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Oskarshamn site investigation

Hydraulic testing of percussion drilled lineament boreholes on Ävrö and Simpevarp, 2004

Sub-area Simpevarp

Nils Rahm, Golder Associates AB Cristian Enachescu, Golder Associates GmbH

November 2004

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Keywords: Site/project, Hydrogeology, Hydraulic tests, Pump tests, Flow logging, Hydraulic parameters, Transmissivity.

This report concerns a study which was conducted for SKB. The conclusions and viewpoints presented in the report are those of the authors and do not necessarily coincide with those of the client.

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Abstract

Hydraulic pump tests together with flow logging and water sampling have been performed in percussion boreholes HSH04, HSH05, HAV11, HAV12, HAV13 and HAV14 at the Ävrö Island and Simpevarp Peninsula at the sub-area Simpevarp, Oskarshamn. The tests are part of the general program for site investigations and specifically for the Simpevarp sub-area. The hydraulic testing programme has the aim to characterise the rock with respect to its hydraulic properties of the fractured zones, especially to selected lineaments discovered by the percussion boreholes. Data is subsequently delivered for the site descriptive model.

This report describes the results and primary data evaluation of the hydraulic pump tests and flow logging in boreholes HSH04, HSH05, HAV11, HAV12, HAV13 and HAV14 performed between 30th June and 22nd of July 2004. In a selection of further boreholes, the piezometric heads were monitored during the pump tests, data of further monitoring boreholes were delivered by SKB for implementation in the test analysis.

The main objective of the hydraulic testing, interference testing, flow logging and water sampling was to characterize the rock around the boreholes (with special respect to connectivity of lineaments) and investigate the water quality of the boreholes. Transient evaluation during flow and recovery period provided additional information such as flow regimes, hydraulic boundaries and interferences. Constant rate pump tests were conducted in the open boreholes. The results of the test interpretation are presented as transmissivity.

Sammanfattning

Hydrauliska pumptester, flödesloggningar och vattenprovtagning har utförts i hammarborrhålen HSH04, HSH05, HAV11, HAV13 och HAV14 på Ävrön, Simpevarpshalvön. Testerna är en del av de platsundersökningar som utförs vid Oskarshamnsverket, Simpevarpsområdet. Hydraultestprogrammet har som mål att karakterisera bergmassans hydrauliska egenskaper i sprickzoner i utvalda lineament som påträffats vid borrningar. Data överförs från testerna till den platsspecifika modellen.

Föreliggande rapport beskriver resultaten och primärdata från utvärderingen av hydrauliska pumptest och flödesloggningar i hammarborrhålen HSH04, HSH05, HAV11, HAV13 och HAV14 utförda mellan den 30 juni till och med den 22 juli 2004. Observationer av grundvattenytor och grundvattentryck har även utförts i närliggande borrhål av SKB i anslutning till pumptesterna. Dessa data har ingått i analysen.

Huvudsyftet för undersökningen har varit att karakterisera responsen av grundvattentrycken mellan pumpbrunnen och observationsbrunnar i samma lineament, grundvattenkvaliteten och de hydrauliska egenskaperna i berget vid borrhålen. Transient utvärdering under flödesoch återhämtningsfasen gav ytterligare information om flödesregimer, hydrauliska gränser och interferenser. Pumptester med konstanta flöden utfördes i öppna borrhål. Resultaten presenteras som transmissiviteter (T).

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1 Introduction

Hydraulic pump tests together with flow logging and water sampling have been performed in six percussion boreholes (HSH04, HSH05, HAV11, HAV12, HAV13 and HAV14). Monitoring of groundwater levels was carried out in a selection of additional monitoring boreholes (HSH06, KAV04A, HAV07, HAV08, HAV12, HAV13 and HAV14); monitoring data of further boreholes were delivered by SKB.



Figure 1-1. The investigation area Simpevarp, Oskarshamn with location of boreholes.

Measurements were carried out according during 30th of June and 23rd of July 2004 following the methodologies described in SKB MD 322.009 (flow logging), SKB MD 321.003 (pump tests) and SKB MD 330.003 (interference tests) and in the activity plan AP PS 400-03-077 (SKB internal controlling documents). Data and results were delivered to the SKB site characterization database SICADA.

The boreholes are situated on the Ävrö Island and Simpevarp Peninsula on the site of the nuclear power plant at Simpevarp and northeast of it, Figure 1-1. The percussion boreholes were mainly drilled in 2004 at approximately 200 m depth with a nominal inner diameter of 140 mm. The upper approximately 10 m are cased with large diameter telescopic casing ranging from diameter 160 mm–147 mm. The boreholes are inclined with approximately 57.8° to 60.4°.

2 Objective

The major objective of the performed testing program was the interference testing and testing of hydraulic connectivity of the lineaments connected to the percussion boreholes.

Further main objectives of the pump testing, flow logging and water sampling in the percussion boreholes was to characterize the rock around the boreholes (with special respect to the lineaments) and investigate the water quality of the boreholes. Transient evaluation during flow and recovery period in combination with further piezometric data of monitoring boreholes provided additional information such as flow regimes, hydraulic boundaries and interferences.

3 Scope of work

The scope of work consisted of preparation of the HTHB tool, which included functional checks, performing pump tests in six open boreholes (HSH04, HSH05, HAV11, HAV12, HAV13 and HAV14), monitoring the piezometric heads in further boreholes (HSH06, KAV04A, HAV07, HAV08, HAV12, HAV13 and HAV14), flow logging, water sampling, analysis and reporting.

Preparation for testing was done according to the activity plan (AP PS 400-03-077) and relevant SKB method descriptions for pump tests (SKB MD 321.003), flow logging (SKB MD 322.009) and for interference tests (SKB MD 330.003) (SKB internal controlling documents). This step mainly consists of functions checks of the equipment to be used, the HTHB tool. Function checks were documented in the daily log and/or relevant documents.

The following test programme was performed:

Borehole	Priority	Method	Monitored boreholes (Golder)	Monitored boreholes (SKB)
HAV12	1	Pumptest, flow logging, water sampling	HAV13, HAV14	HAV02, HAV05, KAV01, KAV03
HAV14	2	Pumptest, flow logging, water sampling	HAV07, HAV08, HAV13, KAV04A	HAV05
HAV11	3	Pumptest, flow logging, water sampling	KAV04A	KSH03, KAV01
HSH04	4	Pumptest, flow logging, water sampling	HSH06	HSH01
HSH05	5	Pumptest, flow logging, water sampling	Single hole test	Single hole test
HAV13	6	Pumptest, water sampling	HAV07, HAV08, HAV12, HAV14	HAV02, HAV05, KAV01, KAV03

Table 3-1. Performed test programme.

3.1 Boreholes

Technical data of the tested and monitored boreholes are shown in Tables 3-2 to 3-11. The reference point in the boreholes is the centre of top of casing (ToC), given as Elevation in the table below. The Swedish National coordinate system (RT90) is used in the x-y direction and RHB70 in the z-direction. Northing and Easting refer to the top of the boreholes at the ground surface. The borehole diameters in the tables refer to the final diameter of the drill bit after drilling to full depth.

Title	Value				
Borehole length (m):	200.000				
Drilling Period(s):	From Date 2002-06-24	To Date 2002-07-02	Secup (m) 0.000	Seclow (m) 200.000	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6366217.770	Easting (m) 1552545.864	Elevation (masl) 2.864	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 4.994	Inclination (- = d -69.994	own)	
Borehole diameter:	Secup (m) 0.000 1.500 12.030	Seclow (m) 1.500 12.030 200.000	Hole Diam (m) 0.270 0.215 0.140		
Casing diameter:	Secup (m) 0.000	Seclow (m) 12.000	Case In (m) 0.160	Case Out (m) 0.168	

Table 3-2. Information about HSH01 (from SICADA 2004-09-08, 15:22:46).

	Table 3-3. Information about HSH04	(from SICADA 2004-06-22, 10:44:18).
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Title	Value				
Borehole length (m):	236.200				
Drilling Period(s):	From Date 2004-04-05	To Date 2004-04-13	Secup (m) 0.000	Seclow (m) 236.200	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6366237.275	Easting (m) 1552223.476	Elevation (masl) 2.858	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 359.774	Inclination (– = down) –59.000		
Borehole diameter:	Secup (m) 0.000 9.200	Seclow (m) 9.200 236.200	Hole Diam (m) 0.190 0.137		
Casing diameter:	Secup (m) 0.000 8.910	Seclow (m) 8.600 9.000	Case In (m) 0.160 0.147	Case Out (m) 0.168 0.168	

Title	Value				
Borehole length (m):	200.200				
Drilling Period(s):	From Date 2004-04-14	To Date 2004-04-19	Secup (m) 0.000	Seclow (m) 200.200	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6365224.711	Easting (m) 1551179.077	Elevation (masl) 2.718	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 180.869	Inclination (– = down) –57.952		
Borehole diameter:	Secup (m) 0.000 6.200	Seclow (m) 6.200 200.200	Hole Diam (m) 0.190 0.139		
Casing diameter:	Secup (m) 0.000 0.000	Seclow (m) 6.200 6.110	Case In (m) 0.147 0.160	Case Out (m) 0.168 0.168	

Table 3-4. Information about HSH05 (from SICADA 2004-06-22, 10:44:36).

	Table 3-5.	Information	about HSH06	(from	SICADA	2004-06-22	2, 10:44:46)
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Title	Value				
Borehole length (m):	203.200				
Drilling Period(s):	From Date 2004-04-20	To Date 2004-04-22	Secup (m) 0.000	Seclow (m) 203.200	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6366214.627	Easting (m) 1552534.621	Elevation (masl) 2.346	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 2.143	Inclination (– = down) –57.772		
Borehole diameter:	Secup (m) 0.000 9.240	Seclow (m) 9.240 203.200	Hole Diam (m) 0.190 0.138		
Casing diameter:	Secup (m) 0.000 0.000	Seclow (m) 9.040 8.950	Case In (m) 0.147 0.160	Case Out (m) 0.168 0.168	

Title	Value				
Borehole length (m):	163.000				
Drilling Period(s):	From Date 1986-08-18	To Date 1986-08-21	Secup (m) 0.000	Seclow (m) 163.000	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367577.809	Easting (m) 1552790.978	Elevation (masl) 6.108	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 137.264	Inclination (= 0 89.100	down)	
Borehole diameter:	Secup (m) 0.000	Seclow (m) 163.000	Hole Diam (m) 0.110		
Casing diameter:	Secup (m) 0.000	Seclow (m) 0.130	Case In (m) 0.140	Case Out (m)	

Table 3-6. Information about HAV02 (from SICADA 2004-09-08, 15:13:01).

Table 3-7. Information about HAV05 (from SICADA 2004-09-09, 08:20:14).

Title	Value				
Borehole length (m):	100.000				
Drilling Period(s):	From Date 1987-07-26	To Date 1987-07-28	Secup (m) 0.000	Seclow (m) 100.000	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367482.658	Easting (m) 1552634.145	Elevation (masl) 6.858	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 191.264	Inclination (- = - -54.500	down)	
Borehole diameter:	Secup (m) 0.000	Seclow (m) 100.000	Hole Diam (m) 0.115		
Casing diameter:	Secup (m) 0.000	Seclow (m) 1.000	Case In (m) 0.130	Case Out (m) 0.140	

Table 3-8. Information about HAV07 (from SICADA 2004-09-08, 15:15:21).

Title	Value				
Borehole length (m):	100.000				
Drilling Period(s):	From Date 1987-07-27	To Date 1987-07-28	Secup (m) 0.000	Seclow (m) 100.000	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367227.487	Easting (m) 1552229.393	Elevation (masl) 4.165	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 66.264	Inclination (– = down) –56.200		
Borehole diameter:	Secup (m) 0.000	Seclow (m) 100.000	Hole Diam (m) 0.115		
Casing diameter:	Secup (m) 0.000	Seclow (m) 4.000	Case In (m) 0.130	Case Out (m) 0.140	

Title	Value				
Borehole length (m):	63.000				
Drilling Period(s):	From Date 1987-09-09	To Date 1987-09-09	Secup (m) 0.000	Seclow (m) 63.000	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367210.125	Easting (m) 1552197.507	Elevation (masl) 7.078	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 28.264	Inclination (- = -61.900	down)	
Borehole diameter:	Secup (m) 0.000	Seclow (m) 63.000	Hole Diam (m) 0.076		
Casing diameter:	Secup (m)	Seclow (m)	Case In (m)	Case Out (m)	

Table 3-9. Information about HAV08 (from SICADA 2004-09-08, 15:16:10).

Table 3-10. Information about HAV11 (from SICADA 2004-06-22, 10:45:13).

Title	Value				
Borehole length (m):	220.500				
Drilling Period(s):	From Date 2004-06-07	To Date 2004-06-14	Secup (m) 0.000	Seclow (m) 220.500	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6366565.254	Easting (m) 1553040.898	Elevation (masl) 2.379	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 113.471	Inclination (- = - -59.610	down)	
Borehole diameter:	Secup (m) 0.000 6.120	Seclow (m) 6.120 220.500	Hole Diam (m) 0.190 0.140		
Casing diameter:	Secup (m) 0.000 0.000	Seclow (m) 6.030 5.940	Case In (m) 0.147 0.160	Case Out (m) 0.168 0.168	

Title	Value				
Borehole length (m):	157.800				
Drilling Period(s):	From Date 2004-05-12	To Date 2004-05-19	Secup (m) 0.000	Seclow (m) 157.800	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367765.872	Easting (m) 1553194.416	Elevation (masl) 9.404	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 0.274	Inclination (– = down) –58.786		
Borehole diameter:	Secup (m) 0.000 6.130	Seclow (m) 6.130 157.800	Hole Diam (m) 0.190 0.140		
Casing diameter:	Secup (m) 0.000 5.940	Seclow (m) 5.940 6.030	Case In (m) 0.160 0.147	Case Out (m) 0.168 0.168	

Table 3-11. Information about HAV12 (from SICADA 2004-06-22, 10:45:19).

Table 3-12. Information about HAV13 (from SICADA 2004-06-22, 10:45:26).

Title	Value				
Borehole length (m):	142.200				
Drilling Period(s):	From Date 2004-05-24	To Date 2004-05-27	Secup (m) 0.000	Seclow (m) 142.200	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367627.858	Easting (m) 1552682.157	Elevation (masl) 2.215	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 0.077	Inclination (– = down) –58.809		
Borehole diameter:	Secup (m) 0.000 9.120	Seclow (m) 9.120 142.200	Hole Diam (m) 0.190 0.140		
Casing diameter:	Secup (m) 0.000 8.950	Seclow (m) 8.950 9.040	Case In (m) 0.160 0.147	Case Out (m) 0.168 0.168	

Title	Value				
Borehole length (m):	182.400				
Drilling Period(s):	From Date 2004-06-01	To Date 2004-06-04	Secup (m) 0.000	Seclow (m) 182.400	Drilling Type Percussion drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367227.977	Easting (m) 1552350.548	Elevation (masl) 7.761	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 271.462	Inclination (- = -60.418	down)	
Borehole diameter:	Secup (m) 0.000 6.120	Seclow (m) 6.120 182.400	Hole Diam (m) 0.190 0.136		
Casing diameter:	Secup (m) 0.000 5.940	Seclow (m) 5.940 6.030	Case In (m) 0.160 0.147	Case Out (m) 0.168 0.168	

Table 3-13. Information about HAV14 (from SICADA 2004-06-22, 10:45:46).

Table 3-14. Information about KAV01	(from SICADA 2004-09-08, 15:28:36).
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Title	Value				
Borehole length (m):	757.310				
Drilling Period(s):	From Date 2003-06-11	To Date 2004-01-10	Secup (m) 0.000	Seclow (m) 757.310	Drilling Type Core drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367257.524	Easting (m) 1553084.922	Elevation (masl) 14.100	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 237.264	Inclination (- = 0 -89.200	down)	
Borehole diameter:	Secup (m) 0.000 0.000 68.740 68.840 70.040	Seclow (m) 68.740 502.000 68.840 70.040 757.310	Hole Diam (m) 0.200 0.056 0.165 0.076 0.056		
Casing diameter:	Secup (m) 0.000 67.490 67.740	Seclow (m) 68.040 67.740 70.040	Case In (m) 0.160 0.158 0.058	Case Out (m) 0.168 0.066	

Title	Value				
Borehole length (m):	248.400				
Drilling Period(s):	From Date 1986-09-23	To Date 1986-10-05	Secup (m) 0.000	Seclow (m) 284.400	Drilling Type Core drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6367624.119	Easting (m) 1553355.586	Elevation (masl) 8.738	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 146.264	Inclination (– = –89.400	down)	
Borehole diameter:	Secup (m) 0.000	Seclow (m) 248.400	Hole Diam (m) 0.056		
Casing diameter:	Secup (m) 0.000	Seclow (m) 2.800	Case In (m) 0.057	Case Out (m) 0.064	

Table 3-15. Information about KAV03 (from SICADA 2004-09-08, 15:33:37).

Table 3-16. Information about KAV04A (from SICADA 2004-06-23, 10:54:05).

Title	Value				
Borehole length (m):	1004.000				
Drilling Period(s):	From Date 2003-10-06 2003-12-10	To Date 2003-11-01 2004-05-03	Secup (m) 0.000 99.550	Seclow (m) 100.020 1,004.000	Drilling Type Percussion drilling Core drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6366795.764	Easting (m) 1552474.999	Elevation (masl) 10.353	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 77.032	Inclination (– = –84.905	down)	
Borehole diameter:	Secup (m) 0.000 12.670 99.550 100.950	Seclow (m) 12.670 100.200 100.950 1,004.000	Hole Diam (m) 0.349 0.245 0.086 0.076		
Core diameter:	Secup (m) 99.550 100.950	Seclow (m) 100.950 1,004.000	Core Diam (m) 0.072 0.050		
Casing diameter:	Secup (m) 0.000 0.000	Seclow (m) 100.000 12.630	Case In (m) 0.200 0.265	Case Out (m) 0.208 0.273	

Title	Value				
Borehole length (m):	1,000.700				
Drilling Period(s):	From Date 2003-08-13 2003-09-11	To Date 2003-09-03 2003-11-07	Secup (m) 0.000 100.600	Seclow (m) 100.600 1,000.700	Drilling Type Percussion drilling Core drilling
Starting point coordinate: (centerpoint of TOC)	Length (m) 0.000	Northing (m) 6366018.660	Easting (m) 1552711.167	Elevation (masl) 4.146	Coord Sys. RT90-RHB70
Angles:	Length (m) 0.000	Bearing 125.025	Inclination (- = 0 -59.105	down)	
Borehole diameter:	Secup (m) 0.500 11.640 100.000 101.260	Seclow (m) 11.640 100.500 101.260 1,000.700	Hole Diam (m) 0.350 0.247 0.086 0.076		
Core diameter:	Secup (m) 100.000 101.260	Seclow (m) 101.260 1,000.700	Core Diam (m) 0.072 0.050		
Casing diameter:	Secup (m) 0.000 0.000 96.610 96.910	Seclow (m) 100.050 11.620 96.910 101.260	Case In (m) 0.200 0.265 0.195 0.100	Case Out (m) 0.208 0.273 0.100 0.080	

Table 3-17. Information about KSH03A (from SICADA 2004-09-08, 15:27:31).

3.2 Tests

The hydraulic tests performed in the boreholes are listed in Table 3-10. They were conducted according to the Activity Plan AP PS 400-03-077 (SKB internal document). Pump tests and flow logging tests were carried out with the HTHB (Hydro Testutrustning i Hammar-Borrhål) system. Interference tests were carried out with additional installation of pressure transducers in selected monitoring boreholes. Groundwater data of further monitoring boreholes were provided by SKB. The different test types were performed according to the corresponding methodology descriptions for single-hole pump tests (SKB MD 321.003, Metodbeskrivning för Hydrauliska Enhålspumptester), impeller flow meter logging (SKB MD 322.009, Metodbeskrivning för Flödesloggning), interference testing (SKB MD 330.003, Metodbeskrivning för Vattenprovtagning in Hammarborhål efter Borrning) (SKB internal controlling documents). In conjunction with the flow logging, an electric conductivity- and temperature logging of the borehole water was performed.

During the capacity test and at the end of the pump test, water samples were taken and submitted to the SKB Äspö Laboratory for analysis.

Additional manual groundwater level measurements were performed in the pumped and monitoring boreholes according to Table 3-1.

Table 3-18.	. Tests	performed.
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Bh ID	Test section (m)	Test type ¹	Test no	Test start Date, time (yyyy-mm-dd hh:mm:ss)	Test stop Date, time (yyyy-mm-dd hh:mm:ss)
HAV12	11.34-157.80	1B, 6,	1	2004-07-02	2004-07-03
		L-EC, L-Te		08:53:40	08:44:27
HAV12	11.34-157.80	1B, 2	2	2004-07-04	2004-07-05
				08:24:35	08:43:12
HAV14	6.03-182.40	1B, 2, 6,	1	2004-07-07	2004-07-09
		L-EC, L-Te		08:09:24	10:11:00
HAV11	6.03-220.50	1B, 2, 6,	1	2004-07-11	2004-07-14
		L-EC, L-Te		08:24:24	09:05:45
HSH04	9.00-236.20	1B, 2, 6,	1	2004-07-15	2004-07-17
		L-EC, L-Te		08:11:19	08:35:25
HSH05	6.20-200.20	1B, 6,	1	2004-07-17	2004-07-19
		L-EC, L-Te		13:07:59	08:43:10
HAV13	9.04-142.20	1B, 2,	1	2004-07-20	2004-07-22
		L-EC, L-Te		08:02:58	13:30:55

¹ 1B: Pump test submersible pump, 2: interference test, 6: flow logging-impeller, L-EC: electric conductivity logging, L-Te: temperature logging

3.3 Control of equipment

Control of equipment was mainly performed according to the HTHB tool description (Mätssystembeskrivning (MSB) för HTHB), SKB MD 326.001–015 (SKB internal controlling documents), which is composed of a general part and technical documents of the HTHB tool components.

Function checks were performed before and during the tests. Among these pressure sensors were checked at air pressure and while running in the hole calculated to the static head. Temperature and electric conductivity was checked at ground level and while running in. The impeller used in the flow logging tool was checked by the rotation of the impeller while running in the borehole. The measuring wheel (used to indicate the position of the flow logging tool in the borehole) and the sensor attached to it was checked against the previously measured and marked length of the cable.

Any malfunction was recorded, and measures were taken accordingly for proper operation. Approval was made according to SKB site manager or the "Mätssystembeskrivning".

4 Equipment

4.1 Description of equipment

The equipment called HTHB (Swedish abbreviation for Hydraulic Test System for Percussion Boreholes) is a modular tool for testing boreholes up to ca 200 m depth (see conceptual drawing in Figure 4-1). The system components are stored inside a container suitable for transport to remote test sites and use at any weather. Briefly, the components consist of a submersible borehole pump with housing, expandable packers, pressure transducers and a pipe string and/or hose. During flow logging, sensors for measuring electric conductivity and temperature as well as an impeller for measuring the downhole flow rate are used. On the surface, the total pump rate (or injection rate) is adjusted manually by a control valve and monitored by an electromagnetic flow meter. Data are sampled by a logger with automatically sequenced intervals or at intervals set by the test operator. An external power supply of 230V is necessary to run the HTHB system.



Figure 4-1. A view of the layout and equipment of HTHB for a pump test in an open borehole.

The HTHB is designed for percussion boreholes and used to perform pumping and injection tests in open boreholes or in packered sections of the borehole. It is possible to combine a pump test in an open borehole with a flow logging survey along the borehole (Figure 4-1). Tests can be performed with a constant hydraulic head or alternatively with a constant flow rate. Hydraulic tests can also be performed in packered borehole sections down to a total depth of 200 m (Figure 4-2). According to the number of pipes available, the upper packer can not be located deeper than 80 m at injection tests.

The packers are normally expanded by water with nitrogen used to pressurize the water. By deep groundwater levels (e.g. h > 25 m by a borehole diameter of 140 mm), the packers are expanded by nitrogen gas. A folding pool is used to collect the discharged water from the borehole if the salinity does not allow a direct discharge to the environment or if the water is to be used in subsequent injection tests.

The HTHB equipment is documented in photographs 1-4.



Figure 4-2. A view of the layout and equipment of HTHB for a pump test in a packered borehole section.



Photo 1. Container with spool for hose.



Photo 2. Equipment installed in a borehole with guiding spools on TOC.





Photo 3. Surface flow meter for measuring total flow rate.

Photo 4. Depth measuring wheel on TOC.

4.2 Sensors

Technical specifications of the sensors used together with estimated data specifications of the HTHB test equipment for pump tests and flow logging are listed in Table 4-1.

Errors in reported borehole data (e.g. borehole diameter) may significantly increase the error in measured and calculated data. Especially the flow logging impeller is very sensitive to variations in the borehole diameter. A rough borehole wall or variations in borehole diameter may lead to a bypassing water flow, indicating a too low water flow at the flow logging. In general, the flow logging impeller is calibrated for different borehole diameters. The nominal borehole diameter for all tested boreholes given by the activity plan is 140 mm, however, the information provided from the SICADA database indicating borehole diameters ranging from 136 mm to 140 mm. After positioning of the flow logger to a measurement depth, sufficient stabilisation time should be provided. The stabilisation time may be up to 30 s at flow rates close to the lower measurement limit whereas at high flow rates this stabilisation time is almost of no importance.

Parameter	Sensor	Unit	Sensor range	HTHB range	Comments
Pressure	Output signal Meas. range Resolution	mA kPa kPa	4–20 0–1,500 0.05	0–1,500	
	Accuracy	kPa	± 1.5 *	± 10	Depending on uncertainties of sensor position
Temperature	Output signal Meas. range Resolution	mA °C °C	4–20 0–50 0.1	0-50	
Electric Conduc- tivity	Accuracy Output signal Meas. range Resolution Accuracy	V mS/m % o.r. ** % o.r. **	± 0.8 0–2 0–50,000	± 0.8 0–50,000 1 ± 10	With conductivity meter
Flow (Spinner)	Output signal Meas. range Resolution *** Accuracy ***	Pulses/s L/min L/min % o.r. **	c 0.1–c 15	2–100 3–100 4–100 0.2 ± 20	115 mm borehole diameter 140 mm borehole diameter 165 mm borehole diameter 140 mm borehole diameter and 100 s sampling time
Flow (surface)	Output signal Meas. range Resolution Accuracy	mA L/min L/min % o.r. **	4–20 1–150 0.1 ± 0.5	5–c 80 **** 0.1 ± 0.5	Passive Pumping tests

Table 4-1. Technical specifications of sensors.

* Includes hysteresis, linearity and repeatibility.

** Maximum error in % of actual reading (% o.r.).

*** Applicable to boreholes with a borehole diameter of 140 mm and 100 s sampling time.

**** For injection tests the minimal flow rate is 1 l/min.

Table 4-2 shows the position of sensors for each test. Positions for the following equipments are given: Pump (bottom), pressure (P1), temperature (Te) and electric conductivity (EC). The sensors for temperature and electric conductivity are placed in the flow logging unit and therefore of variable depth during a test. Positions are given in meter from the reference point (TOC). Equipment affecting the wellbore storage coefficient (WBS) is given with diameter of the submerged tool. All pump tests were performed in open boreholes, therefore, all positions are "in section". The volume of the submerged pump (ca 4 dm³) is in most cases of minor importance.

Borehole information		Sensors		Equipment affecting WBS coefficient			
ID	Test section (m)	Test no	Туре	Position (m fr ToC)	Position	Function	Outer diameter (mm)
HAV12	11.34–157.80	1	Pump (bottom) P1 Flow logging Equipment	27.00 23.72 variable (30–156)	in section	Pump string (hose) signal cable signal cable	37 8 13.5
HAV12	11.34–157.80	2	Pump (bottom) P1 Flow logging Equipment	27.00 23.72 30	in section	Pump string (hose) signal cable signal cable	37 8 13.5
HAV14	12.85–182.40	1	Pump (bottom) P1 Flow logging Equipment	om) 27.00 in section Pump string 23.72 (hose) ng variable signal cable (32–180) signal cable		37 8 13.5	
HAV11	6.03–220.50	1	Pump (bottom) P1 Flow logging Equipment	20.00 16.72 variable (26–122)	in section	Pump string (hose) signal cable signal cable	37 8 13.5
HSH04	9.00–236.20	1	Pump (bottom) P1 Flow logging Equipment	Pump (bottom) 20.00 ir P1 16.72 Flow logging variable Equipment (25–202)		Pump string (hose) signal cable signal cable	37 8 13.5
HSH05	6.20–200.20	1	Pump (bottom) P1 Flow logging Equipment	ump (bottom) 30.00 in 1 26.72 ow logging variable quipment (36–198)		Pump string (hose) signal cable signal cable	37 8 13.5
HAV13	9.04–142.20	1	Pump (bottom) P1 Flow logging Equipment	18.00 14.72 22	in section	Pump string (hose) signal cable signal cable	37 8 13.5

Table 4-2. Sensor positions and wellbore storage (WBS) controlling factors.

4.3 Data acquisition system

The data acquisition system in the HTHB unit contains a data logger (Campbell CR 5000) which transforms the raw data automatically to engineering units and a laptop with the software PC 9000 to download the data for further processing. A second laptop is connected to the HTHB laptop, containing the evaluation software, Interpret 2000.

The data acquisition system can be set to sequenced logging intervals or can be manually set to fix logging intervals depending on the change of pressure versus time. The pump tests were started and stopped by switching the pump on or off manually.

Additional data loggers (Geometrik) were installed in selected monitoring wells. Previously to the pump test, an approximately 24 h period was logged with a 2 min logging interval for general background data. For the period of the pump test and recovery phase, the loggers in the monitoring wells were set to an interval of 1 min.

5 Execution

5.1 Preparations

All sensors of the HTHB system are calibrated at GEOSIGMAs engineering workshop in Librobäck, Uppsala. Calibration is performed on a yearly basis, or more often if needed. The last calibration before the described pump test campaign was done in June 2004. Protocols of the performed calibration were submitted with the HTHB system description, a calibration protocol form including the actual calibration constants was submitted with the delivery of raw data after finishing the test campaign.

Following preparation work and functional checks were conducted prior to starting test activities:

- Placing the container beside the borehole.
- Cleaning of all in-hole equipment with alcohol.
- Synchronize clocks on all computers.
- Run in the borehole with a dummy to check if the hole is free.
- Lowering the flow logger to the bottom of the borehole respectively the lower logging depth.
- Check pressure gauges against atmospheric pressure and then on test depth against column of water, a malfunction of P1 was detected after finishing the pump test in HAV12, it was replaced by P2.
- Check functionality of sensors for temperature and electric conductivity.
- Check functionality of measuring wheel against measured cable length.
- Measure and assemble test tool.
- Lower the pump according to the previous measured groundwater level considering the expected drawdown.

5.2 Execution of tests/measurements

5.2.1 Test principle

Pump tests

The pump tests were conducted as constant flow rate tests (CRw phase) followed by a pressure recovery period (CRr phase). The intention was to obtain approximately steady-state conditions at the end of the pump phase. To set up an appropriate flow rate for the pump test with a target value of 10 m drawdown, a capacity test was performed with duration of approximately 10 min.

