P-04-150

Oskarshamn site investigation

Drilling of two flushing water wells, HAV09 and HAV10

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September 2004

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ISSN 1651-4416
SKB P-04-150

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Keywords: Percussion drilling, Flushing water well, Soil, Bedrock.

Summary

Drilling of percussion holes is required as a supplement to the drilling of deep cored holes. In general, the percussion holes serve two principal purposes: water supply for core drilling and as investigation boreholes to shallow depth.

Boreholes HAV09 and HAV10 were drilled for supply of flushing water to the deep cored borehole KAV04.

Borehole HAV09 did not yield enough water and a second percussion hole was drilled close by but in a different direction. The new hole was called HAV10 but did not yield sufficient amounts of water either.

The drilling was performed by contractor Sven Andersson in Uppsala AB in October 2003.

Supportive means to the drilling operations were given from SKB personnel regarding planning, coordination, infrastructure, sampling and on-site measurements.

A summary of data from boreholes HAV09 and HAV10 is given in Table 0-1.

Table 0-1. Technical summary.

	HAV09	HAV10
Easting RT90	1552411	1552412
Northing RT90	6366653	6366661
Elevation (m.a.s.l) RH70	2.17	2.23
Azimuth (0–360)	179	35
Dip (0–90)	–68	–68
Drilling dates	031013–031016	031020–031022
Casing depth	14.9 m	11.9 m
Casing inner diameter (mm)	160	160
Hole diameter (mm)	136.1	140.0
Length (m)	200.2	100.0
Water yield	3 l/min	2,5 l/min

Lengths in the boreholes are given as metres below “top of casing”.

Sammanfattning

Hammarborrhål borras i allmänhet två olika ändamål: dels vattenförsörjning för kärnborrrning dels för att möjliggöra undersökningar i ytligare berggrund.

Borrhålen HAV09 och HAV10 utfördes som spolvattenbrunnar inför kärnborrningen av KAV04. HAV09 gav inte tillräckliga mängder vatten och ett andra borrhål utfördes i närheten men i en annan riktning. Det nya hålet kallades HAV10 men inte heller detta hål gav tillräckliga mängder vatten.

Borrningen utfördes på entreprenad av Sven Andersson i Uppsala AB under oktober 2003. SKB personal utförde planering och koordinering av aktiviteten samt vissa stödinsatser vid borrning tex borrplatsanläggning, provtagningar och mätningar.

En sammanfattning av data från borrhål HAV09 och HAV10 ges i tabell 0-1.

Table 0-1. Teknisk sammanfattning.

	HAV09	HAV10
Öst RT90	1552411	1552412
Nortd RT90	6366653	6366661
Elevation (m.a.s.l) RH70	2.17	2.23
Riktning (0–360)	179	35
Lutning (0–90)	–68	–68
Datum för borrning	031013–031016	031020–031022
Foderrörslängd	14.9 m	11.9 m
Foderrör innerdiameter (mm)	160	160
Hål diameter (mm)	136.1	140.0
Längd (m)	200.2	100.0
Vatten mängd	3 l/min	2,5 l/min

Borrhålslängder anges som meter under foderrörets överkant.

Contents

1 Introduction

SKB performs site investigations in order to evaluate the feasibility of locating a deep repository for high level radioactive waste /1/ in two Swedish municipalities: Östhammar and Oskarshamn. The Simpevarp subarea of the investigation area in Oskarshamn is situated close to the nuclear power plant at Simpevarp /2/, see Figure 1-1.

This report will describe the drilling of the two percussion holes, HAV09 and HAV10, and the measurements performed during the drilling phase. Measurements performed in the holes after the drilling was completed will be presented in other reports.

The drilling and all related on-site operations were performed according to a specific Activity Plan (AP PS-03-074). Reference is given in the activity plan to procedures in the SKB Method Description for Percussion Drilling (SKB MD 610.003, Version 1.0) and relevant method instructions for handling of chemicals, surveying and evaluation of cuttings. Method descriptions and activity plans are SKB internal documents.

A notification of the drilling activity was issued to the Regional Environmental Authorities on October 1, 2003.

