P-02-06

Execution programme for the initial site investigations at Simpevarp

Svensk Kärnbränslehantering AB

October 2002

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1 Introduction

1.1 SKB's site investigation programme

In the feasibility studies that were completed in 2001, eight sites were identified as potentially suitable for hosting a repository. All the identified sites meet the safety requirements with respect to bedrock conditions that could be checked at that time /SKB, 2000b/. The feasibility studies have revealed good potential when it comes to the technical and environmental aspects as well. Summaries of results from the feasibility studies are presented in /SKB, 2001a/.

Based on an integrated evaluation SKB proposed to start site investigations with test drillings at three sites; Simpevarp, Forsmark, and Tierp north /SKB, 2000b/. The site investigations have started at Simpevarp and Forsmark. The municipal council of Tierp rejected a site investigation in April 2002.

The site investigations are divided into two main phases; *initial* and *complete* investigations. Initial Site Investigation is performed to identify the site within a specified area that is deemed to be most suitable for a deep repository and to determine whether the feasibility study's judgement of the suitability of the area holds up in the light of borehole data from repository depth. The Initial Site Investigation is expected to take about 3 years. If the assessment shows that the site has good potential to host a repository, Complete Site Investigation will follow for an expected duration of another 3 years. The purpose of the Complete Site Investigation is to gather all information required to select one of the sites as the main alternative and to apply for a permit for construction of the deep repository at that site.

A general programme in which the results from feasibility studies are summarised, the candidate sites presented and the framework of programme for the site investigation phase presented has been published /SKB, 2000b/. The general programme, and main references to the programme, specifies which data are required in order to design the repository and carry out a safety assessment /SKB, 2000a; Lindborg and Kautsky, 2000; Blomqvist et al, 2000, 2001/, how the investigations should be carried out in order to provide these data /SKB, 2001b/, criteria with which the site must comply, as well as criteria for the discontinuation of the investigations /Andersson et al, 2000/.

A site-specific programme adapted for the site investigation at Simpevarp based on the general execution programme /SKB, 2001b/ has been developed /SKB, 2002/. The site-specific programme gives an overview of the whole site investigation phase as well as a detailed description of the initial stage. The results of the initial investigations will determine whether Simpevarp is appropriate for further investigation, i.e. the Complete Site Investigation.

This document summarizes the investigations that will be carried out at Simpevarp during the Initial Site Investigations. The document is a working document, which will be successively updated as results from the investigations become available.

1.2 The candidate area at Simpevarp

The candidate area at Simpevarp lies about thirty kilometres north of the town of Oskarshamn and comprises Simpevarp peninsula together with an area of the adjoining land to the west.

The localisation alternative at Simpevarp has the advantage of being close to CLAB and of Simpevarp's resources regarding industrial land, infrastructure etc. Furthermore, SKB's main alternative is to build the encapsulation plant adjacent to CLAB.

The candidate area is about 50 square kilometres in size, see Figure 1. The terrain on the Simpevarp peninsula and in the area to the west of Simpevarp is generally flat. On a small scale, the landscape is gently rolling, with a large number of small hills and valleys. The hills are forested and covered by a relatively thin, poor moraine soil, with exposed bedrock in places. The valley bottoms are characterised by more productive soils and richer vegetation; most of the agricultural land in the area is found here. The area is typical of the coastal district in this part of the country.

A comprehensive study of the Simpevarp peninsula and its surroundings has been carried out in conjunction with the localisation and construction of Äspö laboratory, Oskarshamn's nuclear power station and CLAB. As a result, the bedrock in the area is well characterised to a depth of about 100 metres. There are two deep cored boreholes about three kilometres northwest of the Simpevarp peninsula at Laxemar, boreholes KLX01 and KLX02, see Figure 2. In the area close to the boreholes, different types of investigation have been carried out, for example seismic reflection. However, the available information for most of the western part of the Simpevarp area is relatively summary.

The results of the feasibility study /SKB, 2001a/ show that the bedrock in the Simpevarp area is characterised by:

- Dominance of Småland's granite.
- Usually good homogeneity over large areas.
- A varying presence of hypabyssal rocks and other heterogeneities.
- Almost total absence of ore potential.
- Small degree of metamorphosis and plastic deformation.
- Few major plastic shear zones.
- Fracture zones on all scales, to an extent that is normal for Swedish crystalline basement.

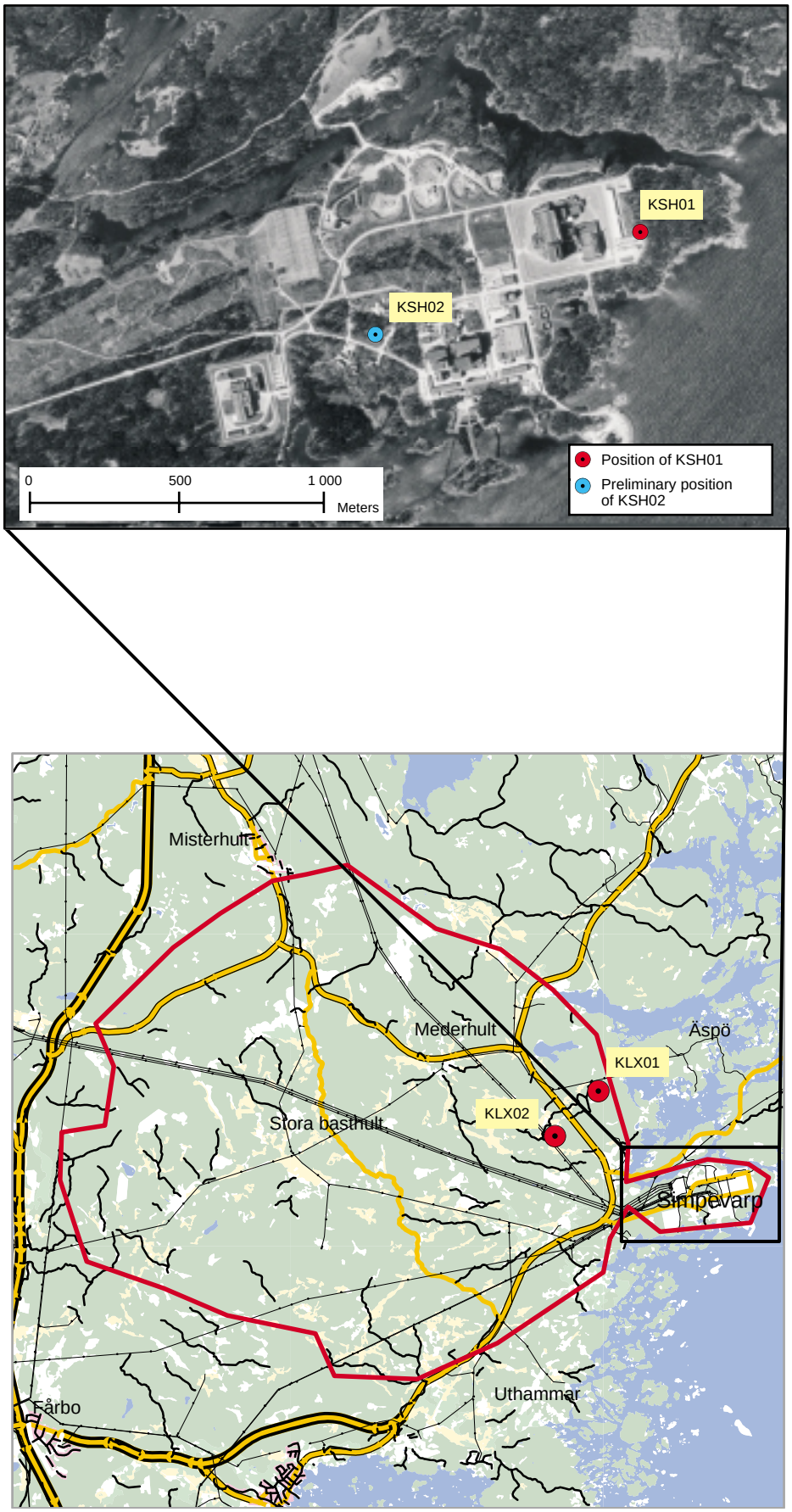

Figure 1. *The candidate area at Simpevarp. The position of boreholes KLX01 and KLX02 in Laxemar (lower figure) and KSH01 and KSH02 are illustrated (upper figure).*

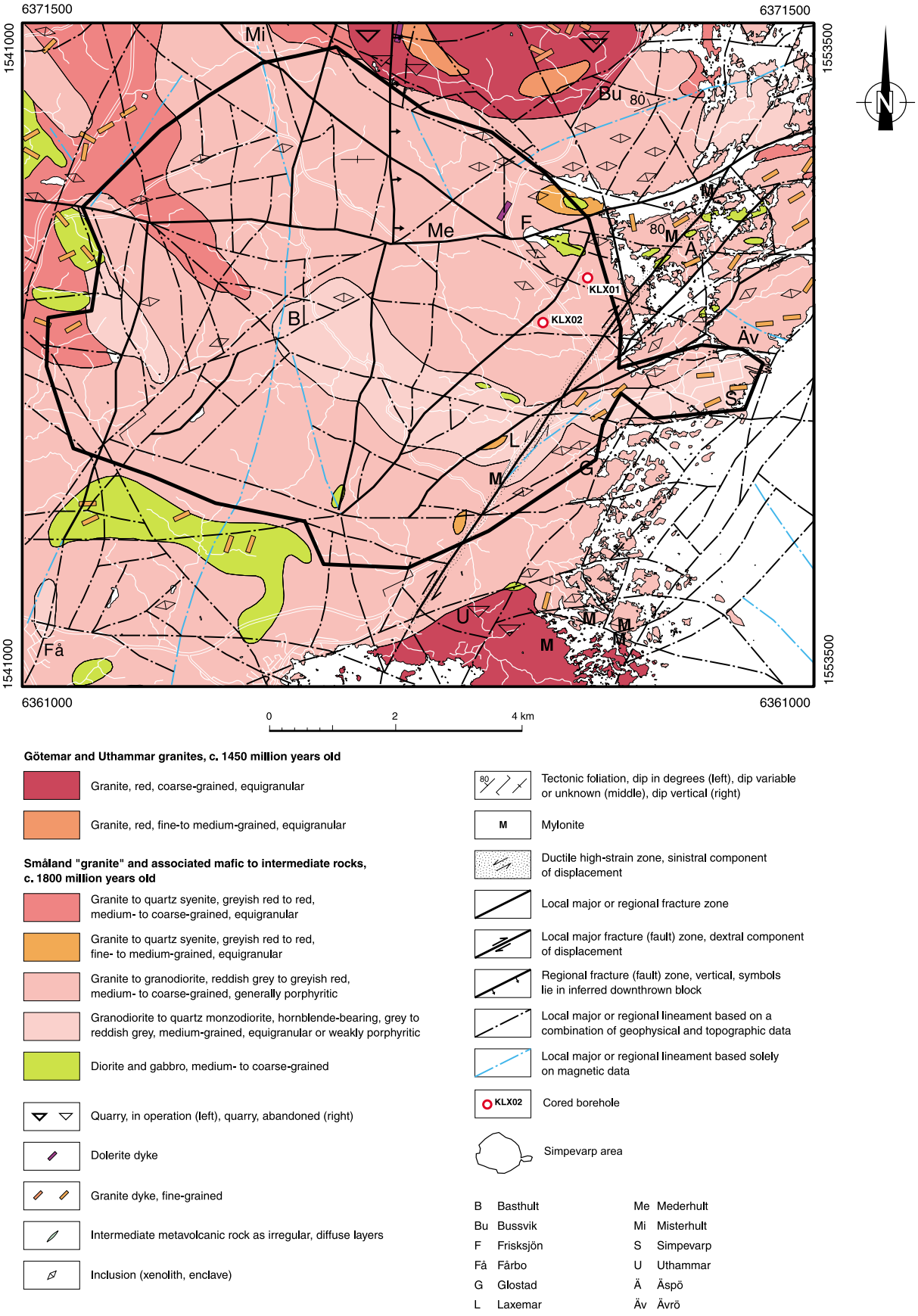

Figure 2. *Bedrock map over the Simpevarp area. The candidate area and the position of boreholes KLX01 and KLX02 is illustrated in the figure.*

2 Site investigation

2.1 Aim – general

The main aim of the site investigation is to obtain permits to site and build the deep repository for spent nuclear fuel and the encapsulation plant.

The main task of the site investigation at Simpevarp is to study the local bedrock and environment. This information is needed to evaluate the long-term safety of a repository for spent nuclear fuel at the studied site. Data is also needed to describe how the above- and underground parts of the deep repository can be designed and built with respect to the bedrock conditions and infrastructure. In addition, information is needed for the evaluation of the consequences of a repository for the environment during the construction and operating phases.

2.2 Aim for investigations at Simpevarp

In the feasibility study, it was shown that the bedrock on the Simpevarp peninsula is generally more heterogeneous than the rock further to west. It was not clear whether there is a sufficiently large volume of rock with suitable properties for the construction of a deep repository on the peninsula. However, the positive experiences from the construction of the existing rock-facility, CLAB, should be pointed out. The conclusions of the feasibility study were that a site investigation should focus on the characterisation of the conditions at depth both on the Simpevarp peninsula and in the area to the west of Simpevarp.

The investigation programme takes into account both site-specific questions that have been identified in the feasibility study as well as questions of a more general nature. In addition, new site-specific questions will probably arise as the investigation proceeds. Important geological questions which have been identified and which must be addressed are:

- The size and position of bedrock blocks with favourable properties. The size of the blocks is especially important on the Simpevarp peninsula.
- The occurrence of veins of fine-grained granite and fracture zones and their importance to permeability to water.

