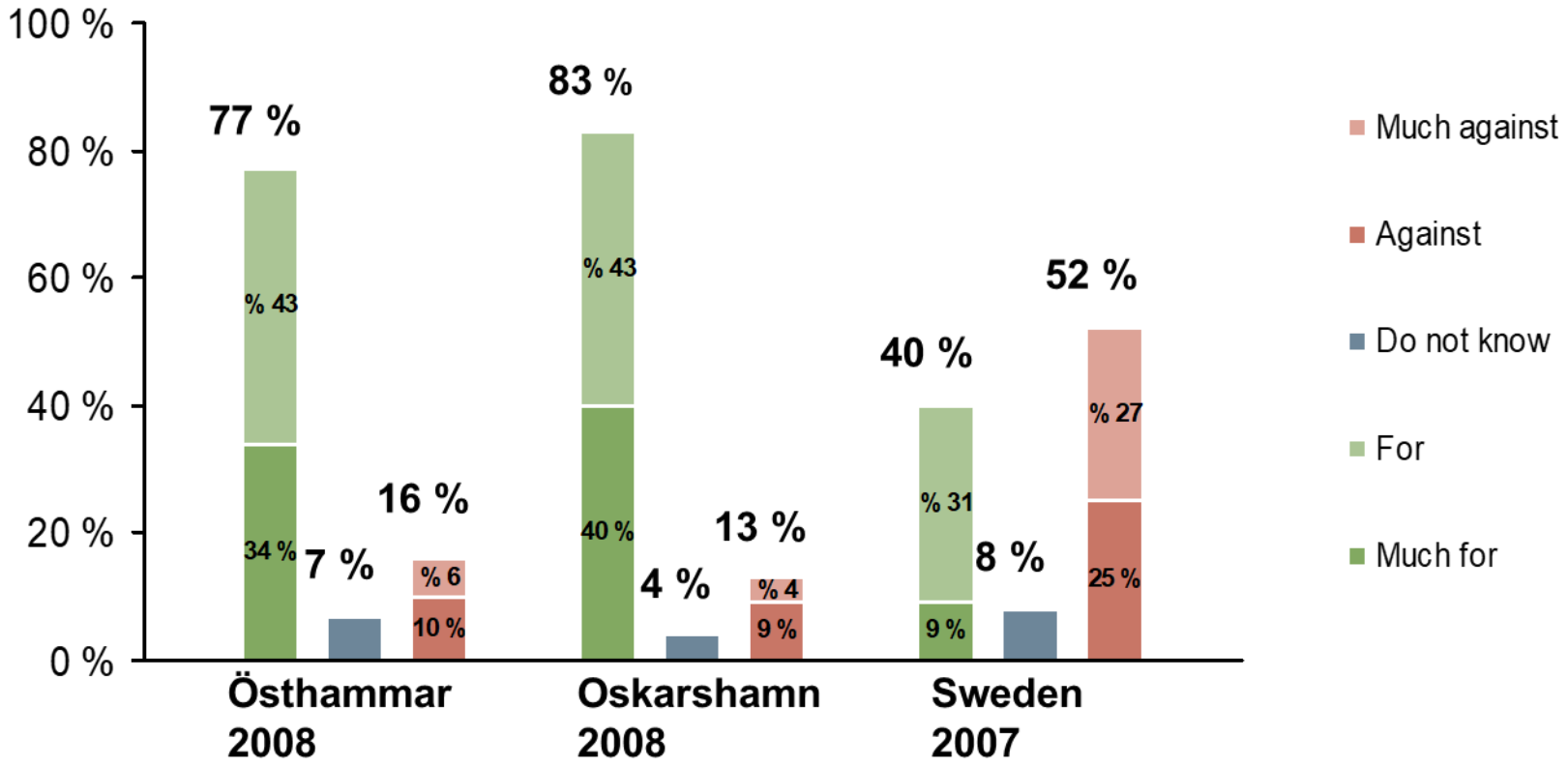
HEALTH AND ENVIRONMENT

- **Natural values**
  - Forsmark judged to have substantial natural values (Endangered species, Nature-2000 areas)
- **Cultural values**
  - Oskarshamn judged to have substantial cultural values
- **Noice, traffic etc.**
  - Similar impacts at both sites
- **Conclusions**
  - A need to make sure that repository construction and operation is adapted to the environment and people's health.
  - Very detailed environmental assessments made for both sites
  - Differences between sites – not a determining factor