Flow logging

The flow logging was performed during pumping with flow measurements at constant intervals of 2 m, starting from the bottom of the borehole and upward. In cases of an increase of the flow rate of > 1 l/min from one interval to the next, additional flow logging

was performed in 0.5 m intervals downwards to the previous measurement. To allow a stabilization of the flow in the borehole, flow logging started earliest 2 hours after start of pumping. Every flow logging was performed with a logging duration of 100 s. The uppermost flow logging was made with a minimum distance of 4 m to the bottom of the pump to avoid errors caused by turbulences from the pump. In general, duration of flow logging is between 3–7 hours in a percussion borehole but this duration depends on the length and character of the borehole.

Observation wells

For evaluation as interference tests, selected boreholes were used to monitor the groundwater levels previous to and during running pump tests. Approximately 24 hours before starting the pump tests, data loggers were installed in the selected observation boreholes and started with a logging interval of 2 min to collect background data. Before starting the pump test, these loggers were set to intervals of 1 min for the pump and recovery phase of the pump test.

Groundwater level data from further observation boreholes were provided by SKB from long time monitoring programs. These data were included in the interference test analysis.

5.2.2 Test procedure

Before starting a pump test, function checks, cleaning and preparation of equipment together with time synchronisation of clocks, data loggers and laptops were performed according to the activity plan and method descriptions. All tests were carried out when the drill work at the borehole locations were finished.

Pump tests

A short (10 min) flow capacity test was carried out prior to each pump test to choose an appropriate flow rate for the test. The evaluation of the capacity test was performed according to Appendix 5 of the method description for single borehole tests (SKB MD 321.003) (SKB internal controlling documents). The extracted water was discharged on the hard rock, running down slope to the sea from the pumped borehole.

The general schedule for the performed pump tests consisted of a 10 hours pump phase in combination with flow logging (except pump test in HAV13) and monitoring of further observation wells (except pump test in HSH05). At the pump tests in HSH04 and HSH05, the pump rate was adjusted during the pump phase to maintain a constant flow rate. The flow phase was followed by a recovery phase of approximately 13 to 15 hours. For the sampling frequency during the pump phase, the automatically sequence option of the data logger was used (Table 5-1). For the recovery phase, the sampling frequency was set manually as shown in Table 5-2.

Table o 1. Camping nequency for pump phase (sequence option)
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Time interval (s) from start of pumping	Sampling frequency (s)
1–300	1
301–600	10
601–3,600	60
> 3,600	600

Time interval (s) from start of pumping	Sampling frequency (s)		
1–300	1		
301–600	5		
601–900	10		
> 900	60		

Table 5-2. Sampling frequency for recovery phase (manual).

Flow logging

As preparation for flow logging, the flow log impeller was lowered to the bottom of the holes respectively to the lowest flow log depth according to the observations during the borehole check with the dummy.

The flow logging was performed during the pump phase and started approximately 2 hours after start of pumping. Starting from the bottom, the flow logger was lifted in steps of 2 m and halted for measurements with a time period of 100 s. When a flow anomaly with a difference of > 1 l/min comparing to the previous measurement was detected, the flow logger was then lowered in 0.5 m steps until the previous flow rate was retrieved for a more detailed depth identification of the anomaly. The flow logging then continued in further 2 m intervals along the hole.

5.3 Data handling

The data handling followed several stages. The data acquisition software included in the logger (Campbell CR 5000) transformed the data already to engineering units. These files are comma-separated (*.dat files) and contain the time, pressure, flow rate, temperature and electric conductivity data.

The *.dat files of the pump test were synthesized in Excel to a *.xls file for plotting purposes of the Karthesian plot. Finally, the processed test data to be delivered to SKB were exported from Excel in *.csv format. These files were also used for the subsequent test analysis with Interpret 2000.

The *.dat files of the flow logging were synthesized with an Excel macro for evaluation.

All raw data files were renamed and handed over to SKB (Appendix 1).

5.4 Analyses and interpretation

5.4.1 Analysis software

The tests were analysed using a type curve matching method. The analysis was performed using Interpret 2000. Interpret 2000 is an interactive analysis environment allowing the user to interpret constant pressure and constant rate in a source as well as in observation boreholes. The program allows the calculation of type-curves for homogeneous, dual porosity and composite flow models in variable flow geometries from linear to spherical.

5.4.2 Analysis approach

Constant rate and pressure recovery tests are analysed using the method described by /Gringarten, 1986/ and /Bourdet et al. 1989/ by using type curve derivatives calculated for different flow models.

5.4.3 Analysis methodology

Each of the relevant test phases is subsequently analyzed using the following steps:

- Identification of the flow model by evaluation of the derivative on the log-log diagnostic plot. Initial estimates of the model parameters are obtained by conventional straight-line analysis.
- Superposition type curve matching in log-log coordinates. A non-linear regression algorithm is used to provide optimized model parameters in the latter stages.
- Non-linear regression in semi-log coordinates (superposition HORNER plot; /Horner, 1951/. In this stage of the analysis, the static formation pressure is selected for regression.

The test analysis methodology is best explained in /Horne, 1990/.

5.4.4 Steady state analysis

In addition to the type curve analysis, an interpretation based on the assumption of stationary conditions was performed as described by /Moye, 1967/.

5.4.5 Flow models used for analysis

The flow models used in analysis were derived from the shape of the pressure derivative calculated with respect to log time and plotted in log-log coordinates.

In several cases the pressure derivative suggests a change of transmissivity with the distance from the borehole. In such cases a composite flow model was used in the analysis.

In other cases, the use of a homogeneous flow model led to very large skin factors (e.g. 20). In these cases, in addition to the homogeneous flow model analysis an analysis using a composite flow model was conducted. In these cases the skin was represented explicitly as inner composite zone.

The flow dimension displayed by the test can be diagnosed from the slope of the pressure derivative. A slope of 0.5 indicates linear flow, a slope of 0 (horizontal derivative) indicates radial flow and a slope of -0.5 indicates spherical flow. The flow dimension diagnosis was commented for each of the tests. However, in all cases it was possible to achieve to acceptable analysis results (good match quality) by using radial flow geometry (flow dimension of 2).

5.4.6 Calculation of the static formation pressure and equivalent freshwater head

The static pressure measured at transducer depth, was derived from the pressure recovery (CRr) following the constant rate pump phase by using straight line or type curve extrapolation in the Horner plot. No corrections of measured data (e.g. for atmospheric

pressure variations, tidal and other background effects) have been made by the analysis of data but a general air pressure correction has been performed.

The equivalent freshwater head (expressed in meters above sea level) was calculated from the static formation pressure, corrected for the vertical depth considering the inclination of the borehole, by assuming a water density of 1,000 kg/m³ (freshwater). The equivalent freshwater head is the static water level an individual open borehole would show if full of freshwater.

The freshwater head in meters above sea level is calculated as following:

$$h_{iwf} = \frac{(p^* - p_{atm})}{\rho \cdot g}$$

which is the P* value expressed in a water column of freshwater.

With consideration of the elevation of the reference point (RP) and the gauge depth (Gd), the freshwater head is

$$head = RP_{elev} - Gd + \frac{(p^* - p_{atm})}{\rho \cdot g}$$

5.4.7 Derivation of the recommended transmissivity and the confidence range

In most of the cases more than one analysis was conducted on a specific test. Typically both test phases were analysed (CRw and CRr). The parameter sets (i.e. transmissivities) derived from the individual analyses of a specific test usually differ. In the case when the differences are small (which is typically the case) the recommended transmissivity value is chosen from the test phase that shows the best data and derivative quality, which is most of the cases at the CRr phase. In cases when a composite flow model was deemed to be most representative for the hydraulic behaviour of the specific test section, than the outer zone transmissivity was selected as recommended value, because it is regarded as most representative for the large scale undisturbed formation properties.

The confidence range of the transmissivity was derived using expert judgement. Factors considered were the range of transmissivities derived from the individual analyses of the test as well as additional sources of uncertainty such as noise in the flow rate measurement, numeric effects in the calculation of the derivative or possible errors in the measurement of the wellbore storage coefficient. No statistical calculations were performed to derive the confidence range of transmissivity.

5.4.8 Flow logging

The parameters derived from flow logging (flow rate, temperature and electric conductivity of the borehole fluid) are plotted versus borehole length. Flow anomalies where the flow rate changes more than 1 l/min were identified along the borehole. The range of the inflow at the flow anomaly is determined by the relevant change in flow rate at the anomaly interval. In most cases, flow anomalies are accompanied by corresponding changes in temperature and/or electric conductivity.

Flow logging was performed in the borehole interval from 1 m above the bottom of the borehole to 4 m below the submersible pump. The upper part of the borehole (from 4 m below the submersible pump to the groundwater level) could not be flow-logged, although high inflow zones may be observed (e.g. in HSH04). Such superficial inflows were identified by comparing the cumulative flow at the top of the flow-logged interval (ΣQ_i) with the discharged flow rate (Q_p) from the hole according to the surface flow meter. One or more inflow zones are most likely to exist above the flow-logged interval if the latter flow rate is significantly higher than the cumulative flow rate.

The transmissivity (T) of the entire borehole is calculated from the analysis of the pump test during flow logging. The cumulative transmissivity at the top of the flow-logged interval (ΣT_i) is then calculated according to the SKB document "Methodology for flow logging" (SKB MD 322.009, Metodbeskrivning för flödesloggning) (SKB internal controlling documents) with the assumption of a zero natural flow in the borehole.

 $\Sigma T_{i} = T \cdot \Sigma Q_{i} / Q_{p}$ (5-1)

Flow anomalies above the flow-logged interval will lead to $\Sigma Q_i < Q_p$. In this case, the order of magnitude of the sum of these anomalies is estimated from equation (5-1).

The transmissivity of an individual flow anomaly in the flow logged interval (T_i) is calculated from the measured inflow rate (Q_i) of the anomaly and the calculated transmissivity of the entire borehole (T) according to the SKB document "Methodology for flow logging" (SKB MD 322.009, Metodbeskrivning för flödesloggning) (SKB internal controlling documents):

$$T_i = T \cdot Q_i / Q_p \tag{5-2}$$

The lower limit of transmissivity (Tl-measl) in the flow logging interval is estimated similar to equation (5-1):

$$T_{\text{Fmeasl-L}} = T \cdot Q_{\text{Fmeasl-L}} / Q_{\text{p}}$$
(5-3)

In a borehole with a diameter of 140 mm, the lower measuring limit for the flow rate is: $Q_{\text{Fmeasl-L}} = 3 \text{ l/min}$ (see Table 4-1) whereas Q_p is the actual flow rate during flow logging measured with the surface flow meter.

The flow logging test data are summarized in Appendix 5.

6 Results

In the following, results of all tests are presented and analysed. The results are given as general comments to test performance, the identified flow regimes and calculated parameters and finally the parameters which are considered as most representative are chosen and justification is given. All results are also summarised in Tables 7-1, 7-2 and 7-3 of the Synthesis chapter and in the test summary sheets (Appendix 3).

6.1 Nomenclature and symbols

The nomenclature and symbols used during evaluation and for presentation of the results of the pump tests and flow logging are according to the SKB documents "Instruction for analysis of single-hole injection and pump tests" (SKB MD 320.004, Instruktion för analysis av injections- och enhålspumptester), "Instruction for analysis of interference tests" (SKB MD 330.003, Metodbeskrivning för Interferenstester) and "Methodology description for flow logging" (SKB MD 322.009, Metodbeskrivning för flödesloggning), respectively (SKB internal controlling documents). If additional symbols are used, they are explained in the report text.

6.2 Water sampling

At the beginning of the capacity tests and at the end of the pump phase of the pump tests, water samples were taken and submitted to the SKB Äspö laboratory for subsequent analysis. Bottles prepared with acid for sample stabilization during storage and transport as well as filters, were received from SKB prior to sampling. The water samples were stored in a fridge until delivery to SKB. All samples taken and submitted for analysis are listed in Table 6-1.

Borehole ID	Date	Time	Section (m)	Pumped volume (m³)	Sample ID	Remarks
HAV12	2004-06-30	18:35	11.34–157.80	0.33	7558	capacity test
	2004-07-02	21:24	11.34–157.80	36.9	7556	pump test
HAV14	2004-07-07	13:06	6.03–182.40	0.26	7553	capacity test
	2004-07-08	19:35	6.03–182.40	41.3	7559	pump test
HAV11	2004-07-12	13:38	6.03–220.50	0.43	7552	capacity test
	2004-07-13	18:17	6.03–220.50	41.9	7551	pump test
HSH04	2004-07-15	10:30	9.00–236.20	0.60	7554	capacity test
	2004-07-16	17:25	9.00–236.20	19.4	7555	pump test
HSH05	2004-07-17	13:39	6.20–200.20	0.32	7550	capacity test
	2004-07-18	17:18	6.20–200.20	2.3	7556	pump test
HAV13	2004-07-20	11:10	9.04–142.20	1.1	7549	capacity test
	2004-07-21	17:44	9.04–142.20	37.5	7557	pump test

Table 6-1. Data of water samples taken during pump tests.

6.3 Pump tests

In the following, the analysis results of the single borehole pump tests are represented. No corrections of measured data (e.g. for atmospheric pressure changes, tidal and other background effects) have been made by the analysis of data but a general air pressure correction has been performed. General test data and test summary sheets are presented in Appendix 3.

6.3.1 Borehole HAV12, first test

Comments to test

The test was composed of a constant rate pump test phase with a mean flow rate of 64 l/min, followed by a pressure recovery phase. The flow rate control during the CRw phase was good. The pumped flow rate decreased from 67.8 l/min at start of the CRw phase to 63.7 l/min at the end. The recovery phase (CRr) shows no problems and is adequate for quantitative analysis.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test the CRw and CRr phases show a valley of the derivative at middle times and a hump at the late time of the phase. For the analysis of the CRw and CRr phase a radial composite flow model was chosen. The interpretation of the derivative curves assumes a change in transmissivity and storativity depending on the distance to the borehole. The analysis is presented in Appendix 2-1.

Selected representative parameters

The recommended transmissivity of $2.8E-4 \text{ m}^2/\text{s}$ was derived from the analysis of the CRr phase (inner zone), which shows a good data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $1.0E-4 \text{ m}^2/\text{s}$ to $3.0E-4 \text{ m}^2/\text{s}$. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRr phase using straight line extrapolation in the Horner plot to a value of 217 kPa.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.3.2 Borehole HAV12, second test

Comments to test

The pump test in the borehole HAV12 was repeated while a malfunction of the data loggers in the observation boreholes during the first test was detected. The test was composed of a constant rate pump test phase with a mean flow rate of 64 l/min, followed by a pressure recovery phase. The flow rate control during the CRw phase was good. The pumped flow rate decreased from 67.7 l/min at start of the CRw phase to 63.5 l/min at the end. The recovery phase (CRr) shows no problems and is adequate for quantitative analysis.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test the CRw and CRr phases show a valley of the derivative at middle times and a hump at the late time of the phase. For the analysis of the CRw and CRr phase a radial composite flow model was chosen. The interpretation of the derivative curves assumes a change in transmissivity and storativity depending on the distance to the borehole. The analysis is presented in Appendix 2-1.

Selected representative parameters

The recommended transmissivity of 8.0E-4 m²/s was derived from the analysis of the CRr phase (inner zone), which shows the best data and derivative quality. The confidence range for the borehole transmissivity is estimated to be 1.0E-4 m²/s to 1.0E-3 m²/s. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRr phase using straight line extrapolation in the Horner plot to a value of 221 kPa.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.3.3 Borehole HAV14

Comments to test

The pump test in the borehole HAV14 was composed of a constant rate pump test phase with a mean flow rate of 64.4 l/min, followed by a pressure recovery phase. The flow rate control during the CRw phase was good. The pumped flow rate decreased from 66.9 l/min at start of the CRw phase to 63.4 l/min at the end. The recovery phase (CRr) shows no problems and is adequate for quantitative analysis.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test the CRw shows a slightly dropping derivative. The CRr phase shows a slightly increasing derivative in the middle part of the phase and a sharp valley at the end of the phase. This last part of the CRr derivative is most likely influenced by some background effects – the data curves of observation wells HAV07 and HAV08 show a background effect at the same time range. Therefore this late part of the CRr derivative was not considered in the evaluation. For the analysis of the CRw and CRr phase a radial composite flow model was chosen. The interpretation of the derivative curves assumes a slight change in transmissivity and storativity depending on the distance to the borehole. The analysis is presented in Appendix 2-2.

Selected representative parameters

The recommended transmissivity of $1.6E-4 \text{ m}^2/\text{s}$ was derived from the analysis of the CRr phase (inner zone), which shows a good data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $1.0E-4 \text{ m}^2/\text{s}$ to $3.0E-4 \text{ m}^2/\text{s}$. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRr phase using straight line extrapolation in the Horner plot to a value of 208 kPa.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.3.4 Borehole HAV11

Comments to test

The pump test in the borehole HAV11 was composed of a constant rate pump test phase with a mean flow rate of 71.4 l/min, followed by a pressure recovery phase. The flow rate control during the CRw phase was good. The pumped flow rate decreased from 72.0 l/min at start of the CRw phase to 71.2 l/min at the end. The recovery phase (CRr) shows no problems and is adequate for quantitative analysis.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test the CRw and CRr phases show an increasing derivative to the end of the test phases. For the analysis of the CRw and CRr phase a radial composite flow model was chosen. The interpretation of the derivative curves assumes a change in transmissivity and slight change in storativity depending on the distance to the borehole. The analysis is presented in Appendix 2-3.

Selected representative parameters

The recommended transmissivity of $7.2E-4 \text{ m}^2/\text{s}$ was derived from the analysis of the CRw phase (inner zone), which shows the best data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $8.0E-5 \text{ m}^2/\text{s}$ to $1.0E-3 \text{ m}^2/\text{s}$. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRr phase using straight line extrapolation in the Horner plot to a value of 248 kPa.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.3.5 Borehole HSH04

Comments to test

The pump test in the borehole HSH04 was composed of a pump test phase with a mean flow rate of 34.9 l/min, followed by a pressure recovery phase. The flow rate has to be readjusted 38 min after start of pumping. An uncontrolled change in the pump rate happened during flow logging when the flow logger got slightly stuck in the borehole and subsequent rescue operations. Control during the CRw phase was poor. The pumped flow rate started with 43.6 l/min, was readjusted 38 min after start of pumping to 34.5 l/min and changed uncontrolled to 33.7 l/min approximately 5 h and 20 min after start of pumping. At the end of the pump phase, the rate was at 33.6 l/min. The recovery phase (CRr) shows no problems and is adequate for quantitative analysis.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test the CRw phase was not analysed according to changes in the flow rate. The CRr phase shows a flat derivative at the late test phase. For

the analysis of the CRr phase a radial homogenous infinite acting flow model was chosen. The analysis is presented in Appendix 2-4.

Selected representative parameters

The recommended transmissivity of $9.6E-4 \text{ m}^2/\text{s}$ was derived from the analysis of the CRr phase, which shows the best data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $6.0E-4 \text{ m}^2/\text{s}$ to $2.0E-3 \text{ m}^2/\text{s}$. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRr phase using straight line extrapolation in the Horner plot to a value of 242 kPa. The calculated skin of 83 is very high. This skin may be related to e.g. turbulent flow in fractures entering the borehole.

The analysis of the CRr phase shows good quality. No further analysis is recommended.

6.3.6 Borehole HSH05

Comments to test

The pump test in the borehole HSH05 was composed of a pump test phase with a mean flow rate of 4.2 l/min, followed by a pressure recovery phase. The flow rate was slightly readjusted to keep the rate stabile for the whole pump phase. Control during the CRw phase was good. The pumped flow rate started with 4.2 l/min, was readjusted 1 min after start of pumping to 4.2 l/min and again readjusted after 4 h and 9 min after start of pumping to 4.1 l/min. At the end of the pump phase, the rate was at 4.1 l/min. The recovery phase (CRr) shows no problems and is adequate for quantitative analysis.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. The CRw phase shows a flat derivative at the late test phase with a decreasing derivative at the very late end. In case of the present test the CRw phase was analysed using a radial homogenous infinite acting flow model. For the analysis of the CRr phase a radial composite flow model was chosen. The analysis is presented in Appendix 2-5.

Selected representative parameters

The recommended transmissivity of 5.2E-6 m²/s was derived from the analysis of the CRr phase (inner zone), which shows a good data and derivative quality. The confidence range for the borehole transmissivity is estimated to be 4.0E-6 m²/s to 6.0E-4 m²/s. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRr phase using straight line extrapolation in the Horner plot to a value of 324 kPa.

The analysis of the CRw and CRr phases shows inconsistencies in the derivative evaluation. The data curves of the pump and recovery phases are of very different shape and together with the derivative decrease at the very late end of the pump phase there is an indication of some change of transmissivity during pumping. Probably some fractures were washed out from drill mud by pumping and/or the transmissivity increases by around two decades at a larger distance from the borehole. Therefore, the inner zone transmissivity of the recovery phase was chosen as recommended transmissivity representing the formation in the near vicinity of the borehole. No further analysis is recommended.

6.3.7 Borehole HAV13

Comments to test

The pump test in the borehole HAV13 was composed of a constant rate pump test phase with a mean flow rate of 70.1 l/min, followed by a pressure recovery phase. The flow rate control during the CRw phase was good. The pumped flow rate decreased from 70.3 l/min at start of the CRw phase to 69.1 l/min at the end. The recovery phase (CRr) shows no problems and is adequate for quantitative analysis.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. In case of the present test the CRw and CRr phases show a flat derivative at middle times and a hump at the late time of the phases. For the analysis of the CRw and CRr phase a radial composite flow model was chosen. The interpretation of the derivative curves assumes a change in transmissivity and storativity depending on the distance to the borehole. The analysis is presented in Appendix 2-6.

Selected representative parameters

The recommended transmissivity of $2.2E-4 \text{ m}^2/\text{s}$ was derived from the analysis of the CRw phase (inner zone), which shows the best data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $1.0E-4 \text{ m}^2/\text{s}$ to $3.0E-4 \text{ m}^2/\text{s}$. The flow dimension displayed during the test is 2. The static pressure measured at transducer depth, was derived from the CRr phase using straight line extrapolation in the Horner plot to a value of 198 kPa.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.4 Flow logging

Flow logging diagrams including the measured flow rates along the borehole during flow logging in combination with the electric conductivity (EC) and the temperature (Te) of the borehole fluid is shown in Appendix 4. General test data for the flow logging in the boreholes HAV12, HAV14, HAV11, HSH04, HSH05 and HAV13 are presented in Appendix 5. All flow logging was performed during the pump tests in the open boreholes.

The nomenclature used for the flow logging test evaluation is according to the SKB document "Method description for flow logging" (SKB MD 322.009, Metodbeskrivning för flödesloggning) (SKB internal controlling documents). The measured inflow (Q_i) at the detected flow anomalies together with the percentages of the total flow rate at the surface are presented in subsequent tables at logging results. The cumulative transmissivity (ΣT_i) at the top of the flow-logged borehole section was calculated according to equation (5-1) and the individual transmissivity of single flow anomalies (T_i) according to equation (5-2). The specific flow (Q_i/s_{FL}) of single anomalies was used for an interpretation of the transmissivity of these anomalies.
6.4.1 Borehole HAV12

Comments to test

The flow logging in HAV12 was performed from 156 m below TOC upward. There was no flow logging from 156 m to the bottom of the hole at 157.8 m to avoid lowering the flow logger in drill mud at the bottom of the hole. The first flow anomaly was detected at 151 m. The step length between flow measurements in the borehole was maximally 2 m. When anomalies were detected, the length between measurements was reduced to 0.5 m. The flow logging was performed between 156 m and 30 m below TOC.

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump test during flow logging to $T = 2.82 \text{ E}-4 \text{ m}^2/\text{s}$.

HAV12		ΣQ _i = 1.14E-3 (m³/s)	Q _p = 1.07E-3 (m³/s)	ΣT _i = 2.82E-4 (m²/s)	s _{FL} = 7.88 m	Remarks
Anomaly depth (m from TOC)	Anomaly length (m)	Q _i (m³/s)	Q _i /Q _p (%)	T _i (m²/s)	Q _i /s _{FL} (m²/s)	
152-151	1	4.78E-4	44.8	1.19E-4	6.07E-5	
146-142.5	3.5	3.57E-4	33.4	8.85E-5	4.53E-5	
136-134.5	1.5	1.35E-4	12.7	3.35E-5	1.71E-5	
36-32.5	3.5	1.67E-4	15.6	4.13E-5	2.12E-5	
Total		1.14E-3	106.5	2.82E-4	1.44E-4	
Difference		Qp-ΣQ _i = -7E-5	6.5	T- ΣΤ _i = 0		Inconsistency in flow rates Q_p and ΣQ_i

Table 6-2. Analyses results; flow logging HAV12.

 ΣQ_i = cumulative flow at the top of the logged section, Q_p = pumped flow rate at surface flowmeter, s_{FL} = drawdown during pump test.

The total flow of the logged interval from 156 m to 30 m below TOC (ΣQ_i) is slightly above the measured flow rate of the total flow at the surface (Q_p). This indicates that there is no additional inflow to the borehole between the groundwater level at 11.34 m below TOC and the top of the logged section. The major inflow to the borehole was measured near the bottom of the hole in three separate sections between 152 m and 134.5 m depth, covering approximately 90% of the total flow. One further inflow was measured in shallow depths of 36 m to 32.5 m below TOC.

Appendix 4-1 shows the logging diagrams. A decrease in electric conductivity and temperature is related to every of the detected inflow zones. A further decrease in electric conductivity and temperature was observed at the section from 44 m to 42 m below TOC, but no flow anomaly was measured at this depth. Appendix 4-1 shows the calculated cumulative transmissivity (ΣT_i) along the borehole length. Since the detected flow anomalies running over a specific interval of the borehole, the change in transmissivity is represented by a sloping line across this interval. The calculated lower limit of transmissivity and the total borehole transmissivity (T) are also shown in this appendix.

6.4.2 Borehole HAV14

Comments to test

The flow logging in HAV14 was performed from 180 m below TOC upward. There was no flow logging from 180 m to the bottom of the hole at 182.4 m to avoid lowering the flow logger in drill mud at the bottom of the hole. The first flow anomaly was detected at 167 m. The step length between flow measurements in the borehole was maximally 2 m. When anomalies were detected, the length between measurements was reduced to 0.5 m. The flow logging was performed between 180 m and 32 m below TOC.

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump test during flow logging to $T = 1.58 \text{ E}-4 \text{ m}^2/\text{s}$.

HAV12		ΣQ _i = 1.00E-3 (m³/s)	Q _p = 1.07E-3 (m³/s)	ΣΤ _i = 1.48E-4 (m²/s)	s _{FL} = 6.47 m	Remarks
Anomaly depth (m from TOC)	Anomaly length (m)	Q _i (m³/s)	Q _i / Q _p (%)	T _i (m²/s)	Q _i /s _{FL} (m²/s)	
167-165	2	6.13E-4	57.2	9.03E-5	9.47E-5	
45-42	3	3.92E-4	36.5	5.77E-5	6.043E-5	
Total		1.00E-3	93.7	1.58E-4	1.5544E-4	
Difference		Qp-ΣQ _i = 7.0E-5	6.3	T- ΣT _i = 1.0E-5		Further inflow at 32-12.85 m?

Table 6-3 Analyses results; flow logging HAV14.

 ΣQ_i = cumulative flow at the top of the logged section, Q_p = pumped flow rate at surface flowmeter,

s_{FL} = drawdown during pump test.

The total flow of the logged interval from 180 m to 32 m below TOC (ΣQ_i) is slightly below the measured flow rate of the total flow at the surface (Q_p). This indicates one or several additional inflows to the borehole between the groundwater level at 12.85 m below TOC and the top of the logged section. The major inflow to the borehole was measured near the bottom of the hole between 167 m and 165 m depth, covering approximately 57% of the total flow. One further inflow was measured in shallow depths of 45 m to 42 m below TOC, covering further approximately 36% of the total inflow.

Appendix 4-2 shows the logging diagrams. The electric conductivity (29.7–32.6 mS/m) is in general low compared with the other tested boreholes. At the inflow at 167–165 m depth, a slight increase in electric conductivity was observed followed by a general increasing trend along the borehole upwards. At the upper inflow (45–42 m), a sharp drop of electric conductivity from 32.5 mS/m to 31.4 mS/m was observed, an indication of some sweetwater inflow to the borehole at this shallow depth. Further up the electric conductivity increases slightly. The temperature decreases slightly from bottom to top of the borehole with additional decreasing trends at the two inflow zones. Appendix 4-2 shows the calculated cumulative transmissivity (ΣT_i) along the borehole length. Since the detected flow anomalies running over a specific interval of the borehole, the change in transmissivity is represented by a sloping line across this interval. The calculated lower limit of transmissivity and the total borehole transmissivity (T) are also shown in this appendix.

6.4.3 Borehole HAV11

Comments to test

The flow logging in HAV11 was performed from 122 m below TOC upward. There was no flow logging from 122 m to the bottom of the hole at 220.5 m because of problems checking the borehole with a dummy previous to the flow logging at those depths. A major inflow was detected when starting flow logging at 122 m. The step length between flow measurements in the borehole was maximally 2 m. When anomalies were detected, the length between measurements was reduced to 0.5 m. The flow logging was performed between 122 m and 26 m below TOC.

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump test during flow logging to $T = 7.20 \text{ E}-4 \text{ m}^2/\text{s}.$

HAV12		ΣQ _i = 1.19E-3 (m³/s)	Q _p = 1.19E-3 (m³/s)	ΣT _i = 7.21E-4 (m²/s)	s _{FL} = 4.10 m	Remarks
Anomaly depth (m from TOC)	Anomaly length (m)	Q _i (m³/s)	Q _i / Q _p (%)	T _i (m²/s)	Q _i /s _{FL} (m²/s)	
220.5-122	98.5	1.10E-3	92.3	6.65E-4	2.68E-4	
61.5-57.5	4	9.17E-5	7.7	5.55E-5	2.24E-5	
Total		1.19E-3	100	7.20E-4	2.90E-4	
Difference		$Qp-\Sigma Q_i = 0.0$	0.0	T- ΣT _i = -1E-6		

Table 6-4. Analyses results; flow logging HAV11.

 ΣQ_i = cumulative flow at the top of the logged section, Q_p = pumped flow rate at surface flowmeter, s_{FL} = drawdown during pump test.

The total flow of the logged interval from 122 m to 26 below TOC (ΣQ_i) matches the measured flow rate of the total flow at the surface (Q_p). This indicates no further additional inflows to the borehole between the bottom of casing at 6.03 m below TOC and the top of the logged section. The major inflow to the borehole was measured between the bottom of the hole and the deepest flow logging at 122 m, covering approximately 92% of the total flow. One further inflow was measured in depths of 61.5 m to 57.5 m below TOC, covering further approximately 8% of the total inflow.