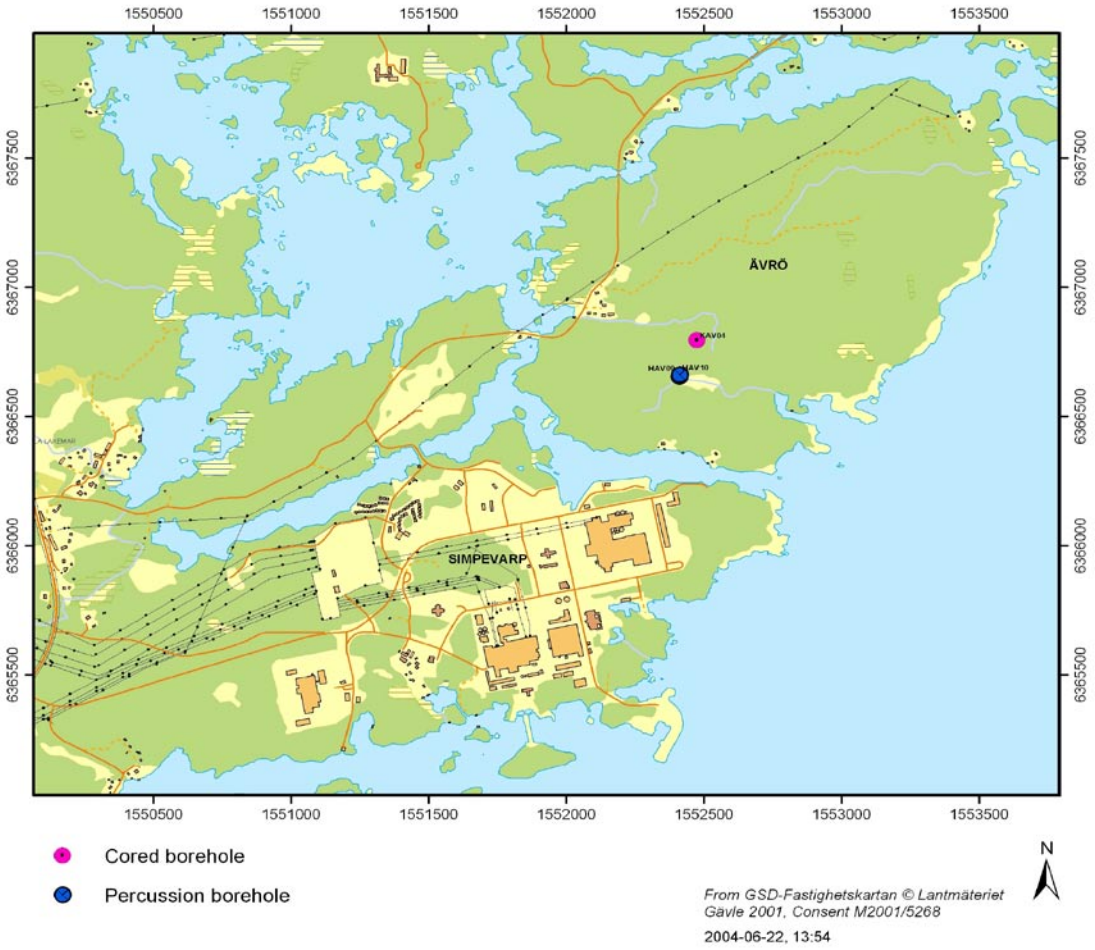


Figure 1-1. *Location of boreholes HAV09, HAV10 and KAV04 on Ävrö in the Simpevarp subarea.*

Table 1-1. Controlling documents for the performance of the activity.

Activity plan	Number	Version
Hammarborrning av HAV09 och HAV10, spolvattenbrunnar för KAV04	AP PS 400-03-074	1.0
Method descriptions	**Number**	**Version**
Metodbeskrivning för hammarborrning	SKB MD 610.003	1.0
Metodbeskrivning för undersökning av borrkax	SKB MD 142.001	1.0
Instruktion för rengöring av borrhålsutrustning och viss markbaserad utrustning	SKB MD 600.004	1.0
Instruktion för användning av kemiska produkter och material vid borrning och undersökningar	SKB MD 600.006	1.0
Instruktion för borrplatsanläggning	SKB MD 600.005	1.0
Instruktion för spolvattenhantering	SKB MD 620.007	1.0
Instruktion för utsättning och inmätning av borrhål	SKB MD 600.002	1.0

The activity plans and method descriptions are SKB internal documents.

All data were stored in the SICADA database for Oskarshamn. The field note numbers for entry into SICADA are:

Simpevarp 153 HAV09

Simpevarp 155 HAV10

2 Equipment and methods

In this chapter descriptions are given of the drilling equipment, the technique and equipment for gap injection of the borehole casings and of the instrumentation used for deviation measurements performed after completion of drilling. Also the equipment used for measurements and sampling during drilling is briefly described.

Drilling, completion and deviation measurements were made by contractor Sven Andersson, Uppsala AB.

2.1 Drilling equipment

Drilling of the two percussion boreholes was made with a Puntel percussion drilling machine supplied with accessories.

The drilling machine was equipped with separate engines for transportation and power supplies. For the raising of water and drill cuttings from the borehole, a 27 bar diesel air-compressor, type Atlas-Copco XRVS 455 Md was used. The DTH drillhammer was of type Secoroc 5”, lowered into the borehole by a Driconeq 76 mm pipe string.

Figure 2-1. *Establishing the percussion drill rig at the drill site.*

2.2 Equipment for measurements and sampling during drilling

Flow measurements during drilling were performed using measuring a graded vessel and a stop watch. Measurement of the drilling penetration rate was done manually.