There are additional questions which must be addressed, for example the occurrence of high rock-stresses, the potential for radon occurrence, the rock mechanics, the water chemistry and the thermal conditions.

3 Execution of the work

3.1 General

The Simpevarp area is made up of two sub-areas, the Simpevarp peninsula and the area west of Simpevarp. Both sub-areas will be investigated to the degree required to enable a decision on whether a Complete Site Investigation is to be undertaken. The site investigation at the Simpevarp peninsula started in 2002. For the investigations in the area to the west of Simpevarp SKB needs to get permission from the land owners, before starting.

The bedrock of the Simpevarp peninsula is relatively well characterised down to a depth of about 100 metres. The next investigations will therefore concentrate on characterising the bedrock down to a depth of about 1,000 metres. This will be done by drilling and carry out investigations in the boreholes.

The area to the west of Simpevarp is so large that the investigations must first concentrate on prioritising a specific site and thereafter provide a basis for assessment of its suitability, based on data from repository-depth. The priority site is defined primarily on the basis of a detailed airborne geophysical survey, with follow-up studies in the field in certain cases. If the conditions seem to be similar in the entire area, we intend to select a site near the Simpevarp peninsula. When the site has been defined, a more detailed investigation will be carried out, with, among other things, cored boreholes to a depth of about 1,000 metres.

The main components of the Initial Site Investigations at Simpevarp are illustrated in Figure 3 and can be summarised as:

- *Investigation of the properties of the bedrock of Simpevarp peninsula.* The properties of the bedrock will be studied by means of three cored boreholes to a depth of about 1,000 metres, see Figure 1. In addition, the peninsula and its surroundings will be investigated with the help of ground geophysics and percussion drilling. In order to discover and study any horizontal structures, a reflection seismological investigation is planned.

- *Choice of a priority site within the area west of Simpevarp.* The priority site will be chosen mainly on the basis of existing information, airborne geophysical measurements, see Figure 4, and geological surveys. Further investigations will be carried out to the degree required to confirm the choice of site. If several alternative sites are judged to be equally suitable, proximity to Simpevarp peninsula will be prioritised.

- *Investigation of the priority site west of Simpevarp*. The properties of the bedrock will be investigated preliminarily with 2–4 deep cored boreholes. Further investigation of the site and its surroundings will be carried out with, among other things, ground geophysical measurements, geological mapping, excavation and percussion drilling.

- *Preliminary site description*. The preliminary site description forms the basis for decisions concerning a Complete Site Investigation. The Complete Site Investigation can cover either the Simpevarp peninsula, the priority site west of Simpevarp, or a combination of both.

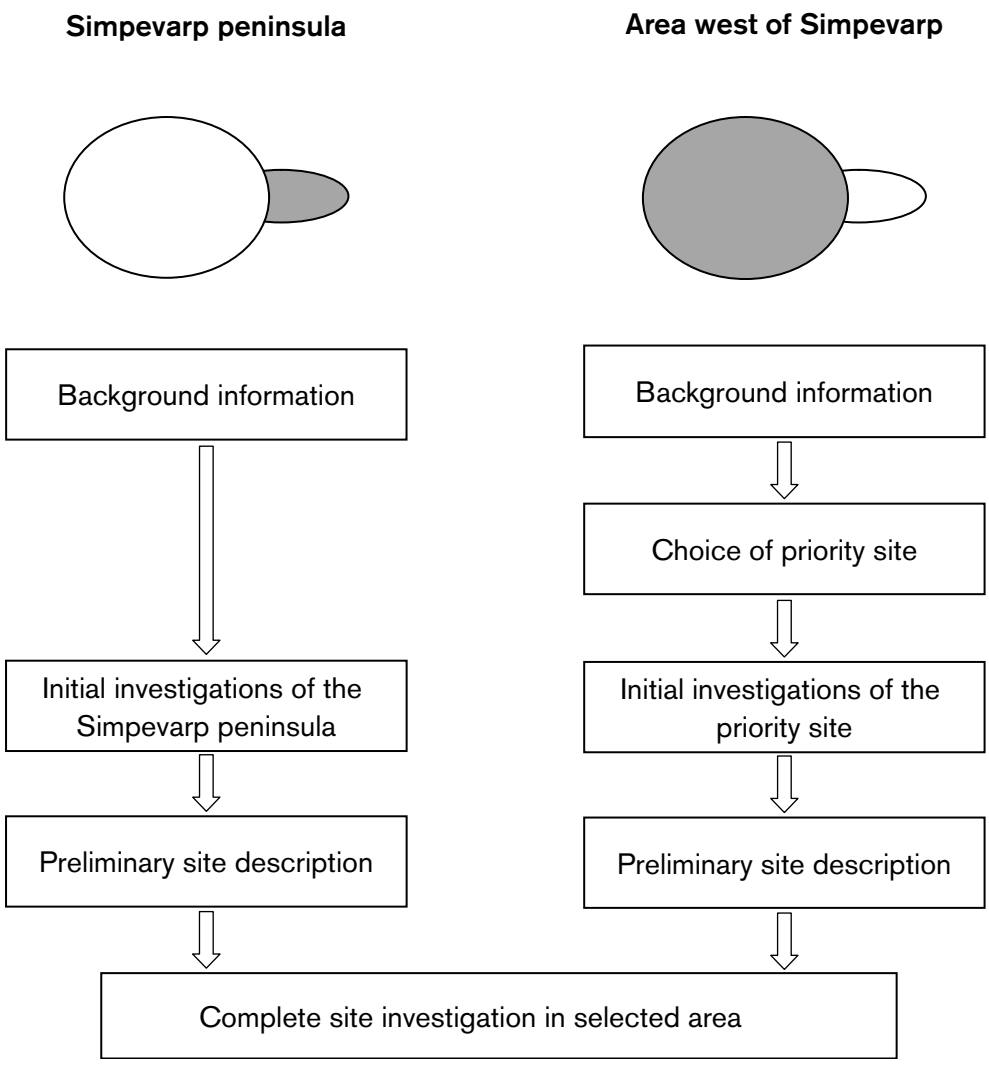

Figure 3. *Schematic illustration of the main components in the Initial Site Investigations.*

Figure 4. *Area for airborne geophysics (helicopter).*

3.2 Initial Site Investigations

The aim of the Initial Site Investigations is to answer the site-specific issues listed in section 2.2 and to assess if the judgement from the feasibility study regarding the suitability of the area still holds in the light of borehole data from repository depth. The Initial Site Investigations at Simpevarp can be divided into the following stages:

- Characterisation of the Simpevarp peninsula.
- Choose of priority site within the area west of Simpevarp.
- Characterisation of priority site of the area west of Simpevarp.

3.2.1 Background information

Preparatory work has been carried out in order to clarify the environmental and geological conditions and technical aspects of the investigation, as well as to initiate a continuous monitoring programme. The available background information also includes the collection of meteorological, hydrological and hydrogeological information, which forms reference or input data to the following study areas; surface ecosystem, hydrogeochemistry and hydrogeology. As part of the preparatory work, aerial photography of the Simpevarp area has been carried out to provide updated information about the terrain, land use, vegetation and infrastructure, see Figure 5.

The preparatory work also includes the setting-up of a first regional-scale model of the site (version 0) which presents an integrated description of the site (geosphere and biosphere) and its regional environs with respect to current state and naturally ongoing processes. The Simpevarp candidate area and regional model area is illustrated in Figure 6.

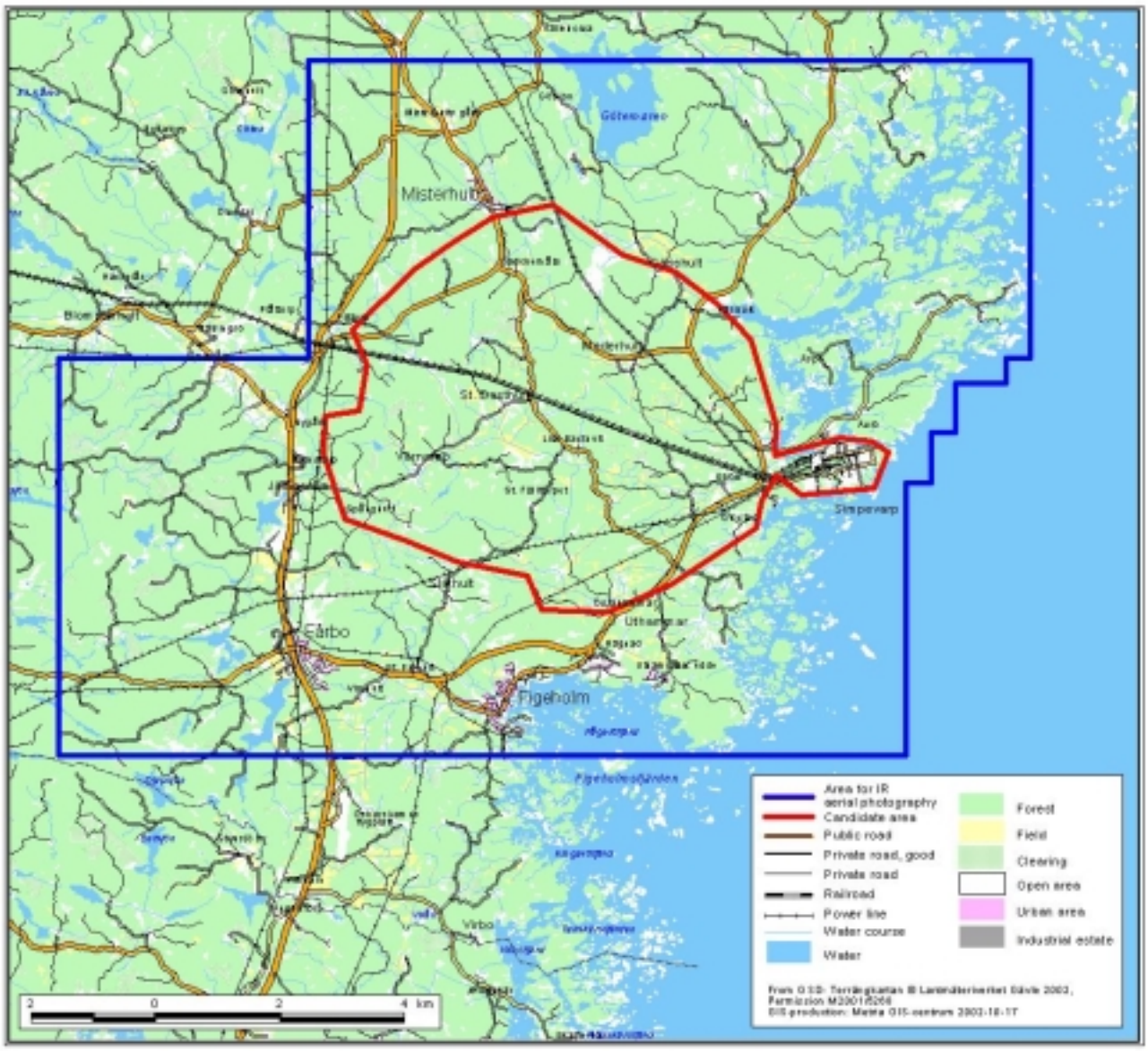

Figure 5. *Area for aerial photography.*

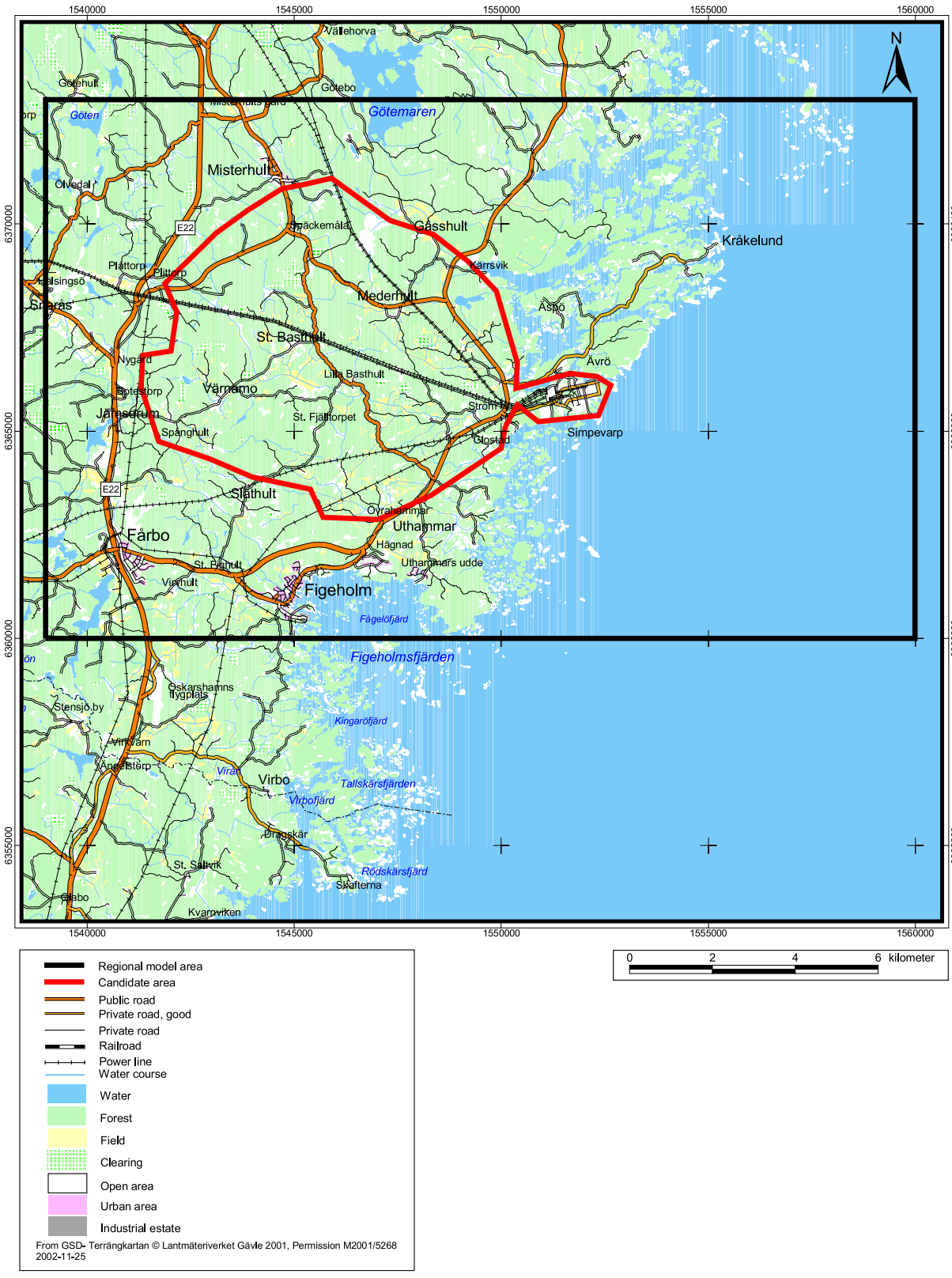

Figure 6. *The Simpevarp candidate area and regional model area used for the site descriptive model version 0.*

3.2.2 Characterisation of the Simpevarp peninsula

Three core-drilled boreholes are planned to a depth of about 1,000 metres, in order to study the bedrock of the Simpevarp peninsula. The two first ones are illustrated in Figure 1. The boreholes have been preliminarily located on the basis of available information about the geology of the bedrock.