Appendix 4-3 shows the logging diagrams. The electric conductivity shows water with high salinity and an increasing trend from the bottom of the borehole upwards. At the inflow at 61.5–57.5 m depth, a sharp drop in electric conductivity was observed followed by a stabilisation along the borehole upwards. A further slight drop in electric conductivity was observed at a depth between 44–42 m from TOC. The temperature decreases slightly from bottom to top of the borehole with an additional drop at the inflow zones at 61.5–57.5 m depth. Appendix 4-3 shows the calculated cumulative transmissivity (ΣT_i) along the borehole length. Since the detected flow anomalies running over a specific interval of the borehole, the change in transmissivity is represented by a sloping line across this interval. The calculated lower limit of transmissivity and the total borehole transmissivity (T) are also shown in this appendix.

6.4.4 Borehole HSH04

Comments to test

The flow logging in HSH04 was performed from 202 m below TOC upward. There was no flow logging from 202 m to the bottom of the hole at 236.2 m because of problems checking the borehole with a dummy previous to the flow logging at those depths and the length of the measuring cable. A minor inflow was detected at 29–28 m. The step length between flow measurements in the borehole was maximally 2 m. When anomalies were detected, the length between measurements was reduced to 0.5 m. The flow logging was performed between 202 m and 25 m below TOC.

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump test during flow logging to $T = 9.60 \text{ E}-4 \text{ m}^2/\text{s}$.

HAV12		ΣQ _i = 4.35E-5 (m³/s)	Q _p = 5.82E-4 (m³/s)	ΣT _i = 7.20E-5 (m²/s)	s _{FL} = 8.41 m	Remarks
Anomaly depth (m from TOC)	Anomaly length (m)	Q _i (m³/s)	Q _i / Q _p (%)	T _i (m²/s)	Q _i /s _{FL} (m²/s)	
29-28	1	4.35E-5	7.5	7.20E-5	5.17E-6	
Total		4.35E-5	7.5	7.20E-5	5.17E-6	
Difference		Qp-ΣQ _i = 5.39E-4	92.5	T- ΣT _i = 8.9E-4		

Table 6-5. Analyses results; flow logging HSH04.

 ΣQ_i = cumulative flow at the top of the logged section, Q_p = pumped flow rate at surface flowmeter, s_{FL} = drawdown during pump test.

The total flow of the logged interval from 202 m to 25 below TOC (ΣQ_i) was much below of the measured flow rate of the total flow at the surface (Q_p). This indicates further additional inflows to the borehole between the bottom of casing at 9.00 m below TOC and the top of the logged section. The minor inflow to the borehole at 29–28 m covers only approximately 7.5% of the total flow.

Appendix 4-4 shows the logging diagrams. The electric conductivity shows water with high salinity and a decreasing trend from the bottom of the borehole upwards to 132 m depth. Above of a depth of 132 m there is a slightly increasing electric conductivity. A sharp drop of electric conductivity was observed from 54–50 m, with an increase upwards of this depth to the top of the logged interval, including a sharp up rise from 40–38 m depth. The temperature decreases slightly from bottom of the borehole upwards to 134 m depth. Above of a depth of 134 m there is a slightly increasing of the temperature until the top of the logged interval, including a sharp up rise from 40–38 m depth. Above of a depth of 134 m there is a slightly increasing of the temperature until the top of the logged interval up to 12.5°C. This remarkable up rise of temperature near the surface may be influenced by the neighboured cooling water outlet of the three power plants. Appendix 4-4 shows the calculated cumulative transmissivity (ΣT_i) along the borehole length. Since the detected flow anomalies running over a specific interval of the borehole, the change in transmissivity is represented by a sloping line across this interval. The calculated lower limit of transmissivity and the total borehole transmissivity (T) are also shown in this appendix.

6.4.5 Borehole HSH05

Comments to test

The flow logging in HSH05 was performed from 198 m below TOC upward. There was no flow logging from 198 m to the bottom of the hole at 200.2 m to avoid lowering the flow logger in drill mud at the bottom of the hole. A minor inflow was detected at 64–62 m which was actually below of the measurement limit but nevertheless indicated some inflow to the borehole. The step length between flow measurements in the borehole was maximally 2 m. When anomalies were detected, the length between measurements was reduced to 0.5 m. The flow logging was performed between 198 m and 36 m below TOC.

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump test during flow logging to $T = 5.22 \text{ E}-6 \text{ m}^2/\text{s}.$

HAV12		ΣQ _i = 1.67E-5 (m³/s)	Q _p = 5.26E-5 (m³/s)	ΣT _i = 1.25E-6 (m²/s)	s _{FL} = 13.37 m	Remarks
Anomaly depth (m from TOC)	Anomaly length (m)	Q _i (m³/s)	Q _i / Q _p (%)	T _i (m²/s)	Q₀/s _{FL} (m²/s)	
64-62	1	1.67E-5	31.7	1.25E-6	1.25E-6	
Total		1.67E-5	31.7	5.22E-6	1.25E-6	
Difference		Qp-ΣQ _i = 5.26E-5	68.3	T- ΣT _i = 3.97E-6		Further inflow at 36-9 m ?

Table 6-6. Analyses results; flow logging HSH04.

 ΣQ_i = cumulative flow at the top of the logged section, Q_p = pumped flow rate at surface flowmeter, s_{FL} = drawdown during pump test.

The total flow of the logged interval from 198 m to 6.2 m below TOC (ΣQ_i) was much below of the measured flow rate of the total flow at the surface (Q_p) by a low flow rate at all. This indicates further additional inflows to the borehole between the bottom of casing at 6.20 m below TOC and the top of the logged section. The inflow to the borehole at 64–62 m covers only approximately 31.7% of the total flow.

Appendix 4-5 shows the logging diagrams. The electric conductivity shows water with high salinity and a decreasing trend from the bottom of the borehole upwards. At the depth interval from 140–110 m, two major drops with following increase of the electric conductivity were observed. From 110 m to 64 m a slightly decrease of the electric conductivity was detected, followed by a moderate decrease from 64 m upwards. The temperature decreases slightly from bottom of the borehole upwards to the top of the logged interval with a moderate decrease from 140 m to 130 m and a stabilization from 62 m upwards. Appendix 4-5 shows the calculated cumulative transmissivity (ΣT_i) along the borehole length. Since the detected flow anomalies running over a specific interval of the borehole, the change in transmissivity is represented by a sloping line across this interval. The calculated lower limit of transmissivity and the total borehole transmissivity (T) are also shown in this appendix.

6.4.6 Borehole HAV13

Comments to test

The flow logging in HAV13 was not performed due to major problems by running in with the dummy prior to flow logging. The flow log was placed instead below the pump at a depth of 22 m below TOC, where one flow logging measurement was performed. At this depth, the measured flow matched the total flow measured with the surface flow meter.

Logging results

The transmissivity of the entire borehole was derived from the transient calculation of the pump test during flow logging to $T = 2.16 \text{ E}-4 \text{ m}^2/\text{s}$.

HAV12		ΣQ _i = 1.20E-3 (m³/s)	Q _p = 1.17E-3 (m³/s)	ΣT _i = 1.88E-4 (m²/s)	s _{FL} = 4.81 m	Remarks
Anomaly depth (m from TOC)	Anomaly length (m)	Q _i (m³/s)	Q i/ Q p (%)	T _i (m²/s)	Q _i /s _{FL} (m²/s)	
142.2-22	120.2	1.20E-3	102.6	2.16E-4	2.49E-4	
Total		1.20E-3	102.6	2.16E-4	2.49E-4	
Difference		Qp-ΣQ _i = 5.26E-5	68.3	T- ΣΤ _i = 0		

Table 6-7. Analyses results; flow logging HAV13.

 ΣQ_i = cumulative flow at the top of the logged section, Q_p = pumped flow rate at surface flowmeter,

 s_{FL} = drawdown during pump test.

The total flow of the interval below of the pump from 142.2 m to 22 m below TOC (ΣQ_i) was matching the measured flow rate of the total flow at the surface (Q_p). This indicates no further additional inflows to the borehole between the bottom of casing at 9.04 m below TOC and the top of the logged section. The inflow to the borehole at 142.2–22 m covers approximately 102.6% of the total flow; the slightly higher value of the flow rate from the flow log against the total flow of the surface flow meter may be related to fluctuations of the flow rate during the pump test.

Appendix 4-6 shows the logging diagrams. The electric conductivity shows water with high salinity. The temperature was in the typical range of the comparable temperatures measured during the pump tests. Appendix 4-6 shows the calculated cumulative transmissivity (ΣT_i) along the borehole length. Since the detected flow anomalies running over a specific interval of the borehole, the change in transmissivity is represented by a sloping line across this interval. The calculated lower limit of transmissivity and the total borehole transmissivity (T) are also shown in this appendix.

6.5 Interference tests

During the performed pump tests, a selected number of observation boreholes were monitored by installation of pressure transducers. Monitoring data from further observation boreholes were obtained from SKB (see Table 3-1) and recalculated to Swedish summer time. The following table shows, where a clear response of the water level during the performed pump tests could be observed.

Pumped Borehole	Point of application (m btoc)	Monitored boreholes	Packer position (secup- seclow)	Point of application (m btoc)	Radial distance (m)	Observed response (max kPa)
HAV12	157	HAV02, HAV05, HAV13, HAV14, KAV01, KAV03	no packer no packer 16–142.2 17.2–182.4 no packer no packer	midhole midhole 121 182 midhole midhole	488 692 535 1,120 651 372	 0.7
HAV14	167	HAV05, HAV07, HAV08, HAV13, KAV04A	no packer no packer no packer 16–142.2 18–1,004	midhole midhole midhole 121 secmid	440 102 135 620 492	- 6.2 3.2 -
HAV11	220	KAV01, KAV04A, KSH03A	no packer 20–1,004 no packer	midhole secmid midhole	751 734 785	- - -
HSH04	125	HSH01, HSH06	no packer 18–203.2	midhole midhole	329 316	
HSH05	-	Single hole test	-	-	-	-
HAV13	121	HAV02, HAV05, HAV07, HAV08, HAV12, HAV14, KAV01, KAV03	no packer no packer no packer 18–157.8 18–182.4 no packer no packer	midhole midhole midhole 158 182 midhole midhole	163 253 630 677 535 629 654 745	8.8 - - 0.9 - -

Table 6-8. Distances and observed interference during pump tests.

No further response could be observed in any other of the observation boreholes. Some of the observation boreholes showed background effects with regular time intervals. Further background effects like general trends and/or changes in water level which could not be matched with the performed pump tests were observed as well.

Table 6-9. Response matrix for the interference tests.

Interferenstester, Appendix 4) where applicable responses were observed (SKB internal controlling documents). The response matrix gives an overview of the monitored observation boreholes and a classification of the observed responses. The Index 1 (for recovery data) and Index 2 (drawdown data) were calculated according to (SKB MD 330.003) (Metodbeskrivning for

Where a response at observation wells was observed, these data were evaluated. The distance between the pumped and observed boreholes was calculated as the distance between the positions of dominating flow anomalies identified during drilling and flow logging respectively to the midpoint of the uncased borehole where no distinctive flow anomalies were detected. Radial distance data were provided by SKB and included in Table 6-8 above.

The boreholes where responses were observed are all related to a fractured zone running in a general northeast-southwest direction at the northern edge of the Ävrö Island. Selected representative parameters for the observation boreholes are presented in Test Summary Sheets in Appendix 3.

Selected diagrams of the evaluated observation wells are presented in Appendix 2-1 to Appendix 2-6. For all five evaluated observation wells, the drawdown and recovery periods were evaluated. In general a very good consistency of both of the periods was observed by evaluation.

According to the Indices 1 and 2, shown in the response matrix (Table 6-9), there is a medium to bad normalised response time and a low, respectively no response evaluated for the five monitored boreholes where a response was observed at all. At all other monitored boreholes, no response related to the pump tests was observed. Even where a hydraulic connection between pumped and monitored boreholes was observed, this connectivity is of poor quality.

In the following, observed and analysed responses in the monitoring boreholes are discussed more in detail. The monitoring data where no response was observed are documented in Appendix 2 related to the relevant pumped boreholes.

6.5.1 Borehole HAV12 pumped, HAV14 observed

Comments to test

The test was composed of a constant rate pump test phase in HAV12 with a mean flow rate of 64 l/min, followed by a pressure recovery phase. In HAV14, a maximum drawdown response of 0.7 kPa was observed which is rated by Index 2 as "no response" because of a response < 1 kPa. Index 1 was not calculated because of the low response.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. For the analysis of the CRw and CRr phase a homogeneous radial flow model was chosen. The analysis is presented in Appendix 2-1 and Appendix 3-1.

Selected representative parameters

The recommended transmissivity of $8.75E-4 \text{ m}^2/\text{s}$ was derived from the analysis of the CRr phase (inner zone), which shows a good data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $6.0E-4 \text{ m}^2/\text{s}$ to $3.0E-3 \text{ m}^2/\text{s}$. The flow dimension displayed during the test is 2. According to the low response in combination with background effects, no static pressure could be derived from straight line extrapolation in the Horner plot.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.5.2 Borehole HAV14 pumped, HAV08 observed

Comments to test

The test was composed of a constant rate pump test phase in HAV14 with a mean flow rate of 64 l/min, followed by a pressure recovery phase. In HAV08, a maximum drawdown response of 3.2 kPa was observed which is rated by Index 1 with a "bad response time" and with Index 2 as "low response".

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. For the analysis of the CRw phase a composite and for the CRr phase a homogeneous radial flow model was chosen. The analysis is presented in Appendix 2-2 and Appendix 3-2.

Selected representative parameters

The recommended transmissivity of $2.32E-4 \text{ m}^2/\text{s}$ was derived from the analysis of the CRr phase (inner zone), which shows a good data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $5.0E-5 \text{ m}^2/\text{s}$ to $3.0E-3 \text{ m}^2/\text{s}$. The flow dimension displayed during the test is 2. According to the low response in combination with background effects, no static pressure was derived from straight line extrapolation in the Horner plot.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.5.3 Borehole HAV14 pumped, HAV07 observed

Comments to test

The test was composed of a constant rate pump test phase in HAV14 with a mean flow rate of 64 l/min, followed by a pressure recovery phase. In HAV07, a maximum drawdown response of 6.2 kPa was observed which is rated by Index 1 with a "medium response time" and with Index 2 as "low response".

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. For the analysis of the CRw and CRr phase a radial composite flow model was chosen. The analysis is presented in Appendix 2-2 and Appendix 3-2.

Selected representative parameters

The recommended transmissivity of $2.2E-4 \text{ m}^2/\text{s}$ was derived from the analysis of the CRr phase (inner zone), which shows a good data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $1.0E-4 \text{ m}^2/\text{s}$ to $1.0E-3 \text{ m}^2/\text{s}$. The flow

dimension displayed during the test is 2. According to the low response in combination with background effects, no static pressure was derived from straight line extrapolation in the Horner plot.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.5.4 Borehole HAV13 pumped, HAV12 observed

Comments to test

The test was composed of a constant rate pump test phase in HAV13 with a mean flow rate of 70 l/min, followed by a pressure recovery phase. In HAV12, a maximum drawdown response of 0.9 kPa was observed which is rated by Index 2 as "no response" because of a response < 1 kPa. Index 1 was not calculated because of the low response.

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. For the analysis of the CRw and CRr phase a homogeneous radial flow model was chosen. The analysis is presented in Appendix 2-6 and Appendix 3-6.

Selected representative parameters

The recommended transmissivity of 7.59E-4 m²/s was derived from the analysis of the CRr phase, which shows a good data and derivative quality. The confidence range for the borehole transmissivity is estimated to be 5.0E-4 m²/s to 5.0E-3 m²/s. The flow dimension displayed during the test is 2. According to the low response in combination with background effects, no static pressure was derived from straight line extrapolation in the Horner plot.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

6.5.5 Borehole HAV13 pumped, HAV02 observed

Comments to test

The test was composed of a constant rate pump test phase in HAV13 with a mean flow rate of 70 l/min, followed by a pressure recovery phase. In HAV02, a maximum drawdown response of 8.8 kPa was observed which is rated by Index 1 with a "bad response time" and with Index 2 as "low response".

Flow regime and calculated parameters

The flow dimension is interpreted from the slope of the semi-log derivative plotted in log-log coordinates. For the analysis of the CRw and CRr phase a homogeneous radial flow model was chosen. The analysis is presented in Appendix 2-6 and Appendix 3-6.

Selected representative parameters

The recommended transmissivity of $5.37E-5 \text{ m}^2/\text{s}$ was derived from the analysis of the CRw phase, which shows a good data and derivative quality. The confidence range for the borehole transmissivity is estimated to be $4.0E-5 \text{ m}^2/\text{s}$ to $1.0E-4 \text{ m}^2/\text{s}$. The flow dimension displayed during the test is 2. According to the low response in combination with background effects, no static pressure was derived from straight line extrapolation in the Horner plot.

The analysis of the CRw and CRr phases shows good consistency. No further analysis is recommended.

7 Synthesis

The synthesis chapter summarizes the basic test parameters and analysis results. In addition, the correlation between steady state and transient transmissivities as well as between the matched and the theoretical wellbore storage (WBS) coefficient are presented and discussed.

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Table

Borehole ID	Borehole secup (m)	Borehole seclow (m)	Date and time for test, start YYYYMMDD hh:mm	Date and time for test, stop YYYYMMDD hh:mm	Q _p (m**3/s)	Q _m (m**3/s)	tp (s)	t⊧ (s)	p₀ (kPa)	p _i (kPa)	p _e (kPa)	p⊧ (kPa)	Te _w (°C)	EC _w (mS/m)	Test ph Analys marked	ases measured ed test phases bold
HAV12	11.34	157.80	20040702 08:54	20040703 08:44	1.06E-03	1.07E-03	36180	39180	I	215.9	137.1	214.1	8.34	820.8	CRw	CRr
HAV12 repeat	11.34	157.80	20040704 08:24	20040705 08:43	1.06E-03	1.07E-03	36060	51540	I	218.4	137.3	215.9	8.36	817.7	CRw	cRr
HAV14	6.03	182.40	20040707 08:09	20040709 10:11	1.06E-03	1.07E-03	39000	45300	I	208.9	144.2	203.6	8.42	32.0	CRw	CRr
HAV11	6.03	220.50	20040711 08:24	20040714 09:06	1.19E-03	1.19E-03	38220	48840	I	246.7	205.5	242.7	8.79	1143	CRw	CRr
HSH04	00.6	236.20	20040715 08:11	20040717 08:35	5.60E-04	5.82E-04	36240	51600	I	240.2	156.1	242.1	12.49	878.0	NN#	CRr
HSH05	6.20	200.20	20040717 13:08	20040719 08:43	6.95E-05	6.93E-05	36600	51900	I	325.5	191.8	322.4	8.52	737.3	CRw	CRr
HAV13	9.04	142.20	20040720 08:03	20040722 13:31	1.15E-03	1.17E-03	36060	67500	I	197.2	149.1	194.9	8.66	833.7	CRw	CRr
#NV Not	analvsed															

not analysed. Constant rate pump (withdrawal) phase. Recovery phase following the constant rate pump phase. C R V

Interval p	osition		Stationary	flow	Transient	analysis													
			parameter	ស	Flow regiı	ne	Formation	ı parameter	õ									Static co	onditions
Borehole ID	up m btoc	low m btoc	Q/s m²/s	T _M m²/s	Perturb. Phase	Recovery Phase	T ₁ m²/s	T _{t2} m²/s	T _{s1} m²/s	T _{s2} m²/s	T _T m²/s	T _{⊤MIN} m²/s	T _{TMAX} m²/s	C m³/Pa	~ I	dt, min	dt² min	p* kPa	h _{wif} masl
HAV12	11.34	157.80	1.35E-04	1.71E-04	WBS22	WBS22	2.1E-04	2.6E-04	2.8E-04	1.8E-04	2.8E-04	1.0E-04	3.0E-04	1.98E-06	1.6	6	600	217	-0.24
HAV12 repeat	11.34	157.80	1.31E-04	1.66E-04	WBS22	WBS22	3.0E-04	1.7E-04	8.0E-04	1.1E-04	8.0E-04	1.0E-04	1.0E-03	1.99E-06	16.1	12	600	221	+0.17
HAV14	6.03	182.40	1.63E-04	2.10E-04	WBS22	WBS22	1.6E-04	2.1E-04	1.6E-04	1.4E-04	1.6E-04	1.0E-04	3.0E-04	1.59E-06	-2.79	12	240	208	-1.23
HAV11	6.03	220.50	2.89E-04	3.85E-04	WBS22	WBS22	7.2E-04	9.2E-05	9.5E-04	1.2E-04	7.2E-04	8.0E-05	1.0E-03	2.75E-06	1.02	9	600	248	+0.21
HSH04	9.00	236.20	6.65E-05	8.89E-05	NN#	WBS2	NN#	NN#	9.6E-04	NN#	9.6E-04	8.0E-04	1.0E-03	1.65E-06	83.3	36	480	242	+0.19
HSH05	6.20	200.20	5.20E-06	6.81E-06	WBS2	WBS22	4.2E-06	NN#	5.2E-06	5.2E-04	5.2E-06	4.0E-06	6.0E-04	2.28E-06	0	420	600	324	+0.12
HAV13	9.04	142.20	2.39E-04	2.99E-04	WBS22	WBS22	2.2E-04	1.8E-04	2.3E-04	2.2E-04	2.2E-04	1.0E-04	3.0E-04	1.58E-06	-4.39	2.4	300	198	-0.63
Notes																			
1 11 10	and T2 re :ase a two	efer to the 5 zones co	transmissiv omposite m	vity(s) deriv lodel was re	ed from the commende	e analysis wl ed both T1 a	hile using thund the provided t	he recomn given.	nended flov	w model. Ir	ר case a h	omogeneo	us flow mc	del was rec	ommeno	ded only	one T v	alue is re	sported,
Η	e recomm	lended tra	nsmissivity	TT typically	y refers to t	the T1 value	(inner zon	e transmis	sivity).										
2 Th	e paramet	ter p* den	oted the st	atic formatic	on pressure	؛ (measured	at transdu	cer depth)	and was d	¹ erived fron	n the HOR	NER plot	of the CRr	phase using	g straight	t line or t	type-cur	ve extrap	oolation.

- 2
- The flow regime description refers to the recommended model used in the transient analysis. WBS denotes wellbore storage and skin and is followed by a set of numbers describing the flow dimension used in the analysis (1 = linear flow, 2 = radial flow, 3 = spherical flow). If only one number is used (e.g. WBS2 or 2) a homogeneous flow model (1 composite zone) was used in the analysis, if two numbers are given (WBS22 or 22) a 2 zones composite model was used. ო
- Not analysed. NN#

Table 7-2. Results from analysis of constant rate pump tests.

Observati	on borehol	e	Pumped b	orehole	Transient Flow regin	analysis	Formation	naramotor	ų								U	static col	ditione
						2			0								,	סומוור הס	
Borehole	dn	low	Borehole	Distance	Perturb.	Recovery	T _{ri}	T_{t_2}	T_{s_1}	T_{s_2}	Ļ,	T _{TMIN}	T _{tmax}	S	ŝ	dt	dt ₂ p	*	J _{wif}
₽	m btoc	m btoc	₽	E	Phase	Phase	m²/s	m²/s	m²/s	m²/s	m²/s	m²/s	m²/s	I	I	min	min	кРа	nasl
HAV14	6.03	182.40	HAV12	1120	WBS2	WBS2	1.7E-03	NN#	8.8E-04	NN#	8.8E-04	6.0E-04	3.0E-03	1.3E-05	1.02				
HAV08	0.00	63.00	HAV14	135	WBS22	WBS2	7.0E-05	1.4E-03	2.3E-04	NN#	2.3E-04	5.0E-05	3.0E-03	5.8E-04	-0.88	I	1		1
HAV07	4.00	100.00	HAV14	102	WBS22	WBS22	2.2E-04	5.4E-04	3.3E-04	7.8E-04	2.2E-04	1.0E-04	1.0E-03	2.0E-04	-0.35	1	1		
HAV12	11.34	157.80	HAV13	535	WBS2	WBS2	7.6E-04	NN#	2.8E-03	NN#	7.6E-04	5.0E-04	5.0E-03	1.2E-04	-0.10	1	1		
HSH02	0.13	163.00	HAV13	163	WBS2	WBS2	7.8E-05	NN#	5.4E-05	NN#	5.4E-05	4.0E-05	1.0E-04	1.3E-04	-0.13		'		
Notes																			
1 in 1	and T2 re arse a two	fer to the zones co	transmissiv mposite mo	rity(s) deriv∉ odel was rev	∋d from the commende	analysis wł d both T1 a	nile using th nd T2 are (ne recomm given.	iended flov	v model. Ir	ר case a ho	omogeneo	us flow mo	del was re	commenc	ded only	one T va	alue is re	eported,
Th	e recomm	ended trar	1smissivity	T_{T} typically	refers to th	e T2 value i	(far field tra	ansmissivit	y).										
Ч Н С	1	0000 *0 50	oto ott pott							and bestine				aio: oooqo	teleitette te	tine of			

Table 7-3. Results from analysis of interference tests.

- The parameter p* denoted the static formation pressure (measured at transducer depth) and was derived from the HORNER plot of the CRr phase using straight line or type-curve extrapolation. 3 5
 - The flow regime description refers to the recommended model used in the transient analysis. WBS denotes wellbore storage and skin and is followed by a set of numbers describing the flow dimension used in the analysis (1 = linear flow, 2 = radial flow, 3 = spherical flow). If only one number is used (e.g. WBS2 or 2) a homogeneous flow model (1 composite zone) was used in the analysis, if two numbers are given (WBS22 or 22) a 2 zones composite model was used.

Not analysed. NN#

7.2 Correlation analysis

A correlation analysis was used with the aim of examining the consistency of results and deriving general conclusion regarding the testing and analysis methods used.

7.2.1 Comparison of steady state and transient analysis results

The steady state derived transmissivities (T_M and Q/s) were compared in a cross-plot with the recommended transmissivity values derived from the transient analysis (see following figure).

The correlation analysis shows that most of the steady state derived transmissivities differ by less than one order of magnitude from the transmissivities derived from the transient analysis. In the borehole of HSH04, where the difference is approximately one order of magnitude, the steady state calculation is considered as probably influenced by some turbulent flow (very high skin of 83) whereas the transient analysis shows that the transmissivities are much higher in larger distance to the borehole.



Figure 7-1. Correlation analysis of transmissivities at pumped boreholes derived by steady state and transient methods.

7.2.2 Comparison between the matched and theoretical wellbore storage coefficient

The wellbore storage coefficient describes the capacity of the test interval to store fluid as result to a unit pressure change in the interval. For a closed system (i.e. closed downhole valve) the theoretical value of the wellbore storage coefficient is given by the product between the interval volume and the test zone compressibility. The interval volume is calculated from the borehole radius and interval length. There are uncertainties concerning the interval volume calculation. Cavities or high transmissivity fractures intersecting the interval may enlarge the effective volume of the interval. The test zone compressibility is given by the sum of compressibilities of the individual components present in the interval (water, packer elements, other test tool components, and the borehole wall). A minimum value for the test zone compressibility is given by the water compressibility which is approx 5E-10 1/Pa. For the calculation of the theoretical wellbore storage coefficient a test zone compressibility of 7E-10 1/Pa was used. The matched wellbore storage coefficient is derived from the transient type curve analysis by matching the unit slope early times derivative plotted in log-log coordinates.

The following figure presents a cross-plot of the matched and theoretical wellbore storage coefficients.

It can be seen that the matched wellbore storage coefficients are less of one order of magnitude larger than the theoretical values and therefore showing a good consistency of the results.



Figure 7-2. Correlation analysis of theoretical and matched wellbore storage coefficients of pumped boreholes.

8 Conclusions

8.1 Transmissivity

Figure 7-1 presents a correlation analysis of transmissivities derived from steady state calculations and from the transient analysis. The method used for deriving the recommended transmissivity and its confidence range is described in Section 5.4.7.

Whenever possible, the transmissivities derived are representative for the "undisturbed formation" further away from the borehole. The borehole vicinity was typically described using a skin effect.

In one case (pump test in HSH05) the steady state analysis shows a much smaller transmissivity than the recommended transmissivity. However, the transient analysis derived a consistent transmissivity in the near vicinity of the borehole but a much larger transmissivity for the "undisturbed formation" at larger distance.

In one case (HSH04), the pump phase was not analysable due to changes in the flow volume. In this case, only the recovery period of the test was analysed.

The transmissivities derived from the transient analysis of the responses in observation boreholes are in consistency with the range of the recommended transmissivities from the pumped boreholes. The tested formation is typically characterized by transmissivities in the range from 1E-4 m²/s to 1E-3 m²/s. In the near vicinity of the boreholes and between a pumped and monitored borehole with small distance the derived transmissivities may show different ranges of transmissivities.

8.2 Flow regimes encountered

The flow models used in analysis were derived from the shape of the pressure derivative calculated with respect to log time and plotted in log-log coordinates.

In several cases the pressure derivative suggests a change of transmissivity with the distance from the borehole. In such cases a composite flow model was used in the analysis.

The flow dimension displayed by the test can be diagnosed from the slope of the pressure derivative. A slope of 0.5 indicates linear flow, a slope of 0 (horizontal derivative) indicates radial flow and a slope of -0.5 indicates spherical flow. The flow dimension diagnosis was commented for each of the tests. However, in all cases it was possible to achieve to acceptable analysis results (good match quality) by using radial flow geometry (flow dimension of 2).

8.3 Interference tests and hydraulic connectivity

During five of the six performed pump tests, an overall amount of 13 different boreholes were used for monitoring responses along specific lineaments. Only in five of the monitored boreholes, responses could be observed related to the pump tests.

The boreholes where responses were observed are all related to a lineament running in a general northeast-southwest direction at the northern edge of the Ävrö Island. The pumped boreholes HAV12, HAV13 and HAV14 are all connected to this lineament as well as the boreholes where a response could be observed (i.e. HAV02, HAV07, HAV08, HAV12 and HAV14).

The evaluation of the interference test data shows in general a poor hydraulic connectivity and a medium to bad normalised response time.

No further response at all other monitored boreholes (even when linked to other lineaments) could be observed.

