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Äspö Hard Rock Laboratory

Prototype Repository

Hydraulic tests in exploratory holes
Drill campaign 3A

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Geosigma

June 1999

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Foreword

This International Progress Report is one out of seven reports presenting the results from the hydrogeological field characterisation work prior to boring of the six deposition holes in the Prototype Repository tunnel in the Äspö Hard Rock Laboratory. The field investigations have been conducted in seven test campaigns between November 1997 and August 1999. The results from each campaign are described in a separate report and the following seven ones have been published.

Gentzschein, B. 1997: Äspö Hard Rock Laboratory. Prototype Repository. Hydraulic Tests in Pilot Holes. Drill campaign 1. SKB International Progress Report IPR 99-27, December 1997.

Gentzschein, B. 1998: Äspö Hard Rock Laboratory. Prototype Repository. Hydraulic Tests in Exploratory Holes. Drill campaign 2. SKB International Progress Report IPR 99-28, May 1998.

Gentzschein, B. 1999: Äspö Hard Rock Laboratory. Prototype Repository. Hydraulic Tests in Exploratory Holes. Drill campaign 3a. SKB International Progress Report IPR 99-29, June 1999.

Gentzschein, B. 1999: Äspö Hard Rock Laboratory. Prototype Repository. Hydraulic Tests in Exploratory Holes. Drill campaign 3b. SKB International Progress Report IPR 99-30, June 1999.

Gentzschein, B. 1999: Äspö Hard Rock Laboratory. Prototype Repository. Hydraulic Tests in Exploratory Holes. Injection Tests. SKB International Progress Report IPR 99-31 , May 1999.

Gentzschein, B. 1999: Äspö Hard Rock Laboratory. Prototype Repository. Hydraulic Tests in Exploratory Holes. interference Tests A after drill campaign 3. SKB International Progress Report IPR 99-32, May 1999.

Gentzschein, B. 1999: Äspö Hard Rock Laboratory. Prototype Repository. Hydraulic Tests in Exploratory Holes. interference Tests B after drill campaign 3. SKB International Progress Report IPR 99-33, November 1999.

The reports include technical specifications and description of the equipment used, measurement procedures, results of the flow and pressure measurements, relevant test data and all the background data necessary for interpretation and evaluation of field data.

Each test produces a great number of diagrams showing responses in test sections or observation boreholes caused by pressure draw-downs. Each report comprises between 120 and 600 diagrams sorted in appendices after the describing text. Due to the great number, the diagrams are not included in the printed versions of the reports. But the reports, including the diagrams are also stored as Word documents on a CD-R. In addition each diagram is stored as a file (GIF – format). The Word-documents, converted to PDF-format, as well as the diagram-files are available at the Äspö Hard Rock Laboratory.

Abstract

The Prototype Repository in the Äspö Hard Rock Laboratory aims at simulating conditions in the future Deep Repository as realistically as possible. Some of many tasks are to observe the water saturation and homogenisation of the bentonite buffer and the backfill, and their interaction with the rock as well as to compare developed codes and material models with the observations. These tasks among other things need information on the hydraulic properties of the rock. The geohydraulic characterisation of the rock around the Prototype Repository is made in three stages. Each stage is intended to contribute to more details useful for determination of the localisation of the deposition holes and the boundary and rock conditions needed for the interpretation of the experimental data. The three stages are focused on

1. Mapping of the tunnel
2. Pilot and exploratory holes
3. Deposition holes

This International Progress Report is report number 3 out of seven in a series which presents the results from stage 2, i e hydrogeological characterisation in pilot and exploratory holes, which have been obtained during seven test campaigns between November 1997 and August 1999. More precisely the present International Progress Report presents the results from the hydraulic tests in the 11 new holes, 2 short, i e 12 m, and 9 long, i e 30 m, exploratory holes, and in four of the old holes that were extended to a depth of 30 m. The new drilling took place in April, May and June 1998. (The first two reports concerned studies in the 10 pilot holes and 10 first short holes respectively.)

Packers were installed in all 31 holes and the groundwater pressure over the entire boreholes were measured several times. The result was readings between 0 and 3.8 MPa. The flow rate was measured in the 10 new holes as well as the pressure build-up. The highest flow rate was approx. 8 000 ml/min, but negligible flow rates were registered as well. When the flow rate exceeded 10 ml/min an interference test was performed by measuring the pressure responses in nine to ten of the nearest drill holes. Eleven such interference tests were performed. The flow rates were also measured in the 15 new holes in one-meter sections and three-meter sections respectively, and interference tests were made when these flow rates exceeded 10 ml/min, which was the case in 53 sections. Water samples were taken and analysed if the flow rate exceeded 50 ml/min in the one-meter sections or 200 ml/min in the three-meter sections.

Sammanfattning

Prototypförvaret i Äspölaboratoriet byggs för att simulera förhållandena så naturnära som möjligt i det framtida djupförvaret. Några av många uppgifter är att observera bentonitbuffertens och återfyllens vattenmättnad och homogenisering liksom den interaktion mellan materialen och berget som sker. samt att jämföra utvecklade koder och materialmodeller med de gjorda observationerna. För dessa uppgifter behöver bl a bergets hydrauliska egenskaper kunna beskrivas. Denna geohydrauliska karakteriseringen av berget omkring Prototypförvaret görs i tre steg. Varje steg ska bidra med mer användbar detaljinformation om lokalisering av deponeringshål samt randvillkor och bergegenskaper som behövs för tolkning av framtida observationer. De tre stegen inriktas på:

1. Kartering av tunneln
2. Pilot-och undersökningshål
3. Deponeringshål

Denna International Progress Report utgör rapport nummer 3 av sju i en serie som presenterar resultaten från Steg 2, dvs de hydrogeologiska karakteriseringar i pilot-och undersökningshål som gjorts i sju testkampanjer mellan november 1997 och augusti 1999. Mer precist redovisar föreliggande International Progress Report resultaten från mätningar i 11 nya hål, 2 korta, dvs 12 m, och 9 långa, dvs 30 m, undersökningshål samt i 4 gamla som förlängts till 30 m. De nya hålen borrades under april-juni 1998. (Den två första rapporterna redovisade resultaten från testerna i de 10 pilothålen respektive i de därefter borrade 10 korta hålen.)

Manschetter installerades i alla 31 hålen och grundvattentrycket i hela hålet mättes flera gånger. Tryck mellan 0 och 3,8 MPa erhölls. Inflödet mättes liksom tryckets uppbyggnadsförlopp i de 15 nya hålen. Som mest mättes ett inflöde på ca 8 000 ml/min, i några hål, men obetydliga flöden registrerades också. När inflödet var större än 10 ml/minut gjordes interferenstester med tryckförändringar i de närmaste nio till tio borrhålen. Elva sådana interferenstester genomfördes. Därefter mättes flödet i varje metersektion respektive i varje tremeterssektionoch interferenstester gjordes i de metersektioner där flödet var större än 10 ml/min, vilket var fallet i 53 sektioner. Vattenprover togs och analyserades när flödet var större än 50 ml/min i enmeterssektionerna och mer än 200 ml/min i tremeterssektinerna.

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1. BACKGROUND

Within the scope of SKB's program for RD&D 1995, SKB has decided to carry out a project named "Prototype Repository" at the Äspö Hard Rock Laboratory. The aim of the project is to test important components in SKB's deep repository system in full scale and in a realistic environment.

The Prototype Repository is focused on testing and demonstrating the function of SKB's deep repository system. Activities aimed at contributing to development and testing of the practical engineering measures required to rationally perform the steps of a deposition sequence are also included. However, efforts in this direction are limited, since these matters are addressed in the Demonstration of Repository Technology project and to some extent in the Backfill and Plug test.

The characterisation of the test site, located in the TBM-drilled part of the Äspö HRL-tunnel, will be made in three stages. Each stage is intended to contribute to more details useful for the determination of the localisation of the deposition holes and also the boundary and rock conditions needed for the interpretation of the experimental data. The three stages are:

1. Mapping of the tunnel
2. Pilot and exploratory holes
3. Deposition holes

Stage 1 is completed and stage 2 has been divided into three drilling campaigns:

1. Drilling of pilot holes
2. Drilling of exploratory holes-short boreholes
3. Drilling of exploratory holes-long boreholes

Ten pilot holes were drilled between October 14th and October 20th 1997 in the tunnel interval 3/539 m - 3/593 m. Ten of the short exploratory boreholes were drilled in the tunnel interval 3/544 m - 3/588 m between March 16th and March 24th 1998. Hydraulic tests were performed in these boreholes in November 1997 and in April 1998. Two short exploratory holes were drilled April 25th and 26th. Nine long exploratory (30 m) boreholes were drilled June 3rd - June 28th.

Further more four of the older boreholes were extended to 30m depth during May. This report describes the hydraulic tests that were carried out in the 15 boreholes that were drilled after the second test campaign in April.

2. OBJECTIVES

2.1 General

The Prototype Repository should simulate a real repository in as many aspects as possible, regarding geometry, materials, and rock environment. The Prototype Repository is a demonstration of the integrated function of the repository components. Results will be compared with models and assumptions to their validity.

The major objectives for the Prototype Repository are:

- To demonstrate the integrated function of a full-scale prototype of the repository system
- To provide a full-scale reference for testing/scrutinization of models, experiments and assumptions
- To develop, test and demonstrate appropriate engineering standards and quality standards and quality assurance systems.
- To demonstrate technology for monitoring of the Repository system

The objectives for the characterisation program are:

- To provide a basis for determination of localisation of the deposition holes
- To provide data on boundary and rock conditions to enable interpretation of the experimental data.

2.2 Objectives of the hydraulic tests - drill campaign 3

The objectives of the long exploratory holes is to obtain data mainly for the geological and hydrogeological models but also for prediction of the characteristics in the deposition holes and to quantify the criteria needed for validation of the suitability of the position of canister deposition. Acceptance of a canister position as based on scrutinisation of characterisation data such as fracturing, permeability and stability of the borehole wall.

The objectives for the hydraulic tests in the long exploratory bore holes are:

- The hydraulic tests in the long exploratory holes shall provide hydrogeological data useful for setting up a hydrogeological model of the rock volume around the TBM tunnel up to a distance of approximately 30 m from the TBM tunnel
- Data shall together with the geological interpretation be a base for designing specific interference tests with several packed off sections in a number of boreholes and to chose sections for flow measurements during natural conditions and during interference test.

- The test shall partly be of similar character as for drill campaign 1 and 2 in order to provide data for statistical treatment.
- Take water samples useful for the hydrochemical characterisation of the rock volume around the Prototype Repository.

3. Scope

The length of the boreholes KA3574G01 and KA3576G01 is 12 m. The length of the remaining 13 (new) holes is about 30 m. KA3548A01 was drilled due south and horizontally in the tunnel wall about 2 meters above the tunnel floor. The eight new exploratory boreholes in the tunnel floor were drilled with the inclination of c. 45 degrees. All the other boreholes drilled for the Prototype Repository are vertical or subvertical. The nominal diameter is 76 mm. The date of drilling is presented in Table 3-1.

Prior to the hydraulic tests mechanical packers were installed in the exploratory holes (see Table 3-1). Packers were also installed in the earlier drilled pilot boreholes (Table 3-2). The groundwater pressure was measured in the exploratory holes and in the pilot holes prior to the tests.