Of the three boreholes, located as shown in Figure 1, the drilling of the borehole furthest to the east started in September 2002. The aim of this borehole, KSH01, is to study the bedrocks homogeneity at depths down to 1,000 metres, but also to obtain information about the north-north-easterly oriented lineament which runs parallel to the coast out to sea. If this zone is vertical, or dips to the northwest, it will be crossed by the borehole. The aim of borehole KSH02, which will be drilled second, is to investigate the central part of Simpevarp peninsula, where the most homogenous bedrock is expected to be. The third borehole, KSH03, is also intended to investigate the homogeneity of the bedrock at depth. The position of this borehole has not been decided yet.

The first cored borehole is designated as a so-called "chemistry-prioritised" hole. The aim of such a borehole is to ensure that data on undisturbed groundwater is obtained. The second borehole is designated as a "rock-mechanics prioritised" hole, as the variation in rock-mechanics with depth will be studied in addition to the base-programme.

In the general execution programme /SKB, 2001b/, it is mentioned that percussion boreholes can be drilled to confirm the position of, and to characterise, steeply dipping fracture zones, as well as to study the permeability of the bedrock down to a depth of about 150 metres. No percussion boreholes are however planned to be drilled on the peninsula during this phase.

The Simpevarp peninsula was included in the geophysical measurements from a helicopter, which have been carried out over the entire Simpevarp area, see Figure 4. Geophysical measurements from the ground will be carried out primarily to obtain information about the position, width, dip and direction of fracture zones in order to optimise the drilling programme.

The existing bedrock geological mapping of the Simpevarp peninsula may need to be completed by mapping of the rock outcrops in the area. Marine-geological investigations will be carried out as well as a somewhat limited mapping of soil types, and studies of the soil chemistry and hydrology in the soil pipes.

3.2.3 Area to the west of the Simpevarp peninsula, choice of priority site

Within the area to the west of the Simpevarp peninsula, a priority site will be identified and its boundaries set on the basis of existing information, geophysical measurements from a helicopter and geological surveys.

The chosen site, or sites, will be checked in the field by means of a survey of a number of larger areas of exposed bedrock, mainly with respect to the type of rock occurring, the homogeneity of the bedrock and the frequency of fractures. Anomalies in the aerial geophysical measurements that can be of significance to the assessments of the suitability of the site for a deep repository, will be followed up. Ground-based geophysical measurements may be carried out in order to confirm the choice of site, or to enable a choice between several sites to be made.

3.2.4 Area to the west of the Simpevarp peninsula, characterisation of the priority site

The aim of the investigation will be to produce the information required in order to judge whether or not the site is appropriate for a Complete Site Investigation.

The investigation includes ecological, geological, geophysical, hydrogeological and hydrogeochemical studies of the site and its surroundings. The main focus of the study will be the boreholes and the borehole measurements which will be made in order to study the properties of the bedrock.

To begin with, percussion drilling will include 4–6 boreholes and will be carried out to confirm and characterise the fracture zones identified by data interpretation, which form the boundaries of the priority site.

In order to study the rock to a depth of about 1,000 metres, 2–4 core-drilled boreholes are planned. If the priority site already contains the boreholes KLX01 and KLX02, these will be used for further investigations. The boreholes are located on the basis of the results of the work carried out to define the boundaries of the site, with the support of complementary geophysical measurements, if required. During and after drilling, borehole investigations will be carried out according to the base-programme for cored boreholes. Special measurements to be carried out in the boreholes will be decided on the basis of site-specific questions which arise during the site investigation.

Ground-based geophysical measurements are planned in order to investigate firstly, the larger fracture zones which form the boundary or the block or blocks of rock within the priority site and secondly, the smaller fracture zones and the rock mass between the fracture zones.

The geological characterisation of the bedrock will focus mainly on the distribution of rock-types, the description of the rock-types and on the structure of, for example, fractures and fracture zones.

At the priority site, a survey of soil types and soil series will be carried out together with studies of the soil chemistry and hydrological tests in boreholes in the surface layers. The ecology and hydrology of the area will also be studied.

3.3 Complete Site Investigation

The subject of the Complete Site Investigation can be either the Simpevarp peninsula, the priority site in the area to the west of the peninsula, or a combination of both. The aim of the Complete Site Investigation is to provide the knowledge about the chosen site required for a safety assessment and the preparation of an application for permit for the deep repository.

The Complete Site Investigation will be carried out in accordance with the general programme /SKB, 2001b/, but with adaptations to site-specific conditions.

The scope of the investigations should be such that when it is finished, the underground parts of the repository can be designed and a safety assessment can be carried out. A geoscientific understanding of the site should also be obtained. The site-specific data required for a safety assessment can be divided into two categories:

- Data on properties that are expected to be similar at repository depth at all sites, for example, anaerobic groundwater, groundwater chemistry, thermal conductivity, etc. In most of these cases, a check must be made to ensure that these properties lie within the expected interval as specified for example in /Andersson et al, 2000/.

- Data that directly affect the repository design and the results of dose calculations for certain scenarios. For example, the position and properties of larger deformation-zones, the hydraulic conductivity of the bedrock and the transport resistance.

The number of boreholes in the drilling programmes and the scope of the measurements cannot be specified in advance, since they are dependent on the conditions on the site. A reasonable estimate is that 10–20 cored holes and roughly 20–40 percussion holes are required.

Drilling is carried out continuously, with about four cored holes per year. Measurements and evaluation of the results follow this. It takes several months to drill a deep borehole, after which measurements are performed in the borehole for approximately six months. A preliminary estimate is that 2–2.5 years will be needed to obtain a good description of a site.

After each drilling campaign the rock models, the layout, and the evaluation of long-term safety are updated. The analysis of the uncertainties in the model descriptions is used to plan the next drilling campaign. The boreholes are positioned and aimed in order, for example, to verify the occurrence, location, orientation and properties of deformation zones and rock type boundaries. A number of holes are drilled to obtain data from potentially suitable repository volumes between the deformation zones. The properties of this bedrock are most essential for the safety assessment. The results are evaluated in relation to the requirements and criteria discussed in /Andersson et al, 2000/ and with respect to remaining uncertainties in the description of the site. The investigations are discontinued when the reliability of the site description has reached such a level that the body of data for safety assessment and design is sufficient, or until the body of data shows that the rock does not satisfy the requirements.

3.4 General planning considerations

The generic site investigation programme /SKB, 2000a, 2001b/ provides a strategy and general specification of the investigations to be undertaken during the site investigation phase. The program does not specify the amount of investigations to be performed at a specific site nor where and when measurements should be undertaken. This is done in the site-specific programme. However, the site-specific programme is defined successively as it depends on the outcome from investigations and the integrated analyses of these results. The current programme is based on information available after the completion of the feasibility study, and is compiled in site-descriptive model, version 0.

The basic idea of the continuous development of the site-specific programme is that the site-descriptive model development is undertaken in parallel with the investigation activities. For each version of the site-descriptive model a specific goal is defined. Based on that goal, it is possible to define the data required to meet the objective and the time when the objective has to be fulfilled. At an appropriate time a “data freeze” is made and the data set going into the next version of the model is defined. The site-descriptive model, tentative repository layouts and preliminary evaluation of long-term safety are updated. The analysis of uncertainties in

the model as well as feedback from design and safety assessment is used to plan the investigations following the presentation of the current model version. The time estimated from the "data freeze" to presentation of the model is expected to 3–4 months.

To make efficient use of the resources at the site, investigations have to proceed continuously. At each planning step a detailed investigation programme is planned for a time extending beyond the "data freeze" that includes the time estimated for completing the updated version of the site-descriptive model. Hence, investigations will proceed as the model is updated and the model will thus not include the latest data at the time of its presentation. This could imply that some investigations are undertaken in less than optimal locations, but this is a risk that SKB considers worth taking for making best use of available resources.

This procedure will also be followed when passing from the Initial to the Complete Site Investigation phase, i.e. investigations belonging to the Complete Site Investigation phase will be started before the decision is taken to proceed with the Complete Site Investigation.

3.5 Alternative plans

During the site investigation, boreholes will be drilled and used for various measurements. Measurements will be carried out from the ground and by using a helicopter. The investigation programme is not planned in detail, but will be updated and revised due to results from early measurements. It is therefore not possible to draw up a complete alternative investigation plan to be used in cases where the investigations cannot be carried out as originally planned. It is however, necessary to be prepared for such cases, and therefore have some flexibility in the planning. It is important to ensure that the site investigation is carried out in such a way that the technical and scientific goals are fulfilled.

4 Work plan

A short description of the work plans for the Initial Site Investigations in the Simpevarp area is given below. Detailed descriptions of the aim and scope of the investigations are given in the appendix.

4.1 Investigations

During the Initial Site Investigations, information about the site and the surroundings will be derived mainly from:

- studies to select the site,
- studies carried out to characterise the sites and the surroundings,
- monitoring studies.

The investigations to be performed at the Simpevarp peninsula and in the area to the west of Simpevarp are very similar. The investigations include:

- Core drilling and measurements in the boreholes (see Figure 1).
- Percussion drilling and measurements in the boreholes.
- Geophysical measurements from helicopter (see Figure 4).
- Geophysical measurements from ground level.
- Marine-geological investigations.
- Mapping of the bedrock.
- Studies of the transport properties, strength and thermal properties of the bedrock.
- Mapping of soil types and soil thickness and hydrological tests in boreholes in the soil.
- Hydrological and ecological studies.
- Vegetation mapping and inventories of birds and mammals.

Monitoring studies include studies and long-term documentation of different types of changes, for example, in the bedrock and in the natural environment. Monitoring is required partly to study changes, which can be caused by the site investigations, partly to study and understand natural variation and analyse which effects different dynamic processes have on the deep repository and thereby on its long-term safety. Monitoring covers mainly:

- Meteorological and hydrological conditions.
- The natural environment.
- Radionuclides and environmental contaminants.
- Seismic activity.
- Deformation of the bedrock.

4.2 Main milestones

The Initial Site Investigations will be carried out step by step and include several milestones. In short, the procedure will be to start from the site-descriptive model, version 0, carry out measurements on the ground and in boreholes, update the site-descriptive model based on the results from the measurements, plan and design further measurements based on results from the previous steps. Hence, main decisions will be based on the different versions of the site-descriptive models. The procedure for the site investigation at Simpevarp is illustrated in Figure 7. Detailed information about the measurements and the site-descriptive models are found in the appendix.

4.2.1 The Simpevarp peninsula

A regional site-descriptive model, version 0, for the whole candidate area has been developed on the basis of the feasibility study and associated inventories. This model has been used to determine the location of the first three cored boreholes on the peninsula, KSH01–03. The drilling of KSH01 started in September 2002.

Based on the regional site-descriptive model, version 0, and the first investigation results at the Simpevarp peninsula, a site-descriptive model, version 1.1, will be developed in 2003. In 2004, the site descriptive model of the Simpevarp peninsula will be updated to version 1.2. Version 1.1 will include information from measurements in borehole KSH01, and to some extent also from KSH02, while version 1.2 will include information from all three boreholes, KSH01–03.

Simultaneously to the drillings, airborne and surface measurements will be carried out. These will include airborne geophysics, ground geophysics, geological mapping, marine geological investigations, surface ecosystems, hydrology, hydrochemistry and rock mechanics. Some investigations will cover the regional area, others will be focussed to the site. Some results from these investigations will be included in site-descriptive model, version 1.1. Most of the results will be included in site-descriptive model, version 1.2.

Version 1.2 of the model will form the basis for the further investigations if the Simpevarp peninsula is suitable for Complete Site Investigation.

4.2.2 The area west of Simpevarp

A presumption for the investigations in the area to the west of Simpevarp is that SKB get permits from the landowners.