Samples of soil and drill cuttings were collected in sampling pots. Water samples were collected in conjunction with flow measurements, typically at 100 and 200 metres length or where noticeable changes in water flow occurred.

3 Execution

The work was performed in accordance with SKB MD 610.003, Version 1.0 (Method Description for Percussion Drilling, SKB internal document) and consisted of:

- preparations,
- drilling through overburden,
- gap injection techniques and equipment,
- percussion drilling in hard rock,
- sampling and measurements,
- borehole completion,
- data handling,
- environmental control.

3.1 Preparations

The preparation stage included the Contractor's functional control of his equipment. The machinery and chemicals used have to comply with SKB MD 600.006, Version 1.0 (Method Instruction for Chemical Products and Materials, SKB internal document).

The equipment was cleaned in accordance with SKB MD 600.004, Version 1.0 (Method Instruction for Cleaning Borehole Equipment and certain Ground-based Equipment, SKB internal document).

3.2 Drilling through overburden

The terrain encountered in the Simpevarp area of investigation consists of gently undulating bedrock surface with low to moderate relief. The crystalline rock basement frequently outcrops or subcrops in the higher terrain and is covered with unconsolidated soil in the more shallow parts.

HAV09

Excentric percussion drilling with 260 mm diameter ("ODEX 215") was made through the unconsolidated soil and fractured near-surface bedrock to a depth of 5.4 metres.

A pilot hole to 14.9 metres was drilled with 140 mm nominal diameter and subsequently reamed to diameter 200 mm down to 14.9 metres, where a casing with diameter 168 mm was installed.

HAV10

Excentric percussion drilling with 260 mm diameter ("ODEX 215") was made through the unconsolidated soil and fractured near-surface bedrock to a depth of 3.3 metres.

A pilot hole to 11.9 metres was drilled with 140 mm nominal diameter and subsequently reamed to diameter 200 mm down to 11.9 metres, where a casing with diameter 168/160 mm was installed.

3.3 Gap injection techniques and equipment

In order to prevent surface water and shallow groundwater to infiltrate into deeper parts of the borehole, the gap between the borehole wall and the casings was grouted with cement.

A cement plug was installed at the bottom of the cased section and the concrete introduced between the casing and bedrock wall.

A reference sample of the cement paste was kept cool and dark on the surface to ensure that drilling was not resumed until the mixture had hardened. The concrete seal was tested by blowing compressed air in the hole and measuring the amount of water. As no water could be measured in either hole, the tightness of the gap injection was considered to be sufficient.

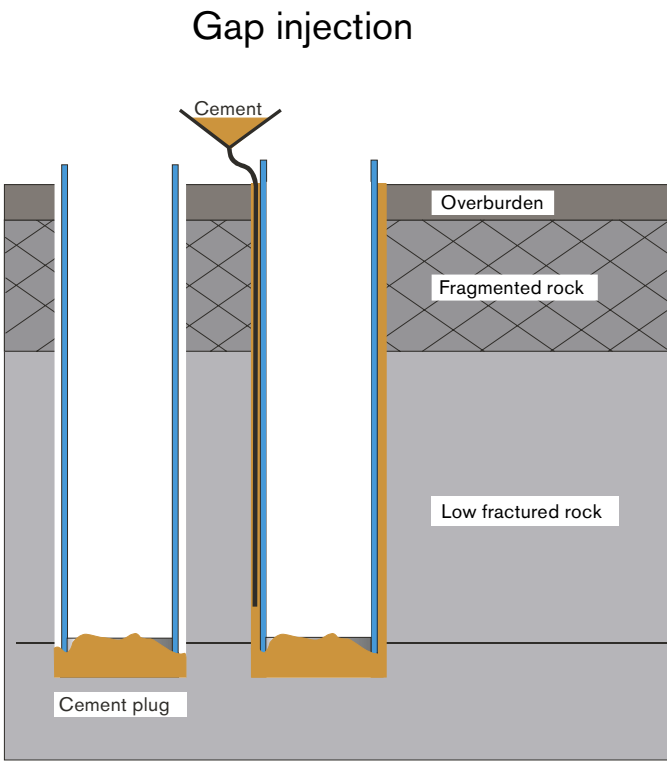


Figure 3-1. *Gap injection technique.*

3.4 Percussion drilling in hard rock

After allowing the cement to harden, drilling could continue and was performed to the full borehole length with conventional percussion drilling with a nominal diameter of 140 mm.

At the beginning and end of drilling the diameter of the drill bit was measured. The drilled lengths and decrease in diameter on the drill bits are given in Table 4-1.

3.5 Sampling and measurements

Sampling and measurements done by the drill coordinators during drilling included:

- Soil samples were taken while drilling through the overburden as follows:

Borehole	interval
HAV09	0.0–3.5 m
HAV10	0.3–3.0 m

- Samples of rock chip drill cuttings were taken along the holes. Three grab samples were taken over a length of three meter and collected to one sample. The samples were stored for later logging and analysis.
- Penetration rate (expressed as seconds per 20 cm) was manually recorded.
- Noticeable changes in water flow and colour of return water were recorded manually.