PUBLIC OPINION

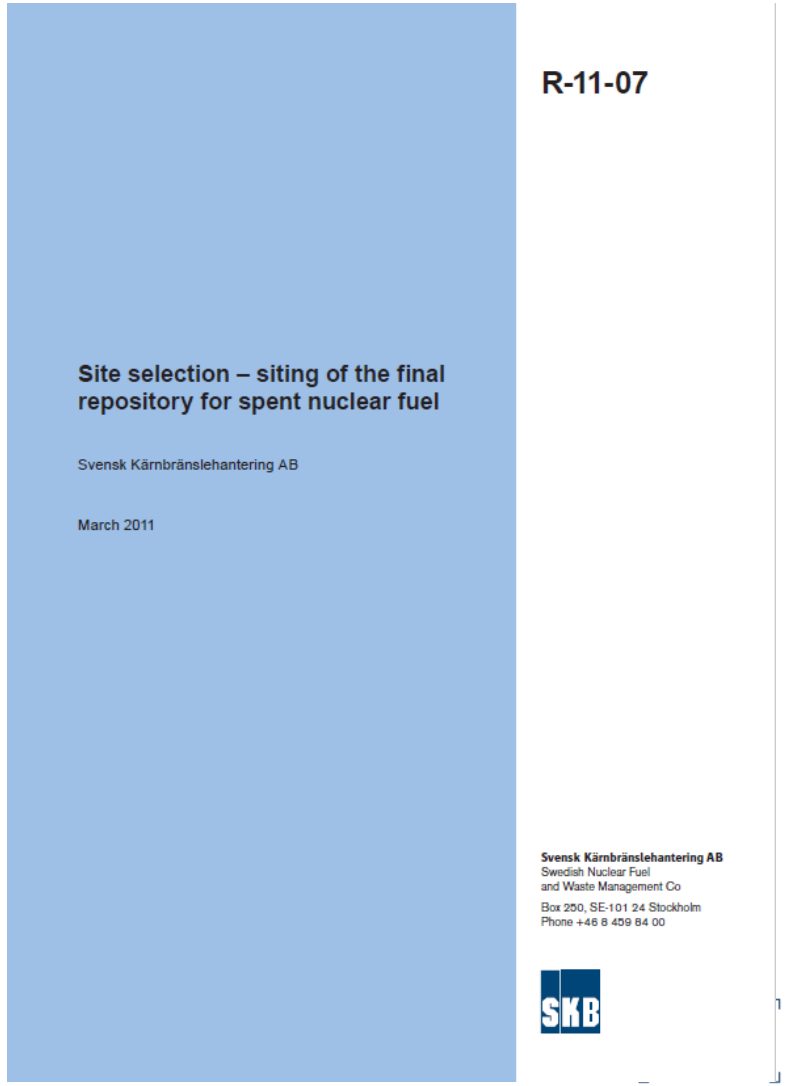
If there is a suitable site - are you for or against a repository for spent nuclear fuel in your municipality?



Källa: Synovate

SKB HAS CHOSEN FORSMARK

- **The rock in Forsmark offers much better conditions for long-term, safe disposal and facilitates implementation**
  - The rock is homogenous and has few water-conducting fractures at repository depth
  - Good thermal conductivity allows for a compact repository layout
  - Less rock mass and material for backfill
- **Buildings above ground can be built within the existing industrial area**
  - Access to infrastructure
  - Limits impact on the environment
- **Potential public acceptance**



SUMMARY

- **Objectives of Site Characterization**
  - Explore whether site is potentially suitable for a repository
    - Safety
    - Constructability
    - Space
  - Provide information for
    - Selection of repository concept
    - Safety Assessment
    - Design and layout
- **Aspect to search for - depends on host rocks**
- **Evaluation of field data – Site Descriptive Model**
- **Siting principle**
  - Safety, technology (layout/design), health and environment, public opinion
  - Best conditions for realizing long term safety to be selected.
  - If there are no significant differences other aspects considered