The first step in the site investigation aim at obtaining data as a basis for selecting a priority site within the area west of Simpevarp. Existing information (the regional site descriptive model version 0 of the candidate area), helicopter-borne geophysical measurements, and geological surveys will be used to evaluate and describe the geological conditions with regard to heterogeneity and lineaments. This information will be used for selecting the priority site, in early 2003. If several alternative sites are judged to be equally suitable, proximity to Simpevarp peninsula will be prioritised.

When a priority site is selected, the site is investigated with 2–4 boreholes drilled to study the bedrock down to a depth of about 1,000 metres. Simultaneously to the drillings surface measurements will be carried out. These will include geological mapping, surface ecosystems, hydrology, hydrochemistry and rock mechanics. Some investigations will cover the regional area, others will be focussed to the site. Some results from these investigations will be

included in site-descriptive model, version 1.1 of the area west of Simpevarp that will be developed in early 2004. The work will be collated in a site-descriptive model, version 1.2 that will be developed in late 2004.

Version 1.2 of the model will form the basis for the decision if the area to the west of the peninsula is suitable for Complete Site Investigation.

4.2.3 Complete Site Investigation

When the initial investigations of the two sub-areas are finished investigations will continue with a Complete Site Investigation, under conditions that the site has a good prospect to fulfil the requirements for a deep repository. The site to be chosen for the Complete Site Investigation may be either the Simpevarp peninsula, the priority site in the area west of Simpevarp, or a combination of both.

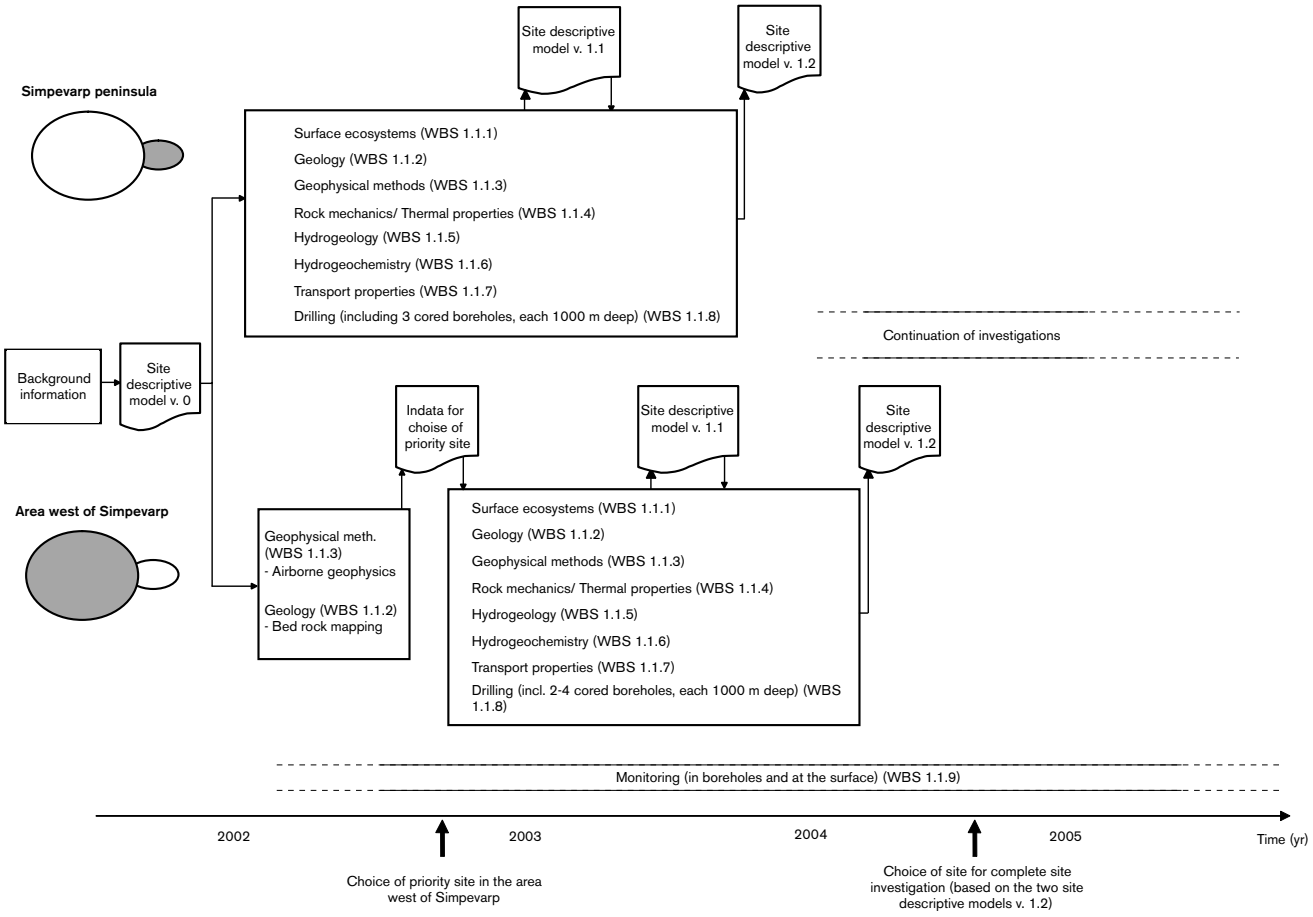

Figure 7. *Simpevarp – Initial Site Investigations.*

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Site specific programme - Simpevarp