9 References

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APPENDIX 1

File Description Table

Borehole: HAV12

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HYDROT	'ESTI	NG WITH	I HTHB		DRILLHOLE IDENTIFICATION NO).: HAV12		
TEST- AN	VD FII	EPROTO	DCOL		Testorder dated : 2004-06-29			
Teststa	ц Ц	Interval boun	idaries (m)		Name of Datafile			
Date	Time	Upper	Lower	Test type	Data file	Parameters	Comments	
02.07.2004	08:54	11.34	157.8	1B, 6, L-EC, L-Te	HAV12_11.34-157.80_040702_1_CRwr_r.xls	P, Q, EC, Te		
02.07.2004	08:54	11.34	157.8	1B, 6, L-EC, L-Te	HAV12_030_040624_Ref_Da00.DAT	C, R		
02.07.2004	08:54	11.34	157.8	1B, 6, L-EC, L-Te	HAV12_030_040629_FlowLo00_original.DAT	P, Q, EC, Te		
02.07.2004	08:54	11.34	157.8	1B, 6, L-EC, L-Te	HAV12_030_040702_FlowLo00_edited.DAT	P, Q, EC, Te		
02.07.2004	08:54	11.34	157.8	1B, 6, L-EC, L-Te	HAV12_030_040629_Spinne00.DAT	(P, Q) EC, Te, Sp	P, Q only at Spinn	ner data
02.07.2004	08:54	11.34	157.8	1B, 6, L-EC, L-Te	HAV12_030_040629_Spinner_evaluated.xls	(P, Q) EC, Te, Sp	P, Q only at Spinn	ier data
02.07.2004	08:54	11.34	157.8	1B, 6, L-EC, L-Te	HAV13_040702_obs.TXT	Ρ		
02.07.2004	08:54	11.34	157.8	1B, 6, L-EC, L-Te	HAV14_040702_obs.TXT	Р		
04.07.2004	08:24	11.34	157.8	1B	HAV12_11.34-157.80_040704_2_CRwr_r.xls	P, Q, EC, Te	test repeated	
04.07.2004	08:24	11.34	157.8	1B	HAV12_030_040629_FlowLo00_original.DAT	P, Q, EC, Te	test repeated	
04.07.2004	08:24	11.34	157.8	1B	HAV12_030_040704_FlowLo00_edited.DAT	P, Q, EC, Te	test repeated	
04.07.2004	08:24	11.34	157.8	1B	HAV13_040704_obs.TXT	Ρ	test repeated	
04.07.2004	08:24	11.34	157.8	1B	HAV14_040704_obs.TXT	Ρ	test repeated	

Page 1/3 Borehole: HAV14

HYDROTEST	ING WITE	HTHB		DRILLHOLE IDENTIFICATION NO.	:: HAV14	
TEST- AND FI	LEPROT	DCOL		Testorder dated : 2004-06-29		
Teststart	Interval boun	idaries (m)		Name of Datafile		
Date Time	Upper	Lower	Test type	Data file	Parameters	Comments
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV14_6.03-182.40_040707_1_CRwr_r.xls	P, Q, EC, Te	
07.07.2004 08:(99 6.03	182.4	1B, 6, L-EC, L-Te	HAV14_032_040624_Ref_Da00.DAT	C, R	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV14_032_040708_FlowLo00.DAT	P, Q, EC, Te	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV14_032_040708_Spinne00.DAT	(P, Q) EC, Te, Sp	P, Q only at Spinner data
07.07.2004 08:(9 6.03	182.4	1B, 6, L-EC, L-Te	HAV14_032_040708_Spinner_evaluated.xls	(P, Q) EC, Te, Sp	P, Q only at Spinner data
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV07_040707_obs_1.TXT	Р	
07.07.2004 08:(99 6.03	182.4	1B, 6, L-EC, L-Te	HAV07_040707_obs_2.TXT	Ρ	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV07_040707_obs_edited.TXT	Ρ	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV08_040707_obs_1.TXT	Р	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV08_040708_obs_2.TXT	Ρ	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV08_040707_obs_edited.TXT	Ρ	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV13_040707_obs_1.TXT	Ρ	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV13_040708_obs_2.TXT	Р	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	HAV13_040707_obs_edited.TXT	Ρ	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	KAV04A_040707_obs_1.TXT	Ρ	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	KAV04A_040708_obs_2.TXT	Ρ	
07.07.2004 08:0	99 6.03	182.4	1B, 6, L-EC, L-Te	KAV04A_040707_obs_edited.TXT	Ρ	

Borehole: HAV11

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HYDROT	ESTIF	NG WITE	HTHB		DRILLHOLE IDENTIFICATION NO	:: HAV11		
TEST- AN	ID FII	EPROTO	DCOL		Testorder dated : 2004-06-29			
Teststar	t.	Interval boun	daries (m)		Name of Datafile			
Date	Time	Upper	Lower	Test type	Data file	Parameters	Comments	
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	HAV11_6.03-220.50_040711_1_CRwr_r.xls	P, Q, EC, Te		
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	HAV11_026_040624_Ref_Da00_original.DAT	C, R		
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	HAV11_026_040711_Ref_Da00_edited.DAT	C, R		
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	HAV11_026_040707_FlowLo00_original.DAT	P, Q, EC, Te		
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	HAV11_026_040711_FlowLo00_edited.DAT	P, Q, EC, Te		
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	HAV11_026_040708_Spinne00_original.DAT	(P, Q) EC, Te, Sp	P, Q only at Spinner c	lata
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	HAV11_026_040711_Spinne00_edited.DAT	(P, Q) EC, Te, Sp	P, Q only at Spinner d	lata
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	HAV11_026_040711_Spinner_evaluated.xls	(P, Q) EC, Te, Sp	P, Q only at Spinner c	lata
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	KAV04A_040711_obs_1.TXT	Р		
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	KAV04A_040713_obs_2.TXT	Р		
11.07.2004	08:24	6.03	220.5	1B, 6, L-EC, L-Te	KAV04A_040711_obs_edited.TXT	Р		

Page 1/5 Borehole: HSH04

HYDROTI	ESTIN	IC WITH	HTHB		DRILLHOLE IDENTIFICATION NO.	:: HSH04	
TEST- AN	D FIL	EPROTC	COL		Testorder dated : 2004-06-29		
Teststart	t	Interval boun	daries (m)		Name of Datafile		
Date	Time	Upper	Lower	Test type	Data file	Parameters	Comments
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH04_9.00-236.20_040715_1_CRwr_r.xls	P, Q, EC, Te	
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH04_025_040624_Ref_Da00_original.DAT	C, R	
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH04_025_040717_Ref_Da00_edited.DAT	C, R	
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH04_025_040715_FlowLo00.DAT	P, Q, EC, Te	
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH04_025_040716_Spinne00.DAT	(P, Q) EC, Te, Sp	P, Q only at Spinner data
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH04_025_040716_Spinner_evaluated.xls	(P, Q) EC, Te, Sp	P, Q only at Spinner data
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH06_040715_obs_1.TXT	Ρ	
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH06_040716_obs_2.TXT	Ρ	
15.07.2004	08:11	6	236.2	1B, 6, L-EC, L-Te	HSH06_040715_obs_edited.TXT	Ρ	

Borehole: HSH05

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TFCT AND	ING ML	TH HTHB		DRILLHOLE IDENTIFICATION NO	D.: HSH05	
THE FLORE	FILEPRO	TOCOL		Testorder dated : 2004-06-29		
Teststart	Interval b	oundaries (m)		Name of Datafile		
Date Ti	ne Upper	Lower	Test type	Data file	Parameters	Comments
17.07.2004	3:08	5.2 200.2	1B, 6, L-EC, L-Te	HSH05_6.20-200.20_040717_1_CRwr_r.xls	P, Q, EC, Te	
17.07.2004	3:08	5.2 200.2	1B, 6, L-EC, L-Te	HSH05_036_040624_Ref_Da00_original.DAT	C, R	
17.07.2004	3:08	5.2 200.2	1B, 6, L-EC, L-Te	HSH05_036_040717_Ref_Da00_edited.DAT	C, R	
17.07.2004	3:08	5.2 200.2	1B, 6, L-EC, L-Te	HSH05_036_040717_FlowLo00.DAT	P, Q, EC, Te	
17.07.2004	3:08	5.2 200.2	1B, 6, L-EC, L-Te	HSH05_036_040718_Spinne00.DAT	(P, Q) EC, Te, Sp	P, Q only at Spinner d
17.07.2004	3:08	5.2 200.2	1B, 6, L-EC, L-Te	HSH05_036_040718_Spinner_evaluated.xls	(P, Q) EC, Te, Sp	P, Q only at Spinner d

Page 1/7 Borehole: HAV13

HYDRO	TESTIN	VITE	HTHB		DRILLHOLE IDENTIFICATION NO.	:: HAV13		
TEST- A]	ND FII	EPROT	OCOL		Testorder dated : 2004-06-29			
Testst	art	Interval boun	idaries (m)		Name of Datafile			
Date	Time	Upper	Lower	Test type	Data file	Parameters	Comments	
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV13_9.04-142.20_040720_1_CRwr_r.xls	P, Q, EC, Te		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV13_022_040624_Ref_Da00_original.DAT	C, R		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV13_022_040720_Ref_Da00_edited.DAT	C, R		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV13_022_040721_FlowLo00.DAT	P, Q, EC, Te		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV13_022_040721_Spinne00.DAT	(P, Q) EC, Te, Sp	P, Q only at Spinner data	I.
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV13_022_040721_Spinner_evaluated.xls	(P, Q) EC, Te, Sp	P, Q only at Spinner data	ı
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV07_040720_obs_1.TXT	P		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV07_040721_obs_2.TXT	Ρ		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV07_040720_obs_edited.TXT	Ρ		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV08_040720_obs_1.TXT	Ρ		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV08_040721_obs_2.TXT	Ρ		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV08_040720_obs_edited.TXT	P		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV12_040720_obs_1.TXT	P		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV12_040721_obs_2.TXT	Ρ		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV12_040720_obs_edited.TXT	Ρ		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV14_040720_obs_1.TXT	P		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV14_040721_obs_2.TXT	Р		
20.07.2004	08:03	9.04	142.2	1B, 6, L-EC, L-Te	HAV14_040720_obs_edited.TXT	Ρ		

APPENDIX 2-1

HAV12

Pump Test Analysis diagrams



Pressure and flow rate vs. time; cartesian plot (1st test)



Pressure, temperature and conductivity vs. time; cartesian plot (1st test)



Pressure and flow rate vs. time; cartesian plot (2nd test)



Pressure, temperature and conductivity vs. time; cartesian plot (2nd test)



CRw phase; log-log match (1st test)



CRwr phase; log-log match (1st test)



CRwr phase; HORNER match (1st test)



CRw phase; log-log match (2nd test)



CRwr phase; log-log match (2nd test)



CRwr phase; HORNER match (2nd test)



Pressure vs. time; HAV12 pumped and HAV02 observed



Pressure vs. time; HAV12 pumped and HAV05 observed


Pressure vs. time; HAV12 pumped and KAV0101 observed



Pressure vs. time; HAV12 pumped and KAV01o2 observed



Pressure vs. time; HAV12 pumped and KAV03 observed



Pressure vs. time; HAV12 pumped and HAV02 observed



Pressure vs. time; HAV12 pumped and HAV05 observed



Pressure vs. time; HAV12 pumped and HAV13 observed



Pressure vs. time; HAV12 pumped and HAV14 observed



Pressure vs. time; HAV12 pumped and KAV0101 observed



Pressure vs. time; HAV12 pumped and KAV01o2 observed



Pressure vs. time; HAV12 pumped and KAV03 observed



CRw phase; log-log match; HAV14 observed by HAV12 pumped (2nd test)



CRwr phase; log-log match; HAV14 observed by HAV12 recovered (2nd test)



CRwr phase; HORNER match; HAV14 observed by HAV12 recovered (2nd test)