Table 3-1 Drilling data and packer installation data for the exploratory holes.

Borehole	Drilling completed (Date)	Date/time of packer installation (borehole closed)	Measurement section (m)
KA3544G01	980324	980627	0.39 - 12.00
KA3546G01	980323	980629 18:07	0.39 - 12.00
KA3548G01	980323	980625	0.25 - 12.01
KA3550G01	980322	980625	0.25 - 12.03
KA3552G01	980321	980625	0.39 - 12.01
KA3572G01	980320	980625 15:01	0.39 - 12.00
KA3578G01	980319	980625 15:00	0.39 - 12.58
KA3584G01	980318	980625 15:00	0.39 - 12.00
KA3586G01	980317	980625 15:17	0.39 - 8.00
KA3588G01	980316	980625 15:00	0.39 - 8.00
KA3574G01	980425	980625 15:01	0.39 - 12.00
KA3576G01	980426	980625 15:01	0.39 - 12.01
KA3548A01	980628	980629 16:52	2.65 – 30.00 (horizontal)
KA3590G01	980623	980626 17:12	0.39 – 30.06 (inclin.=45°)
KA3590G02	980616	980626 17:15	0.39 – 30.05 “
KA3566G01	980623	980625	0.39 – 30.01 “
KA3566G02	980616	980625	0.39 – 30.01 “
KA3554G01	980623	980629 18:06	0.39 – 30.01 “
KA3554G02	980616	980629 18:06	0.39 – 30.01 “
KA3542G01	980623	980626 17:12	0.39 – 30.04 “
KA3542G02	980616	980626 17:15	0.39 – 30.01 “

Table 3-2 Drilling data and packer installation data for the pilot holes.

Borehole	Date of drilling	Date/time of packer installation (borehole closed)	Measurement section (m)
KA3539G	971018	980629 16:00	0.39 - 30.01(extended 980513)
KA3545G	971020	980629 16:00	0.39 - 8.04
KA3551G	971017	980625	0.39 - 8.04
KA3557G	971016	980625	0.39 - 30.04 (extended 980512)
KA3563G	971016	980625	0.39 - 30.00 (extended 980507)
KA3569G	971015-16	980625 15:02	0.39 - 8.04
KA3575G	971015	980625 15:02	0.39 - 8.04
KA3581G	971015	980625 15:17	0.39 - 8.04
KA3587G	971014	980626 17:12	0.39 - 8.04
KA3593G	971014	980625 15:00	0.39 - 30.02 (extended 980506)

After the packer installation the ground-water pressure of the boreholes stabilised during one to four days. The packer installation of some of the boreholes was delayed since the drilling machine was not removed from borehole KA3548A01 until late in the afternoon on the 29th of June.

Pressure build-up tests of the entire boreholes (i.e. the interval from 0.50 m to the borehole bottom) were carried out between the 1st and 6th of July. If the water flow rate exceeded 10 ml/minute an interference test was performed. The pressure responses in nine or ten of the adjacent boreholes were monitored. In addition the ground water pressure of the three boreholes KA3510A, KA3573A and KA3600F was measured. A list of tests is shown in Table 3-3

During the interference tests water samples were collected.

Table 3-3 A list of hydraulic tests conducted in the entire exploratory boreholes. Prototype Repository - drill campaign 3, July 1998

Borehole	Date of test	Test No	Type of test	Observation boreholes
KA3590G02	980701	5	I	KA3590G01, KA3593G, KA3588G01, KA3566G01, KA3566G02, KA3548A01,KA3586G01, KA3587G, KA3581G, KA3579G, KA3510A, KA3573A, KA3600F
KA3590G01	980701	6	I	KA3590G02,KA3593G, KA3588G01, KA3566G01, KA3566G02, KA3548A01,KA3586G01, KA3587G, KA3581G, KA3579G, KA3510A, KA3573A, KA3600F
KA3593G	980701	7	I	KA3590G01,KA3590G02, KA3588G01, KA3566G01, KA3566G02, KA3548A01,KA3586G01, KA3587G, KA3581G, KA3579G, KA3510A, KA3573A, KA3600F
KA3566G02	980701	8	I	KA3566G01,KA3590G01, KA3590G02, KA3574G01,KA3572G01, KA3548A01,KA3554G01, KA3554G02, KA3569G, KA3557G, KA3563G, KA3510A, KA3573A, KA3600F
KA3566G01	980702	9	I	KA3566G02,KA3590G01, KA3590G02, KA3574G01,KA3572G01, KA3548A01,KA3554G01, KA3554G02, KA3569G, KA3557G, KA3563G, KA3510A, KA3573A, KA3600F
KA3554G01	980702	10	I	KA3554G02, KA3566G01,KA3566G02,KA3548G01, KA3548A01, KA3542G01,KA3542G02, KA3552G01,KA3550G01,KA3557G, KA3551G, KA3510A, KA3573A, KA3600F
KA3554G02	980702	11	I	KA3554G01,KA3566G01,KA3566G02,KA3548G01, KA3548A01 KA3542G01, KA3542G02, KA3552G01, KA3550G01, KA3557G, KA3551G, KA3510A, KA3573A, KA3600F
KA3542G02	980703	12	I	KA3542G01, KA3554G01,KA3554G02,KA3550G01, KA3548G01, KA3546G01,KA3544G01, KA3548A01, KA3551G, KA3545G, KA3539G, KA3510A, KA3573A, KA3600F
KA3542G01	980703	13	I	KA3542G02, KA3554G01,KA3554G02,KA3550G01, KA3548G01, KA3546G01,KA3544G01, KA3548A01, KA3551G, KA3545G, KA3539G, KA3510A, KA3573A, KA3600F
KA339G	980703	14	I	KA3542G01, KA3542G02, KA3554G01,KA3554G02,KA3550G01, KA3548G01, KA3546G01,KA3544G01, KA3548A01, KA3551G, KA3545G, KA3510A, KA3573A, KA3600F
KA3557G	980704	15	PBT	
KA3574G01	980704	16	PBT	
KA3576G01	980705	17	PBT	
KA3548A01	980705	18	I	KA3542G01, KA3542G02, KA3554G01,KA3554G02,KA3552G01, KA3550G01, KA3548G01,KA3546G01, KA3544G01, KA3545G, KA3539G, KA3510A, KA3573A, KA3600F
KA3536G	980706	19	PBT	

PBT = Pressure Build-Up Test, I = interference Test

Flow logging of the 15 new holes was performed during two periods: June 24^{th} – 26^{th} and between July 6 and August 8. A double packer system was used. The test section length was 1 meter down to the depth of 12 meter, below the section length was 3 m. Eight to sixteen double packer sections of each borehole were measured. A section covering the bottom of every hole was measured using a single packer tool.

If the flow rate of the measurement section exceeded 10 ml/minute a pressure build-up test was performed.

In all, flow measurements were carried out in 202 intervals.

In 53 sections a flow rate > 10ml/min was measured and a pressure build-up test was conducted, see Table 3-4.

Water sampling was carried out if the flow rate exceeded 50 ml/minute in the 1 m-sections or 200 ml/minute in the 3 m-sections.

Table 3-4. Pressure build-up tests of features in exploratory holes, July-Aug. 1998. Prototype Repository, drill campaign 3 a.

Borehole	Section (m)	Test No	Comment
KA3590G02	12.0 – 15.0	1	
KA3590G02	18.0 – 21.0	2	
KA3590G02	24.0 – 27.0	3	
KA3590G02	27.0 – 30.0	4	
KA3590G01	1.0 – 2.0	20	
KA3590G01	2.0 – 3.0	21	
KA3590G01	5.0 – 6.0	22	
KA3590G01	8.0 – 9.0	23	
KA3590G01	9.0 – 10.0	24	
KA3593G	11.0 – 12.0	25	
KA3590G01	21.0 – 24.0	26	
KA3566G01	13.0 – 16.0	27	
KA3566G01	16.0 – 19.0	28	
KA3566G01	19.0 – 22.0	29	
KA3566G02	15.0 – 18.0	30	
KA3566G02	18.0 – 21.0	31	
KA3566G02	21.0 – 24.0	32	
KA3554G02	8.0 – 9.0	33	
KA3554G02	11.0 – 12.0	34	
KA3554G02	12.0 – 15.0	35	
KA3554G02	15.0 – 18.0	36	
KA3554G02	27.0 – 30.0	37	Failed, packer moved
KA3554G02	27.0 – 30.0	37b	Failed, packer moved
KA3554G01	18.0 – 21.0	38	
KA3554G01	21.0 – 24.0	39	
KA3554G01	24.0 – 27.0	40	
KA3554G01	27.0 – 30.0	41	
KA3542G02	3.0 – 4.0	42	
KA3542G02	5.0 – 6.0	43	
KA3542G02	4.0 – 5.0	44	
KA3542G02	10.0 – 11.0	45	

Borehole	Section (m)	Test No	Comment
KA3542G02	11.0 – 12.0	46	
KA3542G02	12.0 – 15.0	47	
KA3542G02	15.0 – 18.0	48	
KA3542G02	18.0 – 21.0	49	
KA3542G02	24.0 – 27.0	50	
KA3542G01	12.0 – 15.0	51	
KA3542G01	15.0 – 18.0	52	
KA3542G01	18.0 – 21.0	53	
KA3542G01	21.0 – 24.0	54	
KA3542G01	27.0 – 30.0	55a	Failed, packer moved
KA3542G01	27.0 – 30.0	55b	Failed, packer moved
KA3539G	11.0 – 12.0	56	
KA3539G	12.0 – 15.0	57	
KA3539G	15.0 – 18.0	58	
KA3539G	18.0 – 21.0	59	
KA3539G	21.0 – 24.0	60	
KA3548A01	5.0 – 6.0	61	
KA3548A01	6.0 – 7.0	62	
KA3548A01	9.0 – 10.0	63	
KA3548A01	12.0 – 15.0	64	
KA3548A01	15.0 – 18.0	65	
KA3548A01	18.0 – 21.0	66	
KA3548A01	21.0 – 24.0	67	
KA3548A01	24.0 – 27.0	68	

4. Equipment used

When measuring the borehole pressures and carrying out the pressure build-up tests and interference tests of the entire boreholes, most of the boreholes were shut in by mechanically operated packers manufactured by Livinstone AB. The sealing rubber length of the packers was 0.15 m. The length of the packer system was c. 1.5 m.

In two of the boreholes a new type of mechanical packer was installed. It has no packer pipe outside the borehole, and reaches 280 mm into the hole. The sealing length is 135 mm.

In KA3548A01 a mechanical packer primarily made for probe holes at the tunnel front, was installed. The length of the pack is 4 m and the sealing length is c. 300 mm.

A valve arrangement, including a pressure gauge for manual reading, and sealing BAT rubber disc mounted in a nozzle, was connected on the inner packer pipe

The pressure transducers used were Druck PTX 1400. The pressure range was mostly 60 bar. During flow logging of KA3590G02 and performing the first four pressure build-up tests in that hole no 60 bar sensor was available. Instead a 35 bar transducer was used. On the transducer housing a hypodermic needle was mounted. When connecting the transducer to the valve arrangement on the packer pipe, the needle penetrated the rubber disc, enabling a hydraulic communication between the measurement section and the transducer. The ”BAT-connections” and the transducers were positioned on top of the packers, just below the closing valve, see Table 4-1

Table 4-1 Level of pressure transducers above the tunnel floor during pressure measurements of the entire exploratory holes, July 1998.