Appendix

Description of planned activities during initial site investigations

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1	**Initial site investigations**	To select a priority site within the area west of Simpevarp. To determine, with limited efforts at the two subareas, whether the feasibility study's judgement of the suitability of the candidate area holds up in the light of in-depth data. To select a suitable site for complete site investigation.	The Simpevarp candidate area comprise two parts: the peninsula and the area west of Simpevarp. Both areas will be investigated during the initial site investigations to the extent needed for the decision where to continue with complete site investigations.	The Simpevarp candidate area. The Simpevarp peninsula. The area west of Simpevarp. A presumption for the investigations in the area west of Simpevarp is that SKB get permits from the land owners.	/SKB, 2001b/.
	Choice of priority site within the area west of Simpevarp.	First step in the initial site investigation within the area west of Simpevarp, aimed at obtaining data as a basis for selecting a priority site for further investigations.	Decision basis comprise information of whether main lineament, block structure and bedrock heterogenity (fine grained granite) shows preference for any of the area to the west.	Airborne geophysics and limited geologic mapping over the whole candidate area.	/SKB, 2001b/ section 3.2. The priority site will be chosen mainly on the basis of existing information (site descriptive model version 0), air-borne geophysical measurements, and geological surveys. Further investigations will be carried out to the degree required to confirm the choice of site. If several alternative sites are judged to be equally suitable, proximity to Simpevarp peninsula will be prioritised.
	Investigations of priority site within the area west of Simpevarp.	Second step of the initial site investigation within the area west of Simpevarp aim at obtaining information about the priority site also at depth from a limited amount of investigations.	Input to site descriptive models versions 1.1 and 1.2 for the area west of Simpevarp. Model version 1.1 will be used for planning of the additional measurements that will be carried out during initial site investigation. The site descriptive models version 1.2 (preliminary site description) for the Simpevarp peninsula and for the area west of Simpevarp will be used for the decision where to carry out complete site investigations.	The priority site will be investigated at surface and by means of 2-4 deep boreholes.	/SKB, 2001b/ section 3.3. Information collected during the first part of the initial site investigation will be included in the site descriptive model version 1.1. Data freeze 2003-12-01. All information that is collected during the initial site investigation will be included in the site descriptive model version 1.2. Data freeze 2004-09-01.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Investigations of the Simpevarp peninsula.	Obtaining information about the Simpevarp peninsula also at depth from a limited amount of investigations.	Input to site descriptive models versions 1.1 and 1.2 for the Simpevarp peninsula. Model version 1.1 will be used for planning of the additional measurements that will be carried out during initial site investigation. The site descriptive models version 1.2 (preliminary site description) for the Simpevarp peninsula and the area west of Simpevarp will be used for the decision where to carry out complete site investigations.	The peninsula of Simpevarp will be investigated at depth by means of 3 boreholes. Information down to 100 m depth are already available.	/SKB, 2001b/ section 3.3. Information collected during the first part of the initial site investigation will be included in the site descriptive model version 1.1. Data freeze 2003-07-01. All information that is collected during the initial site investigation will be included in the site descriptive model version 1.2. Data freeze 2004-04-01.
1.1.1	**Surface ecosystems**	Main goals are: - characterisation of the undisturbed ecosystem conditions in the candidate area, - collection of relevant data for safety assessment and design, - obtaining a general understanding of the regional model area's surface ecosystems so as to be able to develop and justify models and make predictions of the area's future evolution, - with the aid of collected data, present a framework for the further execution of the investigations with consideration for nature and the environment.	- Identification and characterisation of biologically sensitive areas in the studied candidate area, - identification of the parameters in the surface ecosystems that are needed to achieve sufficient knowledge of the area, - compilation of existing data on the areas, - start of monitoring programmes for parameters that require long time series. The obtained information will be presented in GIS.	Regional model area. Compilation of parameters included in the model description of surface ecosystems: - Hydrogeology (groundwater, surface water, lakes, water-courses, seas, metrology) - Hydrogeochemistry (soil and sediment in lakes and seas, soil water and groundwater, lakes, water-courses and seas) - Ecosystems (forestry, agriculture, fishing, hunting and outdoor recreation, toxic pollutants, flora, population, fauna) - Climate - Aquatic parameters.	/SKB, 2001b/. General information in chapter 3.2.1, 3.3.1 and 10. Goals are found in chapter 10.1.2. Compilation of parameters included in the model description of surface ecosystems are found in Table 10-1. See also /Blomqvist et al, 2000/ (lakes) and /Blomqvist et al, 2001/ (rivers).
1.1.1.1	**Vegetation and biotope mapping**	A general vegetation mapping of the area's vegetation types will be carried out in the initial phase of the site investigation. Another goal is to identify threatened and rare species.	An estimate will be made of the area's vegetation and biotopes and presented in GIS format with the aid of IR aerial photos, the key habitat inventory and digital satellite photos.	Regional model area.	Vegetation types are important features that characterise the landscape. Vegetation types are interesting also in a monitoring context, since they are, in contrast to most species, relatively easy to identify and thus to follow in a long term perspective. /SKB, 2001b/, chapter 3.2.1, 3.3.1 and 10.3.2. /Kyläkorpi et al, 2000/, chapter 4.2.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Vegetation mapping	General mapping of vegetation types.	GIS database.	Regional model area (from aerial photos).	Has been performed during 2002.
	Inventory of vegetation	Inventory of vegetation types within selected areas.	GIS database. Detailed information about species, coverage, strata, fungus.	In the local model area. Three types of mapping areas will be set up: - circular areas with a radius of 500 m (about 3 areas) - 30x30 m (total number 1-3) - 1x1m (total number 10-20).	Will be performed during 2002-2003.
	Inventory of key biotopes	Identify sensitive key biotopes.	GIS database.	Within the regional model area.	Has been performed during 2002.
	Validation of vegetation map	Verification of the vegetation mapping (aerial photos).	Confirmation of vegetation zone extensions.	Within the regional model area.	Will be performed during 2003.
	Biomass determination	Obtain information about biomass quantities.	Compilation of the total quantity (biomass) of the dominant species.	In the Laxemar area (e.g. some of the 1x1m large mapping areas used for the inventory of vegetation).	Will be performed during 2003.
1.1.1.2	**Bird and mammal surveys**	Identification of species and populations and identify threatened and rare species.	Species and population.	Regional model area.	/Kyläkorpi et al, 2000/, chapter 4.7.
	Bird survey		Species and population. Including identification of threatened and rare species.	Regional model area.	Has been performed during 2002.
	Mammal survey		Species and population. Basis for nature protection. Biomass.	The survey will focus on an inventory of the game stock and threatened species in the regional model area and in a reference area outside the regional area. Possibly survey from helicopter.	Will be performed during 2002-2003.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.1.3	**Surface waters**	Characterization of surface waters with respect to chemical, physical and biological parameters.	Limnological parameters in lakes will be collected. Lake type and ecological functioning will be described with the aid of models based on the constituent lake parameters. A thorough inventory of the lake's abiotic parameters such as temperature, stratification, light conditions, pH, buffering capacity, colour, nutrients and oxygen conditions will also be done during at least one annual cycle. The properties of watercourses will be described in a manner similar to that for lakes. Seas. Existing information as well as information from SMHI and other regular measurements of the sea's temperature, salinity, currents and water level variations will be compiled.		/SKB, 2001b/, chapter 3.2.7, 3.2.1 and 10.3.10. /Kyläkorpi et al, 2000/, chapter 5. See also /Blomqvist et al, 2001/ and /Blomqvist et al, 2000/. Sampling started in 2002.
	Characterization of lakes	The characterization of lakes provides morfometrical and biological data.	Data for modelling work and background information for continued (biological) investigations, qualitative data on species, occurence of red-listed species.	Regional scale.	Will be performed during 2003.
	Mapping and inventory of vegetation and bottom fauna in shallow brackish waters.	Produce maps showing density and occurrence of different species of plants and animals in fresh and brackish waters.	Maps.	In coastal areas of the regional model area.	Will be performed during 2002-2003.
	Oceanography/limnology - investigations	Measurements of physical parameters at permanent (fixed) locations.	Data for modelling work and background information for continued investigations.	7-8 fixed measurement equipments.	Will be performed during 2003 or 2004.
	Aquatic flora and fauna		Species and population.	10-15 sampling sites in the regional model area.	Will be performed during 2003.
	Fish	Compilation of available data, samples, analysis (toxic polutants and radionuclides).	Species and population.	In fresh and brackish waters on a regional scale.	Will be performed during 2003 or 2004.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Sampling of surface waters	See WBS 1.1.6.1			
1.1.1.4	**Soil mapping**	Characterization of the soil strata.	The soil mapping will provide information on soil chemistry, soil moisture content, supracrustal boulder frequency, soil depth, cultural impact etc. The results will be used as input into the soil model.	A few samples will be taken on a regional scale.	/SKB, 2001b/, chapter 10.3.7 and Table 4-3. Will be performed during 2003. Co-ordonation with Quaternary mapping, WBS 1.1.2.2
1.1.1.5	**Toxic pollutants and radionuclides in biomass**	Obtain background levels of toxic pollutants and radionuclides in biomass in the Simpevarp area. Part of the environmental impact monitoring programme.	Existing information from the Swedish Environmental Protection Agency's (EPA) and SSI's environmental monitoring will be compiled. In the chemistry programme, samples will be taken from water and soil. In the site investigation programme, a survey will be performed to obtain a good idea of the background levels in the area. Data will be used in safety assessment.	Sampling or toxic pollutants and radionuclides in plants and animals (e.g. mushrooms, lichens, fish, animals) on a regional scale. The extent can not be quantified yet.	Programme under development. Will be performed during 2003 or 2004.
1.1.2	**<u>Geology</u>**	The geological work is mainly aimed at investigating: - topographical forms and the extent of the quarternary deposits - the composition of the bedrock - the bedrock's deformation pattern - the geological evolution.	The investigations serve as a basis for devising geological models which comprise a part of the site descriptions, which are in turn used for design and safety assessment.		/SKB, 2001b/, chapter 4 and Table 4-3. Main goals are found in chapter 4.1.2.
1.1.2.1	**Bedrock surface investigations**	Main goals are: -Document key properties of lithological units, including mineralizations. -Document key properties of structures, including the frequency and orientation of fractures. -Provide 2D-model for the bedrock geology at the Earth´s surface (lineaments, deformation zones, lithological units).			/SKB, 2001b/, chapters 3.2.3, 3.3.3 and 4.3.4, Table 4-3.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Bedrock mapping		Expected results are: - Database of primary information at outcrop scale - Analyses of rock samples (modal, geochemical and petrophysical) - Analysis of measured structures - Geochronological data pertinent to the geological evolution - Bedrock geological map at the scale 1:10 000	Rock outcrops, rock cuts, rock quarries and stripped rock outcrops are surveyed for description of lithology and bedrock structures. Regional and local major ductile and brittle structures are mapped. The rock surface is sampled as a basis for petrographical, geochemical, petrophysical, and geochronological determination. An overview mapping with focus on the rock heterogenity in the area to the west is being conducted before chosing priority site (se WBS1.1.2.8). An available survey is being complemented for the peninsula. A new survey will be performed for the area to the west.	Will mainly be carried out during 2003.
	Detailed fracture mapping	Provide input data for the statistical assessment of fractures at selected localities.	Database of measured fracture properties. Surface-mapping: Detailed maps of studied outcrops showing the location and ID-number of all fractures exceeding the truncation level. Line-mapping: Location and direction of the mapping-line, location and ID-number of fractures along the line exceeding the truncation level.	Detailed mapping of all fractures at a few (3-5) relatively large stripped outcrops. Mapping is performed either as surface or line mapping.	Will mainly be carried out during 2003.
	Lineament interpretation	Lineament interpretation of digital elevation data, aerial photos and airborne geophysical maps is used to obtain information on large-scale lineaments that may comprise regional or local fracture zones.	Lineament maps. Background information to the structural model.	The area to the west will be interpreted at an early stage. The Peninsula, Ävrö and Hålö will be interpreted thereafter.	/SKB, 2001b/, chapter 4.3.4 (section "Lineament interpretations") and chapter 3.2.3 (section "Lineament interpretation - identification of regional fracture zones"). The overview lineament interpretation in the area to the west will be used for the selection of priority site (see WBS1.1.2.8). Supplementary work during 2003.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.2.2	**Quaternary deposit mapping**	Devise a model for the key properties and extent of the Quaternary deposits both at the Earth´s surface and down to the bedrock interface.	Expected results are: - Analyses of Quaternary deposit samples (e.g. grain-size variation, petrological, geochemical) - Documentation of ice-movement direction - Documentation of stratigraphy and structures (primary and tectonic) in key sections - Compilation of the variation in thickness of the Quaternary deposits - Quaternary geological map at the scale 1:10 000	The Quaternary deposit mapping includes: - aerial photo interpretations - field mapping - sampling (digging, drilling) - bog survey - investigation of lake sediments	/SKB, 2001b/, chapters 3.2.3, 3.3.3, 4.3.4, and Table 4-3. Will mainly be carried out during 2003.
1.1.2.3	**Late- to post-glacial faulting**	To determine whether late- to post-glacial faulting has occurred within the studied area.	Description of location and properties of late- to post-glacial faulting.	Interpretations of aerial photographs with negative-size of at least 1:30 000. Field checks of indications of late faulting from maps and aerial photographs. Superficial investigations in existing cuts and quarries outside the regional model area and investigation of new cuts along possible late faults. Trenches are dug in sediment areas to look for possible signs of neotectonic movements along fracture zones that have affected overburden soil layer.	/SKB, 2001b/, chapters 3.3.3, 4.3.4, and Table 4-3. Will mainly be carried out during 2003 and coordinated with Quaternary deposit mapping (WBS1.1.2.2).
1.1.2.4	**Marine geological investigations**	Hydroacustic measurements and marine-geological sampling give information about sea bottom topography and depth to bedrock.	The information is primary used for the quarternary deposit and structure models, but also as input to the ecological modelling of the area.	The measurements will take place in an area extending about 5 km along the coast line and about 2 km out from the coast line. The distance between the profiles are 100-400 m.	Was carried out during 2002.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.2.5	**Boremap mapping**	Geological characterisation along a borehole.	The measurements will give information regarding: - Rock type distribution - Rock type description - Ductile structures - Brittle structures (fractures, faults) and their location/orientation - Properties of fracture surfaces	Part of the base program in all cored boreholes. Part of base program in all percussion boreholes. Boremap mapping of boreholes are mainly based on BIPS and drill core (or drill cuttings) and information from drilling parameter registrations, borehole radar and geophysical borehole logging.	/SKB, 2001b/, chapter 3.3.3, 3.4.3 (section "Investigations of boreholes…"), 3.5.3 and 4.3.5.
1.1.2.6	**Sampling and laboratory experiments**	Provide data on rock properties.	Data from measurement on core samples. Analyses of rock samples (modal, geochemical and petrophysical).	Part of the base program in cored boreholes. Samples will be taken from bedrock outcrops and cores. The samples will be used for modal, geochemical and petrophysical analysis. Sampling points and number of samples to be determined after bedrock surface mapping and Boremap mapping in boreholes and interpretation.	/SKB, 2001b/, chapter 3.5.3, 4.3.5, 5.3.2 and 6.3.2.
1.1.2.7	**Single hole interpretation, geology**	To provide an integrated description of the geological structures and rock types along the borehole.	Identification and preliminary classification of rock types, fracturing and alteration. Properties and description of rock properties along the borehole.	Compilation of all available information (cored borehole). Carried out in cored boreholes and percussion drilled boreholes.	Based on co-interpretation of information from Boremap, BIPS, borehole radar and geophysical borehole logging.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.2.8	**Geological co-interpretation**	To provide an integrated description of rock types and structures in the Simpevarp area as a basis to update the geological and structural model. The basis for the geological co-interpretation is provided by co-interpretation of information from helicopterborne geophysical surveys, topography, geological mapping, marinegeology and sampling.	Identification and preliminary classification of rock types and ductile and brittle fracture zones.	Compilation of all available information from the Simpevarp area. Data from the area to the west of Simpevarp will be prioritised in order to focus on a smaller priority area. The data from the Simpevarp peninsula will be evaluated after the data from the area to the west of Simpevarp. Co-interpretations will be performed in connection to updating of geological site descriptive models.	Information from description of rock properties on outcropping bedrock and co-interpretation of helicopterborne geophysical surveys, maringeology and sampling.
1.1.3	**<u>Geophysical methods</u>**	Geophysical surface measurements are mainly performed to get information on fracture zones (location, width, dip and strike). Geophysical borehole measurements are used to get detailed information on rockmass (composition and fractures).	The character of the bedrock and the occurence of ductile and brittle structures, as well as overlying quaternary deposits. The borehole geophysical methods will give information about borehole geometry, lithological parameters, groundwater salinity, hydraulic conductors, temperatures etc.		Surface geophysical methods: /SKB, 2001b/, chapter 3.2.3, 3.3.3, 4.3.3 and Table 4-5. Borehole geophysical methods: /SKB, 2001b/, chapter 3.3.3, 3.4.3 (section Investigations of boreholes and drill cores), 4.3.6 and Table 4-8.
1.1.3.1	**Airborne geophysics**	The airborne geophysical maps are used for an assessment of the occurrence of regional and local major fracture zones and various rock type volumes and their character.	Information on the location of regional and local major fracture zones. The results will be used in models describing: - structures - rock types - quaternary deposits	The airborne geophysical methods used are magnetic, electromagnetic and radiometric methods. Measurements along north-south lines separated by 50 m. The measurements will cover the whole candidate site. The area investigated is about 90 km2, see Figure 4.	/SKB, 2001b/, chapter 3.2.3, 4.3.3, section "Airborne geophysics". Has been carried out in the autumn 2002. The information will be used for the lineament interpretation (WBS 1.1.2.1). The lineament interpretation in the area to the west will be used for the selection of priority site in area west of Simpevarp.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.3.2	**Seismic reflection**	Seismic reflection investigations are carried out to discover large, gently-dipping fracture zones in the bedrock.	Data on location, orientation and mechanical properties of gently-dipping features.	The measurements are carried out along profiles (preferably crossing profiles). Pulled array seismic (PAS) is planned to be used on the Simpevarp peninsula due to the existing infrastructure. The measurements will include about 6 kilometres in length. Traditional reflection seismic (based on explosives in short boreholes) is planned to be used in the area west of Simpevarp.	/SKB, 2001b/, chapter 3.3.3 and 4.3.3, section "Ground geophysical survey". Simpevarp peninsula - spring 2003. Area to the west - autumn 2003.
1.1.3.3	**Ground geophysics**	Ground geophysical surveys are carried out in order to obtain information about different rock types and subvertical fracture zones.	Extent (depth and area coverage) of different rock types and location, width, strike and dip of subvertical fracture zones.		/SKB, 2001b/, chapter 3.3.3 and 4.3.3.
	Gravimetry	Gravimetric measurements mainly provides information on the extent of the different rock types at depth and some information on soil depths where they vary widely.	Gravity data at measured points.	In a regional scale over the Simpevarp area, about 1 point per km2.	/SKB, 2001b/, chapter 4.3.3, section "Ground geophysical survey". Will mainly be carried out in the autumn of 2003.
	Profile mats	Profile mats are carried out to augment the geological-structural characterization.	Location and strike of structures, depth of overburden. The results will be used in models describing: - structures - rock types - quatenary deposits Measurement results will provide possible locations for percussion drilled boreholes to follow up the interpretations.	Each mat will normally have 3-5 parallel profiles each with a length of 200 - 1000 m. The spacing between the profiles are about 50 m. About 10 profile mats will be positioned in the Simpevarp area, mainly over interpreted lineaments. The areas that will be measured are selected based on field observations, aerial photos or the results from the radar reflection measurements. Seismic refraction may also be carried out in the sea (near-coast area) south of the Simpevarp peninsula.	/SKB, 2001b/, chapter 3.3.3, section "Fracture zones and fractures". Normally geophysical profile measurements, mainly magnetic, electromagnetic or electrical methods and refraction seismics arranged in several parallel profiles (so-called profile mats). Will be carried out during 2003. Will be used for the site-descriptive model, version 1.1.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Other geophysical measurements	The information from geophysical methods provide a basis for interpretation of: - rock types - structures - deep saline groundwater	Geophysical information.	Several surface geophysical methods are available, for example: - resistivity (VES and CVES) - transient electromagnetic sounding (TEM) - ground-penetrating radar Scope of investigations to be determined.	/SKB, 2001b/, chapter 4.3.3 and Table 4-5. VES was carried out in 2002.
1.1.3.4	**Borehole geophysics**	To obtain detailed information about lithological composition and fractures, as input data for Boremap (WBS1.1.2.5) and Single hole interpretation (WBS1.1.2.7)	Borehole status, lithological parameters, structures, groundwater salinity, rock temperature, water-bearing fractures, fracture orientation etc.		/SKB, 2001b/, chapter 4.3.6 and Table 4-8.
	BIP (Borehole Image Processing) system	To obtain information of rock type distribution and fracturing.	Image of borehole wall. Fold-out of the borehole. Fractures more than approximately 1 mm in width are detected by current equipment. 3D orientation of fractures.	Entire borehole. Part of the base program in all cored boreholes. Part of base program in all percussion drilled boreholes.	/SKB, 2001b/, chapter 3.3.3, 3.4.3 (section "Investigations of boreholes…"), 3.5.3 and 4.3.6. BIPS consists of a digital TV camera that tapes the borehole wall while the camera is lowered into the borehole.
	Borehole radar	To obtain information of rock structures (dykes and deformation zones).	Borehole radar measurements provides information on the orientation of local minor and major structures.	Radar reflection measurements in the entire borehole. Part of the base program in all cored boreholes. Part of base program in all percussion drilled boreholes.	/SKB, 2001b/, chapter 3.3.3, 3.4.3 (section "Investigations of boreholes…"), 3.5.3 and 4.3.6.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Geophysical logging	Interpretation support for Boremap and single hole interpretation.	The measurements will give information regarding: - Borehole status, geometry - Lithological parameters - Structures - Groundwater salinity - Hydraulic conductors - Structures - Rock temperature - Water-bearing fractures	The following measurements will be carried out along the entire borehole below 100 m: gamma-gamma, magnetic susceptibility, single-point resistance, focused resistivity, normal resistivity, natural gamma, full-wave sonic, caliper, temperature. Part of the base program in all cored boreholes. Part of base program in all percussion drilled boreholes.	/SKB, 2001b/, chapter 3.3.3, 3.4.3 (section "Investigations of boreholes…"), 3.5.3 and 4.3.5.
1.1.3.5	**VSP (Vertical Seismic Profiling)**	Identification and characterisation of rock structures in the rock volume penetrated by the borehole. Identification of steeply dipping features to supplement information from seismic reflection survey (WBS 1.1.3.2).	Will give information about structures (regional, local major and local minor) within up to 500 m from the borehole.	The entire borehole will be used for these measurements. A possible test layout is to have geophones every 5 m in the borehole and generate sound waves from about ten explosive charges placed on the ground. In the initial site investigations, the plans are to carry out VSP in one borehole at the Simpevarp peninsula and in one borehole in the area to the west. Part of supplementary investigations in cored boreholes.	/SKB, 2001b/, chapter 4.3.6 and Table 4-8. Planned to be carried out autumn 2003 and spring 2004.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.4	**Rock mechanics/Thermal properties**	The rock mechanical work is mainly aimed at: - determining whether the selected site is large enough to accommodate a repository, - determine and assess the distribution of initial rock stresses within the site, - identify the risk of extensive spalling problems or other rock breakout, - determine mechanical properties of fracture zones and individual fractures, - determine mechanical properties of intact rock and various rock masses, - identify possible problems where tunnels may pass fracture zones. The main task of the thermal programme is to: - determine the initial temperature at repository level and identify the presence (if any) of a high geothermal gradient, - determine the distribution of the thermal properties within the candidate site.	Site specific predictions of the possibility to construct a repository. The thermal properties and temperature conditions of the rock have a direct influence on the layout and other design issues for the deep repository.	Data from the rock units are of fundamental interest for design of the repository. Data from surrounding fracture zones may be of high importance to determine the feasability of a proposed access route to the repository.	/SKB, 2001b/, chapters 5 and 6 and Tables 5-2 and 6.2, /Andersson et al, 2002/.
1.1.4.1	**Sampling and laboratory experiments**	Provide data on rock properties (e.g. density, shear strength, tensile strength, Young's module, Poisson's ratio, P-wave velocity). Provide data on thermal properties (thermal conductivity in rock, heat capacity in rock, temperature in rock and groundwater)	Data from measurement on core samples to database.	Part of base programme in cored boreholes. Samples will be taken at about three levels, that are related to repository depth.	/SKB, 2001b/, chapter 3.5.3, 4.3.5, 5.3.2 (Table 5-7), and 6.3.2.
	Determination of mechanical and hydromechanical properties of fractures	Provide data on joint roughness coefficient, joint compressive strength, base friction angle, friction angle after failure, possible filling material in fracture.	Database.	Laboratory tests are performed on samples from cored boreholes. Core samples from the deep boreholes at Laxemar may be used.	/SKB, 2001b/, chapter 5.3.3 and Tables 5-8 and 5-9.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Thermal properties	To obtain parameters on thermal properties that will be used for the design of the repository and in the safety assessment.	Database.	Laboratory tests are performed on samples from cored boreholes. Core samples from the deep boreholes at Laxemar may be used.	/SKB, 2001b/, chapter 6, 6.2 and Table 6-2. The thermal properties of the rock (thermal conductivity and heat capacity) are determined primarily on the basis of mineral composition and by means of laboratory studies of recovered rock cores.
1.1.4.2	**Rock stress measurements**	Determine the original state of stress in the rock mass.	Data on rock stresses at tested locations and mechanical properties of the tested rock.	The two most common methods for direct rock stress measurement are overcoring and hydraulic fracturing.	/SKB, 2001b/, chapter 5.3.1 and Tables 5-5, 5-6.
	Overcoring		Overcoring gives the three principal stresses and their direction.	Rock stress measurements are carried out by means of the overcoring method at 2-3 depths down to about 500 m.	
	Hydraulic fracturing		Hydraulic fracturing gives the stresses in the plane perpendicular to the borehole.	Hydraulic fracturing is used at the same locations, and down to about 700 m. Additional measurements may be required in relation to any fracture zone. Part of supplementary investigations in cored borehole.	
1.1.4.3	**Thermal field methods**	Description of the thermal conditions in the site descriptive model.	Determination of temperature parameters (thermal conductivity, heat capacity, temperature in rock and groundwater). Determination of thermal boundary conditions.	Temperature logging and thermal response tests in boreholes. The usefulness of the thermal response test is being studied.	/SKB, 2001b/, section 6.3.1 and Table 6-3.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.5	**Hydrogeology**	The goals of the hydrogeological programme are in brief to: - compile a hydrogeological description on a regional and local scale - achieve a hydrogeological understanding on the regional scale that is sufficient to delimit and define properties and boundary conditions for regional groundwater flow models and achieve a hydrogeological understanding on the local scale that provides sufficient underpinning for the local hydrogeological description.	The initial site investigations aim at providing a general picture and first estimate of the water-bearing properties of the rock from the ground surface down to a depth of approximately 1,000 m (size and variability both spatially and in terms of properties).	The hydrogeological investigations are initially focused on the regional area. In addition, local investigations will be carried out. Normally it is possible to rely on enough meteorological and hydrological data being available in an area. If needed, supplementary data are obtained from newly-erected measurement stations for collection of meteorological and hydrological data. Measurements locations and frequency to be specified.	/SKB, 2001b/, chapter 3.2.6, 3.3.6, chapter 7 and Table 7-2. All information that is collected during the initial site investigation will be included in site descriptive model 1.2. Information collected during the first part of the initial site investigation will be used for the site descriptive modelling, version 1.1.
1.1.5.1	**Wells and facilities**	Data from existing wells and facilities may comprise an important basis for initial estimates of the properties of the area.		To some extent data are available from feasibility study and well archive.	/SKB, 2001b/, chapter 3.2.6 and 7.3.2.
	Inventory of private wells	To identify and document all private wells in the investigation area.	Identified wells with relevant information. Examples of information gathered are: capacity figures, groundwater abstraction, groundwater levels, water samples.	Wells in the whole candidate area are identified through archive inventory and field recognisance.	Was completed in 2002.
	Facilities and hydrogeological inventory	To identify and document water related facilities and to conduct a general hydrogeological inventory of the area.	Identified water related facilities with relevant information and documentation on the hydrogeology of the area.	Facilities in the whole candidate area identified through archive inventory and field recognisance. General hydrogeological information is compiled from archive data.	Will be carried out during 2003 and 2004.
1.1.5.2	**Meteorology**	Data are important for defining boundary conditions for calculation models.	Meteorological data.	Meteorological data (precipitation, snow depth, temperature, evaporation, air pressure) are obtained from measurement stations run by SMHI. It is planned to establish a new meteorological station during 2003. Meteorological measurements will be carried out on a regular basis. For monitoring, see 1.1.9.3.	/SKB, 2001b/, chapter 3.2.6, 7.3.1 and Figure 3-9. Co-ordinated with surface ecosystem.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.5.3	**Hydrology**	Hydrological investigations comprise an important source of data for defining boundary conditions for the calculation models.	A general description of the hydraulic boundary conditions and the natural variation of surface water levels. Description of land use such as ditching and damming projects, water sources, etc., as well as areas of interest from a nature conservation viewpoint.	The hydrological description comprise: Surface mapping and inventory, meteorological measurements, topography, and measurements in water courses, lakes and the sea. Measurement stations will be established to measure flows in watercourses and levels in lakes. It is planned to establish 10-20 stations in the regional area. Reconnaissance for suitable locations will take place in 2003.	/SKB, 2001b/, chapter 3.2.6, 7.3.1 and Figure 3-9.
	Hydrological inventory	Obtain a hydrological description. Input for defining boundary conditions for the calculation models.	A hydrological description that include discharge basins, runoff data, as well as interpreted recharge and discharge areas.	The hydrologic inventory will cover a regional scale. The near-surface conditions influence the boundary conditions for the groundwater flow models and are essential for calculations of flow and dispersion in the biosphere.	Will be performed during 2003.
	Hydrological measurements	Input for defining boundary conditions for the calculation models.	The activity will establish a hydrological measurement system and collect data for long term monitoring.	The hydrological measurements will cover a regional scale.	Will be performed during 2003.
1.1.5.4	**Measurements and hydraulic tests during core drilling**	Provide a basis for the description of the hydraulic properties of the rock and guidance for further investigations.		Cored boreholes.	/SKB, 2001b/, chapter 3.5.1, 3.5.2 and 7.3.3. Available data will be used in site descriptive model versions 1.1 and 1.2
	Measurements while drilling		Parameters related to drilling such as flushing water pressure, flushing water flow, return water flow, flushing water concentration, drawdown during drilling and electrical conductivity.	To be performed in all cored boreholes.	