APPENDIX 2-3

HAV11

Pump Test Analysis diagrams



Pressure and flow rate vs. time; cartesian plot



Pressure, temperature and conductivity vs. time; cartesian plot



CRw phase; log-log match



CRwr phase; log-log match



CRwr phase; HORNER match



Pressure vs. time; HAV11 pumped and KAV0101 observed



Pressure vs. time; HAV11 pumped and KAV01o2 observed



Pressure vs. time; HAV11 pumped and KAV04A observed



Pressure vs. time; HAV11 pumped and KSH03Ao1 observed



Pressure vs. time; HAV11 pumped and KSH03Ao2 observed



Pressure vs. time; HAV11 pumped and KSH03o3 observed

APPENDIX 3-1

HAV12 HAV140

	Test Sum	nary Sheet				
Project:	Oskarshamn site investigation	Test type:[1]			CRwr	
Area:	Ävrö	Test no:			1	
Borehole ID:	HAV12	Test start:		040702 08:		
Test section from - to (m):	11.34 - 157.80 m	Responsible for		Reinder van der Wa		
Section diameter, 2.rw (m):	0.14	Responsible for			C. Enachescu	
····· ··· ··· ··· ··· ··· ··· ··· ···		test evaluation:				
Linear plot Q and p		Flow period		Recovery period		
225	T 100	Indata		Indata		
HAV12_11.34-157.80_0	40702_1_CRwr_P_r	p ₀ (kPa) =	0			
~~~		p _i (kPa ) =	215.9			
200 -		p _p (kPa) =	137.1	p _F (kPa ) =	214.1	
		Q _p (m ³ /s)=	1.06E-03			
175 - 2	- 60	tp (s) =	36180	t _F (s) =	39180	
y] uns se		S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04	
ž 150	- 40 - 40	EC _w (mS/m)=	820.8			
	4	Temp _w (gr C)=	8.34			
125 -	- 20	Derivative fact.=	0.08	Derivative fact.=	0.04	
	140 160 180 200 220 240 260	Posulte		Posulte		
Elapsed	Time [h]	$O(z_1/z_2^2/z_2)$	1 25.04	nesuits		
Log-Log plot incl. derivates- fl	ow period	Q/s (ff /s) =	1.3E-04			
Log-Log plot litel. derivates- li		I _M (m /s)=	transient	Flow regime:	transient	
		$dt_{\ell}$ (min) =	11011310111 9 00	$dt_{\ell}$ (min) –	9.00	
100		$dt_1(min) = dt_2(min) =$	600.00	$dt_1(min) = dt_2(min) =$	600.00	
SKB Aevroe / HAV12 11.34-157.80 / CRw		$T_{1}(m^{2}/c) =$	2 60E-04	$T_{2}(m^{2}/c) =$	1 84F-04	
• (KPa)		S(-) =	5 33E-07	$\Gamma(m/s) = S(-) = -$	2 25E-06	
10		K (m/s) –	1.78E-06	6 () = K (m/s) =	1 26E-06	
and		$S_{s}(1/m) =$	3.64E-09	$S_{s}(1/m) =$	1.20E 00	
		$C_{\rm s}$ (1/11) =	2.04E-06	$C_{s}(1/11) = C_{s}(1/11)$	1.94E 00	
Denus 1		$C(\Pi/Fa) = C_{D}(-) =$	1 24F+02	$C(\Pi/Fa) = C_{D}(-) =$	2 86E+01	
Pres		ξ(-) –	-0.41	ε ₍₋₎ =	1.6	
		5() -	0.11	5() -		
0.1 0.0001 0.001 0.01	0.1 1 10 100	$T_{}(m^2/c) =$		$T_{}(m^2/c) =$		
Elap	sed time (hrs)	$\frac{S_{GRF}(1173)}{S_{GRF}(-)} =$		$S_{GRF}(-) =$		
		$D_{GBE}(-) =$		$D_{GBE}(-) =$		
Log-Log plot incl. derivatives-	recovery period	Selected represe	ntative paran	neters.		
		$dt_1$ (min) =	9	C (m ³ /Pa) =	1.98E-06	
100		$dt_2$ (min) =	600	$C_{D}(-) =$	2.86E+01	
SKB Aevroe / HAV12		$T_{T}(m^{2}/s) =$	2.82E-04	ξ(-) =	1.6	
ิ ชิ		S (-) =	2.25E-06	*		
4¥) 90 10		$K_s (m/s) =$	1.93E-06			
Det 5		S _s (1/m) =	1.54E-08			
The surger of th		Comments:				
L Change		The recommended	transmissivity of	2.82E-4 m2/s was d	lerived from the	
essare v		analysis of the CRr	phase (inner zoi	ne), which shows a g	ood data and	
ă I		derivative quality.	The confidence $I$	ange for the borehol $m^{2}/s$ . The flow $d^{2}$	e transmissivity	
0.1	·····	displayed during the	.0E-4 10 5.0E-4 e test is 2. The s	tatic pressure measure	red at	
υ.υυυτ 0.001 0.01 Elap	0.1 1 10 100 psed time (hrs)	transducer depth, w	as derived from	the CRr phase using	straight line	
		extrapolation in the	Horner plot to a	a value of 217 kPa.		

Test Summary Sheet						
Project:	Oskarshamn site invest	tigation	Test type:[1]			CRwr
Area:		Ävrö	Test no:			2
Borehole ID:	ID: HAV12		Test start:	040704 08:08		
Test section from - to (m):	11.34 - 15	7.80 m	Responsible for		Reinde	er van der Wall
Section diameter, 2.rw (m):		0.14	Responsible for			C. Enachescu
,			test evaluation:			
Linear plot Q and p			Flow period		Recovery period	
225		1 ¹⁰⁰	Indata	-	Indata	-
HAV12_11.34-157.80_040702_2_0	CRwr_P-r		p ₀ (kPa) =	0		
200 -		80	p _i (kPa ) =	218.4		
/			p _p (kPa) =	137.3	p _F (kPa ) =	215.9
			Q _p (m ³ /s)=	1.06E-03		
175 - Ter St		60 F	tp (s) =	36060	t _F (s) =	51540
	P section	a surf []/	S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04
150	Q surf	40	EC _w (mS/m)=	817.7		
			Temp _w (gr C)=	8.36		
125 -		20	Derivative fact.=	0.05	Derivative fact.=	0.04
100		0				
0.0 2.0 4.0 6.0 8.0 10.0 12.0 Elapsed	14.0 16.0 18.0 20.0 22.0 24.0 26 d Time [h]	5.0	Results		Results	
			$Q/s (m^2/s) =$	1.3E-04		
Log-Log plot incl. derivates- f	low period		$T_{M} (m^{2}/s) =$	1.7E-04		
			Flow regime:	transient	Flow regime:	transient
1000			$dt_1$ (min) =	12.00	$dt_1$ (min) =	12.00
SKB Aevroe / HAV/12			$dt_2$ (min) =	600.00	$dt_2$ (min) =	600.00
(m 100 11.34-157.80 / CRw			$T(m^2/s) =$	1.65E-04	$T(m^2/s) =$	1.06E-04
10	$\langle \rangle$		S (-) =	2.57E-06	S (-) =	1.58E-05
aud			$K_s (m/s) =$	1.13E-06	$K_s (m/s) =$	7.24E-07
			$S_{s}(1/m) =$	1.75E-08	$S_{s}(1/m) =$	1.08E-07
0.1 ·			C (m³/Pa) =	1.96E-06	C (m³/Pa) =	1.99E-06
Pres			$C_{\rm D}(-) =$	2.48E+01	$C_{D}(-) =$	4.09E+00
0.01			$\xi(-) =$	2.18	ξ(-) =	16.14
0.001	1 0.1 1 10	100	2		2	
Elapsed	time (hrs)		$T_{GRF}(m^{2}/s) =$		$T_{GRF}(m^{2}/s) =$	
			$S_{GRF}(-) =$		$S_{GRF}(-) =$	
Log Log plot incl. derivatives	recovery pariod		$D_{\text{GRF}}(-) =$		$D_{\text{GRF}}(-) =$	
Log-Log plot fild. derivatives-	recovery period		dt (min) -	10 10		
			$dt_1(min) = dt_2(min) =$	21 ۵۵۵	$C_{\rm m}$ (m ² /Pa) =	1.99⊑-00
100			$T_{(m^{2}/2)}$	8 035-04	とい(-) - を(-) -	16 14
SKB Aevroe / HAV12 11.34-157.80 / CRwr			$T_{T}(m/s) =$	1.58E-05	<u> </u>	10.14
e (KPa			S(-) = K(m/s) = -	5.48E-06		
			$R_{s}(11/3) =$	1.08E-07		
and	New Market		Commente:	1.002 07	I	
hange			The recommended	tranemiesivity of	$f = 0.3E / m^2/s$ was a	larived from the
			analysis of the CRr	phase, which sh	ows the best data an	d derivative
Jee .			quality. The confide	ence range for th	e borehole transmis	sivity is
			estimated to be 1.01	E-4to 1.0E-3 m2	/s. The flow dimens	ion displayed
0.0001 0.001 0.01	0.1 1 10	I 100	during the test is 2.	The static press	ure measured at tran	sducer depth,
Elapsed	time (hrs)		was derived from the Horner plot to a val	ue of 221 kPa.	ng straight line extra	ipolation in the

	Test Sumr	nary Sheet				
Project: C	Skarshamn site investigation	Test type:[1]			CRw	
Area:	Ävrö	Test no:				
Borehole ID:	HAV14o	Test start:		040704 08:		
Test section from - to (m):	6.03 - 182.40 m	Responsible for	Reinder van der Wa			
Section diameter, 2.r, (m):	0.14	Responsible for			C. Enachescu	
,,		test evaluation:				
Linear plot Q and p		Flow period		Recovery period		
240	122	Indata		Indata		
220 -	121.8	p ₀ (kPa) =	0			
	121.6	p _i (kPa ) =	121.27			
200	121.4	p _p (kPa) =	120.61	p _F (kPa ) =	121.4	
	121.2 80	Q _p (m ³ /s)=	1.06E-03			
	121 5	tp (s) =	36060	t _F (s) =	5154	
	- 120.8 <b>8</b>	S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04	
	120.6 %	EC _w (mS/m)=				
140	<ul> <li>HAV12</li> <li>120.4</li> </ul>	Temp _w (gr C)=				
_	HAV140	Derivative fact.=	0.14	Derivative fact.=	0.1	
120 -	120					
100	119.8					
04.07 04.48 04.07 02:38 04.07 14:24 04.07 19:12 05:07 Date/Time	00:00 05:07 04:48 05:07 09:38 05:07 14:24	Results		Results		
		Q/s (m²/s)=				
Log-Log plot incl. derivates- flow	period	T _M (m²/s)=				
		Flow regime:	transient	Flow regime:	transient	
Elapsed time (h)	3	$dt_1 (min) =$	30.00	dt ₁ (min) =	60.00	
¹⁰ SKB Aevroe / HAV14	FlowDim Version 2.14b (c) Golder Associates	dt ₂ (min) =	300.00	dt ₂ (min) =	480.00	
Pumping HAV12 / RW		T (m²/s) =	1.71E-03	T (m²/s) =	8.75E-04	
10 0	10 °	S (-) =	2.73E-05	S (-) =	1.31E-0	
		$K_s (m/s) =$	9.70E-06	$K_s (m/s) =$	4.96E-06	
8	10 ⁻¹ 2	S _s (1/m) =	1.55E-07	S _s (1/m) =	7.43E-08	
	01.02	C (m ³ /Pa) =	2.00E-06	C (m ³ /Pa) =	2.00E-06	
	•	C _D (-) =	2.38E+00	C _D (-) =	4.96E+0	
10 [°]	10 -2	ξ(-) =	0.65	ξ(-) =	1.02	
· · · · · · · · · · · · · · · · · · ·		T _{GRF} (m²/s) =		T _{GRF} (m²/s) =		
tD/f02		S _{GRF} (-) =		S _{GRF} (-) =		
		D _{GRF} (-) =		D _{GRF} (-) =		
Log-Log plot incl. derivatives- rec	overy period	Selected represe	entative paran	neters.		
		$dt_1 (min) =$	60	C (m ³ /Pa) =	2.00E-06	
Elapsed time (h)	°	$dt_2$ (min) =	480	$C_{D}(-) =$	4.96E+00	
SKB Aevroe / HAV14	FlowDim Version 2.14b     (c) Golder Associates     10	$T_T (m^2/s) =$	8.75E-04	ξ(-) =	1.02	
	•	S (-) =	1.31E-05			
10 **		$K_s (m/s) =$	4.96E-06			
		S _s (1/m) =	7.43E-08			
8 10 ⁻¹		Comments:				
		The recommended analysis of the CRr quality. The confide estimated to be 6.01 during the test is 2.	transmissivity of phase, which sh ence range for th E-4to 3.0E-3 m2	E 8.75E-4 m2/s was own the best data are borehole transmiss /s. The flow dimense	derived from the ad derivative sivity is ion displayed	
10 ⁻⁴ 10 ⁻¹ 10/102	10 ^v 10 ^t					

#### **APPENDIX 3-2**

HAV14 HAV07o HAV08o

Test Summary Sheet						
Project:	Oskarshamn site investigation	Test type:[1]			CRwr	
Area:	Ävrö	Test no:			1	
Borehole ID:	HAV14	Test start:	040707 08			
Test section from - to (m):	6.03 - 182.40 m	Responsible for		Reinder van der Wa		
Section diameter, $2 \cdot r_w$ (m):	0.14	Responsible for			C. Enachescu	
Linear plot Q and p		Flow period		Recovery period		
		Indata		Indata		
230	HAV14_6.03-182.40_040707_1_CRwr_P_r	n. (kPa) –	0	indata	1	
220 -		$p_0(kra) = p_0(kra) =$	208.0			
210 -		р _і (кра) =	208.9		202.6	
200 -	50	р _р (кРа) =	144.2	р _F (кРа ) =	203.6	
		Q _p (m³/s)=	1.06E-03			
190 - E	- ⁴⁰ ਵ	tp (s) =	39000	t _F (s) =	45300	
2 190 - 32 2	o sur Iw	S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04	
170 -	P section	EC _w (mS/m)=	32.0			
160 -	U surt	Temp _w (gr C)=	8.42			
150		Derivative fact.=	0.08	Derivative fact.=	0.05	
	10					
140 -					1	
130 0.00 5.00 10.00 15.00 20.00	25.00 30.00 35.00 40.00 45.00 50.00	Results		Results		
Elaps	eed Time [h]	$Q/s (m^2/s) =$	1.6E-04		I	
Log-Log plot incl. derivates-	flow period	$T_{11}$ (m ² /s)-	2.1F-04			
		Flow regime:	transient	Flow regime:	transient	
		dt. (min) –	12 00	dt. (min) –	12.00	
100		$dt_1(min) =$	600.00	$dt_1 (min) =$	240.00	
SKB Aevroe / HAV14 6.03-182.40 / CRw		$T_{12}(mn) = T_{12}(mn)$	2 05E-04	$T_{12}(1111) =$	1 39E-04	
R 10	· .	I (m /s) =	2.03E-04	I (m /s) =	1.33E-04	
2) 2) 2)	A REAL PROPERTY AND A REAL	S(-) =	4.12E-05	5 (-) =	0.04E-05	
Derive		$\kappa_{s}$ (m/s) =	1.21E-06	$\kappa_{s}$ (m/s) =	8.21E-07	
pue ef		$S_{s}(1/m) =$	2.43E-07	$S_{s}(1/m) =$	3.57E-07	
Change		C (m [°] /Pa) =	2.03E-06	C (m [°] /Pa) =	1.59E-06	
0.1		$C_{D}(-) =$	1.60E+00	$C_D(-) =$	8.55E-01	
a i		ξ(-) =	-2.37	ξ(-) =	-2.79	
0.01						
0.0001 0.001 0.01 Elapse	0.1 1 10 100 ed time (hrs)	T _{GRF} (m²/s) =		T _{GRF} (m²/s) =		
		S _{GRF} (-) =		S _{GRF} (-) =		
		$D_{GRF}(-) =$		$D_{GRF}(-) =$		
Log-Log plot incl. derivatives	- recovery period	Selected represe	entative paran	neters.		
		dt ₁ (min) =	12	C (m³/Pa) =	1.59E-06	
100		dt ₂ (min) =	240	C _D (-) =	8.55E-01	
SKB Aevroe / HAV14		$T_T (m^2/s) =$	1.58E-04	ξ(-) =	-2.79	
6.03-182.40 / CRwr		S (-) =	6.04E-05			
dy ₩ € 10		K _s (m/s) =	9.33E-07			
Jerivati		S _s (1/m) =	3.57E-07			
and D	$\sim$	Comments:				
thange		The recommended	transmissivity of	1.58E-4 m2/s was o	derived from the	
Sure C		analysis of the CRr	phase (inner zoi	ne), which shows a g	good data and	
Pres		derivative quality.	The confidence 1	ange for the boreho	le transmissivity	
		is estimated to be 1	.0E-4 to 3.0E-4	m2/s. The flow dime	ension	
0.0001 0.001 0.01	0.1 1 10 100	displayed during the	e test 1s 2. The s	tatic pressure measu	red at	
Elapsed	time (hrs)	extrapolation in the	Horner plot to a	a value of 208 kPa.	, strangin ille	

	Test Sumr	nary Shoot				
Project:	Oskarshamn site investigation	Test type:[1]			CRwr	
Area:	Ävrö	Test no:			1	
Borehole ID:	HAV07o	Test start:		040707 08:0		
Test section from - to (m):	4.00 - 100.00 m	Responsible for test execution:		Reinde	er van der Wall	
Section diameter, $2 \cdot r_w$ (m):	0.14	Responsible for			C. Enachescu	
l inear plot Q and p		Flow neriod		Recovery period		
	<b>r</b> 38	Indata		Indata		
			0	inuata		
	- 35	$p_0 (kPa) =$	0			
210 -	- 34	p _i (kPa ) =	34.77			
200 -		p _p (kPa) =	28.52	p _F (kPa ) =	33.1	
(e day)	oto (kPa	Q _p (m ³ /s)=	1.06E-03			
e 199 -	22 <del>t</del> i	tp (s) =	39000	t _F (s) =	45300	
9 180 - 00	- 31 ^Q	S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04	
9 9 9 170 -	e cc	EC (mS/m)=		<b>U</b> ( )-		
Pres		Temp (ar  C)				
100	- 1917	Tempw(gr C)=	0.05	Devisionations for at	0.07	
150 -	-+JAVU/01 - 28	Derivative fact.=	0.05	Derivative fact.=	0.07	
140 -	- 27					
07.07.00.00 07.07.12.00 08.07.00.00 08.07 Date	7 12:00 09:07 00:00 06:07 12:00 10:07 00:00	Results	_	Results		
		Q/s (m²/s)=				
Log-Log plot incl. derivates- f	low period	$T_{M} (m^{2}/s) =$				
	•	Flow regime:	transient	Flow regime:	transient	
		dt. (min) –	48.00	dt. (min) –	42.00	
Elapsed ime 10 1	[h]	$dt_1 (min) =$	40.00	$dt_1 (min) =$	42.00	
SKB Aevroe / HAV07	FlowDim Version 2.14b (c) Golder Associates	$al_2 (min) =$	540.00	$a_2 (min) =$	600.00	
Pumping HAV14 / RW	10	T (m²/s) =	5.40E-04	T (m²/s) =	7.84E-04	
10 °		S (-) =	2.01E-04	S (-) =	1.85E-04	
		$K_s (m/s) =$	5.63E-06	$K_s (m/s) =$	8.17E-06	
		S _s (1/m) =	2.09E-06	S _s (1/m) =	1.93E-06	
		C (m ³ /Pa) =	2.00E-06	C (m ³ /Pa) =	2.00E-06	
	10 ⁻¹ 2	$C_{D}(-) =$	3.23E-01	$C_{\rm D}(-) =$	3.51E-01	
10 *		ج (-) =	-0.35	ج (-) =	-0.31	
/./	10 ~	5() –	0.00	5() –	0.01	
		<b>T</b> (m ² (a)		$\tau$ (m ² / ₂ )		
10 ⁻¹ 10 ⁻¹ 10 ⁻¹	10 1 10 2	$I_{GRF}(III /S) =$		$I_{GRF}(III /S) =$		
		$O_{GRF}(-) =$		$O_{GRF}(-) =$		
	· .	$D_{\text{GRF}}(-) =$		$D_{\text{GRF}}(-) =$		
Log-Log plot incl. derivatives	· recovery period	Selected represe	entative paran	neters.		
		$dt_1 (min) =$	48	C (m³/Pa) =	2.00E-06	
10_2 Elapsed time	[h]10, °10, °	dt ₂ (min) =	540	C _D (-) =	3.23E-01	
SKB Aevroe / HAV07	FlowDim Version 2.14b (c) Golder Associates	$T_{T} (m^{2}/s) =$	2.20E-04	ξ(-) =	-0.35	
Pumping HAV14 / RWS	1	S (-) =	2.01E-04			
10 °	in the second se	K _s (m/s) =	2.29E-06			
	10 °	$S_{s}(1/m) =$	2.09E-06			
		Comments:				
		The recommended	transmissivity of	$5 4 \text{E} 4 \text{ m}^2/\text{s}$ was de	rived from the	
		analysis of the CRw phase (inner zone), which shows a good data and				
10 ²		derivative quality.	The confidence i	ange for the boreho	le transmissivity	
•/•/•	10 °	is estimated to be 1	.0E-4 to 1.0E-3	m2/s. The flow dime	ension	
		displayed during the	e test is 2.			
	10 ¹ 10 ²					
iun.						

	Test Sum	mary Sheet				
Project:	Oskarshamn site investigatio	n <u>Test type:[1]</u>		CRwi		
Area:	Ävr	ö Test no:			1	
Borehole ID:	HAV08	o Test start:		040707 08		
Test section from - to (m):	0.00 - 63.00 r	m Responsible for	Reinder van der W		er van der Wall	
Section diameter 2.r., (m):	0.1	4 Responsible for			C Enachescu	
	0.1	test evaluation:			O. Enachesea	
Linear plot Q and p		Flow period		<b>Recovery period</b>		
230	32.5	Indata		Indata		
200.	+ 32	p ₀ (kPa) =	0			
210		p _i (kPa ) =	31.57			
200		p _p (kPa) =	28.35	p _F (kPa ) =	30.1	
[kPa]	- 31 E 4 4	Q _p (m ³ /s)=	1.06E-03			
40 190 -	- 10.5 E	tp (s) =	39000	t _F (s) =	45300	
5 180 -	20 PSec V atk	S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04	
170 .		EC _w (mS/m)=				
160 -	- 22.5 🔮	Temp _w (gr C)=				
190 -	• HAV14 29	Derivative fact.=	0.02	Derivative fact.=	0.05	
140 -	HAV0801 -28.5					
130 07.07 00.00 07.07 12:00 08.07 00.00 08	28 07 12:00 09:07 12:00 10:07 00:00	Besults		Results		
Da	te/Time	$\Omega_{12}$ (m ² /2)	1	Tiesuits	1	
ll og-l og plot incl. derivates-	low period	U/S (III/S) =				
		Flow regime:	transient	Flow regime:	transient	
		$dt_1$ (min) =	60.00	$dt_1$ (min) =	180.00	
Elapsed time	[h]10, ¹ 10, ² 1	$dt_1 (min) =$ $dt_2 (min) =$	600.00	$dt_1 (min) =$	720.00	
SKB Aevroe / HAV08	FlowDim Version 2.14b (c) Golder Associates	$T_{m}(m^{2}/c) =$	1.42F-03	$T_{m_{2}}(m^{2}/c) =$	2.32E-04	
Pumping HAV14 / RW		$\frac{1}{S(-)} =$	1.15E-03	S(-) =	5.79E-04	
10 **		$K_{c}(m/s) =$	2.25E-05	$K_{c}(m/s) =$	3.68E-06	
		$S_{s}(1/m) =$	1.83E-05	$S_{s}(1/m) =$	9.19E-06	
	10 -1	$C_{\rm m}^{3}/P_{\rm a}$ –	2.00E-06	C (m ³ /Pa) -	2.00E-06	
·····//		$C_{\rm D}(-) =$	5.65E-02	$C_{D}(-) =$	1.12E-01	
10 ⁻²	-10 ⁻²	ξ(-) =	0.85	ξ(-) =	-0.88	
		5()		5()		
		$T_{CPF}(m^2/s) =$		$T_{CRF}(m^2/s) =$		
10 ⁻² 10 ⁻¹ tD/r	10 [°] 10 ¹ 10 ² 22	$S_{GRF}(-) =$		$S_{GRF}(-) =$		
		D _{GRF} (-) =		D _{GRF} (-) =		
Log-Log plot incl. derivatives	- recovery period	Selected represe	ntative paran	neters.	<b>.</b>	
		dt ₁ (min) =	180	C (m ³ /Pa) =	2.00E-06	
Elapsed tim	[h]	dt ₂ (min) =	720	C _D (-) =	1.12E-01	
	FlowDim Version 2.14b (c) Golder Associates	$T_T (m^2/s) =$	2.32E-04	ξ(-) =	-0.88	
Pumping HAV14 / RWS	10 ¹	S (-) =	5.79E-04	1		
	and and a	K _s (m/s) =	3.68E-06			
10 -1	in and in the second se	S _s (1/m) =	9.19E-06			
		The recommended in analysis of the CRr quality. The confide estimated to be 5.0I during the test is 2.	transmissivity of phase, which sh ence range for th E-5 to 3.0E-3 m.	f 2.3E-4 m2/s was de ows a good data and he borehole transmis 2/s. The flow dimens	erived from the derivative sivity is sion displayed	

## **APPENDIX 3-3**

## HAV11

	Test Sum	nary Sheet				
Project:	Oskarshamn site investigation	Test type:[1]			CRwr	
Area:	Ävrö	Test no:			1	
Borehole ID:	HAV11	Test start:		040711 08:2		
Test section from - to (m):	6.03 - 220.50 m	Responsible for		Reinde	r van der Wall	
Section diameter, 2.rw (m):	0.14	test execution: Responsible for			C. Enachescu	
		test evaluation:				
Linear plot Q and p		Flow period		Recovery period		
	80 Burn D r	Indata		Indata		
	70	$p_0 (kPa) =$	0			
250 -		$p_i(kPa) =$	240.7	n (kBa) -	2427	
	60	$p_p(\mathbf{k} \mathbf{r} \mathbf{a}) = 0$	1 10E 03	р _F (кга) =	242.7	
240 -	50	Q _p (m ⁻ /s)= tn (s) =	38220	t _r (s) -	48840	
କ୍ଟ କୁଥି 230 -	40 [uiuu] J	$\frac{(p(3))}{2}$	1 00F-04	$r_{\rm F}(3) = \frac{1}{2}$	1 00F-04	
Press	a su a	S (-)= FC (mS/m)=	1143	5 (-)=	1.001 04	
220 •	P section	Temp _w (ar C)=	8.79			
	Q surf 20	Derivative fact.=	0.075	Derivative fact.=	0.082	
210 -						
200 25.0 30.0 35.0 40.0 45.0 50	0.0 55.0 60.0 65.0 70.0 75.0	Results		Results		
Elapsed	Time [h]	Q/s $(m^{2}/s)=$	2.9E-04			
Log-Log plot incl. derivates- fl	ow period	$T_{M} (m^{2}/s) =$	3.8E-04			
		Flow regime:	transient	Flow regime:	transient	
		dt ₁ (min) =	6.00	dt ₁ (min) =	3.60	
1000 SKB Aervoe / HAV11		dt ₂ (min) =	600.00	dt ₂ (min) =	600.00	
6.03-220.50 / CRw		T (m²/s) =	9.24E-05	T (m²/s) =	1.19E-04	
요. 100 옷		S (-) =	1.15E-04	S (-) =	2.58E-05	
Derivat		$K_s (m/s) =$	4.31E-07	$K_s (m/s) =$	5.55E-07	
pup 10	- and the second second	$S_{s}(1/m) =$	5.36E-07	$S_s(1/m) =$	1.20E-07	
Change Change	a manufacture and a second second	C (m ³ /Pa) =	2.75E-06	C (m ³ /Pa) =	1.67E-06	
ensse 1		C _D (-) =	7.77E-01	C _D (-) =	2.10E+00	
й.		ξ(-) =	1.02	ξ(-) =	3.17	
0.1				2		
0.0001 0.001 0.01 E	0.1 1 10 100 Elapsed time (hrs)	$T_{GRF}(m^2/s) =$		$T_{GRF}(m^2/s) =$		
		$S_{GRF}(-) =$		$S_{GRF}(-) =$		
Les Les platinet derivatives	wasawamu naviad	$D_{\text{GRF}}(-) =$		$D_{\text{GRF}}(-) =$		
Log-Log plot incl. derivatives-	recovery period	dt (min) -			0.7EE.06	
		$dt_1(min) = dt_2(min) =$	0	$C_{\rm m}$ (m ² /Pa) =	2.73E-00 7 77E_01	
100		$T_{(m^2/2)}$	7 20F-04	ε ₍₋₎ –	1 02	
SKB Aervoe / HAV11 6.03-220.50 / CRwr		$S_{T_{T}}(m/s) =$	1 15E-04	<u> </u>	1.02	
10 IO	~	$K_{-}(m/s) =$	3.36E-06			
Derror		$R_{s}(1/m) =$	5.36E-07			
	and the second se	Comments:	0.002 0.			
• • •		The recommended t	ransmissivity of	7.2E-4 m2/s was de	rived from the	
U.1 0.1		analysis of the CRw	phase, which sl	hows the best data a	nd derivative	
		quality. The confide	ence range for th	e borehole transmis	sivity is	
estimated to be 8.0E-5 to 1.0E-3 m2/s. The flow dimension displa				ion displayed		
0.001 0.001 0.01	0.1 1 10 100 lapsed time (hrs)	was derived from th	e CRr phase usi	ng straight line extra	polation in the	
		Horner plot to a val	ue of 248 kPa.		-	

Borehole: HSH04

### **APPENDIX 3-4**

#### HSH04

Test Summary Sheet						
Project:	Oskarshamn site investigation	Test type:[1]			CRwr	
Area:	Simpevarp	Test no:				
Borehole ID:	HSH04	Test start:		040715 08:		
Test section from - to (m):	9.00 - 236.20 m	Responsible for		Reinde	er van der Wall	
Section diameter 2.r (m):	0.14	test execution:			C. Enachescu	
	0.14	test evaluation:			O. Enacricada	
Linear plot Q and p		Flow period		Recovery period		
260	70	Indata		Indata		
HSH04_9.00-236.20_	_040715_1_CRwr_P_r	p ₀ (kPa) =	0			
240	- 60	p _i (kPa ) =	240.2			
		p _p (kPa) =	156.1	p _F (kPa ) =	242.1	
200 -	- 30	Q _p (m ³ /s)=	5.60E-04			
<u>ē</u> 200 -	- 40 E	tp (s) =	36240	t _F (s) =	51600	
y] arnss e	und) True C	S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04	
G. 180 -	P section	EC _w (mS/m)=	878			
160 -	Q surf 20	Temp _w (gr C)=	12.49			
		Derivative fact.=	NA	Derivative fact.=	0.05	
140 -	- 10					
0.0 5.0 10.0 15.0 20.0 Elapse	25.0 30.0 35.0 40.0 45.0 50.0 ed Time (h)	Results		Results		
		Q/s (m²/s)=	6.7E-05			
Log-Log plot incl. derivates- fl	ow period	T _M (m²/s)=	8.9E-05			
		Flow regime:	transient	Flow regime:	transient	
		dt ₁ (min) =	NA	dt ₁ (min) =	36.00	
		$dt_2$ (min) =	NA	$dt_2$ (min) =	480.00	
		T (m²/s) =	NA	T (m²/s) =	9.60E-04	
		S (-) =	NA	S (-) =	1.00E-04	
		$K_s (m/s) =$	NA	$K_s (m/s) =$	4.23E-06	
Not Ar	nalysed	S _s (1/m) =	NA	$S_s(1/m) =$	4.40E-07	
		C (m³/Pa) =	NA	C (m ³ /Pa) =	1.65E-06	
		$C_D(-) =$	NA	C _D (-) =	5.36E-01	
		ξ(-) =	NA	ξ(-) =	83.25	
		$T_{GRF}(m^2/s) =$		$T_{GRF}(m^2/s) =$		
		$S_{GRF}(-) =$		S _{GRF} (-) =		
	· .	$D_{\text{GRF}}(-) =$		D _{GRF} (-) =		
Log-Log plot Incl. derivatives-	recovery period	oelected represe	manve param		1 655 00	
		$dt_1(min) =$	30	C (m ⁻ /Pa) =		
100		$u_2(mm) =$		$C_D(-) =$	5.30E-01	
SKB Simpevarp / HSH04 9.00-236.20 / CRwr		$I_{T} (m^{-}/s) =$	9.00E-04	ς(-) =	03.25	
99 (KDs		S (-) =	1.00L-04			
		$R_{s}(11/3) =$	4.25E-00			
		Comments:	4.402-07			
Change	indexes a second	The recommended t	transmissivity of	$= 0.6E 4 m^2/s$ was de	rived from the	
		analysis of the CRw	r phase, which s	shows the best data a	and derivative	
		quality. The confide	ence range for th	e borehole transmis	sivity is	
	•	estimated to be 6.01	E-4 to 2.0E-3 m ²	2/s. The flow dimens	ion displayed	
0.0001 0.001 0.01 Elapse	0.1 1 10 100 ed time (hrs)	auring the test is 2. was derived from the	I he static pressine CRr phase usi	are measured at trans	soucer depth,	
		Horner plot to a val	ue of 242 kPa.		Polution in the	
		1				

Borehole: HSH05

## **APPENDIX 3-5**

## HSH05

	Test Summ	nary Sheet				
Project:	Oskarshamn site investigation	Test type:[1]			CRwr	
Area:	Simpevarp	Test no:		1		
Borehole ID:	HSH05	Test start:		040717 13:0		
Test section from - to (m):	6.20 - 200.20 m	Responsible for test execution:		Reinde	er van der Wall	
Section diameter, $2 \cdot r_w$ (m):	0.14	Responsible for			C. Enachescu	
Linear plot Q and p		Flow period	I	Recovery period		
		Indata		Indata		
350 HSH05_6.20-200.20_040717_1_0	CRwr_P_r	$p_{o}$ (kPa) =	0			
325 -	4.5	$p_{i}(kPa) =$	325 5			
300 -	4	$p_{\rm r}({\rm kPa}) =$	191.8	n∈(kPa) =	322.4	
275 -	- 3.5	$\frac{p_p(\mathbf{k} \cdot \mathbf{a})}{Q_{p(\mathbf{k}} \cdot \mathbf{a}^3/\mathbf{a})}$	6 95E-05	p _F (Ki a ) =	522.7	
250-	- 3	$Q_p (m/s) =$	0.95E-05	t_ (c) _	51000	
	lumi	$\frac{(p(s))}{2}$	1.00E.04	ι _F (S) –	1 00E 04	
5220 ·	2.3 tis o	S(-)=	1.00E-04	S (-)=	1.00E-04	
200 -		$EC_w (mS/m) =$	/3/.3			
175 -	Q surf	Temp _w (gr C)=	8.52			
150 -	- 1	Derivative fact.=	0.03	Derivative fact.=	0.02	
125 -	- 0.5					
0.0 5.0 10.0 15.0 20.0 Elapsed T	25.0 30.0 35.0 40.0 45.0 ime [h]	Results	-	Results	-	
		Q/s (m²/s)=	5.2E-06			
Log-Log plot incl. derivates- flo	ow period	T _M (m²/s)=	6.8E-06			
		Flow regime:	transient	Flow regime:	transient	
1000		$dt_1$ (min) =	90.00	dt ₁ (min) =	420.00	
SKB Simpevarp / HSH05		dt ₂ (min) =	360.00	dt ₂ (min) =	600.00	
6.20-200.20 / CRw		T (m²/s) =	4.23E-06	T (m²/s) =	5.22E-04	
(K		S (-) =	1.00E-04	S (-) =	1.00E-04	
100 June 100		$K_s (m/s) =$	2.18E-08	K _s (m/s) =	2.69E-06	
eand	and the second sec	S _s (1/m) =	5.15E-07	S _s (1/m) =	5.15E-07	
Change	· .	C (m ³ /Pa) =	4.14E-06	C (m ³ /Pa) =	2.28E-06	
	<i>.</i>	$C_{\rm D}(-) =$	1.34E+00	$C_{\rm D}(-) =$	7.41E-01	
		ξ(-) =	-2.93	ξ(-) =	C	
1 0.01 0.1	 1 10 100	$T_{GBF}(m^2/s) =$		$T_{GBE}(m^2/s) =$		
Elapsec	I time (hrs)	$S_{GRF}(-) =$		S _{GRF} (-) =		
		$D_{GRF}(-) =$		$D_{GRF}(-) =$		
Log-Log plot incl. derivatives-	recovery period	Selected represe	ntative paran	ieters.		
	• •	$dt_1$ (min) =	420	C (m ³ /Pa) –	2.28E-06	
1000		$dt_2$ (min) =	600	$C_{\rm D}(-) =$	7.41E-01	
SKB Simpevarp / HSH05		$T_{\tau}$ (m ² /s) –	5.22E-06	ξ(-) =		
100 0.20-200.20 / CHW តិ		S(-) =	1.00F-04	- ()	<u> </u>	
さ 10 見		$K_{c}(m/s) =$	2 69F-08			
	**************************************	$S_{c}(1/m) =$	5 15F-07			
de out		Comments:	0.102 07			
Change Ch	-	The recommended t	ranemiesivity	5 22E 6 m2/s was	derived from the	
0.01		analysis of the CRr	phase (inner zo	ie), which shows the	best data and	
دّ 0.001		derivative quality. T	The confidence i	ange for the boreho	le transmissivity	
0.0001		is estimated to be 4.	.0E-6 to 6.0E-4	m2/s. The flow dime	ension	
0.0001 0.001 0.01	0.1 1 10 100	displayed during the	e test is 2. The s	tatic pressure measu	red at	
Elapse	d time (hrs)	transducer depth, w	as derived from	the CRr phase using	g straight line	
		extrapolation in the	morner plot to a	i value 01 324 KPa.		

## **APPENDIX 3-6**

HAV13 HAV020 HAV120

		Test Sum	mary Sheet				
Projec	ot:	Oskarshamn site investigatio	n <u>Test type:[1]</u>			CRwr	
Area:		Ävr	ö Test no:			1	
Boreh	ole ID:	HAV1	3 Test start:		040720 08:		
Test s	ection from - to (m):	9.04 - 142.20 r	n Responsible for test execution:		Reinde	er van der Wall	
Sectio	on diameter, 2·r _w (m):	0.1	4 Responsible for			C. Enachescu	
Linea	r plot Q and p		Flow period		Recovery period		
	- p p		Indata		Indata		
200		HAV13_9.04-142.20_040720_1_CRwr_P_r	p₀ (kPa) =	0		I	
		70	$p_i$ (kPa) =	197.2			
190			$p_{\rm p}({\rm kPa}) =$	149.1	p _⊏ (kPa ) =	194.9	
180			$O_{(m^{3}/s)} =$	1.15E-03			
100		- 50	$\frac{d_p (m/s)}{tp (s)} =$	36060	t⊧ (s) =	67500	
[문서] 외 170		40 - 40	$S^{*}(-) =$	1.00E-04	s [*] (-)-	1.00E-04	
Pressu			$S'(-) = FC_{m}(mS/m) =$	833.7	3 (-)_	11002 01	
160		P section     30     G surf	$Temp_{w}(ar C) =$	8.66			
		20	Derivative fact =	0.09	Derivative fact =	0.09	
150		N		0.07		0.07	
		- 10					
140	0.0 5.0 10.0 15.0 20.0 25.0	30.0 35.0 40.0 45.0 50.0 55.0	Results		Results		
	Elaps	ed Time [h]	$\Omega/c$ $(m^2/c)$	-2 3E-04			
l og-l	og plot incl. derivates- f	low period	$U/S (117) = T (m^2/c) = T$	-2.9E-04			
			$T_{M}$ (III /S)=	transient	Flow regime:	transient	
			dt (min) -	2 40	$dt_{\ell}$ (min) =	2 40	
1000			$dt_1 (min) =$	300.00	$dt_1 (min) =$	600.00	
~	SKB Aevroe / HAV13 9.04-142.20 / CRw		$T_{m}^{2}(c) =$	1 83F-04	$T_{m_{2}}(m^{2}/c) =$	2 15E-04	
e (kPa 9 100			S(-) =	4.81E-06	S(-) =	9.64E-07	
erivativ			$K_{1}(m/s) =$	1.37E-06	K. (m/s) =	1.61E-06	
D and D			$S_{s}(1/m) =$	3.61E-08	$S_{c}(1/m) =$	7 24F-09	
Change			$C_{\rm m}^{3/\rm Pa}$	1.58E-06	$C_{\rm m}^{3/\rm Pa} =$	4.71E-07	
esnre (	المستعمدة فالمسبغ		$C_{D}(-) =$	1.07E+01	$C_{D}(-) =$	1.59E+01	
Pré	1		ξ(-) =	-4.39	ε (-) =	-4.34	
0.1	·		5() -	1.00	5() -	1.01	
	0.0001 0.001 0.01 Elaps	0.1 1 10 10 ed time (hrs)	[°] T _{GBF} (m ² /s) =		T _{GRF} (m ² /s) =		
		. ,	S _{GRF} (-) =		S _{GRF} (-) =		
			D _{GRF} (-) =		D _{GRF} (-) =		
Log-L	og plot incl. derivatives.	<ul> <li>recovery period</li> </ul>	Selected represe	entative paran	neters.		
			dt ₁ (min) =	2.4	C (m ³ /Pa) =	1.58E-06	
100			dt ₂ (min) =	300	C _D (-) =	1.07E+01	
	SKB Aevroe / HAV13		$T_{T}$ (m ² /s) =	2.16E-04	ξ(-) =	-4.39	
a)	9.04-142.20 / CRwr		S (-) =	4.81E-06			
			$K_s (m/s) =$	1.62E-06			
Deriva	and the second second		S _s (1/m) =	3.61E-08			