Borehole	Level above tunnel floor (m)	Borehole	Level above tunnel floor (m)	
KA3544G01	1.45	KA3545G	1.47	
KA3546G01	1.47	KA3551G	1.46	
KA3548G01	0.10	KA3557G	1.49	
KA3550G01	0.10	KA3581G	1.51	
KA3552G01	1.35	KA3587G	1.49	
KA3557G	1.45	KA3593G	1.45	
KA3563G	1.49	KA3548A01	c. 2	(=the level of the borehole)
KA3572G01	1.47	KA3590G01	1.00	
KA3574G01	1.47	KA3590G02	0.95	
KA3576G01	1.49	KA3566G01	1.01	
KA3578G01	1.52	KA3566G02	1.06	
KA3584G01	1.47	KA3554G01	0.92	
KA3586G01	1.51	KA3554G02	1.07	
KA3588G01	1.43	KA3542G01	1.01	
KA3539G	1.46	KA3542G02	1.03	

Pressure data were stored using the data logger BORRE MDL ver. 2.2, manufactured by IPA-konsult AB. The software of the logger is very flexible concerning sampling intervals etc. A measurement sequence can be started either by a temporarily connected computer or by using the keypad at the front of the data logger. Pressure values are shown on the computer screen during the measurements. The keypad enables three measurement options. The option ”SLOW” initiates one-hour interval measurement and ”FAST” a 5 minutes interval. The ”SEQUENCE”-option is usually used during hydraulic testing. This option has stepwise increase in measurement intervals starting with 2 seconds (if one channel is used). After 30 minutes and onwards the measurement interval is three minutes. These ”SLOW”-, ”FAST”- and ”SEQUENCE” -options can easily be reprogrammed from the computer.

During the interference tests four data loggers and eleven pressure transducers were used for pressure monitoring .

Water flow rates higher than 1-2 ml/min were measured using graduated cylinders and a stopwatch. Lower rates were achieved by letting the water flows through a vertical mounted Tecalan hose and to measure the rise of the water level. A Tecalan hose with the inner diameter 4 mm was used. The level of the outflow of each test varied, see Table 4-3.

The down-hole equipment used for the flow logging and the PBT’s of a feature in the exploratory holes consisted of two inflatable polyurethane packers, separated by a pipe, a pipe string and two pressure lines. The sealing length of each packer is 1.0 m and they are inflated using water pressurised by nitrogen. The pipe between the packers and a bypass opening at the upper gable of the outer packer equals the ground water pressure on both sides of the measurement section. One of the two pressure hoses (polyamide) is connecting the packers and the pressurising system. The second pressure hose establishes hydraulic contact between the measurement chamber and a transducer positioned outside the borehole.

The pipe string is made of aluminium with threaded pipe joints of stainless steel. The outer/inner diameter is 33/21 mm and the length of individual pipe segments is 1 m.

The test tool and the pipe string were lowered into the borehole using a manually operated winch.

The packer inflation influences the accuracy of the flow measurements. The generated flow in a double packer section caused by the packers used in the tests have been tested in the laboratory, cf. Lindström (1997). The results show that after 30 minutes of inflation, the flow is c. 0.5 ml/min. and after 40 minutes the generated flow is c.0.4ml/min. Consequently, the effect of the packer creep induced flow is most pronounced for low-conductive test sections, see Figure 4-1

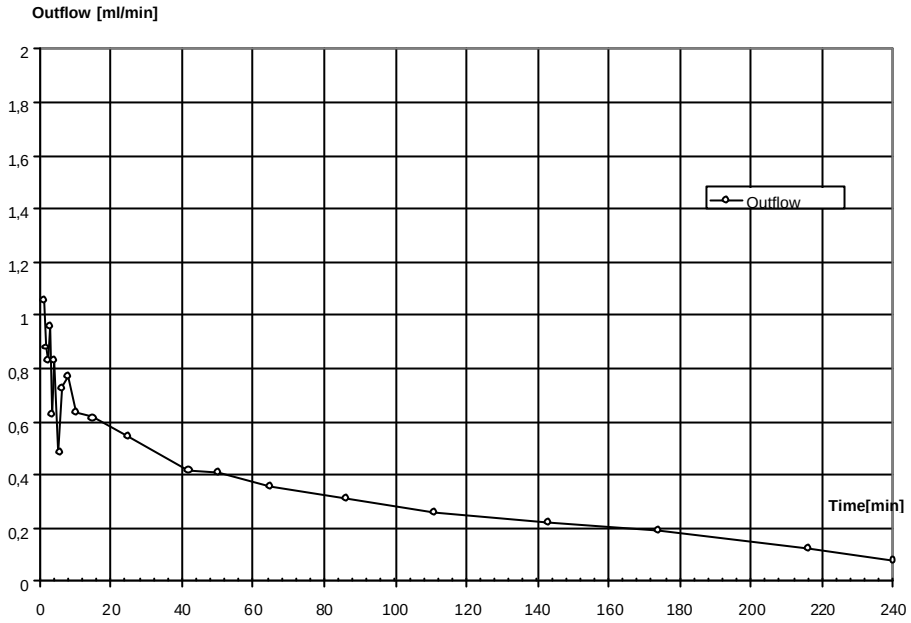

Figure 4-1 Generated flow caused by inflation of double packers PUR 72. Elapsed time from start of inflation, from Lindström 1997

When flow logging the pilot holes in November 1997 flow rates lower than the minimum rates of the laboratory tests were observed. This was somewhat confusing and not easy to explain. In order to study if the function of the packers had been changed by age or by use, the laboratory tests were repeated in April 1998. The same packers used in the November measurements and later used in the exploratory holes were tested in the laboratory. However the result of the new tests was similar to the data achieved at the first test. After 30 to 40 minutes of packer inflation the flow generated by the packer expansion was measured to 0.48 - 0.44 ml/min. see Table 4-2.

Table 4-2 Generated flow caused by inflation of double packers PUR 72. Laboratory tests 98-04-02

Elapsed Time (min)	Squeezed volume (cumulative) (ml)	Flow (ml/ min)	Elapsed Time (min)	Squeezed volume (cumulative) (ml)	Flow (ml/ min)
0	0	0	8	59.42	0.57
2	56.00	28.00	9	59.94	0.53
2.5	56.26	0.53	10	60.50	0.55
3	56.58	0.63	15	63.08	0.52
3.5	56.87	0.58	20	65.61	0.50
4	57.16	0.58	30	70.37	0.48
4.5	57.44	0.58	40	74.80	0.44
5	57.75	0.60	50	78.95	0.41
6	58.31	0.57	60	82.84	0.39
7	58.85	0.54			

5. PERFORMANCE

5.1 Pressure measurements

The ground-water pressure of the exploratory holes was at one occasion measured using pressure transducer, data logger and a portable PC. The transducer was connected to the ”BAT-connection” of the boreholes respectively and the logger value, displayed on the PC-screen, was noted. The pressure was calculated using the calibration constants. Before the measurements, the borehole pressures were stabilised for one to four days.

The borehole pressures were at several occasions also achieved by reading the pressure gauges mounted on the valve adapters.

5.2 Pressure build-up tests of the entire boreholes and interference tests.

Before the measurements, the borehole pressures were stabilized for about four days.

The test cycle was performed as follows:

- The pressure transducers and the data loggers were connected, see chapter 4, to the flowing borehole and the to nearby observation boreholes.
- The logarithmic scanning option (”SEQ”) of the logger was initiated
- The valve of the flowing borehole was opened and the flow was measured during 30 - 240 minutes
- The logarithmic scanning option (”SEQ”) of the loggers was restarted
- The valve was closed and the pressure build-up was registered during 15-120 minutes.
- The data loggers were switched off.
- Transfer to next borehole and reconfiguration of the monitoring equipment.

The duration of the draw-down and the recovery respectively varied depending on the flow, the lower flow rate, the longer draw-down/recovery.

The flow rate was measured using graduated cylinders or a Tecalan hose, see chapter 4.

The data loggers were programmed to measure with the highest sample rate during the first three minutes of the flow phase and recovery phase respectively. Thereafter the sampling interval was 20 seconds. Since 1-5 transducers were connected to each data logger the lowest measurement interval was 2-6 seconds.

If the flow rate exceeded 10 ml/min the test was performed as an interference test. If the flow was less, the test was evaluated as a pressure build-up test in the flowing borehole.

5.3 Flow meter logging with double packers

Shortly before the measurement of an exploratory hole the mechanical packer was removed and the double packer section was assembled.

If the flow rate of a test interval was less than 10 ml/min a measurement cycle was performed as follows:

- The double packer section was lowered to the first position.
- Start of the packer inflation and data logger (SEQ)
- The packers stabilised for 30 minutes
- The packer pipe was filled with water and if necessary a Tecalan hose was mounted on the top of the packer pipe
- Flow measurements during 5 minutes
- Packer deflation
- Transfer to next borehole section

The flow logging started in the uppermost test interval of the boreholes (1.0-2.0 m). Thereafter the packers were lowered 1m for the next test.

When the double packer measurements were completed, the lower packer was removed. The bottom of the borehole was measured with a single packer in the same way as described above.

5.4 Pressure build-up test of a feature in the exploratory boreholes

If the flow rate of a 1m-section or a 3m-section was greater than 10 ml/min, a test cycle was performed as follows:

- The double packer section was lowered to the measurement interval.
- Start of the packer inflation and data logger (SEQ)
- The packers stabilised for c. 5 minutes
- The packer pipe was filled with water
- Flow measurements during 60 minutes
- The logarithmic scanning option (”SEQ”) of the loggers was restarted
- The valve was closed and the pressure build-up was registered during 120 minutes.
- Packer deflation
- Transfer to next borehole section

The flow rate was measured using graduated cylinders and a stopwatch.

6. Results

6.1 Pressure measurements

The results of the pressure measurement are listed in Table 6.1

Table 6-1 Borehole pressures (kPa) measured by pressure gauges or pressure-transducer and data logger in exploratory holes for Prototype Repository, drill campaign 3a

Date: Time	980630 14:33 --	980630 --16:24
Borehole	(press. Gauge)	(pr.tran- sducer)
KA3539G	2980	2953
KA3545G	-	2547
KA3544G01	-	2925
KA3546G01	-	2208
KA3548G01	-	2467
KA3551G	1000	908
KA3550G01	-	2556
KA3552G01	1310	1356
KA3557G	600	605
KA3563G	0	92
KA3569G	930	857
KA3572G01	860(?)	316
KA3574G01	280(?)	94
KA3575G	500	423
KA3576G01	0	55
KA3578G01	0	57
KA3579G	1710	1659
KA3581G	0	-13
KA3584G01	0	-9
KA3587G	1610	1541
KA3586G01	400	330
KA3588G01	2210	2257
KA3593G	239.5	2344
KA3548A01	-	3629
KA3542G01	3810	3770
KA3542G02	3190	3063
KA3554G01	-	3837
KA3554G02	3030	2999
KA3566G01	2250	2295
KA3566G02	3390	3325
KA3590G01	2200	2137
KA3590G02	-	3753

At one occasion pressure gauges and the transducer measured the borehole pressures at the same time. As can be seen in Table 6.1 there is a small discrepancy between the two methods (e.g. KA3572G01 and KA3574G01) Pressure values measured by the data logger/transducer system should however be more reliable since the system was calibrated some days before the exploratory hole measurements. In some boreholes(e.g. KA3574G01) the measured pressure is lower than pressures observed later during the interference tests.