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Hydraulic tests during drilling		To obtain transmissivity in a 100 m scale, ground water pressure and water samples from the most recently drilled borehole interval.	Drilling is interrupted at predetermined length intervals to carry out a transient hydraulic test of the most recent drilled interval. To be performed in all cored boreholes.	
1.1.5.5	**Hydraulic tests in percussion drilled holes**	Identify and characterise permeable features along the borehole and to characterise the surfficial rock.	Data on hydraulic properties of permeable features along the borehole. Flow logging - determination of position of structures and rough estimation regarding the properties of these structures. Hydraulic characterisation - entire borehole. T-values for dominant hydraulic features may be evaluated.	Constitutes part of the base program in all percussion drilled holes.	/SKB, 2001b/, chapter 3.5.3, 7.3.3 and Table 7-6. Available data will be used in site descriptive model versions 1.1 and 1.2
1.1.5.6	**Pumping test & flow logging in cored boreholes**	Identify and characterise permeable features along the borehole as well as the transmissivity of the entire hole.	Data on hydraulic properties of permeable features along the borehole. Pumping test - determination of K-value for rock mass or T-value for dominant hydraulic features. Flow logging - determination of position of inflow structures and rough estimation regarding the properties of these structures. Hydraulic characterisation - entire borehole. T-values for dominant hydraulic features may be evaluated.	Constitutes part of the base program in all percussion drilled holes.	/SKB, 2001b/, chapter 3.5.3, 7.3.3 and Table 7-6. Available data will be used in site descriptive model versions 1.1 and 1.2.
1.1.5.7	**Difference flow logging**	To calculate transmissivity and undisturbed pressure for permeable features.	Distribution of water inflow along the borehole.	To be performed in most core drilled boreholes, below 100 m. Part of supplementary investigations in cored borehole.	/SKB, 2001b/, chapter 3.5.4 and 7.3.3. Available data will be used in site descriptive model versions 1.1 and 1.2.
1.1.5.8	**Hydraulic injection tests in borehole sections**	To obtain data on hydraulic properties.	Hydraulic conductivity distribution for rock mass and deterministic features, groundwater pressure.	Part of supplementary investigations in cored borehole.	/SKB, 2001b/, chapter 3.5.4 and 7.3.3. Available data will be used in site descriptive model versions 1.1 and 1.2.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Hydraulic injection tests, 20 m sections	To obtain data on hydraulic properties in a scale relevant for the SC, Stochastic Continuum, model.		Entire borehole below 100 m. Planned to be carried out in most boreholes.	
	Hydraulic injection tests, 5 m sections	To obtain data on hydraulic properties in a scale relevant for a canister.		Planned to be carried out at repository level (300-700 m) in some boreholes. Extent to be determined after results of diff. flow logging (WBS 1.1.5.7) are available.	
1.1.5.9	**Hydraulic interference tests**	To verify existence of and obtain information on the properties of major conductive features.	Information on geometry, properties and connectivity of major conductive features.	Whether any tests will be performed during initial site investigation depends on preliminary evaluation of site data.	/SKB, 2001b/ section 7.3.3. Available data will be used in site descriptive model versions 1.1 and 1.2.
1.1.5.10	**Groundwater flow measurements**	To obtain information on groundwater flow under natural conditions.	Data on natural groundwater flow in major features. Parameters to be determined are: groundwater flow, Darcy velocity. Verification of structural model (in combination with pumping).	Part of supplementary investigations in cored borehole. Planned to be carried out in some boreholes. Extent to be determined after preliminary evaluation of site data.	/SKB, 2001b/, chapter 3.5.4, 7.3.3 and 9.3.2. Available data will be used in site descriptive model versions 1.1 and 1.2.
1.1.5.11	**Single hole interpretation, hydrogeology**	To provide basis for hydrogeological model.	Description of potential hydraulic rock mass and conductor domains along the borehole.	Compilation of all available hydrogeological information. Carried out for all cored boreholes and percussion drilled boreholes.	The information from the base programme in cored boreholes as well as in percussion drilled boreholes will constitute the base for the single hole interpretation. Available data will be used in site descriptive model versions 1.1 and 1.2.
1.1.5.12	**Monitoring of groundwater**	See WBS 1.1.9.3			
1.1.5.13	Soil hydrogeology	Hydraulic characterization of the soil layer. Provide basis for the description of the hydraulic properties of the soil.	The characterization aims at establishing the thickness of the soil layer as well as its transmissivity and the water level.	A total number of 20-40 soil pipes are planned to be installed in the soil layers. Slug tests will be performed in soil pipes. Groundwater levels will be measured frequently.	/SKB, 2001b/, chapter 3.2.6, 7.3.2 and 11.2.1. Mainly after the initial site investigation.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.6	**Hydrogeochemistry**	The hydrogeochemical work is mainly aimed at: - characterizing the undisturbed hydrogeochemical conditions on the site and describing the origin and flux of the water in the rock, vertically and horisontally, - obtaining specific data on parameters that are of importance for safety assessment and design, such as pH, Eh, sulphide, colloids and chloride, - identifying the possible occurrence of free dissolved oxygen in the groundwater at repository level.	Describtion of the chemistry of the ground water in the deep repository volume with environs from a safety assessment perspective and collect the chemical data required for design of the deep repository. In addition, the chemistry programme contributes to an overall understanding of how the groundwater system behaves at repository depth.	The initial site investigation aim to achieve an overall understanding of the site with respect to near-surface chemical conditions, chemical conditions down to a depth of 100 –200 m, and the reactions that determine the chemical composition of the water. Furthermore, near-surface samplings are carried out on a regional scale to provide initial values for future evaluation of deep groundwaters.	/SKB, 2001b/, chapter 8 and Table 8-2. All information that is collected during the initial site investigation will be included in site descriptive model 1.2. Information collected during the first part of the initial site investigation will be used for the site descriptive modelling, version 1.1.
1.1.6.1	**Sampling of surface waters and precipitation**	Chemistry data from surface waters and precipitation comprise a subset of the data that are needed to describe the water flux in the area and its influence on the groundwater composition.	Analyzed parameters for surface water-courses, springs and sea water correspond generally to class 3, but to class 5 for 1-2 times per year. Precipitation will be analyzed as per class 3.	Sampling of surface waters will take place at 20-30 different locations (mainly in lakes, watercourses and the Baltic Sea) within the area but also in a regional scale. Of these sampling points, approximately 15 will be used for hydrochemistry parameters while all points will be used for ecosystem parameters. Initially, samples will be taken about 5-20 times per year dependent on parameter to be analysed. Precipitation samples from station at Äspö and possibly from another station that might be installed. Precipitation will be analyzed about 6 times per year.	/SKB, 2001b/, chapter 3.2.7, 3.3.7 and 8.3.2. Sampling also for surface ecosystem. Starts in 2002.
1.1.6.2	**Sampling of near-surface groundwater**	Sampling of near-surface groundwater is done to obtain a comprehensive picture of different types of near-surface groundwaters.	Hydrogeochemical parameters as per class 3.	The sampling will mainly be carried out in the area to the west.	/SKB, 2001b/, chapter 3.2.7, 3.3.7 and 8.3.4.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Sampling of wells			Initial sampling in chosen wells. Repeated sampling in a few of these wells approx. six times a year during a two year period in order to determine the size of the natural variation.	Starts in 2003.
	Sampling in soil pipes			Sampling from installed soil pipes approx. 6 times a year during a two years period.	Starts in 2003.
1.1.6.3	**Sampling of sediment pore water**	Sampling of sediment pore water is done to characterize the water that has been transported through sediment layers.	The aim is that the analysis should correspond to class 5.	Initial sampling in chosen sampling points. Repeated sampling may be done in a few of these points (frequency to be determined). Sampling will take place within the entire candidate area.	/SKB, 2001b/, chapter 3.2.7 and 8.3.3. Starts in 2003.
1.1.6.4	**Sampling during core drilling**	Sampling gives an early picture of the water composition in the borehole.	Method provides an early hydrogeochemical overview (water composition in major water bearing fracture zones in the borehole, water composition (adjusted for flushing water contamination), isotope data and ratios. Class 3.	Part of the base program in all cored boreholes. Sampling in about 5 sections/fractures along the borehole.	/SKB, 2001b/, chapter 3.3.7, 3.5.2 and 8.3.7.
1.1.6.5	**Hydrochemical logging**	The purpose of the hydrochemical logging is to get a quick overview of the water composition along the borehole and detect any concentration anomalies.	The method provides an opportunity to identify the interface with saline groundwater. Chemical composition of the groundwater. Class 3.	Part of the base program in all cored boreholes. One sample every 100 m.	/SKB, 2001b/, chapter 3.3.7, 3.5.3 and 8.3.8.
1.1.6.6	**Sampling in percussion boreholes after drilling**	The purpose of sampling in percussion boreholes is to provide groundwater data from the rock penetrated by the borehole (max 200 m depth). Identify and characterise permeable features along the borehole.	Data on hydraulic and hydrogeochemical properties of permeable features along the borehole, as per class 3.	Part of the base programme in percussion drilled boreholes. Will be carried out in selected sections.	/SKB, 2001b/, chapter 3.2.7 and 8.3.6.
1.1.6.7	**Sampling during pumping tests in cored boreholes**	To augment and density the quantity of chemistry data from cored boreholes by performing sampling at the same time as pumping tests.	Data on chemical composition of the groundwater at tested sections, class 4 or 5.	Part of supplementary investigations in cored boreholes. Will be carried out in selected sections in selected boreholes.	/SKB, 2001b/, chapter 3.3.7 and 8.3.10.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.6.8	**Complete hydrochemical characterization**	To get a complete "picture" of the groundwater chemistry in single fractures and local minor fracture zones.	Data on chemical composition of the groundwater at tested sections, class 5.	Part of supplementary investigations in cored borehole (chemistry). Information from methods in the disciplines of geology and hydrogeology is needed to select the borehole sections to be investigated (approximately five sections in each borehole).	/SKB, 2001b/, chapter 3.3.7, 3.5.4, 8.3.9 and Table 8-4.
1.1.6.9	**Sampling during programme for monitoring in boreholes**	See WBS 1.1.9.4.			
1.1.6.10	**Fracture filling mineral analysis**	Fracture filling mineral analyses complement the picture of current and former chemical conditions in the groundwater.	The method provides results in the form of identified minerals and detailed mineral compositions with respect to main components, trace elements and isotopes.	Samples of fracture mineral fillings from drill cores. Will be carried out in a number of boreholes.	/SKB, 2001b/, chapter 8.3.13. Fracture filling minerals always represent the sampled depth, which does not have to be the case with the groundwater samples. Studying the composition of different generations of fracture-filling minerals provides an idea of the stability/ instability of the groundwater composition in a historical perspective (paleohydrology).
1.1.7	**Transport properties of the rock**	The most important properties for the discipline are: - groundwater flows on the deposition hole scale, - transport resistance, - diffusivity and matrix porosity of the rock mass, - sorption properties (sorption coefficients) for the different substances that may be transported with the groundwater.	The investigations include determinations of transport properties for both rock matrix and flow paths. By the word “transport” is meant transport of solutes in the groundwater.	Only laboratory measurements are planned to be carried out during the initial site investigations. Most field experiments will be performed during the complete site investigations. Only methodology tests of SWIW are planned for. For groundwater flow measurements, see hydrogeology WBS 1.1.5.10.	/SKB, 2001b/, chapter 9 and Table 9-2.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.7.1	**Laboratory measurements**	Laboratory measurements of rock samples comprise: - Resistivity measurements - Through diffusion measurements - Gas diffusion measurements - Porosity measurements - Batch sorption measurements	Data on sorption coefficients, matrix porosity and matrix diffusivity for main rock types.	The number of measurements depends on the number of rock types, fracture types and types of fracture zones present at the site. Measurements are performed on rock cores from several different parts of the candidate rock volume under well-controlled conditions.	/SKB, 2001b/, chapter 9.3.1 and Table 9-4. Only a few samples during initial site investigations.
	Resistivity measurements		Matrix diffusivity of main rock types.	Several measurements per borehole.	Also used for calibration of analysis of in-situ resistivity data from borehole logging, se WBS 1.1.7.2.
	Through diffusion measurements		Matrix diffusivity. This measurement also provides indirect determinations of matrix porosity, and sorption coefficients.	A few measurements of main rock types will be made.	
	Gas diffusion measurements		Matrix diffusivity and connected matrix porosity.	Measurements will only be performed on a few selected samples.	Used as a reference method.
	Porosity measurements		Matrix porosity.	Major rock types and fractures/fracture zones and extremes will be sampled.	
	Batch sorption measurements		Determine sorption coefficients (incl surface sorption).	Site-specific sorption coefficients will only be determined for a selection of nuclides, and for the major rock types.	
1.1.7.2	**Analysis of in-situ resistivity measurement**	Full scale test of method to determine formation factor (used to determine matrix diffusivity), based on in-situ resistivity measurements in the field.	Matrix diffusivity. Feasibility of the method.	In at least one borehole.	/SKB, 2001b/, chapter 9.3.2. The analysis will be based on data collected in WBS 1.1.3.4 "Borehole geophysics".