The water yield from the hole was estimated after the drilling phase was completed. The method employed was to blow compressed air through the drillstem and to measure the amount of return water during steady state conditions.

When the drilling was completed the hole was rinsed from drill cuttings by blowing air with the compressor at maximum capacity for 30 minutes.

Deviation measurements have not been made in the two holes.

3.6 Borehole completion

The borehole was secured by mounting a lockable steel cap on the casing.

All equipment was removed, the site cleaned and a joint inspection was made by representatives from SKB and the Contractor to ensure that the site had been restored to satisfactory level.

3.7 Data handling

Data collected by the drill coordinators were reported in daily logs and other protocols and delivered to the Activity Leader. The information was entered to SICADA (SKB database) by database operators.

3.8 Environmental control

The SKB routine for environmental control (SDP-301, SKB internal document) was followed throughout the activity. A checklist was filled in and signed by the Activity Leader and filed in the SKB archive.

All waste generated during the establishment, drilling and completion phases have been removed and disposed of properly. Water effluent from drilling was allowed to infiltrate to the ground in accordance with an agreement with the environmental authorities. The water amounted to very small quantities.

Recovered drill cuttings were collected in a steel container. After completion of drilling, the container was removed from the site and emptied at an approved site.

4 Results

The main purpose for boreholes HAV09 and HAV10 was to provide a water supply for core drilling of borehole KAV04. As the holes did not yield enough water the cored hole was supplied from another source (HSH03).

All data were stored in the SICADA database for Oskarshamn. The field note numbers for entry into SICADA are:

Simpevarp 153 HAV09

Simpevarp 155 HAV10

4.1 Borehole design

A summary of data from holes HAV09 and HAV10 are presented in the Table 4-1.

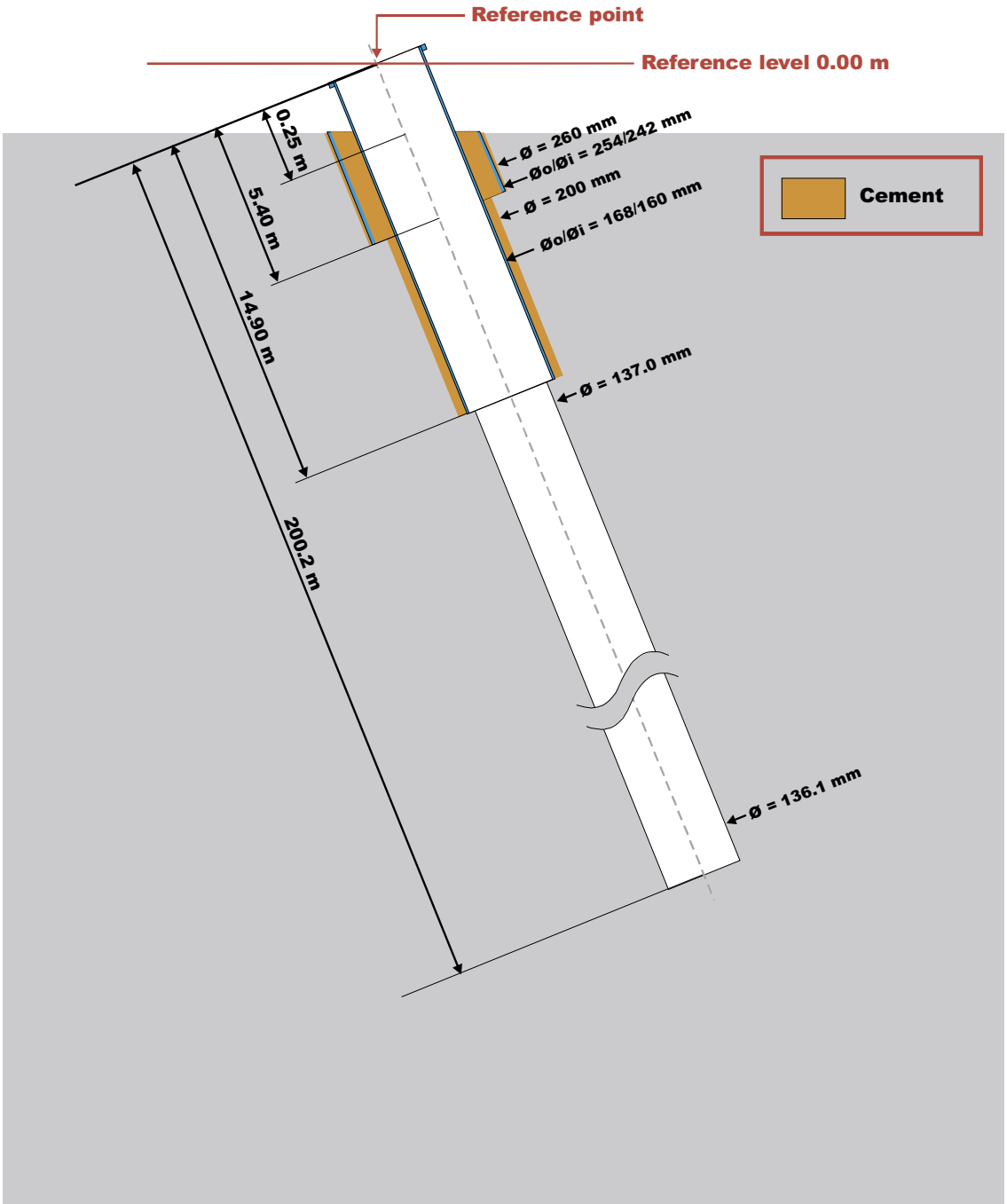
The design of each borehole is illustrated in drawings in Figures 4-1 and 4-2.