6.2 Pressure build-up tests of the entire boreholes and interference tests.

Appendices A1 – A15 contain the diagrams for each test. The different types of diagrams are:

- Lin-Lin plots for the whole test sequence
- Lin-Log plots for the draw-down phase and the pressure build-up
- Log-Log plots for the draw-down phase and the pressure build-up
- Derivative plots for the recovery

The pressure build-up is plotted versus the equivalent time, dt_e , in minutes. The equivalent time is defined as:

$$dt_e = \frac{t_p \cdot dt}{t_p + dt} \quad \text{where}$$

t_p = time in minutes when the test section was open
dt = elapsed time after shutting the valve to the test section.

In the following details and important test data for each test are described
The abbreviations used are:

- Po = Initial pressure before opening of the valve
- Pp = Pressure just before closing the valve
- Pf = Pressure at the end of the pressure build-up period

Borehole KA3590G02, section 0.39 m - 30.05 m

Date:	98-07-01	Field Crew:	B. Gentzschein
Borehole length:	30.05 m	Borehole diameter:	76 mm
Flowing borehole:	KA3590G02		
Valve opened:	980701 093559	Valve closed:	980701 103559
Total flowing time : 60 min		Tot. Pr. Build-up time: 87 min.	

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3590G01, KA3593G, KA3588G01, KA3566G01, KA3566G02, KA48A01, KA3586G01, KA3587G, KA3581G , KA3579G, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)
KA3590G02	3759.8	2.1	3699
KA3590G01	2132	2127.9	2128.6
KA3593G	2385	2274.5	2312.1
KA3588G01	2283	2176.8	2208.8
KA3566G01	2313.3	2307.1	2307.5
KA3566G02	3352.0	2557.5	3290.9
KA3548A01	3663.1	3655.3	3657.4
KA3586G01	373.7	375.1	378.7
KA3587G	1582	1579.5	1573.3
KA3581G	-9.4	-9.8	-10.3
KA3579G	1730.4	1732.4	1735.5
KA3510A	4148.3	4147.9	4147.9
KA3573A:1	4072.0	4068.5	4071.6
KA3573A:2	3987.7	3980.6	3985.2
KA3600F:1	4132.5	4131.3	4132.3
KA3600F:2	4108.1	4106.7	4107.9

Manually measured flow rates of KA3590G02 are presented below. The height of the water flow outlet was 1.02 m above the tunnel floor.

Time	Flow rate (l/min)
09:37	3.65
09:43	3.01
09:49	2.75
09:55	2.60
10:02	2.52
10:08	2.45
10:14	2.45
10:20	2.40
10:26	2.35

Borehole KA3590G01, section 0.39 m - 30.06 m

Date:	98-07-01	Field Crew:	B. Gentzschein
Borehole length:	30.06 m	Borehole diameter:	76 mm
Flowing borehole:	KA3590G01		
Valve opened:	980701 124559	Valve closed:	980701 134759
Total flowing time : 62 min		Tot. Pr. Build-up time:	40 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3590G02, KA3593G, KA3588G01, KA3566G01, KA3566G02, KA48A01, KA3586G01, KA3587G, KA3581G , KA3579G, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)
KA3590G01	2126.7	3.1	2080.1
KA3590G02	3728.4	3741.0	3744.2
KA3593G	2335.7	2311.0	2331.2
KA3588G01	2233.7	2223.0	2231.6
KA3566G01	2308.5	2026.2	2248.1
KA3566G02	3306.2	3323.4	3328.7
KA3548A01	3658.0	3654.4	3666.7
KA3586G01	379.9	381.7	383.3
KA3587G	1572.0	1569.7	1569.2
KA3581G	-10.0	-10.0	-10.0
KA3579G	1736.5	1737.9	1739.0
KA3510A	4148.3	4147.4	4148.1
KA3573A:1	4071.2	4070.1	4071.4
KA3573A:2	3984.4	3981.8	3985.6
KA3600F:1	4132.3	4131.8	4132.3
KA3600F:2	4107.9	4107.0	4107.9

Manually measured flow rates of KA3590G01 are presented below. The height of the water flow outlet was 1.03 m above the tunnel floor.

Time	Flow rate (l/min)
12:47	0.82
12:51	0.805
12:57	0.78
13:03	0.77
13:10	0.77
13:17	0.765
13:25	0.76
13:32	0.76
13:39	0.75
13:44	0.75

Borehole KA3593G, section 0.39 m - 30.02 m

Date:	98-07-01	Field Crew:	B. Gentzschein
Borehole length:	30.02 m	Borehole diameter:	76 mm
Flowing borehole:	KA3593G		
Valve opened:	980701 150700	Valve closed:	980701 161100
Total flowing time : 64 min		Tot. Pr. Build-up time:	31 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3590G01, KA3590G02, KA3588G01, KA3566G01, KA3566G02, KA48A01, KA3586G01, KA3587G, KA3581G, KA3579G, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)
KA3593G	2329.1	0.9	2089.2
KA3590G01	2135.8	2133.5	2142.0
KA3590G02	3746.5	3741.4	3741.9
KA3588G01	2250.8	1633.5	2000.5
KA3566G01	2285.3	2281.0	2290.4
KA3566G02	3332.1	3333.7	3334.2
KA3548A01	3666.6	3660.3	3659.4
KA3586G01	384.7	385.9	386.5
KA3587G	1568.8	1550.8	1538.9
KA3581G	-10.3	-10.5	-10.3
KA3579G	1739.8	1740.7	1738.0
KA3510A	4147.6	4147.0	4146.7
KA3573A:1	4070.4	4069.9	4070.4
KA3573A:2	3986.2	3985.4	3985.2
KA3600F:1	4132.0	4130.9	4130.4
KA3600F:2	4107.2	4106.5	4105.8

Manually measured flow rates of KA3593G are presented below. The height of the water flow outlet was 1.55 m above the tunnel floor.

Time	Flow rate (l/min)
15:11	0.244
15:20	0.230
15:26	0.222
15:34	0.218
15:40	0.212
15:46	0.212
15:53	0.206
16:00	0.204
16:06	0.204

Borehole KA3566G02, section 0.39 m - 30.01 m

Date:	98-07-01(-02)	Field Crew:	B. Gentzschein
Borehole length:	30.01 m	Borehole diameter:	76 mm
Flowing borehole:	KA3566G02		
Valve opened:	98-07-01 17:39.00	Valve closed:	98-07-01 18:42.00
Total flowing time : 63 min		Tot. Pr. Build-up time:	780 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3566G01, KA3590G01, KA3590G02, KA3574G01, KA3554G01, KA3554G02, KA48A01, KA3569G, KA3557G, KA3563G , KA3572G01, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)	.
KA3566G02	3328.6	1.9	3333.9	
KA3566G01	2287.8	2292.9	2305.3	
KA3590G01	2146.1	2149.6	2165.2	
KA3590G02	1240.6	1035.8	788.3	!
KA3574G01	442.9	445.9	457.5	
KA3554G01	3838.5	3837.8	3843.5	
KA3554G02	3021.3	2999.3	3026.5	
KA3548A01	3662.6	3658.5	3703.6	
KA3569G	878.6	879.3	890.9	
KA3557G	659.6	660.3	669.9	
KA3563G	110.1	76.6	111.2	
KA3572G01	326.8	326.5	334.5	
KA3510A	4147.6	4146.5	4149.0	
KA3573A:1	4069.1	4069.5	4073.3	
KA3573A:2	3983.9	3981.8	3990.2	
KA3600F:1	4130.0	4129.3	4132.0	
KA3600F:2	4105.4	4104.9	4108.1	

The pressure of borehole KA3590G02 is much lower than observed during the preceding tests and is decreasing the whole test sequence. Probably there has been a leak around the mechanical packer. Unfortunately no pressure gauge was connected to the borehole, why no manual measurements was observed during the test.

Manually measured flow rates of KA3566G02 are presented below. The height of the water flow outlet was 0.87 m above the tunnel floor.

Manually measured flow rates during interference test in KA3566G02

Time	Flow rate (l/min)
17:40	0.310
17:48	0.234
17:54	0.226
18:00	0.219
18:06	0.211
18:13	0.208
18:20	0.206
18:27	0.204
18:35	0.203

Borehole KA3566G01, section 0.39 m - 30.01 m

Date:	98-07-02	Field Crew:	B. Gentzschein
Borehole length:	30.01 m	Borehole diameter:	76 mm
Flowing borehole:	KA3566G01		
Valve opened:	98-07-02 09:31.01	Valve closed:	98-07-02 10:38.00
Total flowing time : 67 min		Tot. Pr. Build-up time:	74 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3566G02, KA3590G01, KA3590G02, KA3574G01, KA3554G01, KA3554G02, KA48A01, KA3569G, KA3557G, KA3563G , KA3572G01, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)	.
KA3566G01	2296.6	0.8	2256.6	
KA3566G02	3330.9	3341.3	3341.7	
KA3590G01	2164.5	2083.7	2154.6	
KA3590G02	769.9	759.8	750.7	!
KA3574G01	458.0	457.7	457.5	
KA3554G01	3841.4	3838.0	3838.9	
KA3554G02	3025.9	3025.6	3025.4	
KA3548A01	3684.1	3667.4	3652.6	
KA3569G	890.0	756.9	849.0	
KA3557G	671.5	672.0	672.9	
KA3563G	111.0	110.0	109.8	
KA3572G01	336.1	331.8	330.9	
KA3510A	4148.1	4148.3	4148.3	
KA3573A:1	4072.4	4071.2	4073.3	
KA3573A:2	3989.2	3985.2	3987.1	
KA3600F:1	4132.5	4132.3	4132.7	
KA3600F:2	4108.4	4108.1	4108.1	

Also during this test the pressure of borehole KA3590G02 is much lower than expected, probably due to leakage around the mechanical packer.

Manually measured flow rates of KA3566G01 are presented below. The height of the water flow outlet was 0.98 m above the tunnel floor.