je and	· · · · · · · · · · · · · · · · · · ·	and the second se	Comments:		•	•	
Upang 1			The recommended	transmissivity of	f 2.16E-4 m2/s was o	lerived from the	
essure	//.		analysis of the CRw	phase (inner zo	one), which shows th	e best data and	
derivative quality. The confidence range for the borehole tran			e transmissivity				
0.1			displayed during the	.uE-4 to 3.UE-4 e test is 2 The s	m2/s. The flow dime tatic pressure measu	red at	
0.0	0001 0.001 0.01	0.1 1 10 10	transducer depth, w	as derived from	the CRr phase using	g straight line	
	Ela	und (III)	extrapolation in the	Horner plot to a	a value of 198 kPa.	-	

	Test Sum	narv Sheet			
Project:	Oskarshamn site investigation	Test type:[1]			CRwr
Area:	Ävrö	Test no:			1
Borehole ID:	HAV02c	Test start:			040720 08:02
Test section from - to (m):	0.13 - 163.00 m	Responsible for test execution:		Reinde	er van der Wall
Section diameter, $2 \cdot r_w$ (m):	0.14	Responsible for			C. Enachescu
Linear plot Q and p		Flow period		Becovery period	
	<b>7</b> 96	Indata		Indata	
		n. (kPa) –	0	indata	
		$p_0 (KFa) =$	04.02		<b> </b>
		p _i (kPa) =	94.02	n (kDa)	02.25
E 100		$p_p(\kappa Pa) =$	85.21	р _F (кРа ) =	93.25
	sehole []	Q _p (m³/s)=	1.15E-03		
80 170 J		tp (s) =	36060	t _F (s) =	67500
ы # son	at opset	S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04
738 22 4. 100	917882U	EC _w (mS/m)=			
• HAV13	-	Temp _w (gr C)=			
150 — HAV02o	+ 86	Derivative fact.=	0.11	Derivative fact.=	0.02
	V				
140 12.0700.00 14.0700.00 16.0700.00 18.0700.00 20.07 Date	7 00:00 22.07 00:00 24.07 00:00 28.07 00:00 28.07 00:00	Results		Results	
		$\Omega/s$ (m ² /s)-	-1.3E-03		1
Log-Log plot incl. derivates- fl	low period	U/S (1175) =	-1 6F-03		
		$T_{\rm M}$ (III /S)=	transient	Flow regime:	transient
Elassed time	(h)	dt (min) –	150.00	r iow regime. dt. (min) –	490.00
10 ¹	······································	$dl_1 (min) =$	130.00 E40.00	$dt_1 (min) =$	400.00
HAV / HAV02 Pumping HAV13 / RW	FlowDim Version 2.14b (c) Golder Associates	$u_2(1111) =$	7 955 05	$dl_2$ (mm) =	1800.00
		T (m ⁻ /s) =	7.65E-05	T (m ⁻ /s) =	5.37E-05
10 °		S(-) =	1.60E-04	S (-) =	1.30E-04
	10	$\kappa_{s}$ (m/s) =	4.82E-07	$\kappa_{\rm s}$ (m/s) =	3.30E-07
R 10 ⁻¹	[Fa]	$S_{s}(1/m) =$	9.82E-07	$S_{s}(1/m) =$	7.98E-07
a · ·	1,00 10 ° 4 ° C 10 °	C (m³/Pa) =	2.00E-06	C (m³/Pa) =	2.00E-06
	Č.	$C_{D}(-) =$	4.06E-01	$C_{D}(-) =$	5.00E-01
10 2		ξ(-) =	-0.24	ξ(-) =	-0.13
	10 -1			0	
· · · · · / · / · · · · · · · · · · · ·		T _{GRF} (m ² /s) =		$T_{GRF}(m^2/s) =$	
10 ⁻¹ ED/rC	10 [°] 10 ¹	S _{GRF} (-) =		$S_{GRF}(-) =$	
		D _{GRF} (-) =		$D_{GRF}(-) =$	
Log-Log plot incl. derivatives-	recovery period	Selected represe	entative paran	neters.	
Elapsed time (t	h]2	$dt_1 (min) =$	480	C (m ³ /Pa) =	2.00E-06
10	FlowDim Version 2.14b	$dt_2$ (min) =	1800	$C_D(-) =$	5.00E-01
Pumping HAV13 / RWS	(c) Golder Associates	T⊤ (m²/s) =	5.37E-05	ξ(-) =	-0.13
10 °	A	S (-) =	1.30E-04		
	10	$K_s (m/s) =$	3.30E-07		
	10 °	S _s (1/m) =	7.98E-07		
Q 10 ⁻²	[44]	Comments:			
	10 ⁻¹	The recommended	transmissivity of	f 5.37E-4 m2/s was o	lerived from the
10-3	ä	analysis of the CRw	r phase, which	shows the best data a	and derivative
	10 -2	quality. The confide	ence range for the $F_{-5}$ to 1 OF 4 m ²	te borehole transmis	sion displayed
10 -4	[ [ 10 ⁻³	during the test is 2.	5-5 10 1.0E-4 ML		son uspiayeu
10 ⁻¹	2 10 ¹ 10 ²				

	Test Summ	nary Sheet			
Project:	Oskarshamn site investigation	Test type:[1]			CRwr
Area:	Ävrö	Test no:			1
Borehole ID:	HAV12o	Test start:	040720 08:0		
Test section from - to (m):	11.34 - 157.80 m	Responsible for		Reinde	er van der Wal
Section diameter, 2.r., (m):	0.14	test execution: Responsible for			C. Enachesci
	0.11	test evaluation:			O. Endonoood
Linear plot Q and p		Flow period		Recovery period	
200	19.8	Indata		Indata	
		p ₀ (kPa) =	0		
	19.8	p _i (kPa ) =	19.64		
		p _p (kPa) =	18.77	p _F (kPa ) =	19.2
€ 100 · · · · · · · · · · · · · · · · · ·	etoe X	Q _p (m ³ /s)=	1.15E-03		
te 24 29,170		tp (s) =	36060	t _F (s) =	6750
nos te est	at obser	S [*] (-)=	1.00E-04	S [*] (-)=	1.00E-04
160.	19 <b>J</b>	EC _w (mS/m)=			
● HAV13		Temp _w (gr C)=			
150. HAV120		Derivative fact.=	0.12	Derivative fact.=	0.02
140					
20.0700.00 20.0712.00 21.0700.00 21.07 Date	7 12:00 22:07 00:00 22:07 12:00 23:07 00:00	Results		Results	
		Q/s $(m^{2}/s)=$			
Log-Log plot incl. derivates- fl	low period	T _M (m ² /s)=			
		Flow regime:	transient	Flow regime:	transient
Elapsed time (	h]	dt ₁ (min) =	120.00	dt ₁ (min) =	120.00
10 HAV / HAv12 Pumping HAV13 / RW	FlowDim Version 2.14b (c) Golder Associates	dt ₂ (min) =	480.00	dt ₂ (min) =	420.00
		T (m²/s) =	7.59E-04	T (m²/s) =	2.78E-03
10 -	10°	S (-) =	1.22E-04	S (-) =	3.03E-04
		$K_s (m/s) =$	5.18E-06	$K_s (m/s) =$	1.90E-05
10 ⁻¹¹	10-1 3	$S_{s}(1/m) =$	8.33E-07	S _s (1/m) =	2.07E-06
		C (m ³ /Pa) =	2.00E-06	C (m ³ /Pa) =	2.00E-06
	10 °	C _D (-) =	5.32E-01	C _D (-) =	2.14E-0 ⁻
10 -3		ξ(-) =	-0.1	ξ(-) =	-0.5
	10 -3	$T_{(m^{2}/2)}$		$T (m^{2}/c)$	
10-2 10-4	10 ⁰ 10 ¹	$I_{GRF}(m/s) =$		$I_{GRF}(ff1/S) =$	
Chicle Chicle	2	$D_{GRF}(-) =$		$D_{GRF}(r) =$	
Log-Log plot incl. derivatives-	recovery period	Selected represe	ntative paran	neters.	
uontaitoo		dt₁ (min) =	120	$C (m^3/Pa) =$	2.00E-06
Elapsed time (1	nj 0, ¹	$dt_2$ (min) =	480	$C_{\rm D}(-) =$	5.32E-01
HAV / HAv12 Pumping HAV13 / RWS	FlowDim Version 2.14b (c) Golder Associates	$T_{T}(m^{2}/s) =$	7.59E-04	ξ(-) =	-0.1
		S (-) =	1.22E-04		
10 °	1.	$K_s (m/s) =$	5.18E-06		
		$S_{s}(1/m) =$	8.33E-07		
	10 ⁻¹	Comments:			
	10 ⁻⁴	The recommended t analysis of the CRw quality. The confide estimated to be 5.01 during the test is 2.	transmissivity of phase, which s ence range for th E-4 to 5.0E-3 m ²	f 7.59E-4 m2/s was hows the best data a he borehole transmis 2/s. The flow dimen	derived from the nd derivative sivity is sion displayed
טיטע גאינאר	2 10 10				

## **APPENDIX 4-1**

## HAV12

Flow Logging Analysis diagrams



#### Flow logging in HAV12

HAV12: Distribution of flow (Q_i), electric conductivity (EC) and temperature (Te) along the borehole


HAV12: Calculated cumulative transmissivity (T_i) along the borehole

#### **APPENDIX 4-2**

#### HAV14

Flow Logging Analysis diagrams







HAV14: Calculated cumulative transmissivity (T_i) along the borehole

#### **APPENDIX 4-3**

# HAV11

Flow Logging Analysis diagrams



HAV11: Distribution of flow (Q_i), electric conductivity (EC) and temperature (Te) along the borehole



HAV11: Calculated cumulative transmissivity (T_i) along the borehole

# **APPENDIX 4-5**

#### HSH05

Flow Logging Analysis diagrams



#### Flow logging in HSH05

 $\label{eq:HSH05:Distribution of flow (Q_i), electric conductivity (EC) and temperature (Te) along the borehole$ 



#### **Flow logging in HSH05**

HSH05: Calculated cumulative transmissivity (T_i) along the borehole

#### **APPENDIX 4-6**

# HAV13

Flow Logging Analysis diagrams



HAV13: Distribution of flow (Q_i), electric conductivity (EC) and temperature (Te) along the borehole



HAV13: Calculated cumulative transmissivity (T_i) along the borehole

# **APPENDIX 5**

Flow Logging Test Data

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Borehole	Borehole	Borehole	Lo		Test type	Date for	Date for	Te _{wn}	ECwn	TDS _{wn}	ΣQn	۵	tp [t	
	(m)	(m)	(m)	(m)	(1-6)			(° C)	(mS/m)	(mg/ L)	(m³/s)	(m ³ /s)	(min) (	min)
HAV12	30	156			2	20040702	20040702					1.1595E-03	603	653
HAV14	32	180	_		5	20040708	20040708					1.0263E-03	650	755
HAV11	26	122			5	20040713	20040713					1.1740E-03	637	814
HSH04	25	202			5	20040716	20040716					4.3500E-05	604	860
HSH05	36	198			5	20040718	20040718					1.6670E-05	610	865
HAV13	22	22			5	20040721	20040721					1.1980E-03	601	1125
Borehole	Borehole	Borehole	ų	h1	Te _w	EC.	TDSw	ΣQ0	ΣQ	F	ΣΤΙ	T _I -measlim	Reference (	Comments
				-										

Borehole	Borehole	Borehole	h _i	h,	Te _w	EC	TDS _w	ΣQ0	ΣQ	T	ET,	T _i -measlim	Reference C	Comments
	(m)	(m)	(m asl)	(m asl)	(°C)	(mS/m) ((	(mg/ L)	(m ³ /s)	(m ³ /s)	(m ² / s) (	(m ² / s)	(m ² / s)	(	-)
HAV12	30	156	-0.59	1 -8.47	8.34	820.8		1.1595E-03	1.1230E-03	1.84E-04	1.840E-04	6.25E-06		
HAV14	32	180	-3.41	-9.88	8.42	32.0	_	1.0263E-03	1.1230E-03	1.40E-04	1.311E-04	7.46E-06		
HAV11	26	122	0.25	-3.87	8.79	1143.0	-	1.1740E-03	1.1900E-03	9.20E-05	9.200E-05	1.18E-05		
HSH04	25	202	0.28	-8.13	12.49	878.0	_	4.3500E-05	5.8170E-04	9.60E-04	7.180E-05	5.87E-06		
HSH05	36	198	-0.11	-13.48	8.52	737.3	_	1.6670E-05	6.9330E-05	5.22E-04	1.255E-04	3.74E-06		
HAV13	22	22	-0.62	-5.43	8.66	833.7	-	1.1980E-03	1.1688E-03	1.83E-04	1.830E-04	1.04E-05		

# **APPENDIX 6**

Nomenclature

Character	SICADA	Explanation	Dimension	Unit
	designation			
Variables, o	constants	I have a structure of the state	ri 21	2
A _w		Horizontal area of water surface in open borehole, not including area of signal cables, etc.	[[L ⁻ ]	m
b		Aquifer thickness (Thickness of 2D formation)	[L]	m
B		Width of channel		m
-		Corrected borehole length		m
		Uncorrected borehole length		m
		Point of application for a measuring section based on its		m
-p		centre point or centre of gravity for distribution of transmissivity in the measuring section.	[-]	
Lw		Test section length.	[L]	m
dĽ		Step length, Positive Flow Log - overlapping flow logging.	ÎLÎ	m
-		(step length, PFL)		
r		Radius	[L]	m
r _w		Borehole, well or soil pipe radius in test section.	íLi	m
r _{we}		Effective borehole, well or soil pipe radius in test section.	[L]	m
r		Distance from test section to observation section, the	ГI 1	m
I _S		shortest distance	[[_]	
r.		Distance from test section to observation section, the	ri 1	m
•1		<b>interpreted</b> shortest distance via conductive structures.	[[-]	
r _D		Dimensionless radius, $r_{D}=r/r_{w}$	-	-
z		Level above reference point	[L]	m
Zr		Level for reference point on borehole	ľLi	m
Zwii		Level for test section (section that is being flowed), upper	l ILI	m
		limitation	L_1	
Z _{wl}		Level for test section (section that is being flowed), lower limitation	[L]	m
Z _{ws}		Level for sensor that measures response in test section (section that is flowed)	[L]	m
7		Level for observation section upper limitation	ГI 1	m
<b>Z</b> _{OU}		Level for observation section, lower limitation		m
Z ₀		Level for sensor that measures response in observation		m
Zos		section	[[-]	111
F		Evaporation:	$[1^{3}/(T + 2)]$	mm/v
-				mm/d.
		hydrological budget:	[L ³ /T]	m ³ /s
ET		Evapotranspiration	$[L^{3}/(T L^{2})]$	mm/y,
				mm/d,
		hydrological budget:	[L ³ /T]	m ³ /s
Р		Precipitation	$[L^{3}/(T L^{2})]$	mm/y,
				mm/d,
		hydrological budget:	[L ³ /T]	m³/s
R		Groundwater recharge	$[L^{3}/(T L^{2})]$	mm/y,
				mm/d,
		hydrological budget:		mĭ/s
ט		Groundwater discharge	[L˘/(T L²)]	mm/y,
			ru 3( <del>77</del> 1	mm/d,
		nydrological budget:		m [~] /s
		Kun-off rate		m [°] /s
		Pumping rate	[L [×] /]]	mĭ/s
Q		Infiltration rate	[[ĽŸ/]]	mĭ/s
			n 3 cm	3,
Q		Volumetric flow. Corrected flow in flow logging $(Q_1 - Q_0)$ (Flow rate)		mĭ/s
Q ₀		Flow in test section during undisturbed conditions (flow logging).	[L ³ /T]	m³/s

Q _p		Flow in test section immediately before stop of flow.	[L ³ /T]	m ³ /s
		Stabilised pump flow in flow logging.		
Q _m		Arithmetical mean flow during perturbation phase.	[L ³ /T]	m ³ /s
Q ₁		Flow in test section during pumping with pump flow Q _{p1} ,	[L ³ /T]	m ³ /s
		(flow logging).		
Q ₂		Flow in test section during pumping with pump flow $Q_{p1}$ ,	[L ³ /T]	m³/s
		(flow logging).		
ΣQ	SumQ	Cumulative volumetric flow along borehole	[L ³ /T]	m³/s
$\Sigma Q_0$	SumQ0	Cumulative volumetric flow along borehole, undisturbed	[L ³ /T]	m³/s
		conditions (ie, not pumped)		
$\Sigma Q_1$	SumQ1	Cumulative volumetric flow along borehole, with pump	[L ³ /T]	m³/s
		flow Q _{p1}		
$\Sigma Q_2$	SumQ2	Cumulative volumetric flow along borehole, with pump	[L³/T]	m³/s
		flow Q _{p2}		
$\Sigma Q_{C1}$	SumQC1	Corrected cumulative volumetric flow along borehole,	[L³/T]	m³/s
		$\Sigma Q_1 - \Sigma Q_0$		
$\Sigma Q_{C2}$	SumQC2	Corrected cumulative volumetric flow along borehole,	[L ³ /T]	m³/s
		$\Sigma Q_2 - \Sigma Q_0$		
q		Volumetric flow per flow passage area (Specific	$([L^{3}/T^{*}L^{2}])$	m/s
		discharge (Darcy velocity, Darcy flux, Filtration velocity)).		
V		Volume	[L ³ ]	m ³
V _w		Water volume in test section.	[L ³ ]	m ³
Vp		Total water volume injected/pumped during perturbation	[L ³ ]	m ³
		phase.		
V		Velocity	$([L^3/T^*L^2])$	m/s
Va		Mean transport velocity (Average linear velocity (Average	$([L^3/T*L^2])$	m/s
		linear groundwater velocity, Mean microscopic velocity));.		
		v _a =q/n _e		
t		Time	ודו	hour,mi
				n,s
to		Duration of rest phase before perturbation phase.	[T]	S
t _p		Duration of perturbation phase. (from flow start as far as	[T]	S
		p _p ).		
t _F		Duration of recovery phase (from $p_p$ to $p_F$ ).	[T]	S
t ₁ , t ₂ etc		Times for various phases during a hydro test.	[T]	hour,mi
				n,s
dt		Running time from start of flow phase and recovery	[T]	S
		phase respectively.		
dt _e		$dt_e = (dt \cdot tp) / (dt + tp)$ Agarwal equivalent time with dt as	[T]	S
		running time for recovery phase.		
t _D		$t_D = T \cdot t / (S \cdot r_w^2)$ . Dimensionless time	-	-
a		Static pressure: including non-dynamic pressure which	$[M/(LT)^2]$	kPa
		depends on water velocity. Dynamic pressure is normally	[(, , ]	
		ignored in estimating the potential in groundwater flow		
		relations.		
D _a		Atmospheric pressure	$[M/(LT)^2]$	kPa
D _t		Absolute pressure: p.=p.=+p.	$IM/(LT)^{21}$	kPa
		Gauge pressure: Difference between absolute pressure	$[M/(I T)^2]$	kPa
۳g		and atmospheric pressure		
D ₀		Initial pressure before test begins, prior to packer	[M/(  T) ² ]	kPa
<b>P</b> 0		expansion	[	
n.		Pressure in measuring section before start of flow	[M/(Ι Τ) ² 1	kPa
n,		Pressure during perturbation phase	$\frac{[VVV(L I)]}{[M/(I T)^2]}$	kP2
Pf p		Pressure during perturbation priase.	[100/(-1)]	kDo
Ps n		Pressure in measuring section before flow ston	<u>[IVI/(LI)]</u> [Ν//(ΙΤ) ² 1	kDo
Р _р		Pressure in measuring section of ord of recovery	<u>[ויי/(בו)]</u> [אַאַיִאָר בּיַר	kDo
PF n		r = 2 - T n/(Q - n) Dimensionless maximum		кга
PD		$ p_D = 2\pi \cdot 1 \cdot p/(Q \cdot p_w g)$ , Dimensionless pressure	-	-

dp	Pressure difference, drawdown of pressure surface between two points of time.	[M/(LT) ² ]	kPa
dp _f	$dp_f = p_i - p_f$ or $p_f = p_f - p_i$ , drawdown/pressure increase of pressure surface between two points of time during	[M/(LT) ² ]	kPa
	perturbation phase. dp _f usually expressed positive.		
dps	$dp_s = p_s - p_p$ or $p_p - p_s$ , pressure increase/drawdown of pressure surface between two points of time during	[M/(LT) ² ]	kPa
dpp	$dp_p = p_i - p_p$ or $p_p = p_i - p_i$ , <b>maximal</b> pressure increase/drawdown of pressure surface between two	[M/(LT) ² ]	kPa
	points of time during perturbation phase. $dp_p$ expressed positive.		
dp _F	$dp_F = p_p - p_F$ or $= p_F - p_p$ , <b>maximal</b> pressure increase/drawdown of pressure surface between two points of time during recovery phase. dp. every	[M/(LT) ² ]	kPa
	politis of time during recovery phase. dp _F expressed		
H	Total head; (potential relative a reference level) (indication of h for phase as for p). H=h _e +h _p +h _y	[L]	m
h	Groundwater pressure level (hydraulic head (piezometric	[L]	m
	head; possible to use for level observations in boreholes,	_	
	static head)); (indication of h for phase as for p). $h=h_e+h_p$		
h _e	Height of measuring point (Elevation head); Level above reference level for measuring point.	[L]	m
n _p	Pressure head; Level above reference level for height of measuring point of stationary column of water giving corresponding static pressure at measuring point	[L]	m
h _v	Velocity head; height corresponding to the lifting for which the kinetic energy is capable (usually neglected in hydrogeology)	[L]	m
s	Drawdown; Drawdown from undisturbed level (same as dh _p , positive)	[L]	m
S _p	Drawdown in measuring section before flow stop.	[L]	m
h.	Initial above reference level before test begins, prior to		m
	packer expansion.	[[-]	
h _i	Level above reference level in measuring section before start of flow.	[L]	m
h _f	Level above reference level during perturbation phase.	[L]	m
h _s	Level above reference level during recovery phase.	[L]	m
h _p	Level above reference level in measuring section before	[L]	m
h _F	Level above reference level in measuring section at end of recovery.	[L]	m
dh	Level difference, drawdown of water level between two points of time.	[L]	m
dh _f	$dh_f = h_i - h_f$ or $= h_f - h_i$ , drawdown/pressure increase of pressure surface between two points of time during perturbation phase. $dh_f$ usually expressed positive	[L]	m
dh _s	$dh_s = h_s - h_p$ or $= h_p - h_s$ , pressure increase/drawdown of pressure surface between two points of time during	[L]	m
dh _p	$dh_p = h_i - h_p \text{ or } = h_p - h_i$ , maximal pressure increase/drawdown of pressure surface between two points of time during perturbation phase. $dh_p$ expressed	[L]	m
dh _F	$dh_F = h_p - h_F \text{ or } = h_F - h_p$ , maximal pressure increase/drawdown of pressure surface between two points of time during perturbation phase. $dh_F$ expressed	[L]	m
Te _w	Temperature in the test section (taken from temperature		°C
- Sw		1	

		logging). Temperature		
Tewo		Temperature in the test section during undisturbed		°C
		conditions (taken from temperature logging)		Ŭ
		Temperature		
Te		Temperature in the observation section (taken from		°C
1.00		temperature logging) Temperature		Ŭ
FC		Electrical conductivity of water in test section		mS/m
FC _{w0}		Electrical conductivity of water in test section during		mS/m
		undisturbed conditions		mon
FC		Electrical conductivity of water in observation section		mS/m
TDS		Total salinity of water in the test section.	[M/L ³ ]	ma/L
TDSwo		Total salinity of water in the test section during	[M/I ³ ]	ma/l
12000		undisturbed conditions.	[	ing/E
TDS		Total salinity of water in the observation section.	[M/L ³ ]	ma/L
			[ = ]	
				. 2
g		Constant of gravitation (9.81 $m^*s^2$ ) (Acceleration due to	[L/T ² ]	m/s²
		gravity)		
π	рі	Constant (approx 3.1416).	[-]	
		Desiduel r- p. p. r- h. h. etc. Difference hetusen		
ſ		Residual. $r = p_c - p_m$ , $r = n_c - n_m$ , etc. Difference between measured data (n = h = etc) and estimated data (n = h		
		measured data ( $p_m$ , $n_m$ , etc) and estimated data ( $p_c$ , $n_c$ ,		
		Mean error in residuals $MF - \frac{1}{2}\sum_{n=1}^{n} r$		
		mean error in residuals. $ME = -\sum_{i=1}^{n} r_i$		
		Normalized ME_NME=ME/(x,,x,,) x: measured		
		variable considered		
MAF				
		Mean absolute error. $MAE = \frac{1}{\Sigma}  r $		
		$n \sum_{i=1}^{ n } n^{(n)}$		
NMAE		Normalized MAE. NMAE=MAE/(x _{Max} -x _{MIN} ), x: measured		
		variable considered.		
RMS		$(1 n)^{0.5}$		
		Root mean squared error. $RMS = \left[\frac{1}{2}\sum_{r=1}^{\infty}r^{2}\right]$		
		$\left(n \sum_{i=1}^{n} i\right)$		
NRMS		Normalized RMR, NRMR=RMR/(x _{MAY} -x _{MIN} ), x; measured		
		variable considered.		
SDR		Standard deviation of residual.		
_		$\begin{pmatrix} 1 & n \end{pmatrix}^{0.5}$		
		$SDR = \left[ \frac{1}{1-1} \sum_{r=1}^{\infty} (r_r - ME)^2 \right]$		
		$\left(n-1\sum_{i=1}^{2} \binom{n}{i}\right)$		
SEMR		Standard error of mean residual		
		0.5		
		$SEMP = \begin{pmatrix} 1 & \sum_{r=1}^{n} (r & ME)^2 \end{pmatrix}$		
		$\int SEMR = \left(\frac{1}{n(n-1)}\sum_{i=1}^{n} \left(V_i - ME\right)\right)$		
Parameter	 S			1
Q/s		Specific capacity $s=dp_n$ or $s=s_n=h_0-h_n$ (open borehole)	[L ² /T]	m²/s
D		Interpreted flow dimension according to Barker. 1988.	[-]	-
		,		
dt₁		Time of starting for semi-log or log-log evaluated	<b>ГТ</b> Т	s
		characteristic counted from start of flow phase and		
		recovery phase respectively.		
dt ₂		End of time for semi-log or log-log evaluated	[T]	S
		characteristic counted from start of flow phase and		
		recovery phase respectively.		

dtL	Response time to obtain 0.1 m (or 1 kPa) drawdown in observation section counted from start of recovery phase.	[T]	S
ТВ	Flow capacity in a one-dimensional structure of width B and transmissivity T. Transient evaluation of one- dimensional structure	[L ³ /T]	m³/s
-		z ===	2,
		[[L ² /1]	
	I ransmissivity according to Moye (1967)	[L ⁻ /1]	m ⁻ /s
IQ	Q/s and T, as example see Rhén et al (1997) p. 190.		m /s
T _s	Transmissivity evaluated from slug test	[L ² /T]	m²/s
TD	Transmissivity evaluated from PFL-Difference Flow Meter	[L ² /T]	m²/s
T _I	Transmissivity evaluated from Impeller flow log	$[L^2/T]$	m²/s
T _{Sf} , T _{Lf}	Transient evaluation based on semi-log or log-log diagram for perturbation phase in injection or pumping.	[L ² /T]	m²/s
T _{Ss} , T _{Ls}	Transient evaluation based on semi-log or log-log diagram for recovery phase in injection or pumping.	[L ² /T]	m²/s
TT	Transient evaluation (log-log or lin-log). Judged best	[L ² /T]	m²/s
	Evaluation based on non-linear regression.	$[L^2/T]$	m²/s
T _{Tot}	Judged most representative transmissivity for particular test section and (in certain cases) evaluation time with respect to available data (made by SKB at a later stage).	[L ² /T]	m²/s
K	Hydraulic conductivity	[L/T]	m/s
K _s	Hydraulic conductivity based on spherical flow model	[L/T]	m/s
K _m	Hydraulic conductivity matrix, intact rock	[[L/T]	m/s
k	Intrinsic permeability	[L ² ]	m
kb	Permeability-thickness product: kb=k·b	[L ³ ]	m°
SB	Storage capacity in a one-dimensional structure of width B and storage coefficient S. Transient evaluation of one- dimensional structure	[L]	m
SB*	Assumed storage capacity in a one-dimensional structure of width B and storage coefficient S. Transient evaluation of one-dimensional structure	[L]	m
e	Storage coefficient (Storativity)	۲ I	
S C*	Assumed storage coefficient		
S _y	Theoretical specific yield of water (Specific yield; unconfined storage. Defined as total porosity (n) minus retention capacity (S _r )	[-]	-
S _{ya}	Specific yield of water (Apparent specific yield); unconfined storage, field measuring. Corresponds to volume of water achieved on draining saturated soil or rock in free draining of a volumetric unit. $S_{ya} = S_y$ (often called $S_y$ in literature)	[-]	-
Sr	Specific retention capacity, (specific retention of water, field capacity) (Specific retention); unconfined storage. Corresponds to water volume that the soil or rock has left after free draining of saturated soil or rock.	[-]	-
S _f	Fracture storage coefficient	[-]	-
S _m	Matrix storage coefficient	[-]	-
S _{NLR}	Storage coefficient, evaluation based on non-linear regression	[-]	-
S _{Tot}	Judged most representative storage coefficient for particular test section and (in certain cases) evaluation	[-]	-

		time with respect to available data (made by SKB at a		
		later stage).		
Ss		Specific storage coefficient; confined storage.	[ 1/L]	1/m
S _s *		Assumed specific storage coefficient; confined storage.	[ 1/L]	1/m
C _f		Hydraulic resistance: The hydraulic resistance is an	[T]	s
		aquitard with a flow vertical to a two-dimensional		
		formation. The inverse of c is also called Leakage		
		coefficient. c _r =b'/K' where b' is thickness of the aquitard		
		and K' its hydraulic conductivity across the aquitard.		
L _f		Leakage factor: $L_f = (K \cdot b \cdot c_f)^{0.5}$ where K represents	[L]	m
		characteristics of the aquifer.		
٤	Skin	Skin factor	[-]	-
*ع	Skin	Assumed skin factor	[-]	-
Č		Wellbore storage coefficient	$[(LT^2) \cdot M^2]$	m³/Pa
		$C_{\rm D} = C \cdot \rho_{\rm w} q / (2\pi \cdot S \cdot r_{\rm w}^2)$ . Dimensionless wellbore storage		
С		coefficient	[-]	-
- D	Stor-ratio	$\omega = S_{c}/(S_{c} + S_{m})$ storage ratio (Storativity ratio): the ratio	[-1	-
		of storage coefficient between that of the fracture and		
		total storage		
λ	Interflow-coeff	$\lambda = \alpha \cdot (K_m / K_f) \cdot r_w^2$ interporosity flow coefficient	[-]	-
10				
TOPE		Transmissivity interpreted using the GRF method	$[L^2/T]$	m²/s
SCRE		Storage coefficient interpreted using the GRF method	[ 1/L]	1/m
		Flow dimension interpreted using the GRF method	[-]	-
GRF				
Cur		Water compressibility: corresponding to 6 in	$[(LT^2)/M]$	1/Pa
<b>U</b> w		hydrogeological literature.	[(=: ,,]	
C _r		Pore-volume compressibility, (rock compressibility):	$[(LT^2)/M]$	1/Pa
		Corresponding to $\alpha/n$ in hydrogeological literature.	[(=: ),]	
C _t		$c_t = c_r + c_{w_r}$ total compressibility; compressibility per	$[(LT^2)/M]$	1/Pa
-(		volumetric unit of rock obtained through multiplying by		
		the total porosity. n. (Presence of gas or other fluids can		
		be included in $c_i$ if the degree of saturation (volume of		
		respective fluid divided by n) of the pore system of		
		respective fluid is also included)		
nc,		Porosity-compressibility factor: nc+= n·c+	$[(LT^2)/M]$	1/Pa
nc _t b		Porosity-compressibility-thickness product: ncb= n·ctb	$\frac{1}{[(L^2T^2)/M]}$	m/Pa
n		Total porosity	<u>-</u>	-
n.		Kinematic porosity (Effective porosity)	-	-
e		Transport aperture, $e = n_{c}b$	101	m
0	Density	Density	[M/L ³ ]	$ka/(m^3)$
0	Density-w	Fluid density in measurement section during	[M/I ³ ]	$kg/(m^3)$
Pw		pumping/injection		( ¹¹ )
	Density-0	Fluid density in observation section	[M/I ³ ]	$k\alpha/(m^3)$
10	Density_en	Fluid density in standnings from measurement section		$ka/(m^3)$
Psp	my			
μ	my	Dynamic Viscosity (Eluid density in measurement continue		Pa a
μw	IIIy	during pumping/injection)		ras
FC		Luid coefficient for intrincie normachility, transferance of	[ [1/] T]	1/(ma)
		Find coefficient for intrinsic permeability, transference of		1/(115)
50		<b>κ</b> το <b>κ</b> ; <b>κ</b> =FU _T · <b>κ</b> ; FU _T = $\rho_w \cdot \mathbf{g}/\mu_w$	<u> </u>   <b>F N A</b> / <del></del> ² 1 ² -	
FCs		Fluid coefficient for porosity-compressibility, transference	M/ I ⁻ L ⁻ I	Pa/m

	of $c_t$ to $S_s$ : $S_s = FC_s \cdot n \cdot c_t$ : $FC_s = \rho_w \cdot q$	
Index on K.	T and S	
S	S' semi-log	
1		
f	Pump phase or injection phase designation following S	
1	or L (withdrawal)	
-	Di L (minurawai)	
	NIL D: Non linear regression. Deformed on the entire test	
INLR	NLR. Non-linear regression. Performed on the entire test	
N.4		
	Moye	
GRF	Generalised Radial Flow according to Barker (1988)	
m	Matrix	
1	Fracture	
measl	Measurement limit. Estimated measurement limit on	
	parameter being measured (T or K)	
Т	Judged best evaluation based on transient evaluation.	
Tot	Judged most representative parameter for particular test	
	section and (in certain cases) evaluation time with	
	respect to available data (made by SKB at a later stage).	
b	Bloch property in a numerical groundwater flow model	
е	Effective property (constant) within a domain in a	
	numerical groundwater flow model.	
Index on p	and Q	
0	Initial condition, undisturbed condition in open holes	
i	Natural, "undisturbed" condition of formation parameter	
f	Pump phase or injection phase (withdrawal, flowing	
	phase)	
s	Recovery, shut-in phase	
p	Pressure or flow in measuring section at end of	
۳	perturbation period	
F	Pressure in measuring section at end of recovery period.	
m	Arithmetical mean value	
c	Estimated value. The index is placed last if index for	
Ū	"where" and "what" are used. Simulated value	
m	Measured value. The index is placed last if index for	
	"where" and "what" are used. Measured value	
Some misc	ellaneous indexes on p and h	
w	Test section (final difference pressure during flow phase	
	in test section can be expressed do	
	"where" and second index shows "what")	
0	Observation section (final difference pressure during flow	
0	nhase in observation section can be expressed do	
	First index shows "where" and second index shows	
	"what")	
f	Fresh-water head. Water is normally numbed up from	