Table 4-1. Geometric and technical data for boreholes HAV09 and HAV10.

Parameter	HAV09		HAV10	
Drilling period	From 2003-10-13 to 2003-10-16		From 203-10-20 to 2003-10-22	
Borehole inclination (starting point) (0 to –90)	–68.0°		–68.5	
Borehole azimuth (0–360)	178.7°		35.1°	
Borehole length	200.20 m		100.00 m	
Soil depth	3.5 m		3.0 m	
Drill bit diameter	Start of drilling: 0.1370 m End of drilling: 0.1361 m		Start of drilling: 0.1405 m End of drilling: 0.1400 m	
Starting point coordinates (system RT90/RHB70)	Northing: 6,366,653.14 m Easting: 1,552,411.36 m Elevation: 2.172 m.a.s.l.		Northing: 6,366,660.57 m Easting: 1,552,411.84 m Elevation: 2.227 m.a.s.l.	
Water yield	3 l/min		2.5 l/min	
Borehole diameter	0.25–5.4 m	260	0.29–3.3 m	260
(interval) (diameter mm)	5.4–14.9 m	200	3.3–11.9 m	198.5
	14.90–200.2 m	136.1	11.9–100.0 m	140.0
Casing diameter (interval) (diameter mm)	0.25–5.4	Øo = 254 Øi = 242	0.29–3.3 m	Øo = 254 Øi = 242
	0–14.9 m	Øo = 168 Øi = 160	0–11.9 m	Øo = 168 Øi = 160

Technical data

Borehole HAV09



Drilling reference point

Northing:	**6366653.14 (m), RT90 2,5 gon V 0:-15**
Easting:	**1552411.36 (m), RT90 2,5 gon V 0:-15**
Elevation:	**2.172 (m), RHB 70**