Time	Flow rate (l/min)
09:33	0.200
09:39.30	0.193
09:47	0.190
09:53	0.188
10:00	0.186
10:07	0.184
10:14	0.185
10:21	0.184
10:34	0.184

Borehole KA3554G01, section 0.39 m - 30.01 m

Date: 98-07-02 Field Crew: B. Gentzschein, J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm

Flowing borehole: KA3554G01
Valve opened: 98-07-02 13:07.00 Valve closed: 98-07-02 14:11.00
Total flowing time : 64 min Tot. Pr. Build-up time: 84 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3554G02, KA3566G01, KA3566G02, KA3557G, KA3552G01, KA3550G01, KA48A01, KA3551G, KA3548G01, KA3542G01, KA3542G02, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)
KA3554G01	3831.4	1.6	3829.5
KA3554G02	3018.3	2991.5	3004.6
KA3566G01	2290.5	2199.8	2280.4
KA3566G02	3338.2	3316.2	3327.6
KA3557G	662.2	663.5	664.7
KA3552G01	1405.5	1302.2	1379.4
KA3550G01	2622.2	2613.0	2610.3
KA35548A01	3643.9	3496.2	3580.0
KA3551G	1375.9	1377.9	1383.4
KA3548G01	2515.0	2502.4	2502.2
KA3542G01	3782.6	3635.0	3765.5
KA3542G02	3078.5	3051.0	3064.6
KA3510A	4147.2	4135.9	4146.3
KA3573A:1	4070.6	4012.8	4067.6
KA3573A:2	3973.4	3954.0	3980.8
KA3600F:1	4133.4	4128.1	4130.9
KA3600F:2	4108.1	4094.8	4105.6

According to the data file borehole KA3548A01 recovered to a maximum pressure (3613 kPa) at 15:27. Then the pressure values decreased. The fall off was probably not caused by ground-water conditions, but more likely an effect of a bad connection between the borehole and the pressure transducer discovered later (July 5th).

Manually measured flow rates of KA3554G01 are presented below. The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates, interference test in KA3554G01

Time	Flow rate (l/min)
13:07:45	8.89
13:14:15	8.40
13:20	8.28
13:28	8.30
13:36	8.21
13:44	8.26
13:51	8.18
13:58	8.24
14:05	8.24

Borehole KA3554G02, section 0.39 m - 30.01 m

Date: 98-07-02 Field Crew: B. Gentzschein, J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm

Flowing borehole: KA3554G02
Valve opened: 98-07-02 16:16.59 Valve closed: 98-07-02 17:27.59
Total flowing time : 71 min Tot. Pr. Build-up time: 39 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3554G02, KA3566G01, KA3566G02, KA3557G, KA3552G01, KA3550G01, KA48A01, KA3551G, KA3548G01, KA3542G01, KA3542G02, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)	.
KA3554G02	3000.4	3.4	2960.6	
KA3554G01	3839.1	3838.2	3838.0	
KA3566G01	2287.3	2291.9	2293.3	
KA3566G02	3332.0	3229.4	3308.1	
KA3557G	665.6	666.1	667.0	
KA3552G01	1397.8	1395.7	1394.3	
KA3550G01	2618.3	2510.1	2563.3	
KA35548A01	3225.0	3403.9	458.9	!
KA3551G	1385.9	1389.3	1391.6	
KA3548G01	2510.5	2421.3	2457.6	
KA3542G01	3770.7	3767.8	3765.9	
KA3542G02	3069.4	2939.1	3041.4	
KA3510A	4147.4	4147.0	4147.0	
KA3573A:1	4068.9	4068.0	4068.3	
KA3573A:2	3982.0	3980.3	3981.2	
KA3600F:1	4131.1	4131.6	4132.0	
KA3600F:2	4106.1	4106.7	4106.5	

The pressure data curve of borehole KA3548A01 shows great variations. This is an effect of a bad connection between the borehole and the pressure transducer discovered later (July 5th).

Manually measured flow rates of KA3554G02 are presented below. The height of the water flow outlet was 1.01 m above the tunnel floor.

Time	Flow rate (l/min)
16:18	0.660
16:23	0.632
16:31	0.615
16:38	0.606
16:45	0.610
16:52	0.611
17:00	0.612
17:07	0.607
17:23	0.602

Borehole KA3542G02, section 0.39 m - 30.01 m

Date: 98-07-03 Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm

Flowing borehole: KA3542G02
Valve opened: 98-07-03 08:58.00 Valve closed: 98-07-03 10:06.00
Total flowing time : 68 min Tot. Pr. Build-up time: 84 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3542G01, KA3554G01, KA3554G02, KA3548A01, KA3550G01, KA3548G01, KA46G01, KA3551G, KA3544G01, KA3545G, KA3539G, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)	.
KA3542G02	3051.6	3.6	2933.5	
KA3542G01	3743.7	3714.0	3722.0	
KA3554G01	3835.2	3819.4	3826.5	
KA3554G02	3005.7	1615.6	2910.8	
KA3548A01	36.4	39.1	51.0	!
KA3550G01	2635.5	2129.3	2427.6	
KA3548G01	2525.6	2094.8	2321.1	
KA3546G01	2288.0	1969.6	2112.2	
KA3551G	1442.2	1441.6	1446.6	
KA3544G01	2933.3	2089.7	2797.9	
KA3545G	2386.9	2027.2	2057.0	
KA3539G	2966.8	2113.1	2849.7	
KA3510A	4146.7	4145.3	4146.0	
KA3573A:1	4067.2	4061.4	4063.6	
KA3573A:2	3977.4	3964.0	3970.3	
KA3600F:1	4132.0	4130.9	4131.3	
KA3600F:2	4106.7	4104.9	4105.1	

The data curve of borehole KA3548A01 shows too low pressure values. This is an effect of a bad connection between the borehole and the pressure transducer discovered later (July 5th).

Manually measured flow rates of KA3542G02 are presented below. The height of the water flow outlet was 1.01 m above the tunnel floor.

Time	Flow rate (l/min)
08:58:30	5.95
09:03	5.50
09:10	5.12
09:20	4.92
09:26	4.68
09:31	4.56
09:38	4.54
09:44	4.46
09:51	4.41

Borehole KA3542G01, section 0.39 m - 30.04 m

Date: 98-07-03 Field Crew: B. Gentzschein
Borehole length: 30.04 m Borehole diameter: 76 mm

Flowing borehole: KA3542G01
Valve opened: 98-07-03 12:09.59 Valve closed: 98-07-03 13:10.00
Total flowing time : 60 min Tot. Pr. Build-up time: 56 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3542G02, KA3554G01, KA3554G02, KA3548A01, KA3550G01, KA3548G01, KA46G01, KA3551G, KA3544G01, KA3545G, KA3539G, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)	.
KA3542G01	3727.5	3.4	3696.7	
KA3542G02	2987.1	3001.1	3021.9	
KA3554G01	3829.8	3765.0	3822.2	
KA3554G02	2957.8	2970.6	2988.4	
KA3548A01	50.6	48.3	47.8	!
KA3550G01	2510.4	2549.3	2572.7	
KA3548G01	2401.3	2430.5	2456.7	
KA3546G01	2178.3	2169.3	2212.2	
KA3551G	1447.9	1450.2	1452.3	
KA3544G01	2861.4	2877.4	2899.5	
KA3545G	2010.9	1870.8	1738.4	
KA3539G	2901.3	2912.3	2936.8	
KA3510A	4145.3	4140.0	4144.7	
KA3573A:1	4064.7	4043.2	4062.6	
KA3573A:2	3971.5	3921.6	3967.1	
KA3600F:1	4130.9	4129.5	4130.2	
KA3600F:2	4105.6	4100.5	4104.4	

The data curve of borehole KA3548A01 shows too low pressure values. This is an effect of a bad connection between the borehole and the pressure transducer discovered later (July 5th). The manual measurements (manometer) resulted in Po = c. 34 bar , Pp= c. 30.7 bar and Pf= c. 34 bar respectively. The manometer was placed 2 meters above the tunnel floor and was not easy to read.

Manually measured flow rates of KA3542G01 are presented below. The height of the water flow outlet was 1.01m above the tunnel floor.

Manually measured flow rates during interference test in KA3542G01

Time	Flow rate (l/min)
12:11	5.16
12:15	4.33
12:21	4.34
12:28	4.08
12:35	4.03
12:43	3.98
12:50	3.96
12:57	3.94
13:05	3.91

Borehole KA3539G, section 0.39 m - 30.01 m

Date: 98-07-03 (-04) Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm
Flowing borehole: KA3539G
Valve opened: 98-07-03 14:24.59 Valve closed: 98-07-03 15:28:59
Total flowing time : 64 min Tot. Pr. Build-up time: 921 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3554G01, KA3554G02, KA3548A01, KA3542G01, KA3542G02, KA3550G01, KA3548G01, KA46G01, KA3551G, KA3544G01, KA3545G, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)	.
KA3539G	2921.8	5.7	2934.4	
KA3554G01	3826.5	3814.2	3826.3	
KA3554G02	2994.4	2231.0	3015.5	
KA3542G01	3728.8	3705.7	3722.6	
KA3542G02	3029.5	2038.3	3052.3	
KA3548A01	46.9	41.9	24.7	!
KA3550G01	2583.3	2011.5	2642.4	
KA3548G01	2468.6	1992.8	2528.4	
KA3546G01	2226.7	1884.4	2207.1	
KA3551G	1453.9	1453.0	1499.9	
KA3544G01	2907.5	1622.4	2924.8	
KA3545G	1699.9	1583.1	1177.6	!
KA3510A	4144.9	4144.4	4145.6	
KA3573A:1	4063.4	4059.8	4064.3	
KA3573A:2	3970.0	3960.1	3970.3	
KA3600F:1	4130.2	4130.0	4130.9	
KA3600F:2	4104.4	4104.7	4105.4	

The data curve of borehole KA3548A01 shows too low pressure values. This is an effect of a bad connection between the borehole and the pressure transducer discovered late (July 5th). The manual measurements (manometer) resulted in Po = c. 34 bar, Pp= c. 34 bar and Pf= c. 33 bar respectively. The manometer was placed 2 meters above the tunnel floor and not easy to read.

The data curves of borehole KA3545G also show low pressure values compared to earlier measurements. The reason is not obvious but could be bad connection between the transducer and the borehole section.

Manually measured flow rates of KA3539G are presented below. The height of the water flow outlet was 1.55 m above the tunnel floor.

Manually measured flow rates during interference test in KA3539G

Time	Flow rate (l/min)
14:27	7.20
14:31	6.38
14:38	6.00
14:45	5.68
14:53	5.54
15:00	5.30
15:07	5.18
15:15	5.06
15:22	5.02

Borehole KA3557G, section 0.39 m - 30.04 m

Date: 98-07-04 Field Crew: B. Gentzschein
Borehole length: 30.04 m Borehole diameter: 76 mm

Flowing borehole: KA3557G
Valve opened: 98-07-04 09:36.00 Valve closed: 98-07-04 13:37.00
Total flowing time : 241 min Tot. Pr. Build-up time: 136.5 min.

The test was performed as a Pressure Build-up Test. The groundwater pressure was measured only in borehole KA3557G

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)
KA3557G	676.7	4.1	203.1

The flow rate of KA3557G was determined by measuring the rise of the water level in a 6/4 mm Tecalan tube (during 6 minutes), see the table below: The height of the water flow outlet was 1.57 m above the tunnel floor.

Manually measured flow rates during interference test in KA3557G

Time	Start level (mm)	Stop level (mm)	Flow rate) (l/min
09:39-45	25	163	$2.8x10^{-4}$
10:04-10	15	105	$1.9x10^{-4}$
10:41-47	18	99	$1.7x10^{-4}$
11:12-18	17	92	$1.6x10^{-4}$
11:31-37	14	86	$1.5x10^{-4}$
13:07-13	15	83	$1.4x10^{-4}$
13:30-36	15	82	$1.4x10^{-4}$

Borehole KA3574G01, section 0.39 m - 12.00 m

Date: 98-07-04 Field Crew: B. Gentzschein
Borehole length: 12.00 m Borehole diameter: 76 mm

Flowing borehole: KA3574G01
Valve opened: 98-07-04 16:30.00 Valve closed: 98-07-04 20:30.00
Total flowing time : 240 min Tot. Pr. Build-up time: 734 min.