1	section to measuring bases where pressure and level are	
	observed. Density of the water is therefore approximately	
	the same as that of the measuring section. Measured	
	aroundwater level is therefore normally represented by	
	yroundwater revents therefore normality represented by what is defined as point water boad. If procedure at the	
	what is defined as point-water field. If pressure at the	
	measuring level is recalculated to a level for a column of	
	water with density of fresh water above the measuring	
	point it is referred to as tresh-water head and h is	
	indicated last by an r. Observation section (final level	
	during flow phase in observation section can be	
	expressed n _{opf} ; the first index shows "where" and the	
	second index snows "what" and the last one	

## **APPENDIX 7**

SICADA Data Tables

## **APPENDIX 7-1**

Capacity Test

# **APPENDIX 7-2**

Flow Logging-Impeller

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SKB			$\mathbf{S}$	CA	DA/	Data	Impo	ort Templa	ate	(Simplified version v1.2 SKB & Ergodata AB 200	[4 2)			
File Identit Created B Create	9 F K K K K K K K K K K K K K K K K K K	500 sinder van der Wall 2004.09.21 11.07	·											
Activity Typ	<u>e</u>	JLU Flow logging-Impelk	5		<b>[1</b>	Project			AP PS 400-03-077		[]			
Activity Inforn	lation					Additional	Activity Data							
						C10	1250	P20	P200	P220	R110	R240	R25	R90
Idcode	Start Date	Stop Date	Secup (m)	Seclow (m)	Section No	Company	Test equipment	Field crew manager	Field crew	Person evaluating data	Field Notes ID	calibratio n type	Report	Quality plan
HAV12	2004.07.02 13:50	2004.07.02 20:52	30.00	156.00	C	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Tomas Cronqui	st Reinder van der Wal	_			
HAV14	2004.07.08 11:00	2004.07.08 19:36	32.00	180.0	0	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Tomas Cronqui	st Reinder van der Wal	=			
HAV11 HSH04	2004.07.13 10:30 2004.07 16 10:15	2004.07.13 19:03 2004.07.16 15:50	26.00	122.0 202.0(		Golder	HTHB	Reinder van der Wall Reinder van der Wall	Reinder van der Wall, Karsten Ebeling Reinder van der Wall Karsten Fbeling	g Reinder van der Wal Reinder van der Wal	= =			
HSH05	2004.07.18 10:30	2004.07.18 15:18	36.00	198.00	0	Golder	НТНВ	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Beinder van der Wal				
HAV13	2004.07.21 11:42	2004.07.21 11:42	22.00	22.0	0	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	g Reinder van der Wal	_			

Table	Flov	plu_impel wlogging with impeller, ev	II_main_res
Column	Datatype	Unit	Column Description
site	CHAR	•	Investigation site name
activity type	CHAR		Activity type code
start date	DATE		Date (yymmdd hh:mm:ss)
stop_date	DATE		Date (yymmdd hh:mm:ss)
project	CHAR		project code
idcode	CHAR		Object or borehole identification code
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
section_no	INTEGER	number	Section number
corr	FLOAT	m	Corrected length to point of measured value
_ cum_flow_q	FLOAT	m**3/s	Q: Cumulative flow rate:Q1-Qo, see table description
cum_flow_qo	FLOAT	m**3/s	Qo: Undisturbed cumulative flow rate, see table description
cum_flow_q1	FLOAT	m**3/s	Q1: Pumpeded cumulative flow rate, see table description
cum_flow_qt	FLOAT	m**3/s	Q_T:Cumulative flow rate:Q at the top of meas.interval,see .
cum_flow_q1t	FLOAT	m**3/s	Q_1T:Cumulative flow:Q1at the top of measured interval,see .
qt_corr	FLOAT	m**3/s	QTcorr:Cumulative flow QT based on corrected bh.diameter.
transmissitivy_	FLOAT	m**2/s	T: Transmissivity of the entire hole, see table description
value_type_t	CHAR		0:true value,-1:T <lower meas.limit,1:t="">upper meas.limit</lower>
bc_t	CHAR		Best choice code: 1 means T is best transm. choice, else 0
cum_transmis	FLOAT	m**2	T_F: Cumulative transmissivity, see table description
value_type_tf	CHAR		0:true value,-1:TF <lower meas.limit,1:tf="">upper meas.limit</lower>
bc_tf	CHAR		Best choice code: 1 means TF is best transm. choice, else 0
transmissivity_	FLOAT	m**2	T_FT: Cumulative transmissivity, see table description
value_type_tft	CHAR		0:true value,-1:TFT <lower meas.limit,1:tft="">upper meas.limit</lower>
l_meas_limit_t	1FLOAT	m**2/s	Lower measurement limit of T_F,see table description
u_meas_limit_	FLOAT	m**2/s	Upper measurement limit of T_F, see table description
bc_tft	CHAR		Best choice code: 1 means TFT is best transm. choice,else 0
fluid_temp_tev	FLOAT	oC	Undisturbed fluid temperature of test section, see
fluid_elcond_e	FLOAT	mS/m	Undisturbed fluid el.conductivity of testsection, see descr.
total_salinity_t	FLOAT	mg/l	Undisturbed total salinity of test section, see table descr.
fluid_temp_tev	FLOAT	oC	Fluid temperature of test section, see table descr.
fluid_elcond_e	FLOAT	mS/m	Fluid el.conductivity of test section, see table descr.
total_salinity_t	FLOAT	mg/l	Total salinity of test section, see table descr.
reference	CHAR		SKB number for reports describing data and results
comments	CHAR		Short comment to evaluated data (optional)
error_flag	CHAR		If error_flag = "*" then an error occured and an error
in_use	CHAR		If in_use = "*" then the activity has been selected as
sign	CHAR		Signature for QA data accknowledge (QA - OK)

idcode	start date	ston date	secup	seclow	section no	L corr	cum_flow_	
	2004 07 02 13:50	2004 07 02 20:52	30.00	156.00	section_no	1_0011	1 1505E 03	
	2004.07.02 13.50	2004.07.02 20.32	32.00	180.00			1.1393E-03	
	2004.07.00 11.00	2004.07.13 10:03	26.00	122.00			1.0203E-03	
	2004.07.15 10.30	2004.07.15 19.03	20.00	202.00			1.1740E-03	
HSH05	2004.07.10 10.13	2004.07.18 15:18	36.00	198.00			1.6670E-05	
	2004.07.10 10.30	2004.07.10 13.10	22.00	22.00			1.0070E-03	
IIAV15	2004.07.21 11.42	2004.07.21 11.42	22.00	22.00			1.19002-03	
idcode	cum flow go	cum flow q1	cum_flow_q t	cum_flow_q 1t	gt corr	transmissitiv v hole t	value_type t	bc t
HAV/12			1 1230E-03			1 84F-04	0	0
HAV14		}	1 1230E-03			1 40F-04	0	0
HAV11			1 1900E-03			9 20E-05	0	0
HSH04			5 8170E-04		+	9.60F-04	0	0
HSH05			6.9330E-05			5 22E-04	0	0
HAV13			1 1688E-03			1.83E-04	0	0
idcode	cum_transmissivi ty_tf	value_type_tf	bc_tf	transmissivi ty_tft	value_type_ tft	I_meas_limit _tf	u_meas_li mit_tf	bc_tft
HAV12	1.84000E-04	0	0			6.25E-06		Í
HAV14	1.31100E-04	0	0			7.46E-06		
HAV11	9.20000E-05	0	0			1.18E-05		
HSH04	7.18000E-05	0	0			5.87E-06		1
HSH05	1.25500E-04	0	0			3.74E-06		
HAV13	1.83000E-04	0	0			1.04E-05		
idaada	fluid town town	fluid alcord covo	total_salinit	fluid_temp_	fluid_elcond	total_salinity	roforonoo	commonto
			y_105W0	0.04			reference	
	8.83	993.0		8.34	820.8			<b> </b>
HAV14	9.37	30.8		8.42	32.0			
HAV11	8.92	1161.0		8.79	1143.0			
HSHU4	9.63	824.8		12.49	878.0	<u> </u>	<b> </b>	l
HSH05	9.34	/89.0		8.52	/3/.3			
HAV13		1	1	8.66	833.7			1

Table		plu_impeller_an	omaly								
	E	valuated data of interprete	ed anomalies								
L					1						
Column	Datatype	Unit	Column Des	cription				1			
site	CHAR		Investigation site	name							
activity_type	CHAR		Activity type code	e							
start_date	DATE		Date (yymmdd hl	h:mm:ss)							
stop_date	DATE		Date (yymmdd hl	h:mm:ss)							
project	CHAR		project code								
idcode	CHAR		Object or boreho	le identification co	de						
secup	FLOAT	m 	Upper section lim	nit (m)							
section no	INTEGER	number	Section number	iit (m)							
upper limit	FLOAT	m	Corrected upper	limit of anomaly, s	ee table descriptio	n					
lower limit	FLOAT	m	Corrected lower I	limit of anomaly in	borehole.see desc	л. я.					
fluid temp tew	FLOAT	oC	Section fluid tem	perature, see table	e description.						
fluid_elcond_ecw	FLOAT	mS/m	section fluid elect	tric conductivity,se	e table description						
fluid_salinity_tdsw	FLOAT	mg/l	Total salinity of s	ection fluid, see ta	ble description						
deltaqi	FLOAT	m**3/s	deltaQi : Flow rat	te of interpreted flo	w anomaly i						
deltaqi_corr	FLOAT	m**3/s	deltaQicorr=delta	Q1 based on corr	ected borehole dia	m.					
spec_cap_deltaqi_s	f FLOAT	m**2/s	deltaQi/S_FL: Sp	ecific capacity of i	nterpreted flow and	omaly					
value_type_qi_sfl	CHAR		0:true value,-1: <l< td=""><td>ower meas.limit,1:</td><td>&gt;upper meas.limit.</td><td></td><td></td><td></td><td></td><td></td><td></td></l<>	ower meas.limit,1:	>upper meas.limit.						
bi	FLOAT	m	Interpreted forma	ation thickness rep	resentative for Ti, s	see					
transmissivity_ti		m**2/s	Otrue volue 1:Ti	ISMISSIVITY OF FIOW a	anomaly,see table	descr.					
value_type_ti	CHAR		Best choice code	1 means Ti is be	t choice oT else (	) )					
L meas limit ti	FLOAT	m**2/s	Lower measurem	ent limit of Tillsee	table description	,					
u meas limit ti	FLOAT	m**2/s	Upper measurem	nent limit of Ti, see	table description						
comments	CHAR		Short comment of	on evaluated parar	neters						
error_flag	CHAR		If error_flag = "*"	then an error occu	ured and an error						
in_use	CHAR		If in_use = "*" the	en the activity has	been selected as						
sign	CHAR		Signature for QA	data accknowledg	ge (QA - OK)						
								l			
	1	1	1	T	T	1	1	1	. <u></u>		9
idcode	start date	ston date	secun	seclow	section no	upper limit	lower limit	fluid_te	fluid_elco	fluid_salin	
	2004 07 02 13:50	2004 07 02 20:52	30.00	156.00		151.00	152.00	8.82	002.8	ity_taon	
HAV12	2004.07.02 13:50	2004.07.02.20:52	30.00	156.00		142.50	146.00	8 75	962.3	3	
HAV12	2004.07.02 13:50	2004.07.02 20:52	30.00	156.00		134.50	136.00	8.71	951.8	3	
HAV12	2004.07.02 13:50	2004.07.02 20:52	30.00	156.00	)	32.50	36.00	8.41	898.0		
HAV14	2004.07.08 11:00	2004.07.08 19:36	32.00	180.00		165.00	167.00	9.04	29.8	3	
HAV14	2004.07.08 11:00	2004.07.08 19:36	32.00	180.00		42.00	45.00	8.66	32.5	5	
HAV11	2004.07.13 10:30	2004.07.13 19:03	26.00	122.00	)	122.00	220.50	8.92	1160.0	)	
HAV11	2004.07.13 10:30	2004.07.13 19:03	26.00	122.00		57.50	61.50	8.81	1154.0		
HSH04	2004.07.16 10:15	2004.07.16 15:50	25.00	202.00		28.00	29.00	12.18	863.0		
HSH05	2004.07.18 10:30	2004.07.18 15:18	36.00	198.00		62.00	64.00	8.53	769.6	,	
HAV 13	2004.07.21 11.42	2004.07.21 11.42	22.00	22.00	, 	22.00	142.20	0.00	033.7		
			spec cap d	value type		transmissivi	value type		l meas li	lu meas li	
idcode	deltaqi	deltaqi_corr	eltaqi_sfl	qi_sfl	bi	ty_ti	_ti	bc_ti	mit_ti	mit_ti	comments
HAV12	4.7830E-04				1.00	7.74E-05	0	0	6.25E-06	6	
HAV12	3.5670E-04				3.50	5.77E-05	0	0	6.25E-06	6	
HAV12	1.3500E-04	•			1.50	2.19E-05	0	0	6.25E-06	6	
HAV12	1.6670E-04				3.50	2.70E-05	0	0	6.25E-06	6	
HAV14	6.1330E-04				2.00	8.00E-05	0	0	7.46E-06	6	
HAV14	3.9170E-04				3.00	5.11E-05	0	0	7.46E-06	5	
HAV11	1.0980E-03				98.50	8.49E-05	0	0	1.18E-05	-	
	9.16/UE-05	) :			4.00	7.09E-06	0	0	5.87E.00		
HSH05	4.3000E-05			+	2.00	1.10E-05	0	0	3.74E-06		
HAV13	1.1980E-03				120.20	1.83E-04	0	0	1.04E-05	5	
		L		1			12	12		1	

Table		plu_impelle Flow logging using i	pr_basic_d mpeller, basic data	
Column	Datatype	Unit	Column Description	
site	CHAR		Investigation site name	
start_date	DATE		Date (yymmdd hh:mm:ss)	
stop_date	DATE		Date (yymmdd hh:mm:ss)	
start_flowlogging	DATE	yyyymmdd	Date and time of flowlogging start (YYYY-MM-DD hh:mm:ss)	
stop_flowlogging	DATE	yyyymmdd	Date and time of flowlogging stop (YYYY-MM-DD hh:mm:ss)	
I_corrected	FLOAT	m	Corrected length during logging, see table description	
test_type	CHAR		Type of test, one of 7; see table description	
formation_type	CHAR		1: Rock, 2: Soil (supeficial deposits)	
q_measl_l	FLOAT	m**3/s	Estimated lower measurement limit of borehole flow in probe	
q_measl_u	FLOAT	m**3/s	Estimated upper measurement limit of borehole flow in probe	
surface_flow_qp	FLOAT	m**3/s	Flow rate at surface during flow logging	
dur_flow_phase_tp	FLOAT	S	Time for the flowing phase of the test	
dur_flowlog_tfl	FLOAT	S	Time for flowlogging survey	
drawdown_sfl	FLOAT	m	Average drawdown open borehole during flowlogging	
initial_head_ho	FLOAT	m.a.s.l.	Initial hydraulic head (open borehole), see table description	
head_first_pump_hp	FLOAT	m.a.s.l.	Stabilised head during 1st pump period, see table description	
reference	CHAR		SKB report number for reports describing data & evaluation	
comments	VARCHAR		Short comment to the evaluated parameters (optional))	

						start flowloggin	stop flowloggin	l correct		formatio
idcode	start_date	stop_date	secup	seclow	section_no	g	g	ed	test_type	n_type
HAV12	2004.07.02 13:50	2004.07.02 20:52	30.00	156.00		2004.07.02 13:50	2004.07.02 20:52		6	1
HAV14	2004.07.08 11:00	2004.07.08 19:36	32.00	180.00		2004.07.08 11:00	2004.07.08 19:36		6	1
HAV11	2004.07.13 10:30	2004.07.13 19:03	26.00	122.00		2004.07.13 10:30	2004.07.13 19:03		6	1
HSH04	2004.07.16 10:15	2004.07.16 15:50	25.00	202.00		2004.07.16 10:15	2004.07.16 15:50		6	1
HSH05	2004.07.18 10:30	2004.07.18 15:18	36.00	198.00		2004.07.18 10:30	2004.07.18 15:18		6	1
HAV13	2004.07.21 11:42	2004.07.21 11:42	22.00	22.00		2004.07.21 11:42	2004.07.21 11:42		6	1
								head_firs		
			surface_flow	dur_flow_ph	dur_flowlog			t_pump_		comment
idcode	q_measl_l	q_measl_u	_qp	ase_tp	_tfl	drawdown_sfl	initial_head_ho	hp	reference	s
HAV12	5.0000E-05	1.6670E-03	1.0600E-03	36180.00	25320.00	7.88	-0.59	-8.47		
HAV14	5.0000E-05	1.6670E-03	1.0600E-03	39000.00	30960.00	6.47	-3.41	-9.88		
HAV11	5.0000E-05	1.6670E-03	1.1900E-03	38220.00	30780.00	4.12	0.25	-3.87		
HSH04	5.0000E-05	1.6670E-03	5.6000E-04	36240.00	20100.00	8.41	0.28	-8.13	i	
HSH05	5.0000E-05	1.6670E-03	6.9500E-05	36600.00	17280.00	13.37	-0.11	-13.48		
HAV13	5.0000E-05	1.6670E-03	1.1500E-03	36060.00	100.00	4.81	-0.62	-5.43		

# **APPENDIX 7-3**

Interference Test - CRwr

Page 7-3/1

										(Simplified version v1.2)			
C C C C C C C C C C C C C C C C C C C						ADA	/Data Import 7	[emplate]					
										SKB & Ergodata AB 2004	1		
File Identity			<b></b>										
Created By Created	Reinc 20	der van der Wall 304.09.10 13:54											
			7										
Activity Type	bri bri	10 U Interference test - 1	CRwr			Project		AP PS 4	00-03-077				
					-1						-1		
Activity Informa	ttion					Additional	Activity Data						
					5	C10	ID80	P20	P200	P220	R110	R25	R90
			Secu	Seclow S	ection					Person evaluating	Field		Quality
Idcode	Start Date	Stop Date	b (m)	(m)	0	Company	Observation borehole	Field crew manager	Field crew	data	Notes ID	Report	plan
HAV12	040702 08:54	040703 08:44	11.34	157.80	-	Golder	HAV13, HAV14, HAV02, HAV03, HAV05, HAV07, HAV08, KAV01	Reinder van der Wall	Reinder van der Wall, Nils Rahm	Cristian Enachescu			
HAV12 rep	040704 08:24	040705 08:43	11.34	157.80	-	Golder	HAV13, HAV14, HAV02, HAV03, HAV05, HAV07, HAV08, KAV02	Reinder van der Wall	Reinder van der Wall, Tomas Cronquis	t Cristian Enachescu			
HAV14	040707 08:09	040709 10:11	12.85	182.40		Golder	HAV13, KAV04A, HAV05, HAV07, HAV08	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			
HAV11	040711 08:24	040714 09:06	6.03	220.50		Golder	KAV04A, KSH03, KAV01	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			
HSH04	040715 08:11	040717 08:35	9.00	236.20	-	Golder	HSH06, HSH01	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			
HSH05	040717 13:08	040719 08:43	6.20	200.20	-	Golder		Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			
HAV13	040720 08:03	040722 13:31	9.04	142.20	-	Golder	HAV12, HAV14, HAV02, HAV03, HAV05, HAV07, HAV08, KAV01	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			

Table		plu_s_hole	e_test_d
		PLU Injection and pumpin	g, General information
Column	Deteture	110:4	Column Description
Column	Datatype	Unit	
SITE	CHAR		Investigation site name
activity_type	CHAR		Activity type code
start_date	DATE		Date (yymmod nn:mm:ss)
stop_date	DATE		Date (yymmod nn:mm:ss)
project	CHAR		project code
Idcode	CHAR		Object or borehole identification code
secup	FLOAT	m	Upper section limit (m)
seclow	FLOAT	m	Lower section limit (m)
section_no	INTEGER	number	Section number
test_type	CHAR		Test type code (1-7), see table description
formation_type	CHAR		1: Rock, 2: Soil (superficial deposits)
start_flow_period	DATE	yyyymmdd	Date & time of pumping/injection start (YYYY-MM-DD hh:mm:ss)
stop_flow_period	DATE	yyyymmdd	Date & time of pumping/injection stop (YYYY-MM-DD hh:mm:ss)
mean_flow_rate_qm	1 FLOAT	m**3/s	Arithmetic mean flow rate of the pumping/injection
flow_rate_end_qp	FLOAT	m**3/s	Flow rate at the end of the flowing oeriod
value_type_qp	CHAR		0:true value,-1 <lower meas.limit1:="">upper meas.limit</lower>
q_measll	FLOAT	m**3/s	Estimated lower measurement limit of flow rate
q_measlu	FLOAT	m**3/s	Estimated upper measurement limit of flow rate
tot_volume_vp	FLOAT	m**3	Total volume of pumped(positive) or injected(negative) water
dur_flow_phase_tp	FLOAT	s	Time for the flowing phase of the test
dur_rec_phase_tf	FLOAT	s	Time for the recovery phase of the test
initial_head_hi	FLOAT	m	Initial formation head, see table description
head at flow end	FLOAT	m	Hydraulic head at end of flow phase, see table description
final head hf	FLOAT	m	Hydraulic head at end of recovery phase see table descript.
initial_press_pi	FLOAT	kPa	Initial formation pressure. Actual formation pressure
press at flow end	FLOAT	kPa	Pressure at the end of flow phase, see table description.
final_press_pf	FLOAT	kPa	Fimal pressure at the end of the recovery, see table descr.
fluid temp tew	FLOAT	oC	Section fluid temperature, see table description
fluid elcond ecw	FLOAT	mS/m	Section fluid el. conduvtivity see table description
fluid salinity tosw	FLOAT	ma/l	Total salinity of section fluid based on EC see table descr
fluid salinity tdswm	FLOAT	ma/l	Tot, section fluid salinity based on water sampling see
reference	CHAR		SKB report No for reports describing data and evaluation
comments	VARCHAR		Short comment to data
error flag	CHAR		If error flag = "*" then an error occured and an error
in use	CHAR		If in use = "*" then the activity has been selected as
sian	CHAR		Signature for QA data accknowledge (QA - QK)
ln	FLOAT	m	

idcode	start_date	stop_date	secup	seclow	section_no	test_type	formation_ type	
HAV12	040702 08:54	040703 08:44	11.34	157.80		1B	1	
HAV12 rep	040704 08:24	040705 08:43	11.34	157.80		1B	1	
HAV14	040707 08:09	040709 10:11	6.03	182.40		1B	1	
HAV11	040711 08:24	040714 09:06	6.03	220.50		1B	1	
HSH04	040715 08:11	040717 08:35	9.00	236.20		1B	1	
HSH05	040717 13:08	040719 08:43	6.20	200.20		1B	1	
HAV13	040720 08:03	040722 13:31	9.04	142.20		1B	1	
			mean flow r	flow rate e	value type		g measl	
idcode	start_flow_period	stop_flow_period	ate_qm	nd_qp	qp	q_measll	u	
HAV12	2004.07.02 11:48:00	2004.07.02 21:51:00	1.0700E-03	1.0600E-03	0	5.0000E-05	1.6700E-03	
HAV12 rep	2004.07.04 08:25:00	2004.07.04 18:26:00	1.0700E-03	1.0600E-03	0	5.0000E-05	1.6700E-03	
HAV14	2004.07.08 08:50:00	2004.07.08 19:40:00	1.0700E-03	1.0600E-03	0	5.0000E-05	1.6700E-03	
HAV11	2004.07.13 08:27:00	2004.07.13 19:04:00	1.1900E-03	1.1900E-03	0	5.0000E-05	1.6700E-03	
HSH04	2004.07.16 08:12:00	2004.07.16 18:15:00	5.8200E-04	5.6000E-04	0	5.0000E-05	1.6700E-03	
HSH05	2004.07.18 08:08:00	2004.07.18 18:18:00	6.9300E-05	6.9500E-05	0	5.0000E-05	1.6700E-03	
HAV13	2004.07.21 08:44:00	2004.07.21 18:45:00	1.1700E-03	1.1500E-03	0	5.0000E-05	1.6700E-03	
idcode	tot_volume_vp	dur_flow_phase_tp	dur_rec_pha se_tf	initial_head _hi	head_at_flo w_end_hp	final_head_ hf	initial_pres s_pi	press_at_flow_end_ pp
HAV12	3.6900E+01	36180.00	39180.00	-0.59	-8.47	-0.47	215.90	137.10
HAV12 rep	3.8464E+01	36060.00	51540.00	-0.34	-8.45	-0.59	218.40	137.30
HAV14	4.1730E+01	39000.00	45300.00	-3.41	-9.88	-3.94	208.90	144.20
HAV11	4.5482E+01	38220.00	48840.00	0.25	-3.87	-0.15	246.70	205.50
HSH04	2.1092E+01	36240.00	51600.00	0.28	-8.13	0.47	240.20	156.10
HSH05	2.5364E+00	36600.00	51900.00	-0.11	-13.48	-0.42	325.50	191.80
HAV13	4.2190E+01	36060.00	67500.00	-0.62	-5.43	-0.85	197.20	149.10
idcode	final_press_pf	fluid_temp_tew	fluid_elcond _ecw	fluid_salinit y_tdsw	fluid_salinity _tdswm	reference	comments	lp
HAV12	214 10	8.34	820.8					
HAV12 rep	215.90	8.36	817 7					
HAV14	203.60	8 42	32.0					
HAV11	242.70	8.79	1143.0					
HSH04	242 10	12 49	878.0					
HSH05	322.40	8.52	737.3					
HAV13	194.90	8.66	833.7					

	Table	PLU Sing	plu_s_hol gle hole tests, pump	e_test_ed1 ping/injection. Basic e	valuation		_	_	_	_	_	_	_	_		
	Column	Datatype	Unit	Column Descr	iption				1							
diam       Gene       May be address         image       Gene       Final Section Sectin Section Section Sectin Section Sectin Section Section Sectin Se	ite	CHAR		Investigation site na	ame											
	ctivity_type	CHAR		Activity type code												
	tart_date	DATE		Date (yymmdd hh:r	nm:ss)											
	top_date	DATE		Date (yymmdd hh:r	nm:ss)											
	roject	CHAR		Object code	identification code											
	acup	ELOAT	m	Upper section limit	(m)											
	eclow	FLOAT	m	Lower section limit	(m)											
	ection no	INTEGER	number	Section number	()											
	est type	CHAR		Test type code (1-7	), see table descri	ption!										
	ormation_type	CHAR		Formation type cod	le. 1: Rock, 2: Soil	(superficial depos	its)									
		FLOAT	m	Hydraulic point of a	pplication											
	eclen_class	FLOAT	m	Planned ordinary te	est interval during t	est campaign.										
	pec_capacity_q_s	FLOAT	m**2/s	Specific capacity (0	Q/s) of test section,	, see table descrip	t.									
	alue_type_q_s	CHAR		0:true value,-1:Q/s	<lower meas.limit,1<="" td=""><td>1:Q/s&gt;upper meas</td><td>limit</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></lower>	1:Q/s>upper meas	limit									
	ansmissivity_tq	FLOAT	m**2/s	Tranmissivity base	d on Q/s, see table	description										
	alue_type_tq	CHAR		Utrue value,-1:1Q<	lower meas.limit,1	: I Q>upper meas.	limit.									
Lin         Control         Ext control of a run in the spin is for control of run of a run in the spin is for control in the spin in the spin in the spin is for control in the spin in the spin in the spin is for control in the spin in the s	5_1Q anemieeivity move	LIOAT	m**2/e	Tranemiesiwity TM	based on Move (	t choice of 1, eise	U									
Ling Dig         Out         Unit Network was bit 1. Notwer mask bi	c fm	CHAR	111 2/3	Best choice code	1 means Tmove is	best choice of T	else 0									
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bit         bi	dcode	start date	stop date	secup	seclow	section no	test type	vpe	Ip	ass	acity n e	pe cis	vity to	ta	bc to	move
AV12 rep         040704 08:24         040705 08:39         1.1.34         157.80         18         1         152.00         1.31E 040	AV12	040702 08:54	040703 08:44	11.34	157.80		1B	1	152.00	0	1.35F-04	0				1.71F-
AV14         040707 08:09         040709 10:11         6.03         182:40         1B         1         167:00         1.63E:04         0         2.10E           AV11         040710 08:09         040709 10:11         6.03         1220:00         1.63E:04         0         2.10E           AV11         040711 08:24         0407174 09:06         6.03         220:00         1B         1         125:00         2.88E:04         0         3.85E           SH04         040715 08:10         1040717 03:08         040719 08:43         6.20         200:20         1B         1         125:00         6.66E:05         0         6.89E           SH05         040717 13:08         040720 08:03         040720 213:31         9.04         142:20         1B         1         121:00         2.39E-04         0         2.39E           Locde         bc_tm         m         more organization with of ch annel b         th         1         121:00         2.39E-04         0         1         1.00E           AV12         0         0         0         1.82E-04         0         1         1.00E           AV12         0         0         0         1         1.00E         1         1.00E	AV12 rep	040704 08:24	040705 08:43	11.34	157.80		1B	1	152.00		1.31E-04	0				1.66F-
AV11         040711 08:24         040714 09:06         6.03         220:50         1B         1         220:00         2.89E-04         0	AV14	040707 08:09	040709 10:11	6.03	182.40		1B	1	167.00	D	1.63E-04	0				2.10E-
SH04         040715 08:11         040717 08:35         9.00         236.20         1B         1         125.00         6.65E-05         0          6.83E           SH05         040717 13:08         040719 08:43         6.20         200.20         1B         1         120.00         5.20E-06         0         6.65E-05         0         6.63E         6.63E         0         0         6.83E         0         2.39E-04         0         6.63E         0         0         6.83E         0         2.39E-04         0         0         2.39E         0         0         2.39E         0         0         0         0         0         2.39E         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0         0	AV11	040711 08:24	040714 09:06	6.03	220.50		1B	1	220.00	D	2.89E-04	0	1			3.85E-
SH05         040717 13:08         040719 08:43         6.20         200.20         1B         1         5205-06         0         M         6.81E           AV13         040720 08:03         040722 13:31         9.04         142.20         1B         1         121.00         2.39E-04         0         1.30E-04         0         1.30E-04         0         1.30E-04         0         1.30E-04         0         1.30E-04         1.30E-04         0         1.30E-04         0         1.30E-04         0         1.30E-04         1         1.00E           AV12         0         0         0         0         0         0         1         1.00E         1         1.00E         1.30E-04         1         1.00E	SH04	040715 08:11	040717 08:35	9.00	236.20		1B	1	125.00	)	6.65E-05	0				8.89E-
AV13         040720 08:03         040722 13:31         9.04         142.20         1B         1         121.00         2.39E-0         0         m         m         2.99E           Icode         bc_tm         walue_type_t         hydr_cond_m         formation_w         width_of_ch         annel_b         IL         121.00         2.39E-04         0         m         m         2.99E           Icode         bc_tm         walue_type_t         hydr_cond_m         formation_w         width_of_ch         annel_b         IL         meas_tb         assumed_leakage_t         transmissi         value_type_t         bc_tt         I_measl_ga           AV12         0         0         1         1000         1         1000         1         1000           AV12 ep         0         0         1         1         1000         1         1000           AV14         0         0         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         1         <	SH05	040717 13:08	040719 08:43	6.20	200.20		1B	1			5.20E-06	0				6.81E-
kode         kode <th< td=""><td>AV13</td><td>040720 08:03</td><td>040722 13:31</td><td>9.04</td><td>142.20</td><td></td><td>1B</td><td>1</td><td>121.00</td><td>)</td><td>2.39E-04</td><td>0</td><td>L</td><td></td><td></td><td>2.99E</td></th<>	AV13	040720 08:03	040722 13:31	9.04	142.20		1B	1	121.00	)	2.39E-04	0	L			2.99E
interpretation         interpr																
icode         value_type_t         hydr_cond_m (ormation_w)         width_of_ch (widt_b)																
tocode         bc_tm         m         oye         ldth_b         annel_b         tb         l_measl_th         bs         sb         factor_ff         vity_tt         tt         bc_tt         l_measl_q           AV12         0         0         0         0         1         1.00E			value_type_t	hydr_cond_m	formation_w	width_of_ch			u_measl		assumed_	leakage_	transmissi	value_type		
AV12         0         1.80E-04 0         1         1.00E           AV12 rep         0         0         1.06E-04 0         1         1.00E           AV12 rep         0         0         1.06E-04 0         1         1.00E           AV14         0         0         1.39E-04 0         1         1.00E           AV14         0         0         9.20E-05 0         1         8.00E           SH04         0         0         9.20E-04 0         1         8.00E           SH05         0         0         1.33E-04 0         1         4.00E           AV13         0         0         1.33E-04 0         1         1.00E	lcode	bc_tm	m	оуе	idth_b	annel_b	tb	I_measl_tb	_tb	sb	sb	factor_lf	vity_tt	_tt	bc_tt	I_measl_q_s