Orientation

Bearing:	**178.7°**
Inclination:	**–68.0°**

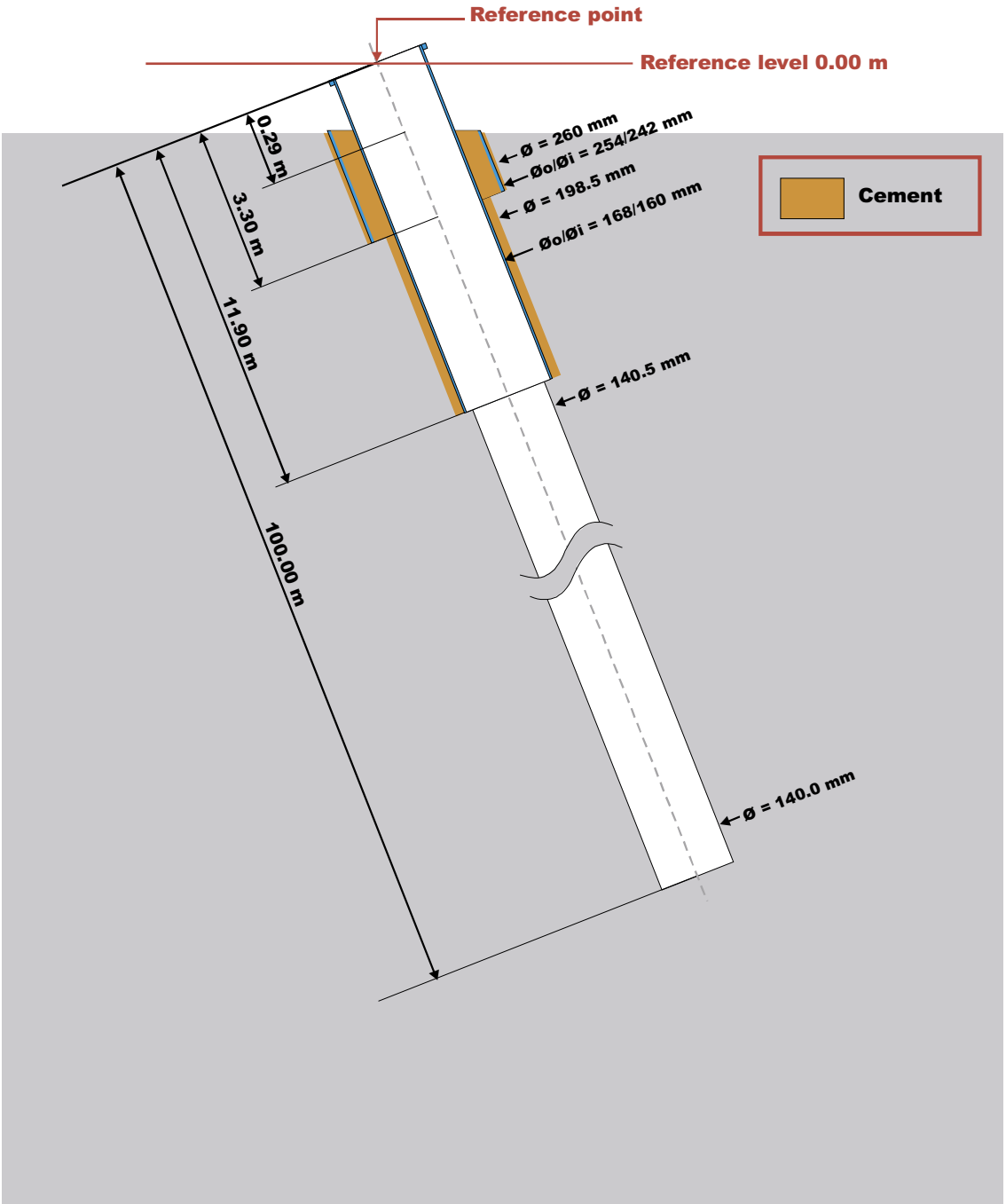
Drilling period

Drilling start date:	**2003-10-13**
Drilling stop date:	**2003-10-16**

Figure 4-1. *Technical data for borehole HAV09.*

Technical data

Borehole HAV10



Drilling reference point

Northing:	**6366660.57 (m), RT90 2,5 gon V 0:-15**
Easting:	**1552411.84 (m), RT90 2,5 gon V 0:-15**
Elevation:	**2.227 (m), RHB 70**

Orientation

Bearing:	**35.1°**
Inclination:	**–68.5°**

Drilling period

Drilling start date:	**2003-10-20**
Drilling stop date:	**2003-10-22**

Figure 4-2. *Technical data for borehole HAV10.*

4.2 Hydrogeological results

The borehole was rinsed from cuttings and water when drilling had been done to full depth. The specific capacity (Q_s) was estimated by assuming that the drawdown of the water table extended to the hole bottom. The specific capacity is calculated by divided the yield (m^3/s) with the hole length (m). The results are given in Table 4-2.

4.3 Hydrogeochemical results

Two samples were taken in conjunction with drilling in HAV10. The results are given in Table 4-3.

4.4 Geological summary

HAV09 is dominated by Ävrö Granite with minor intercalations of fine-grained dioritoide.

HAV10 consists entirely of Ävrö Granite with only minor veining of other rock types.

Technical and geological results achieved in conjunction with drilling are presented in appendices 1 and 2.

4.5 Consumption of oil and chemicals

Small amounts of hammer oil and compressor oil enter the holes during drilling but are continuously retrieved by air flushing during drilling. After the drilling is completed, only minor remainders of the products are left in the borehole.

No consumption of compressor oil (Schuman 46) was noted. No excess consumption of hammer oil (Preem Hydra 46) was noted.

Consumption of cement paste was estimated to 240 litres (214 kg) for HAV09 and 160 litres (143 kg) for HAV10.

4.6 Nonconformities

No nonconformities are registered for the holes.

Table 4-2. Hydrogeological results from HAV09 and HAV10.

Borehole	From (m)	To (m)	Water yield (L/min)	Specific capacity (m^2/s)
HAV09	14.9	200	3	2.7×10^{-7}
HAV10	11.9	100	2.5	4.73×10^{-7}

Table 4-3. Analytical results from HAV10.

Borehole	date	from	to	Sample number	HCO_3 mg/l	Cl mg/l	SO_4 mg/l	F mg/l	pH	El Cond mS/m
HAV09	031016	15	130.9	5906	32	2,561	93.8	0.9	7.3	869
HAV10	031022	12	22.6	5910	285	19	59.5	3.5	9.1	64
HAV10	031022	12	100	5911	292	23	63.7	2.9	8.4	70

The results from samples 5910 and 5911 are reported in full in Table 4-3. Sample 5906 was analysed for several other parameters than the ones presented above, a complete account of the analytical results is shown in Appendix 3.