The test was performed as a Pressure Build-up Test. The groundwater pressure was measured only in borehole KA3574G01

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)
KA3574G01	447.4	4.8	448.1

The flow rate of KA3574G01 was determined by means of a graduated cylinder or by measuring the rise of the water level in a 6/4 mm Tecalan tube (during 2-3 minutes), see the table below. The height of the water flow outlet was 1.55 m above the tunnel floor.

Time	Start level (mm)	Stop level (mm)	Flow rate) (l/min
16:31-32			0.0012
16:35-37	30	166	$8.6x10^{-4}$
16:47-49	30	149	$7.5x10^{-4}$
17:16-19	31	197	$7.0x10^{-4}$
17:50-52	30	141	$7.0x10^{-4}$
18:42-44	30	140	$6.9x10^{-4}$
19:46-48	25	131	$6.7x10^{-4}$
20:07-09	30	137	$6.7x10^{-4}$
20:25-27	30	139	$6.9x10^{-4}$

Borehole KA3576G01, section 0.39 m - 12.01 m

Date: 98-07-05 Field Crew: B. Gentzschein
Borehole length: 12.01 m Borehole diameter: 76 mm

Flowing borehole: KA3576G01
Valve opened: 98-07-05 09:02.59 Valve closed: 98-07-05 13:03.00
Total flowing time : 240 min Tot. Pr. Build-up time: 150 min.

The test was performed as a Pressure Build-up Test. The groundwater pressure was measured only in borehole KA3576G01

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)
KA3576G01	72.1	3.3	57.7

The flow rate of KA3576G01 was determined by measuring the rise of the water level in a 6/4 mm Tecalan tube (during 5-6 minutes), see the table below. The height of the water flow outlet was 1.55 m above the tunnel floor.

Time	Start level (mm)	Stop level (mm)	Flow rate) (l/min
09:04-09	15	68	1.3×10^{-4}
09:21-27	12	59	9.9×10^{-5}
09:51-57	16	59	9.0×10^{-5}
10:28-34	14	53	8.2×10^{-5}
11:37-43	13	48	7.4×10^{-5}
12:07-13	12	45	6.9×10^{-5}
12:27-33	13	44	6.5×10^{-5}
12:53-59	8	38	6.3×10^{-5}

Borehole KA3548A01, section 2.56 m - 30.00 m

Date: 98-07-05 (-06) Field Crew: B. Gentzschein
Borehole length: 30.00 m Borehole diameter: 76 mm

Flowing borehole: KA3548A01
Valve opened: 98-07-05 16:43.00 Valve closed: 98-07-03 17:47:01
Total flowing time : 64 min Tot. Pr. Build-up time 882 min.

The test was performed as an interference test. Pressure responses were monitored in boreholes KA3554G01, KA3554G02, KA3539G, KA3542G01, KA3542G02, KA3552G01, KA3550G01, KA3548G01, KA46G01, KA3544G01, KA3545G, KA3510A, KA3573A and KA3600F.

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)	.
KA3548A01	3495.5	7.3	3390.4	
KA3554G01	3836.4	3726.9	3834.3	
KA3554G02	3019.4	2994.9	3017.6	
KA3542G01	3750.1	3328.4	3757.9	
KA3542G02	3053.5	3029.2	3051.6	
KA3552G01	1401.9	1351.7	1398.2	
KA3550G01	2644.4	2628.6	2641.0	
KA3548G01	2531.3	2514.0	2528.1	
KA3546G01	2292.1	2270.3	2289.1	
KA3544G01	2928.0	2903.1	2927.3	
KA3545G	997.7	948.0	965.4	!
KA3539G	2937.6	2911.0	2936.2	
KA3510A	4146.7	4139.1	4146.3	
KA3573A:1	4065.9	4027.1	4064.9	
KA3573A:2	3969.2	3889.8	3972.8	
KA3600F:1	4131.6	4128.1	4130.0	
KA3600F:2	4106.3	4096.8	4104.7	

Shortly before test start it was discovered that the pressure sensor of KA3548A01 was not sufficiently connected to the borehole. At 16:26 the sensor was properly connected and thereafter data are of good quality again. However, c. 90 minutes after the start of the recovery a small pressure drop occurred. It is unknown weather this was caused by technical problems (packer or sensor) or if it was an effect of an ground-water draw-down

The data curves of borehole KA3545G still show low pressure values compared to earlier measurements. The reason for this is not obvious but could be bad connection between the transducer and the borehole-section.

Manually measured flow rates of KA3548A01 are presented below. The height of the water flow outlet was2.45 m above the tunnel floor, which is approximately the same level as the borehole.

Manually measured flow rates during interference test in KA3548A01

Time	Flow rate (l/min)
16:44	8.13
16:53	7.34
17:01	7.28
17:08	7.32
17:15	7.36
17:22	7.30
17:30	7.32
17:37	7.20
17:43.15	7.20

Borehole KA3563G, section 0.39 m - 30.00 m

Date: 98-07-06 Field Crew: B. Gentzschein
Borehole length: 30.00 m Borehole diameter: 76 mm
Flowing borehole: KA3563G
Valve opened: 98-07-06 09:18.00 Valve closed: 98-07-06 10:53.00
Total flowing time : 95 min Tot. Pr. Build-up time: 67.7 min.

The test was performed as a pressure build-up test. The groundwater pressure was measured only in borehole KA3563G

Pressure data

Borehole	Po (kPa)	Pp(kPa)	Pf(kPa)
KA3563G	97.4	4.3	97.2

The flow rate of KA3563G was determined with the help of a graduated cylinder and a stop watch, see the table below. The height of the water flow outlet was 1.55 m above the tunnel floor.

Time	Flow rate)
09:19.30	0.0095
09:25	0.0091
09:30	0.0090
09:37	0.0089
09:49	0.0090
09:57	0.0090
10:05	0.0090
10:18	0.0089
10:27	0.0089
10:37	0.0090

6.3 Flow meter logging with double packers

The result of the flow logging is presented in Table 6-2.

Table 6-2 Results of flow logging of the exploratory boreholes for the Prototype, Repository, drill campaign 3a.

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3539G	980801	8.00- 9.00	1.5×10^{-5}	
KA3539G	980801	9.00-10.00	2.3×10^{-5}	
KA3539G	980801	10.00-11.00	3.3×10^{-5}	
KA3539G	980801	11.00-12.00	0.088	PBT
KA3539G	980801	12.00-15.00	0.035	PBT
KA3539G	980801	15.00-18.00	4.06	PBT
KA3539G	980802	18.00-21.00	0.049	PBT
KA3539G	980802	21.00-24.00	0.026	PBT
KA3539G	980802	24.00-27.00	1.2×10^{-4}	
KA3539G	980802	27.00-30.00	2.3×10^{-5}	single packer test
KA3542G01	980729	1.00-2.00	5.0×10^{-6}	
KA3542G01	980729	2.00-3.00	4.5×10^{-5}	
KA3542G01	980730	3.00-4.00	8.1×10^{-5}	
KA3542G01	980730	4.00-5.00	1.0×10^{-3}	
KA3542G01	980730	5.00-6.00	1.0×10^{-5}	
KA3542G01	980730	6.00-7.00	1.0×10^{-5}	
KA3542G01	980730	7.00-8.00	5.0×10^{-6}	
KA3542G01	980730	8.00-9.00	2.5×10^{-5}	
KA3542G01	980730	9.00-10.00	$1.5x10^{-5}$	
KA3542G01	980730	10.00-11.00	1.3×10^{-5}	
KA3542G01	980730	11.00-12.00	8.9×10^{-4}	

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3542G01	980730	12.00-15.00	0.044	PBT
KA3542G01	980730	15.00-18.00	0.539	PBT
KA3542G01	980731	18.00-21.00	1.236	PBT
KA3542G01	980731	21.00-24.00	1.195	PBT
KA3542G01	980731	24.00-27.00	$4.3x10^{-5}$	
KA3542G01	980731	27.00-30.00	0.407	Single packer test, PBT failed
KA3542G02	980727	1.00-2.00	2.0×10^{-4}	
KA3542G02	980727	2.00-3.00	6.6×10^{-4}	
KA3542G02	980727	3.00-4.00	0.127	PBT
KA3542G02	980727	4.00-5.00	0.120	PBT
KA3542G02	980727	5.00-6.00	2.535	PBT
KA3542G02	980728	6.00-7.00	5.1×10^{-4}	
KA3542G02	980708	7.00-8.00	3.8×10^{-5}	
KA3542G02	980728	8.00-9.00	6.1×10^{-5}	
KA3542G02	980728	9.00-10.00	3.8×10^{-4}	
KA3542G02	980728	10.00-11.00	0.052	PBT
KA3542G02	980728	11.00-12.00	0.090	PBT
KA3542G02	980728	12.00-15.00	0.021	PBT
KA3542G02	980729	15.00-18.00	0.080	PBT
KA3542G02	980729	18.00-21.00	0.036	PBT
KA3542G02	980729	21.00-24.00	7.6×10^{-4}	
KA3542G02	980729	24.00-27.00	0.0145	PBT
KA3542G02	980729	27.00-30.00	5.7×10^{-3}	Single packer test
KA3548A	980804	3.00-4.00	0.0034	
KA3548A	980804	4.00-5.00	6.5×10^{-5}	
KA3548A	980804	5.00-6.00	0.126	PBT

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3548A	980805	6.00-7.00	0.027	PBT
KA3548A	980805	7.00-8.00	0.0013	
KA3548A	980805	8.00-9.00	0.0011	
KA3548A	980805	9.00-10.00	1.85	PBT
KA3548A	980806	10.00-11.00	0	No flow, the water level is falling
KA3548A	980806	11.00-12.00	1.1×10^{-4}	
KA3548A	980806	12.00-15.00	0.053	PBT
KA3548A	980806	15.00-18.00	0.212	PBT
KA3548A	980807	18.00-21.00	3.4	PBT
KA3548A	980807	21.00-24.00	0.116	PBT
KA3548A	980808	24.00-27.00	0.017	PBT
KA3548A	980808	27.00-30.00	0.048	Single packer test
KA3554G01	980722	1.00-2.00	7.6×10^{-4}	
KA3554G01	980722	2.00-3.00	1.5×10^{-5}	
KA3554G01	980722	3.00-4.00	0.0013	
KA3554G01	980722	4.00-5.00	2.0×10^{-5}	
KA3554G01	980722	5.00-6.00	9.8×10^{-5}	
KA3554G01	980722	6.00-7.00	2.4×10^{-4}	
KA3554G01	980722	7.00-8.00	0.0074	
KA3554G01	980723	8.00-9.00	3.6×10^{-4}	
KA3554G01	980723	9.00-10.00	2.8×10^{-4}	
KA3554G01	980723	10.00-11.00	6.4×10^{-4}	
KA3554G01	980723	11.00-12.00	4.8×10^{-5}	
KA3554G01	980723	12.00-15.00	6.6×10^{-5}	
KA3554G01	980723	15.00-18.00	5.3×10^{-3}	
KA3554G01	980723	18.00-21.00	0.141	PBT