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.7.3	**Single-hole tracer tests**	Field measurements to verify laboratory-determined values.			/SKB, 2001b/, chapter 9.3.2.
	Single-hole tracer tests (in-situ sorption)		Sorption coefficient and matrix diffusivity.		Study of method initiated. No experiment during initial site investigation.
	Single well injection and withdrawal tests (SWIW)	Methodology test. Data from the tests can potentially also be used for estimations of the flow wetted surface and sorption parameters for a selection of weak-to-medium-sorbing substances.	Parameters to be determined are: dispersivity, flow porosity, matrix diffusivity, and sorption coefficients. Feasibility of the method.	Test planned for one borehole	Measurements are performed in combination with groundwater flow measurements (WBS 1.1.5.10) using the same equipment. The method is being developed.
1.1.7.4	**Multi-hole tracer tests**	Results from multi-hole tests are used to calibrate transport models.	Parameters to be determined are: travel time, dispersivity, flow porosity (effective aperture), flow wetted surface. Verification of structural model (connectivity). Comparative sorption data. Indication of matrix diffusion.		/SKB, 2001b/, chapter 9.3.2. No test during initial site investigation. Possible methods are radially converging tracer tests and dipole tests.
1.1.8	**<u>Drilling</u>**				/SKB, 2001b/, chapter 11.
1.1.8.1	**Soil drilling/probing**	Drilling/probing in loose soil layers is done for the purpose of: - determining the depth to the rock surface (in certain cases sampling the rock surface), - determining the soil layer sequence, - collecting soil samples, - driving pipes to permit hydraulic tests and groundwater sampling. Additional goals are related to monitoring of groundwater surfaces and to monitor the environmental impact close to the drilling sites.	Data on the soil layer. Data for the environmental monitoring.	Drillings for characterisation and mapping of the soil will be included in the geological and hydrogeological characterisation of the soil, see WBS 1.1.2.2. Soil drilling close to each cored borehole for monitoring of the environmental impact.	/SKB, 2001b/, chapter 3.2.2, 3.3.2 and 11.2.1. Extension depends on data need for the geological and hydrogeological characterisation.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.8.2	**Percussion drilling programme**	Provide information on the location, orientation and properties of larger structural features at shallow depth (<200 m). Provide a fundamental characterisation of the formation based on uniform methodology. Some of the percussion drilled boreholes will serve as water wells for supplying flushing water during drilling of cored boreholes.	Verification of existence and extent of structural features detected from surface investigations at depth. Data on location, orientation and properties at tested locations.	A limited number of boreholes with a maximum depth of 200 m. Downhole investigations will be performed according to base programmes for percussion boreholes in all completed rock boreholes. The peninsula: 3-6 boreholes for characterisation and water wells for supplying flushing water during drilling of cored boreholes. The area west of Simpevarp: 5-10 percussion boreholes for characterisation and water wells for supplying flushing water during drilling of cored boreholes.	/SKB, 2001b/, chapter 3.2.2, 3.3.2 and 11.2.2.
	Measurements While Drilling (MWD)			During percussion drilling the penetration rate is measured, the flow from the borehole estimated, the flushing water colour judged, the electrical conductivity of the flushing water measured and cutting samples are taken for rock type determination.	/SKB, 2001b/, chapter 3.5.1, 7.3.3 and 11.4.
	Base programme			The base programme will be performed in all percussion drilled boreholes	/SKB, 2001b/, chapter 3.5.3.
	BIP (Borehole Image Processing) system	See WBS 1.1.3.4.			
	Borehole radar	See WBS 1.1.3.4.			
	Geophysical logging	See WBS 1.1.3.4.			
	Hydraulic tests in percussion drilled holes	See WBS 1.1.9.3.			
	Sampling in percussion boreholes after drilling	See WBS 1.1.6.6.			
	Boremap mapping	See WBS 1.1.2.5.			
	Installation for monitoring	See WBS 1.1.5.12.			

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.8.3	**Core drilling programme**			Three cored boreholes are planned to be drilled at the Simpevarp peninsula, see Figure 1. KSH01 (chemistry), KSH02 (rock mechanics) and KSH03. The properties of the bedrock in area to the west of the Simpevarp peninsula will be investigated preliminary with 2-4 deep cored boreholes.	General information about the drilling programme is found in /SKB, 2001b/, chapter 3.3.2 and 11.2.3.
	Cored borehole, KSH01 (Chemistry)	The aim is to obtain data on bedrock properties and groundwater chemical conditions at depth. As this hole will be the first deep borehole drilled, data on the chemistry of undisturbed groundwater is ensured. Address issues: rock type and rock structure, hydrogeochemical conditions, hydraulic properties, bedrock stability.	The aim of KSH01 is to study the bedrock at depth in the eastern part of the Simpevarp peninsula.	The eastern borehole at the Peninsula.	The drilling started in September 2002. Information from the measurements carried out in the borehole will be used for the site-descriptive model, version 1.1.
	Percussion drilling 0-100m	Provide a borehole geometry feasible for maintaining pumping out return water during further drilling and a borehole geometry adopted for investigations and monitoring installations after drilling is completed.	Percussion drilling technique applied in chemistry holes in order to not introduce flushing water into the upper part of the rock formation. In case of unstable rock and/or large inflow of shallow groundwater the borehole is lined with stainless steel casing tubes. The gap between the borehole wall and casing wall is sealed by grouting in order to protect the deeper parts of the borehole from shallow groundwater and/or surface water.		