5 References

/1/ **SKB, 2001.** Platsundersökningar. Undersökningsmetoder och generellt genomförandeprogram. SKB R-01-10, Svensk Kärnbränslehantering AB

/2/ **SKB, 2001.** Geovetenskapligt program för platsundersökning vid Simpevarp. SKB R-01-44, Svensk Kärnbränslehantering AB

WellCad plot HAV09 – geology and drill penetration rate

Title PERCUSSION BOREHOLE HAV09 **Appendix 1**

Site	ÄVRÖ	Coordinate System	RT90-RHB70
Borehole	HAV09	Northing [m]	6366653.14
Diameter [mm]	136	Easting [m]	1552411.36
Length [m]	200.200	Elevation [m.a.s.l.]	2.17
Bearing [°]	178.68	Drilling Start Date	2003-10-13 08:00:00
Inclination [°]	-68.01	Drilling Stop Date	2003-10-16 18:30:00
Date of mapping	2004-06-15 18:00:00	Plot Date	2004-10-11 21:04:14

ROCKTYPE ÄVRÖ
- Ävrö granite
- Fine-grained dioritoid

SOIL
- Soil

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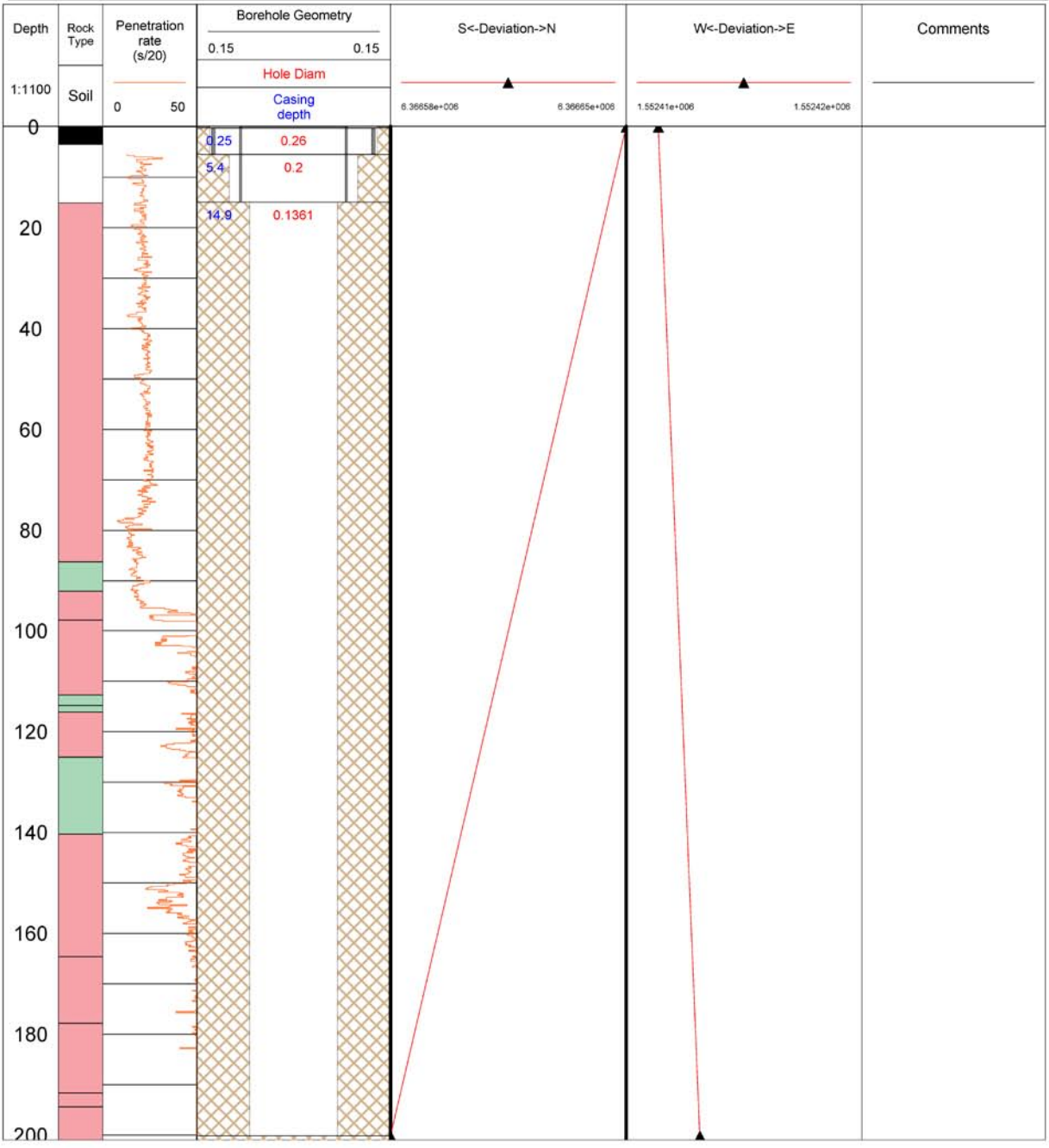
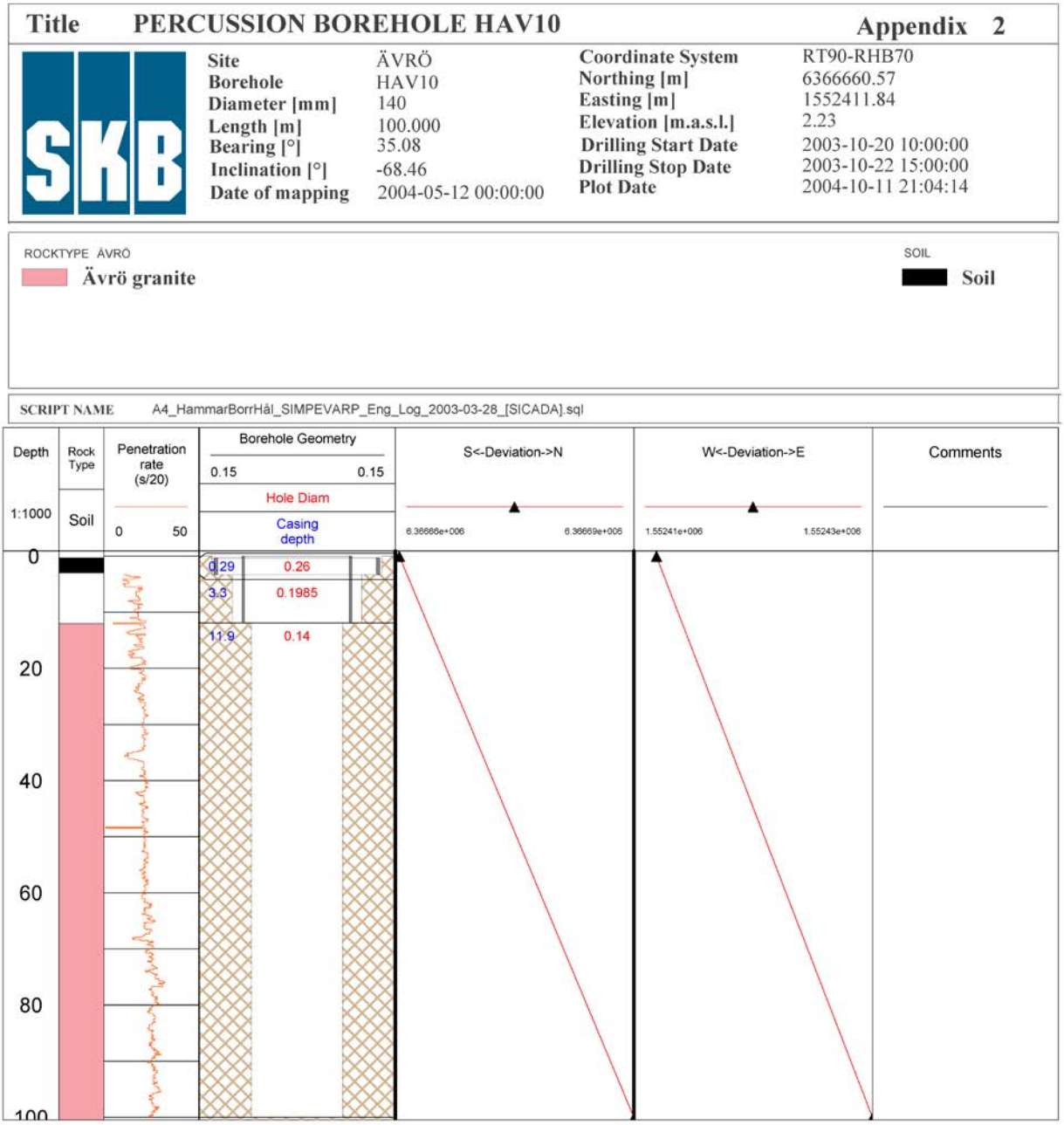


Appendix 2

WellCad plot HAV10 – geology and drill penetration rate



Appendix 3

Chemical results from water sampling in HAV09

Activity	Water sampling, class 3
Idcode	HAV09
Secup (m)	15.00
Seclow (m)	130.9
Sample No	5906
Na (mg	992.0
K (mg/l)	10.80
F (mg/l)	0.94
Si (mg/l)	0.79
Fe (mg/l)	1.9600
Mn (mg/l)	0.98700
Li (mg/l)	0.205
Sr (mg/l)	9.94
Ca (mg/l)	626.0
Mg (mg/l)	80.5
HCO3 (mg/l)	32.00
Cl (mg/l)	2561.1
SO4 (mg/l)	93.76
SO4 S (mg/l)	37.30
Br (mg/l	10.148
pH	7.32
El cond (mS/m)	869.0