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3554G01	980723	21.00-24.00	1.54	PBT
KA3554G01	980723	24.00-27.00	6.8	PBT
KA3554G01	980724	27.00-30.00	0.011	Single packer test, PBT
KA3554G02	980720	1.00-2.00	1.8×10^{-5}	
KA3554G02	980720	2.00-3.00	4.8×10^{-5}	
KA3554G02	980720	3.00-4.00	1.0×10^{-4}	
KA3554G02	980720	4.00-5.00	4.6×10^{-4}	
KA3554G02	980720	5.00-6.00	2.5×10^{-5}	
KA3554G02	980720	6.00-7.00	3.3×10^{-4}	
KA3554G02	980720	7.00-8.00	6.0×10^{-4}	
KA3554G02	980720	8.00-9.00	0.045	PBT
KA3554G02	980720	9.00-10.00	4.0×10^{-5}	
KA3554G02	980720	10.00-11.00	2.3×10^{-5}	
KA3554G02	980720	11.00-12.00	0.128	PBT
KA3554G02	980721	12.00-15.00	0.334	PBT
KA3554G02	980721	15.00-18.00	0.025	PBT
KA3554G02	980721	18.00-21.00	5.4×10^{-4}	
KA3554G02	980721	21.00-24.00	4.5×10^{-5}	
KA3554G02	980721	24.00-27.00	4.5×10^{-5}	
KA3554G02	980721	27.00-30.00	0.035	Single packer test PBT failed
KA3557G	980717	8.00- 9.00	1.5×10^{-4}	
KA3557G	980717	9.00-10.00	5.0×10^{-5}	
KA3557G	980717	10.00-11.00	5.5×10^{-5}	
KA3557G	980717	11.00-12.00	8.6×10^{-5}	
KA3557G	980717	12.00-15.00	5.5×10^{-5}	
KA3557G	980717	15.00-18.00	7.1×10^{-5}	

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3557G	980717	18.00-21.00	9.1×10^{-5}	
KA3557G	980717	21.00-24.00	7.8×10^{-5}	
KA3557G	980720	24.00-27.00	3.5×10^{-5}	
KA3557G	980720	27.00-30.00	2.5×10^{-5}	single packer test
KA3563G	981020	8.00- 9.00	6.4×10^{-5}	
KA3563G	981020	9.00-10.00	7.6×10^{-5}	
KA3563G	981020	10.00-11.00	1.2×10^{-4}	
KA3563G	981020	11.00-12.00	3.0×10^{-5}	
KA3563G	981021	12.00-15.00	1.8×10^{-5}	
KA3563G	981021	15.00-18.00	3.0×10^{-5}	
KA3563G	981021	18.00-21.00	9.4×10^{-4}	
KA3563G	981021	21.00-24.00	1.2×10^{-4}	
KA3563G	981021	24.00-27.00	3.0×10^{-5}	
KA3563G	981021	27.00-30.00	2.3×10^{-5}	single packer test
KA3566G01	980713	1.00-2.00	2.1×10^{-4}	
KA3566G01	980713	2.00-3.00	1.5×10^{-4}	
KA3566G01	980713	3.00-4.00	8.4×10^{-4}	
KA3566G01	980713	4.00-5.00	8.2×10^{-4}	
KA3566G01	980713	5.00-6.00	1.3×10^{-5}	
KA3566G01	980713	6.00-7.00	7.1×10^{-5}	
KA3566G01	980713	7.00-8.00	1.6×10^{-4}	
KA3566G01	980713	8.00-9.00	7.6×10^{-4}	
KA3566G01	980713	9.00-10.00	4.1×10^{-4}	
KA3566G01	980714	10.00-11.00	2.3×10^{-5}	
KA3566G01	980714	11.00-12.00	7.1×10^{-5}	
KA3566G01	980715	12.00-13.00	7.3×10^{-5}	

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3566G01	980714	13.00-16.00	0.0325	PBT
KA3566G01	980714	16.00-19.00	0.091	PBT
KA3566G01	980714	19.00-22.00	0.0145	PBT
KA3566G01	980714	22.00-25.00	0.007	
KA3566G01	980714	25.00-28.00	$1.2x10^{-4}$	
KA3566G01	980715	28.00-30.00	1.8×10^{-4}	Single packer test
KA3566G02	980715	1.00-2.00	2.8×10^{-5}	
KA3566G02	980715	2.00-3.00	2.8×10^{-4}	
KA3566G02	980715	3.00-4.00	3×10^{-4}	
KA3566G02	980715	4.00-5.00	8×10^{-4}	
KA3566G02	980715	5.00-6.00	2.8×10^{-5}	
KA3566G02	980715	6.00-7.00	4.0×10^{-5}	
KA3566G02	980715	7.00-8.00	3.8×10^{-5}	
KA3566G02	980715	8.00-9.00	3.0×10^{-5}	
KA3566G02	980716	9.00-10.00	0.0013	
KA3566G02	980716	10.00-11.00	0.0046	
KA3566G02	980716	11.00-12.00	1.4×10^{-4}	
KA3566G02	980716	12.00-15.00	0.0106	
KA3566G02	980716	15.00-18.00	0.109	PBT
KA3566G02	980716	18.00-21.00	0.022	PBT
KA3566G02	980716	21.00-24.00	0.020	PBT
KA3566G02	980716	24.00-27.00	0.0048	
KA3566G02	980716	27.00-30.00	1.3×10^{-5}	Single packer test
KA3574G01	980710	1.00-2.00	1.8×10^{-5}	
KA3574G01	980710	2.00-3.00	5.6×10^{-4}	
KA3574G01	980710	3.00-4.00	2.5×10^{-5}	

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3574G01	980710	4.00-5.00	4.3×10^{-5}	
KA3574G01	980710	5.00-6.00	2.8×10^{-5}	
KA3574G01	980713	6.00-7.00	3.3×10^{-5}	
KA3574G01	980713	7.00-8.00	5.8×10^{-5}	
KA3574G01	980713	8.00-9.00	3.0×10^{-5}	
KA3574G01	980713	9.00-10.00	9.3×10^{-5}	
KA3574G01	980713	10.00-12.00	1.5×10^{-5}	single packer test
KA3576G01	980709	1.00-2.00	4.5×10^{-5}	
KA3576G01	980709	2.00-3.00	$4.3x10^{-5}$	
KA3576G01	980709	3.00-4.00	2.8×10^{-5}	
KA3576G01	980709	4.00-5.00	1.4×10^{-4}	
KA3576G01	980709	5.00-6.00	1.1×10^{-4}	
KA3576G01	980709	6.00-7.00	5.0×10^{-6}	
KA3576G01	980709	7.00-8.00	2.8×10^{-5}	
KA3576G01	980709	8.00-9.00	1.5×10^{-5}	
KA3576G01	980709	9.00-10.00	1.8×10^{-5}	
KA3576G01	980709	10.00-12.00	1.1×10^{-5}	single packer test
KA3590G01	980706	1.00-2.00	0.394	PBT
KA3590G01	980706	2.00-3.00	0.032	PBT
KA3590G01	980707	3.00-4.00	0.0016	
KA3590G01	980707	4.00-5.00	0.0012	
KA3590G01	980707	5.00-6.00	0.020	PBT
KA3590G01	980707	6.00-7.00	4.5×10^{-5}	
KA3590G01	980707	7.00-8.00	2.3×10^{-5}	
KA3590G01	980707	8.00-9.00	0.202	PBT
KA3590G01	980708	9.00-10.00	0.011	PBT

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3590G01	980707	10.00-11.00	4.0×10^{-5}	
KA3590G01	980707	11.00-12.00	6.3×10^{-5}	
KA3590G01	980709	12.00-15.00	1.0×10^{-4}	
KA3590G01	980709	15.00-18.00	6.1×10^{-5}	
KA3590G01	980709	18.00-21.00	1.8×10^{-5}	
KA3590G01	980709	21.00-24.00	0.013	PBT
KA3590G01	980709	24.00-27.00	8.3×10^{-5}	
KA3590G01	980709	27.00-30.00	4.6×10^{-4}	Single packer test
KA3590G02	980624	1.00-2.00	8.8×10^{-5}	
KA3590G02	980624	2.00-3.00	4.8×10^{-5}	
KA3590G02	980624	3.00-4.00	8.6×10^{-5}	
KA3590G02	980624	4.00-5.00	2.9×10^{-5}	
KA3590G02	980624	5.00-6.00	7.6×10^{-5}	
KA3590G02	980624	6.00-7.00	5.0×10^{-5}	
KA3590G02	980624	7.00-8.00	1.7×10^{-4}	
KA3590G02	980624	8.00-9.00	2.1×10^{-4}	
KA3590G02	980624	9.00-10.00	7.3×10^{-5}	
KA3590G02	980624	10.00-11.00	3.0×10^{-5}	
KA3590G02	980624	11.00-12.00	1.2×10^{-5}	
KA3590G02	980625	12.00-15.00	0.031	PBT
KA3590G02	980625	15.00-18.00	4.3×10^{-4}	
KA3590G02	980625	18.00-21.00	0.037	PBT
KA3590G02	980625	21.00-24.00	8.1×10^{-4}	
KA3590G02	980625	24.00-27.00	1.03	PBT
KA3590G02	980626	27.00-30.00	1.12	Single packer test, PBT
KA3593G	980708	8.00- 9.00	5.5×10^{-5}	

Flowing Borehole	Date of Test	Section (m)	Flow rate (l/min)	Comment
KA3593G	980708	9.00-10.00	7.1×10^{-5}	
KA3593G	980708	10.00-11.00	5.3×10^{-5}	
KA3593G	980708	11.00-12.00	2.0×10^{-5}	
KA3593G	980708	12.00-15.00	4.0×10^{-5}	
KA3593G	980708	15.00-18.00	2.0×10^{-5}	
KA3593G	980708	18.00-21.00	3.5×10^{-5}	
KA3593G	980708	21.00-24.00	0.015	PBT
KA3593G	980709	24.00-27.00	7.6×10^{-5}	
KA3593G	980709	27.00-30.00	6.1×10^{-5}	single packer test

6.4 Pressure build-up test of a feature in exploratory boreholes

In 53 of the flow logged sections flow rates equal to or greater than 0.010 l/minute were measured. In these sections the measurement was extended to a pressure build-up test.

Appendices B1 – B11 contain the diagrams for each test. The different types of diagrams are:

- Lin-Lin plots for the whole test sequence
- Lin-Log plots for the pressure build-up
- Log-Log plots for the pressure build-up
- Derivative plots for the recovery

In the Lin-Log and Log-Log plots a time correction has been performed, see section 6.2

In the following details and important test data for each test are described
Flowing time = time between packer inflation and valve closing

Borehole KA3590G02, section 12.0 m - 15.0 m

Date:	98-06 -25	Field Crew:	B. Gentzschein/J. Olausson
Borehole length:	30.05 m	Borehole diameter:	76 mm (inclination 45°)
Packer inflation:	980625 08:09.20	Valve closed:	980625 09:16.08
Flowing time :	67 min	Tot. Pr. Build-up time:	120 min

Pressure just before closing the valve (Pp, kPa): 2.4
Pressure at the end of the recovery (Pf, kPa) : 1194.0

The pressure transducer used was lying 0.18 m above the borehole.
The height of the water flow outlet was 0.36 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G02, 12.0 - 15.0 m.