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Core drilling 100-1000 m, including measurements and supplementary drilling of a short 100 m deep cored hole after completion of the 1000 m hole.	The measurements that will take place in the borehole are described below. Some main goals are to: - provide access to the bedrock at depth for a characterisation programme, - provide a continuous sequence of rock samples down to 1000 m, - get first strike water samples from conductive fractures, - obtain hydraulic information at large depth in the rock.	Core samples. Data on drilling and flushing water parameters recorded during drilling. Drilling parameters - some of the measuring results could directly or indirectly reflect properties of the drilled rock formation. Flushing water parameters - contribute to the hydrogeological and hydrochemical understanding of the bedrock. They also provide a method for understanding the impact on the aquifer of the injection/withdrawal of flushing water and formation water during the drilling process. Hydraulic and hydrochemical information from tests and sampling during drilling, see WBS 1.1.5.4 and 1.1.6.7.	The drilling parameters include feed pressure, torque, and drilling rate. The flushing water parameters include flow parameters, physical-chemical parameters of the flushing water (tracer content, oxygen content) and physical-chemical parameters of the return water (tracer content, electrical conductivity). The core drilling is interrupted at predetermined length intervals (preliminary 100 m) in order to carry out hydraulic tests of the most recently drilled interval. The drilling process is also interrupted at presumed water-bearing fracture zones for water sampling.	/SKB, 2001b/, chapter 3.5.1, 3.5.2, 11.4 and 7.3.3.
	Base programme	Provide a fundamental characterisation of the formation based on uniform methodology.	Data as specified below.	Downhole investigations will be performed according to the base programme.	/SKB, 2001b/, chapter 3.5.3.
	Surveying	Obtain x-, y- and z-coordinates for the top edge of the casing. Obtain direction and deviation of the borehole.	Borehole length. X, Y, Z (RAK) versus borehole length. Length-corrected measurement points.		/SKB, 2001b/, chapter 4.3.1 and 11.3.3.
	Pumping & flow logging in cored boreholes	See WBS 1.1.5.6.	See WBS 1.1.5.6.		
	Hydrochemical logging	See WBS 1.1.6.5.	See WBS 1.1.6.5.		
	BIP (Borehole Image Processing) system	See WBS 1.1.3.4.	See WBS 1.1.3.4.		
	Borehole radar	See WBS 1.1.3.4.	See WBS 1.1.3.4.		
	Geophysical logging	See WBS 1.1.3.4.	See WBS 1.1.3.4.		
	Boremap mapping	See WBS 1.1.2.5.	See WBS 1.1.2.5.		
	Analysis of drill core samples (geology, rock mechanics, geochemistry)	See WBS 1.1.2.6, 1.1.4.1 and 1.1.6.4.	See WBS 1.1.2.6, 1.1.4.1 and 1.1.6.4.		
	Supplementary investigations (Preliminary plan)	Focused on chemistry in this borehole.	Data as specified below.		/SKB, 2001b/, chapter 3.5.4
	Differential flow logging	See WBS 1.1.5.7.	See WBS 1.1.5.7.		

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Complete hydrochemical characterisation	See WBS 1.1.6.8.	See WBS 1.1.6.8.		
	Hydraulic injection tests in borehole sections	See WBS 1.1.5.8.	See WBS 1.1.5.8.		
	Groundwater flow measurements	See WBS 1.1.5.10.	See WBS 1.1.5.10.		
	Installation for monitoring	See WBS 1.1.9.3.			
	Cored borehole, KSH02 (rock mechanics)	The aim is to obtain data on bedrock properties with special focus on rock stress data from the central part of the peninsula where the most homogenous rock is expected. The information from this borehole will form an important basis for further work, above all for the planning of the design and construction of the underground facility. Address issues: rock type and rock structures, potential for high rock stresses, hydraulic properties.	Data on rock properties in the central part of the area of interest. Data on rock stress and mechanical properties of the rock. Basis for correlation of reflection seismic data to provide for confidence in interpretation of structures based on seismic data.	On the Simpevarp peninsula, see Figure 1. The borehole will be drilled to a depth of about 1000 meters.	General information about the drilling programme is found in /SKB, 2001b/, chapter 3.3.2 and 11. Rock stress measurements are described in chapter 3.3.4 and chapter 5.3.1. The drilling is planned to start in early 2003. Most data from the measurements carried out in the borehole will be used for the site-descriptive model, version 1.1.
	Drilling				
	Core drilling and percussion reaming 0-100 m	See description for KSH01 above.	Core samples. In case of unstable rock after reaming see KSH01 above.		
	Core drilling 100-1000 m, including measurements	See description for KSH01 above.	See description for KSH01 above.		
	Overcore rock stress measurements during core drilling	See WBS 1.1.4.2.	See WBS 1.1.4.2.		
	Base programme	See description for KSH01 above.	See description for KSH01 above.		/SKB, 2001b/, chapter 3.5.3.
	Supplementary investigations (Preliminary plan)				/SKB, 2001b/, chapter 3.5.4.
	Differential flow logging	See WBS 1.1.5.7.			
	Hydraulic injection tests in borehole sections	See WBS 1.1.5.8.			
	Rock stress measurements (hydraulic measurements)	See WBS 1.1.4.2.			
	VSP (Vertical Seismic Profiling)	See WBS 1.1.3.5.			
	Installation for monitoring	See WBS 1.1.9.3.			

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Cored borehole, KSH03	The aim is to obtain data on bedrock homogeneity at depth. Address issues: rock type and rock structures, hydrogeochemical conditions, hydraulic properties. The type of measurements that will be performed in the third borehole will be decided based on results from measurements in the two first boreholes and surface investigations.	The borehole is expected to give information about the bedrock at depth in the western part of the Simpevarp peninsula.	The position of this borehole has not been decided yet.	General information about the drilling programme is found in /SKB, 2001b/, chapter 3.3.2 and 11. The drilling is planned to start in the summer of 2003. Some data from the borehole can be used for the site-descriptive model, version 1.1.
	Core drilling and percussion reaming 0-100 m	See description for KSH02 above.	See description for KSH02 above.		
	Core drilling 100-1000 m, including measurements	See description for KSH01 above.	See description for KSH01 above.		
	Base programme	See description for KSH01 above.	See description for KSH01 above.		/SKB, 2001b/, chapter 3.5.3.
	Supplementary investigations	The focus for the supplementary investigations has not yet been decided.			/SKB, 2001b/, chapter 3.5.4.
	Installation for monitoring	See WBS 1.1.9.3.			
	Cored boreholes (2-4) in area to the west	General goal same as for KSH01-KSH03. Borehole-specific goals can be decided when the priority site is selected.	Generally as for KSH01 - KSH03.		
1.1.9	**Monitoring**	The long-term measurements, monitoring, will take place at the surface as well as in boreholes. The monitoring provide an understanding of the area's natural evolution over an extended period of time. Long time series provide a good basis for documenting undisturbed conditions and for gaining an understanding of seasonal variations in the area.	The monitoring programme will include monitoring of hydrochemistry, hydrology, surface ecosystems, seismic events, creep movements in the bedrock (using GPS technology), pressure and flow in boreholes.		

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
	Installation for monitoring	Long-term monitoring of pressure and hydrochemistry.	Pressure, groundwater flow and chemical composition in the borehole.	Permanent installations of packers etc are done in the cored boreholes for long-term measurements of pressure and for sampling within the long-term monitoring programme. A preliminary estimate is that the pressure will be measured in up to 8 sections in each cored borehole (2-3 in percussion drilled holes). The number of borehole sections for the groundwater flow measurements is much less than for groundwater pressure. In most cored boreholes, 1 to 2 sections are installed for groundwater flow measurements. At least two borehole sections from each cored borehole will be included in long-term hydrochemical monitoring.	/SKB, 2001b/, chapter 7.3.4, 8.3.11, Table 7-7 and Figure 7-6.
1.1.9.1	**Surface ecosystems**	Provide an understanding of the area's natural evolution over an extended period of time.		The characterisation of the surface ecosystems is begun early and is followed up with long term monitoring of hydrochemistry, hydrology and fauna and flora.	/SKB, 2001b/, chapter 3.3.1 and 10.3. Monitoring starts as soon as base and supplementary measurement programmes are completed.
	Monitoring of vegetation	Supervise changes. See WBS 1.1.1.1		Regional model area	
	Bird monitoring	Supervise changes. See WBS 1.1.1.2 (Bird survey)	Species and population (follow-up).	Regional model area	
	Mammal monitoring (individual species)	Supervise changes. See WBS 1.1.1.2 (Mammal survey)	Species and population (follow-up).	Regional model area	
	Aquatic flora and fauna	Supervise changes. See WBS 1.1.1.X	Species and population (follow-up).	Regional model area	

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.1.9.2	**Geology**				
	Deformation measurements	Deformation measurement with GPS technology for monitoring creep movements in the bedrock is a method involving recurrent measurements over a long time.	Data on movements in the bedrock.	Precision networks for these measurements are mainly established over regional fracture zones. About 10-12 measurement steel screws are needed in the Simpevarp area.	/SKB, 2001b/, chapter 3.2.3 and 4.3.2.
	Seismic activity	Complement the existing regional seismic networks to establish a local seismic network that also permits registration of small earthquakes in order to obtain a relatively long time series and thereby gain a better understanding of the causes of seismic events in the area.	Location, magnitude and source parameters of small earthquakes down to a magnitude of 0.0.	The seismic network is a part of the Swedish seismic network which is under construction from Uppsala in the north to Oskarshamn in the south.	/SKB, 2001b/, chapter 3.2.3 and 4.3.2.
1.1.9.3	**Hydrogeological monitoring**	To document natural variations of surface and groundwater hydrology and to obtain initial and boundary conditions for the site descriptive hydrogeological modelling.	Time series of hydrogeological parameters such as water level, groundwater pressure, stream discharge etc.	Monitoring of hydrogeological parameters are planned in: percussion boreholes, cored boreholes, water courses, lakes, sea, and the atmosphere.	/SKB, 2001b/, chapter 3.3.6, 7.3.4 and Table 7-7.
1.1.9.4	**Hydrogeochemistry**	The purpose of the sampling during the long-term monitoring is to see if and how the activities during the site investigation phase affect the groundwater composition.	The sampling provides time series of data as per class 3 and class 5 and comprises a basis for assessment of chemical stability.	Long-term monitoring will be carried out in a number of observation points consisting of wells, soil pipes, percussion boreholes and sections in cored boreholes.	/SKB, 2001b/, chapter 3.2.7 and 8.3.11. Monitoring will be carried out at the Simpevarp peninsula and in the area to the west. Part of the monitoring programme will start during 2003.
1.1.10	**<u>Cultural heritage</u>**				
1.1.10.1	Inventories and investigations	The goal is to achieve all information, that according to the law, is necessary for the EIA work. Besides that it will supply the site investigations with information necessary to adopt these to the relevant protective measurements	GIS-maps combined with reports	The whole candidate area and later focus on the priority site west of Simpevarp.	Program for investigations of the cultural heritage 2002-12-02.
1.1.10.2	Later inverstigations		GIS-maps combined with reports	Mainly the priority site west of Simpevarp.	Program for investigations of the cultural heritage 2002-12-02.

WBS	Activity group / Activity type	Goal	Expected results	Location and scope	Comments / References
1.2	**Site descriptive modelling**				An overview of the different versions of site-descriptive models that are planned to be produced during the site investigation is given in /SKB, 2001b/, Table 2-1.
	Regional site-descriptive model, v 0	All site information regarding earth science and ecosystems gathered during the feasibility study have been presented in a regional site descriptive model, version 0, in a format that will be used during the site investigation.	Site descriptive model, version 0	The regional site descriptive model version 0 covers an area that is larger than the regional investigation area (see Figure 6) in order to cover future discharge areas.	A regional site-descriptive model, version 0, has been devised based mainly on the feasibility study, processing of existing data and field checks.
	Site descriptive model, v 1.1, for the Simpevarp peninsula.	Version 1.1 of the site-descriptive model will be developed during 2003, and will form the basis for the planning of further activities at the peninsula.	Site descriptive model for the Simpevarp peninsula, version 1.1.		
	Site descriptive model, v 1.1, for the area west of Simpevarp.	Version 1.1 of the site-descriptive model will be developed during spring 2004, and will form the basis for the planning of further activities at the peninsula.	Site descriptive model for the area west of Simpevarp, version 1.1.		
	Site descriptive model, v 1.2, for the Simpevarp peninsula.	Version 1.2 of the model will form the basis for the decision if the Simpevarp peninsula is suitable for complete site investigations.	Site descriptive model for the Simpevarp peninsula, version 1.2 (Preliminary site description).		Summer 2004.
	Site descriptive model, v 1.2, for the area west of Simpevarp	Version 1.2 of the model will form the basis for the decision if the site at the area west of Simpevarp is suitable for complete site investigations.	Site descriptive model for the area west of Simpevarp, version 1.2 (Preliminary site description).		End of 2004.