AV12 rep         0         0         1.06E-04[0         1         1.00E           AV14         0         0         1.39E-04[0         1         1.00E           AV14         0         0         1.39E-04[0         1         1.00E           AV11         0         0         9.20E-05[0         1         8.00E           SH04         0         0         9.60E-04[0         1         8.00E           SH05         0         0         1         4.00E         9.22E-04[0         1         4.00E           AV13         0         0         0         1         1.00E         1.00E         1.00E         1.00E	AV12	0	0										1.80E-04	0	1	1.00E-
IAV14         0         0         1.39E-04[0         1         1.00E           VAV11         0         0         9.20E-05[0         1         8.00E           ISH04         0         0         9.20E-05[0         1         8.00E           ISH05         0         0         5.22E-04[0         1         4.00E           AV13         0         0         1         1.00E         1.83E-04[0         1         1.00E	AV12 rep	0	0										1.06E-04	0	1	1.00E-
IAV11         0         0         9.20E-05         1         8.00E           ISH04         0         0         0         9.60E-04         1         8.00E           ISH05         0         0         0         1         4.00E           IAV13         0         0         0         1         4.00E	AV14	0	0										1.39E-04	0	1	1.00E-
ISH04         0         9.60E-04]0         1         8.00E           ISH05         0         0         5.22E-04]0         1         4.00E           IAV13         0         0         1         1.00E         1         1.00E	AV11	0	0										9.20E-05	0	1	8.00E-
ISH05         0         0         5.22E-04         0         1         4.00E           IAV13         0         0         1         1.00E         1         1.00E	ISH04	0	0										9.60E-04	0	1	8.00E-
IAV13 0 0 1.83E-04 0 1 1.00E	ISH05	0	0										5.22E-04	0	1	4.00E-
	AV13	0	0										1.83E-04	0	1	1.00E-

	1		1			1										
dcode	u_measl_q_s	storativity_s	assumed_s	leakage_koe ff	hydr_cond_k s	value_type _ks	l_meas_lim it_ks	u_meas_ limit_ks	spec_sto rage_ss	assumed_ ss	c	cd	skin	stor_rat io	interflow_coef f	
HAV12	3.00E-04	2.25E-06	1.00E-04								1.98E-06	2.86E+01	1.60E+00			ì
HAV12 rep	1.00E-03	1.58E-05	1.00E-04								1.99E-06	4.09E+00	1.61E+01			ĺ
HAV14	3.00E-04	6.04E-05	1.00E-04								1.59E-06	8.55E-01	-2.79E+00			
HAV11	1.00E-03	1.15E-04	1.00E-04								2.75E-06	7.77E-01	1.02E+00			
HSH04	1.00E-03	1.00E-04	1.00E-04								1.65E-06	5.36E-01	8.33E+01			
HSH05	6.00E-04	1.00E-04	1.00E-04								2.28E-06	7.41E-01	0.00E+00			
HAV13	3.00E-04	4.81E-06	1.00E-04								1.58E-06	1.07E+01	-4.39E+00			
			transmissivity	storativity_s	value_type_t					stor_ratio	interflow	transmissi	value_type		storativity_s_g	1
acoae	ατι	atz	_t_ur	_ur	r	bc_t_lir	c_iir	ca_iir	skin_iir	_ur	_coett_iii	vity_t_grt	_t_grt	bc_t_grt	rr	Ľ
														1		

AV13

# **APPENDIX 7-4**

Interference Test – Observed Holes
SKB			SIC		V/Da	ta In	Iport	Temp	late	(Simplified version v1.2) SKB & Ergodata AB 2004					
File Identity Created By Created		einder van der Wall 2004.09.10 13:55									1				
Activity Type	L L L	J Interference test-obs.hc	es		<u>[]</u>	Project			AP PS 400-03-	077					
Activity Inform	ation				◄	dditional A	ctivity Data								
					U	30	240	1160	P20	P200	P220	R110	R25 F	85 R	06
Idcode	Start Date	Stop Date	Secup S (m) (n	eclow S n) N	ection e	ompany valuating ata	Company performing ield work	Instrument	Field crew manager	Field crew	Person evaluating data	Field Notes ID	Report	Jumped/i ijected C oorehole p	tuality Ian
HAV14	2004.07.04 07:59	2004.07.05 08:57	6.03	182.40		tolder 1	Golder		Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu				
HAV08	2004.07.07 09:40	2004.07.09 10:11	0.00	63.00	<u>ں</u>	older	Golder		Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu				
HAV07	2004.07.07 09:13	2004.07.09 09:39	4.00	100.00	C	older	Golder		Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu				
HAV12	2004.07.20 08:19	2004.07.22 11:34	11.34	157.80	<del>ن</del>	older	Golder		Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	<b>Cristian Enachescu</b>				
HAV02	2004.06.26 00:23	2004.07.30 22:23	0.13	163.00		folder	Golder		Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu				
				+	+										

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Table		plu_inf_t	est_obs_d	
		PLU interference test,	Observation section data	
	1			
Column	Deteture	11:4	Column Departmention	
Column	Datatype	Unit		
SITE	CHAR		investigation site name	
activity_type	CHAR			
start_date	DATE			
stop_date	DATE		and a first set of a	
project	CHAR		project code	
Idcode	CHAR		Object or borehole identification code	
secup	FLOAT	m	Upper section limit (m)	
seclow	FLOAT	m	Lower section limit (m)	
section_no	INTEGER	number	Section number	
test_type	CHAR		Test type code, one of 7, see table description	
formation_type	CHAR		1: Rock, 2: Soil (superficial deposits)	
start_flow_period	DATE	yyyymmdd	Date and time start of pumping/injection(YYMMDDhhmmss)	
stop_flow_period	DATE	yyyymmdd	Date and time stop of pumping/injection(YYMMDDhhmmss)	
test_borehole	CHAR		Idcode of pumped/injected borehole	
test_secup	FLOAT	m	Upper limit of pumped/injected section	
test_seclow	FLOAT	m	Lower limit of pumped/injected section	
lp	FLOAT	m	Hydraulic point of application, see table description	
radial_distance_rs	FLOAT	m	Radial distance:test secobs.sec., see table description	
shortest_distance_rt	FLOAT	m	Shortest distance: test secobs.sec., see table description	
time_lag_press_dtl	FLOAT	S	Time lag, pressure response obs. hole. See table description	
initial_head_hi	FLOAT	m	Initial formation hydraulic head, see table description	
head_at_flow_end_h	FLOAT	m	Hydraulic head at end of flow phase, see table description	
final_head_hf	FLOAT	m	Hydraulic head at end of recovery phase, see table descr.	
initial_press_pi	FLOAT	kPa	Initial formation pressure. Actual formation pressure.	
press_at_flow_end_	FLOAT	kPa	Pressure at the end of flow phase, see table descript.	
final_press_pf	FLOAT	kPa	Final pressure at the end of recovery phase, see table desc.	
fluid_temp_teo	FLOAT	oC	Fluid temperature in formation at observation section	
fluid_elcond_eco	FLOAT	mS/m	Fluid electrical conductivity of formation at obs-section	
fluid_salinity_tdso	FLOAT	mg/l	Total salinity of section fluid, based on EC see table descr	
fluid_salinity_tdsom	FLOAT	- mg/l	Tot salinity of section fluid based on sampling, see descr	
reference	CHAR	-	SKB report No for reports describing data and evaluation	
comment	CHAR		Short comment to evaluated data.	
error flag	CHAR		If error flag = "*" then an error occured and an error	
lin use	CHAR		If in use = "*" then the activity has been selected as	
	CHAR		Signature for OA data accknowledge (OA - OK)	

idcode	start date	stop date	secup	seclow	section no	test type	formation_t	start_flow	stop_flow	1
HAV14	2004.07.04 07:59	2004.07.05 08:57	6.03	182.40			1			4
HAV08	2004.07.07 09:40	2004.07.09 10:11	0.00	63.00			1			-
HAV07	2004.07.07 09:13	2004.07.09 09:39	4.00	100.00			1			-
HAV12	2004.07.20 08:19	2004.07.22 11:34	11.34	157.80			1			-
HAV02	2004.06.26 00:23	2004.07.30 22:23	0.13	163.00			1			-
										-
						shortest_			head_at_f	1
					radial_dista	distance_	time_lag_p	initial_he	low_end_	
idcode	test_borehole	test_secup	test_seclow	lp	nce_rs	rt	ress_dtl	ad_hi	hp	
HAV14	HAV12	11.34	157.80	152.00	1120.00		564.00			3
HAV08	HAV14	6.03	182.40	167.00	135.00	1	4196.00			-
HAV07	HAV14	6.03	182.40	167.00	102.00		321.00			-
HAV12	HAV13	9.04	142.20	121.00	535.00	1	5770.00			-
HAV02	HAV13	9.04	142.20	121.00	163.00					-
										-
			press_at_flo	final_press_	fluid_temp_t	fluid_elc	fluid_salinit	fluid_sali nity_tdso		comme
idcode	final_head_hf	initial_press_pi	w_end_pp	pf	eo	ond_eco	y_tdso	m	reference	t
HAV14		121.27	120.61	121.48						
HAV08		31.57	28.35	30.10						
HAV07		34.77	28.52	33.10						
HAV12		19.64	18.77	19.28						
HAV02		94.02	85.21	93.25						

Γ

Table	PLU inte	plu_inf_test_obs	_ed section evaluation											
Column	Datatype	Unit	Column Descrip	otion										
site	CHAR	_	nvestigation site narr	he										
activity_type	CHAR	1	Activity type code											
start_date	DATE	_	Date (yymmdd hh:mn	n:ss)										
stop_date	DATE	_	Date (yymmdd hh:mn	n:ss)										
project	CHAR	4	troject code											
idcode	CHAR	5	Object or borehole idu	entification code										
secup	FLOAT	ر س	Jpper section limit (m	(r										
sectow	FLOAT	ц	.ower section limit (m	(F										
section_no	INTEGER	number 5	Section number											
test_borehole	CHAR	-	dcode of pumped/inje	ected borehole										
test secup	FLOAT	E	Jpper limit of pumped	d/injected section										
test seclow	FLOAT	E	ower limit of pumped	d/injected section										
formation width b	FLOAT	5	rinterpreted formatio	on thickness repr	for evaluated Tr	æ								
width of channel h	ELOAT	. 4	Thremeted width of	formation with ev	valuated TR	1								
			The T-transmission	D = width of form	ation soo table	deor								
l meas limit th	FLOAT	m**3/s F	stimated lower limit)	for evaluated TB	see table descri	int								
i meas limit th	ELOAT	m**3/e	Sumated rower limit	for evaluated TB	see table descr	int								
		200 E	-surrated upper mint. De:S-storativity D=v	iol evaluated in	,see table deed	ipt.								
auo Iaakara fartar Ifa	FLOAT	 = E	for 1D model for eve	wiuti oi ioimatioi	i,see lable uesu a factor									
tranemiseivity #0	FLOAT		To-transmissivity 2	D model see tab	la decrintion									
ualisillisivity_uo		67 II	t U-tidi Isi lissivity, 2 thria vialica /TTa/ 4	ciumone, see lat.		innit 1								
value_type_tto		a/C**m	rue value (110);-1. Stimated lower limit :	For evolution TT	u, u.>upper meau O see table des	IS.III.II.								
				ioi evaluateu i TT-		alpt.								
u_meas_iimit_t	FLUAI FLOAT	S/7	Sumated upper limit	tor evaluated 110	o, see table desc	uond								
storativity_so	FLUAI		SIZU MODELTOF EVAIU		/, see table desc	÷.								
leakage_coeff_o	FLUAT	1/S	C/b ::2D model evaluation	uation of leakage	coefficient,see o	lescr.								
hydr_kond_kso	FLOAT	m**2/s	3Dmodel evaluation c	of hydraulic condt	uctivity,see tabl€	desc.								
I_meas_limit_ks	FLOAT	m**2/s E	Estimated lowermeas	<ol> <li>limit of Ks,see</li> </ol>	table descriptior	_								
u_meas_limit_ks	FLOAT	m**2/s E	Estimated upper mea	as. limit of Ks,see	table description	-								
spec_storage_sso	FLOAT	1/m	3Dmodel for evaluatic	on of specific stor	age,se table de	scr.								
dt 1	FLOAT	s	Estimated start time c	of evaluation, see	table descriptio	L								
dt2	FLOAT	s	Estimated stop time c	of evaluation, see	table descriptio	c								
comments	CHAR	3	short comment to the	evaluated parar	neters(0ptional)									
error_flag	CHAR	-	f error_flag = "*" ther.	n an error occured	d and an error									
in_use	CHAR	_ '	f in_use = "*" then th	le activity has bee	en selected as									
sign	CHAK		signature for QA date	a accknowledge (	(A) - UK)									
						tast horahol		act corl	formation	width of c		l moae li	meae	
idcode	start date	stop date	secup se	clow st	ection no	e t	test secup o		width b	hannel b	tbo	mit tb	mit tb	sbo
HAV14	2004.07.04 07:59	2004.07.05 08:57	6.03	182.40	1	HAV12	11.34	157.80		176.37		1	1	
HAV08	2004.07.07 09:40	2004.07.09 10:11	0.00	63.00		HAV14	6.03	182.40		63.00				
HAV07	2004.07.07 09:13	2004.07.09 09:39	4.00	100.00		HAV14	6.03	182.40		96.00				
HAV12	2004.07.20.08:19	2004.07.22.11:34	11.34	157.80		HAV13	9.04	142.20		146.46				
HAV02	2004.06.26 00:23	2004.07.30 22:23	0.13	163.00		HAV13	9.04	142.20		162.87				
-	-		/alue_type_t	meas_limit u	meas_limi	storativity_s	leakage_co	nydr_kon	L_meas_li	u_meas_li	spec_stor	1	ç	
Idcode	leakage_tactor_ito	transmissivity_tto			1	0		_ KSO	mit_ks	mit_ks	age_sso	at1	312	comments
HAV14		8.75E-04 (				1.31E-05								
HAVU8		Z.32E-04 (				5./9E-04								
HAVU/		7 50F-04 C		+		2.01E-04	Ť							
		5 37F_05 (		+		1 30E-04	+							

## **APPENDIX 7-5**

Pumping Test - Submersible Pump

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SKB			SIC		/Dat	a Imp	ort Temp	late	(Simplified version v1.2	â		
									SKB & Ergodata AB 200	হা		
File Identity	<u> </u>											
Created By	y Rein	ter van der Wall										
Created	<b>d</b>	004.09.09 13:51										
				i								
Activity Type	8	10			Project			AP PS 400-03-077				
	Pur	iping test-submersibl	le pump									
				]						1		
Activity Inform	nation				Additional.	Activity Data						
					C10	1250	P20	P200	P220	R110	R25	R90
			Secup Seclow	/ Section		Test			Person evaluating	Field		Quality
Idcode	Start Date	Stop Date	(m) (m)	No	Company	equipment	Field crew manager	Field crew	data	Notes ID	Report	plan
HAV12	040702 08:54	040703 08:44	11.34 157.6	0	Golder	НТНВ	Reinder van der Wall	Reinder van der Wall, Nils Rahm	Cristian Enachescu			
HAV12 rep	040704 08:24	040705 08:43	11.34 157.6	0	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Tomas Cronquist	Cristian Enachescu			
HAV14	040707 08:09	040709 10:11	12.85 182.4	0	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			
HAV11	040711 08:24	040714 09:06	6.03 220.5	0	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			
HSH04	040715 08:11	040717 08:35	9.00 236.2	0	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	<b>Cristian Enachescu</b>			
HSH05	040717 13:08	040719 08:43	6.20 200.2	0	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			
HAV13	040720 08:03	040722 13:31	9.04 142.2	0	Golder	HTHB	Reinder van der Wall	Reinder van der Wall, Karsten Ebeling	Cristian Enachescu			
					_	_						

Table		plu_s_hole_test	_d						
	FLUI	ljection and pumping, Gene							
Column	Datatyne	Unit	Column Desc	cription				7	
site	CHAR	onit	Investigation site	name					
activity_type	CHAR		Activity type code	е					
start_date	DATE		Date (yymmdd hl	h:mm:ss)					
stop_date	DATE		Date (yymmdd hl	h:mm:ss)					
project	CHAR		project code						
dcode	CHAR		Object or boreho	le identification co	de				
Secup	FLOAT	m	Upper section lim	nit (m)					
sectow	FLOAT	m	Lower section lim	nit (m)					
section no	INTEGER	number	Section number	iii (111)					
est type	CHAR	number	Test type code (1	1-7) see table des	cription				
esi_iype	CHAR		1. Deek 2. Ceil (	I-7), See lable des					
ormation_type	DATE		T. RUCK, Z. SUII (	superiiciai deposit					
start_liow_period	DATE	yyyymmuu	Date & time of pt	umping/injection st		D nn.mm.ss)			
stop_flow_period	DATE	yyyymmaa	Date & time of pl	Imping/injection st	op (YYYY-WW-DL	nn:mm:ss)			
liean_liow_rate_qri	FLOAT	111 3/5	Flamment at the	now rate of the pu	inping/injection				
iow_rate_end_qp		111 3/5	Flow rate at the e	end of the nowing o	Jenou				
/alue_type_qp	CHAR	****	Utrue value,-1 <ic< td=""><td>ower meas.limit1:&gt;</td><td>upper meas.limit</td><td></td><td></td><td></td><td></td></ic<>	ower meas.limit1:>	upper meas.limit				
q_measii	FLOAT	m**3/s	Estimated lower	measurement limit	of flow rate				
_measl_u	FLOAT	m**3/s	Estimated upper	measurement limi	t of flow rate				
ot_volume_vp	FLOAT	m**3	Total volume of p	oumped(positive) o	or injected(negativ	e) water			
jur_flow_phase_tp	FLOAT	s	Time for the flow	ing phase of the te	est				
iur_rec_phase_tf	FLOAT	s	Time for the reco	overy phase of the	test				
nitial_head_hi	FLOAT	m	Initial formation h	nead, see table de	scription				
nead_at_flow_end_l	FLOAT	m	Hydraulic head a	t end of flow phase	e, see table descr	iption			
final_head_hf	FLOAT	m	Hydraulic head a	t end of recovery	phase,see table de	escript.			
nitial_press_pi	FLOAT	kPa	Initial formation p	pressure. Actual fo	rmation pressure				
press_at_flow_end_	FLOAT	kPa	Pressure at the e	end of flow phase,	see table descript	ion.			
final_press_pf	FLOAT	kPa	Fimal pressure a	t the end of the re-	covery, see table	descr.			
luid_temp_tew	FLOAT	oC	Section fluid tem	perature, see table	e description				
fluid_elcond_ecw	FLOAT	mS/m	Section fluid el. c	conduvtivity,see tal	ble description				
fluid_salinity_tdsw	FLOAT	mg/l	Total salinity of s	ection fluid based	on EC,see table of	lescr.			
fluid_salinity_tdswm	FLOAT	mg/l	Tot. section fluid	salinity based on	water sampling, se	e			
reference	CHAR	-	SKB report No fo	or reports describin	g data and evalua	ation			
comments	VARCHAR		Short comment to	o data	9				
error flag	CHAR		If error flag = "*"	then an error occi	ired and an error				
n use	CHAR		If in use = "*" the	an the activity has	heen selected as				
sian	CHAR		Signature for OA	data accknowled	ie (QA - OK)				
<del>-</del>		m	Hydraulic point of	f application	- (				
r			,					<u> </u>	
								-	
							formation_t	.]	
idcode	start_date	stop_date	secup	seclow	section_no	test_type	уре		
HAV12	040702 08:54	040703 08:44	11.34	157.80		1B	1	2	
HAV12 rep	040704 08:24	040705 08:43	11.34	157.80		1B	1	-	
HAV14	040707 08:09	040709 10:11	6.03	182.40		1B	1	-	
HAV11	040711 08:24	040714 09:06	6.03	220 50		1B	1	-	
HSH04	040715 08:11	040717 08:35	9.00	236.20		1B 1B	1	-	
	040717 13:08	040710 08:43	6.00	200.20		18	1	-	
	040717 13.08	040719 00.43	0.20	142.20		10	1	-	
	040720 00.03	040722 13.31	5.04	142.20				-	
							+	-	
			moon flow	flow rate o	lyalua type			7	
dooda	atout flam and at	aton flam and a	roto	now_rate_e	value_type_		M_measi		
acoae	start_tiow_period	stop_tiow_period	rate_qm	Iua_db	db	q_measil	<u> u</u>	]	
HAV12	2004.07.02 11:48:00	2004.07.02 21:51:00	1.0700E-03	1.0600E-03	0	5.0000E-05	1.6700E-03	<u>_</u>	
HAV12 rep	2004.07.04 08:25:00	2004.07.04 18:26:00	1.0700E-03	1.0600E-03	0	5.0000E-05	1.6700E-03	<u>,</u>	
HAV14	2004.07.08 08:50:00	2004.07.08 19:40:00	1.0700E-03	1.0600E-03	0	5.0000E-05	1.6700E-03	<u>,</u>	
HAV11	2004.07.13 08:27:00	2004.07.13 19:04:00	1.1900E-03	1.1900E-03	0	5.0000E-05	1.6700E-03	i .	
HSH04	2004.07.16 08:12:00	2004.07.16 18:15:00	5.8200E-04	5.6000E-04	0	5.0000E-05	1.6700E-03		
HSH05	2004.07.18 08:08:00	2004.07.18 18:18:00	6.9300E-05	6.9500E-05	0	5.0000E-05	1.6700E-03	-	
HAV13	2004.07.21 08:44:00	2004.07.21 18:45:00	1.1700E-03	1.1500E-03	0	5.0000E-05	1.6700E-03	- j	
								-	
								-	
			dur_rec_pha	initial_head_	head_at_flo	final_head_	initial_pres	]	
idcode	tot_volume_vp	dur_flow_phase_tp	se_tf	hi	w_end_hp	hf	s_pi		
HAV12	3.6900E+01	36180 00	39180.00	-0.59	-8.47	-0.47	215.90	)	
HAV12 rep	3.8464F+01	36060.00	51540.00	-0.34	-8 45	-0.59	218.40	,	
HAV14	4 1730E+01	39000.00	45300.00	-3 41	_0.40	_3.04	208 00	ī	
HAV11	4 5482E+01	38220 00	48840 00	0.41	-3.50	_0.15	246 70	-	
HSH04	2 1002E+01	36240.00	51600.00	0.20	-0.07	-0.15	240.70	-	
	2.1032L-01 2.536/E±00	302-0.00	5100.00	0.20	-0.13	0.47	270.20	ī	
HAV13	4.2190E+01	36060.00	67500.00	-0.62	-13.40	-0.42	197.20	ī	
								-	
	press_at_flow_end_		fluid_temp_t	fluid_elcond	fluid_salinity	fluid_salinit	<u> </u>		
dcode	рр	final_press_pf	ew	_ecw	_tdsw	y_tdswm	reference	comments	
HAV12	137 10	214 10	8.34	820.8		1	1	<u> </u>	
	137.10	214.10	AS 8	817 7			+	+	
	107.00	210.90	0.30	220			+	+	
	144.20	203.00	0.42	32.0			+		
	200.00	242.70	0.79	070.0			+	<u> </u>	•
	150.10	242.10	12.49				+	+	
	191.80	322.40	8.52	/3/.3			<b></b>	<b> </b>	
AN 13	149.10	194.90	y 8.66	y 833.7			<u> </u>		_

Table	PI II Sing	plu_s_hole	e_test_ed1	ic evaluation												
	PLU Sing	e noie tests, pumpi	ng/injection. Bas	ac evaluation												
Column	Datatype	Unit	Column De	escription				1								
site	CHAR		Investigation s	ite name				1								
activity_type	CHAR		Activity type co	ode												
stop_date	DATE		Date (yymmdd Date (yymmdd	i hh:mm:ss)												
project	CHAR		project code													
dcode	CHAR		Object or bore	hole identification c	ode											
secup	FLOAT	m	Lower section	limit (m)												
ection_no	INTEGER	number	Section number	er												
est_type	CHAR		Test type code	e (1-7), see table de	scription!											
ormation_type	CHAR	m	Formation type	e code. 1: Rock, 2: t of application	Soil (superficial dep	posits)										
eclen class	FLOAT	m	Planned ordina	ary test interval duri	ng test campaign.											
pec_capacity_q_s	FLOAT	m**2/s	Specific capac	tity (Q/s) of test sec	tion, see table desc	cript.										
alue_type_q_s	CHAR		0:true value,-1	:Q/s <lower meas.lin<="" td=""><td>nit,1:Q/s&gt;upper me</td><td>eas.limit</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></lower>	nit,1:Q/s>upper me	eas.limit										
ransmissivity_tq	CHAR	m**2/s	Otrue value -1	TO <lower lin<="" meas="" td=""><td>able description</td><td>as limit</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></lower>	able description	as limit										
c_tq	CHAR		Best choice co	de. 1 means TQ is	best choice of T, e	lse 0										
ansmissivity_moye	FLOAT	m**2/s	Transmissivity	,TM, based on Mo	/e (1967)											
c_tm	CHAR		Best choice co	de. 1 means Tmoy	e is best choice of	T, else 0										
aide_type_tm tydr cond move	FLOAT	m**2/s	K M: Hvdraulie	c conductivity base	d on Moye (1967)	ao.mml.										
ormation_width_b	FLOAT	m	b:Interpreted for	ormation thickness	repr. for evaluated	T/TB										
vidth_of_channel_b	FLOAT	m	B:Interpreted v	width of formation w	ith evaluated TB											
measl th	FLOAT FLOAT	m**3/s m**3/s	Fstimated low	ssivity,B=width of fo	rmation,see descrip aluated TB coo do	ption scription										
sasi_tb	FLOAT	m**3/s	Estimated upp	er meas. limit of ev	aluated TB,see des	scription										
b	FLOAT	m	SB:S=storativit	ty,B=width of forma	tion,1Dmodel,see	descript.										
assumed_sb	FLOAT	m	SB* : Assumed	d SB,S=storativity,E	=width of formation	n,see										
3akage_factor_lf	FLOAT	m m**2/s	Lf:1D model fo	or evaluation of Leal	kage factor											
alue_type_tt	CHAR	218	0:true value,-1	:TT <lower meas.lin<="" td=""><td>hit,1:TT&gt;upper mea</td><td>as.limit,</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></lower>	hit,1:TT>upper mea	as.limit,										
oc_tt	CHAR		Best choice co	de. 1 means TT is	best choice of T, el	se 0										
_measl_q_s	FLOAT	m**2/s	Estimated lowe	er meas. limit for ev	aluated T,see table	e descr.										
u_measi_q_s storativity_s	FLOAT	m**2/s	Estimated upp     2D model for e	er meas. limit for ev evaluation of S=stor	raiuateo if,see des ativity,see table de	cription script.										
assumed_s	FLOAT		Assumed Stora	ativity,2D model eva	aluation,see table of	descr.										
eakage_koeff	FLOAT	1/s	K'/b':2Dmodel	evaluation of leaka	ge coefficient,see o	desc.										
nydr_cond_ks	FLOAT	m**2/s	Ks:3D model e	evaluation of hydrau	lic conductivity,see	e desc.										
meas limit ks	FLOAT	m**2/s	o:true value,-1: Estimated lowe	.ns <iower meas.lim<br="">er meas.limit for ev:</iower>	iii, i:rs>upper mea aluated Ks. see tab	is.imit, ile desc.										
meas_limit_ks	FLOAT	m**2/s	Estimated upp	er meas.limit for ev	aluated Ks,see tab	le descr.										
pec_storage_ss	FLOAT	1/m	Ss:Specific sto	orage,3Dmodel eval	uation,see table de	escr.										
issumed_ss	FLOAT	1/m m**3/n2	Assumed Spec	c.storage,3D model	evaluation,see tab	ole des.										
- cd	FLOAT	ni arµd	CD: Dimensior	nless wellbore stora	ge constant											
skin	FLOAT		Skin factor													
tor_ratio	FLOAT		Storativity ratio	) ow cooffic'+												
iternow_coeff	FLOAT	s	Estimated star	ow coemcient t time of evaluation	see table descript	ion										
it2	FLOAT	s	Estimated stop	time of evaluation	see table descript	ion										
ransmissivity_t_ilr	FLOAT	m**2/s	T_ILR Transm	issivity based on N	one Linear Regress	sion										
storativity_s_ilr	FLOAT		S_ILR=storativ	ity based on None	Linear Regression	,see as limit										
aue_type_t_lir oc t ilr	CHAR		Best choice co	iLick~iJwer meas ide. 1 means T II R	is best choice of T	oo.mm F, else 0										
ilr	FLOAT	m**3/pa	Wellbore stora	ige coefficient, base	d on ILR, see desc	pr.										
:d_ilr	FLOAT		Dimensionless	wellbore storage c	onstant, see table	descrip.										
skin_ilr stor ratio ilr	FLOAT		Skin factor bas	sed on Non Linear F	Regression, see des	sc. e descr										
nterflow_coeff ilr	FLOAT		Interporosity flo	ow coefficient base	d on Non Linear Re	e dead. Bgr										
ransmissivity_t_grf	FLOAT	m**2/s	T_GRF:Transr	missivity based on 0	Gen.Rad. Flow,see											
alue_type_t_grf	CHAR		0:true value,-1	T_GRF <lower mea<="" td=""><td>s.limit,1:&gt;upper m</td><td>eas.limit</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></lower>	s.limit,1:>upper m	eas.limit										
t_t_grt storativity s orf	UHAR FLOAT		S GRF-Storati	ivity basd on Gen	<ul> <li>Is best choice of Rad.Flow, see table</li> </ul>	i, else 0 e descri.										
low_dim_grf	FLOAT		Flow dimesion	based on Gen. Ra	d.Flow. interpretation	on model										
omment	VARCHAR	no_unit	Short commen	nt to the evaluated p	arameters											
error_flag	CHAR		If error_flag = "	"*" then an error oct	cured and an error											
ii_use sign	CHAR		Signature for C	A data accknowled	ige (QA - OK)											
								]								
							formation_t		seclen_cla	spec_cap	value_typ	transmissiv	value_type		transmissivity	
dcode	start_date	stop_date	secup	seclow	section_no	test_type	уре	lp	SS	acity_q_s	e_q_s	ity_tq	_tq	bc_tq	_moye	
HAV12 HAV12 rep	040702 08:54	040703 08:44	11.34	157.80		1B 1B	1	152.00		1.35E-04	10			<u> </u>	1.71E-04	
HAV14	040707 08:09	040709 10:11	6.03	182.40	0	1B	1	167.00	1	1.63E-04	0	1	1		2.10E-04	
HAV11	040711 08:24	040714 09:06	6.03	3 220.50	)	1B	1	220.00		2.89E-04	0				3.85E-04	
HSH04	040715 08:11	040717 08:35	9.00	236.20	)	1B	1	125.00		6.65E-05	50				8.89E-05	
HAV13	040720 08:03	040719 08:43	6.20	200.20		1B	1	121 00		2 30E-00		-		<u> </u>	0.81E-06	
	0120 00.03	370122 13.31	5.04	142.20			Ľ	121.00		2.000-04					2.352-04	
					<u> </u>											
	h - 4	value_type_t	hydr_cond	formation_wi	width_of_ch	41-		u_measl_t	- 1-	assumed	leakage_f	transmissiv	value_type	h		
	pc_tm	m	_moye	atn_b	annei_b	το	i_measi_tb	a	sD	sp	actor_if	ny_tt	_π	pc_tt	I_measi_q_s	
1AV12 HAV12 rep	0	0	-		-							1.80E-04	0	1	1.00E-04	
HAV14	0	0	1		1	-			1	-	1	1.39E-04	0	1	1.00E-04	
					1	-	1		-		1	0.005.05	0	1.		
HAV11	0	0										9.20E-05	0	1	8.00E-05	
HAV11 HSH04	0	0										9.20E-05 9.60E-04	0	1	8.00E-05 8.00E-04	
HAV11 HSH04 HSH05 HAV13	0 0 0	0 0 0										9.20E-05 9.60E-04 5.22E-04	0	1 1 1	8.00E-05 8.00E-04 4.00E-06	

			assumed_	leakage_koef	hydr_cond_k	value_type	I_meas_lim	u_meas_li	spec_stora	assumed				stor_ra			
idcode	u_measl_q_s	storativity_s	s	f	s	_ks	it_ks	mit_ks	ge_ss	ss	c	cd	skin	tio	interflow_coeff	í I	
HAV12	3.00E-04	2.25E-06	1.00E-04		1				1		1.98E-06	2.86E+01	1.60E+00				
HAV12 rep	1.00E-03	1.58E-05	1.00E-04								1.99E-06	4.09E+00	1.61E+01				
HAV14	3.00E-04	6.04E-05	1.00E-04								1.59E-06	8.55E-01	-2.79E+00				
HAV11	1.00E-03	1.15E-04	1.00E-04								2.75E-06	7.77E-01	1.02E+00				
HSH04	1.00E-03	1.00E-04	1.00E-04								1.65E-06	5.36E-01	8.33E+01				
HSH05	6.00E-04	1.00E-04	1.00E-04								2.28E-06	7.41E-01	0.00E+00				
HAV13	3.00E-04	4.81E-06	1.00E-04								1.58E-06	1.07E+01	-4.39E+00				
			transmissi	storativity_s_	value_type_t					stor_ratio	interflow_	transmissiv	value_type	bc_t_g	storativity_s_g	flow_d	
idcode	dt1	dt2	vity_t_ilr	llr	_ilr	bc_t_ilr	c_ilr	cd_ilr	skin_ilr	_ilr	coeff_ilr	ity_t_grf	_t_grf	rt	rt	im_grt	comment
HAV12	540.00	36000.00															
HAV12 rep	720.00	36000.00															
HAV14	720.00	14400.00															
HAV11	360.00	36000.00															
HSH04	2160.00	28800.00															
HSH05	25200.00	36000.00															
HAV13	144.00	18000.00															