Time	Flow rate (l/min)
08:12.30	0.031
08:23	0.032
08:33	0.031
08:39	0.031
08:48	0.0315
08:58	0.0315
09:03	0.031
09:10	0.0315
09.14	0.0315

Borehole KA3590G02, section 18.0 m - 21.0 m

Date:	98-06 -25	Field Crew:	B. Gentzschein/J. Olausson
Borehole length:	30.05 m	Borehole diameter:	76 mm (inclination 45°)
Packer inflation:	980625 12:00.04	Valve closed:	980625 13:05.00
Flowing time :	65 min	Tot. Pr. Build-up time:	122 min

Pressure just before closing the valve (Pp, kPa): 0.8
Pressure at the end of the recovery (Pf, kPa) : 2059.5

The pressure transducer used was lying 0.18 m above the borehole.
The height of the water flow outlet was 0.36 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G02, 18.0 - 21.0 m.

Time	Flow rate (l/min)
12:05	0.037
12:10	0.043
12:18	0.037
12:27	0.037
12:34	0.0365
12:42	0.037
12:50	0.037
12:58	0.037
13.04	0.037

Borehole KA3590G02, section 24.0 m - 27.0 m

Date:	98-06 -25	Field Crew:	B. Gentzschein/J. Olausson
Borehole length:	30.05 m	Borehole diameter:	76 mm (inclination 45°)
Packer inflation:	980625 15:46.30	Valve closed:	980625 16:51.00
Flowing time :	64.5 min	Tot. Pr. Build-up time:	140.7 min

Pressure just before closing the valve (Pp, kPa): 8.3
Pressure at the end of the recovery (Pf, kPa) : 3018.3

The pressure transducer used was lying 0.18 m above the borehole.
The height of the water flow outlet was 0.66 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G02, 24.0 - 27.0 m

Time	Flow rate (l/min)
15:50	0.95
15:52	1.00
15:57	1.080
16:07	1.014
16:17	1.029
16:27	1.035
16:37	1.030
16:45	1.035

Borehole KA3590G02, section 27.0 m - 30.05 m

Date: 98-06-26 Field Crew: B. Gentzschein/J. Olausson
Borehole length: 30.05 m Borehole diameter: 76 mm (inclination 45°)

Packer inflation: 980626 10:19.22 Valve closed: 9806265 11:25.01
Flowing time : 65.7 min Tot. Pr. Build-up time: 141.7 min

Pressure just before closing the valve (Pp, kPa): 6.3
Pressure at the end of the recovery (Pf, kPa) : 2771.8

The pressure transducer used was lying 0.18 m above the borehole.
The height of the water flow outlet was 0.69 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G02, 27.0 - 30.05 m

Time	Flow rate (l/min)	Comment
10:24	1.03	Flow through pipe string
10:35	1.034	Flow through Tecalan hose
10:44	1.032	" "
10:52	1.12	Flow through pipe string
10:58	1.12	" "
11:07	1.11	" "
11:14	1.11	" "
11:23	1.11	" "

Borehole KA3590G01, section 1.0 m - 2.0 m

Date: 98-07-06 Field Crew: B. Gentzschein
Borehole length: 30.06 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980706 14:19.50 Valve closed: 980706 15:25.56
Flowing time : 66 min Tot. Pr. Build-up time: 123 min

Pressure just before closing the valve (Pp, kPa): 9.2
Pressure at the end of the recovery (Pf, kPa) : 1717.8

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G01, 1.0 - 2.0 m

Time	Flow rate (l/min)
14:27	0.405
14:34	0.402
14:40	0.395
14:47	0.395
14:55	0.394
15:03	0.395
15:10	0.393
15:18	0.394
15:25	0.394

Borehole KA3590G01, section 2.0 m - 3.0 m

Date: 98-07-06 Field Crew: B. Gentzschein
Borehole length: 30.06 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980706 17:35.37 Valve closed: 980706 18:38.54
Flowing time : 63.3 min Tot. Pr. Build-up time: 120 min

Pressure just before closing the valve (Pp, kPa): 10.1
Pressure at the end of the recovery (Pf, kPa) : 756.0

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G01, 2.0 - 3.0 m

Time	Flow rate (l/min)
17:42	0.035
17:49	0.0335
17:55	0.0325
18:05	0.032
18:12	0.0315
18:19	0.032
18:25	0.0325
18:32	0.0325
18:37	0.032

Borehole KA3590G01, section 5.0 m - 6.0 m

Date:	98-07-07	Field Crew:	B. Gentzschein
Borehole length:	30.06 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980707 10:35.38	Valve closed:	980707 11:34.55
Flowing time :	59.6 min	Tot. Pr. Build-up time:	120 min

Pressure just before closing the valve (Pp, kPa): 8.7
Pressure at the end of the recovery (Pf, kPa) : 2957.8

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G01, 5.0 - 6.0 m

Time	Flow rate (l/min)
10:41	0.0255
10:50	0.021
10:56	0.0208
11:03	0.020
11:10	0.020
11:17	0.020
11:25	0.0198
11:30	0.0020
11:34	0.0020

Borehole KA3590G01, section 8.0 m - 9.0 m

Date: 98-07-07 Field Crew: B. Gentzschein
Borehole length: 30.06 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980707 14:54.23 Valve closed: 980707 15:58.55
Flowing time : 64.5 min Tot. Pr. Build-up time: 120 min

Pressure just before closing the valve (Pp, kPa): 8.7
Pressure at the end of the recovery (Pf, kPa) : 3405.7

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates duringpressure build-up test in KA3590G01, 8.0 - 9.0 m

Time	Flow rate (l/min)
15:03	0.206
15:07	0.204
15:15	0.204
15:22	0.204
15:30	0.202
15:37	0.201
15:43	0.200
15:49	0.200
15:57	0.200

Borehole KA3590G01, section 9.0 m - 10.0 m

Date: 98-07-08 Field Crew: B. Gentzschein/J. Onkenhout
Borehole length: 30.06 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980708 09:25.52 Valve closed: 980708 10:28.57
Flowing time : 63 min Tot. Pr. Build-up time: 120 min

Pressure just before closing the valve (Pp, kPa): 8.7
Pressure at the end of the recovery (Pf, kPa) : 3360.2

The pressure transducer used was lying 0.20 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G01, 9.0 - 10.0 m

Time	Flow rate (l/min)
09:32	0.0115
09:42	0.0115
09:51	0.011
09:58	0.011
10:05	0.011
10:12	0.011
10:20	0.0115
10:27	0.011

Borehole KA3590G01, section 21.0 m - 24.0 m

Date: 98-07-09 Field Crew: B. Gentzschein/J. Onkenhout
Borehole length: 30.06 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980709 12:11.22 Valve closed: 980709 13:16.45
Flowing time : 65. 4 min Tot. Pr. Build-up time: 125.7 min

Pressure just before closing the valve (Pp, kPa): 10.5
Pressure at the end of the recovery (Pf, kPa) : 3598.6
Due to logger problems, data is missing c. 52 minutes of the recovery

The pressure transducer used was lying 0.20 m above the borehole.
The height of the water flow outlet was 0.93 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3590G01, 21.0 - 24.0 m

Time	Flow rate (l/min)
12:19	0.013
12:24	0.0125
12:30	0.0125
12:36	0.0125
12:42	0.013
12:48	0.012
12:54.30	0.0125
13:00	0.012
13:06	0.0128
13:14.30	0.012

Borehole KA3593G, section 21.0 m - 24.0 m

Date:	98-07-08(-09)	Field Crew:	B. Gentzschein
Borehole length:	30.02 m	Borehole diameter:	76 mm
Packer inflation:	980708 18:03.37	Valve closed:	980708 19:07.54
Flowing time :	64.3 min	Tot. Pr. Build-up time:	772 min

Pressure just before closing the valve (Pp, kPa): 8.9
Pressure at the end of the recovery (Pf, kPa) : 1494.9

The pressure transducer used was lying 0.20 m above the borehole.
The height of the water flow outlet was 0.90 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3593G , 21.0 - 24.0 m

Time	Flow rate (l/min)
18:09	0.015
18:15	0.015
18:22	0.015
18:30	0.015
18:37	0.015
18:45	0.0148
18:52	0.015
19:01	0.015
19:07	0.0148

Borehole KA3566G01, section 13.0 m - 16.0 m

Date:	98-07-14	Field Crew:	J. Onkenhout
Borehole length:	30.01 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980714 10:44.15	Valve closed:	980714 11:47.38
Flowing time :	63.4 min	Tot. Pr. Build-up time:	120.7 min

Pressure just before closing the valve (Pp, kPa): 10.1
Pressure at the end of the recovery (Pf, kPa) : 1865.3

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.90 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3566G01, 13.0 - 16.0 m

Time	Flow rate (l/min)
10:49	0.035
10:58.30	0.032
11:02	0.0321
11:08	0.0322
11:16	0.0325
11:24	0.0322
11:30	0.0322
11:36	0.0322
11:42	0.0330
11:48	0.0322

Borehole KA3566G01, section 16.0 m - 19.0 m

Date: 98-07-14 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980714 13:58.47 Valve closed: 980714 15:10.58
Flowing time : 72.2 min Tot. Pr. Build-up time: 120 min

Pressure just before closing the valve (Pp, kPa): 9.4
Pressure at the end of the recovery (Pf, kPa) : 2074.7

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3566G01, 16.0 - 19.0 m

Time	Flow rate (l/min)
14:02	0.092
14:08	0.092
14:14	0.091
14:20	0.095
14:26	0.091
14:34	0.091
14:42	0.090
14:48	0.091
14:54	0.091
15:00	0.091

Borehole KA3566G01, section 19.0 m - 22.0 m

Date:	98-07-14	Field Crew:	J. Onkenhout
Borehole length:	30.01 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980714 17:17.32	Valve closed:	980714 18:21.00
Flowing time :	63.5 min	Tot. Pr. Build-up time:	120.4 min

Pressure just before closing the valve (Pp, kPa): 8.9
Pressure at the end of the recovery (Pf, kPa) : 2447.4

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3566G01, 19.0 - 22.0 m

Time	Flow rate (l/min)
17:22	0.015
17:26	0.015
17:32	0.015
17:38	0.015
17:44	0.0145
17:52	0.015
18:00	0.0145
18:08	0.0145
18:14	0.015
18:20	0.0146

Borehole KA3566G02, section 15.0 m - 18.0 m

Date:	98-07-16	Field Crew:	J. Onkenhout
Borehole length:	30.01 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980716 10:56.58	Valve closed:	980716 12:00.27
Flowing time :	63.5 min	Tot. Pr. Build-up time:	128 min

Pressure just before closing the valve (Pp, kPa): 10.1
Pressure at the end of the recovery (Pf, kPa) : 3499.5

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.87 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3566G02, 15.0 - 18.0 m

Time	Flow rate (l/min)
11:00.30	0.108
11:05	0.108
11:11	0.108
11:17	0.108
11:23	0.108
11:31	0.110
11:41	0.109
11:47	0.108
11:53	0.109

Borehole KA3566G02, section 18.0 m - 21.0 m

Date: 98-07-16 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980716 14:21.18 Valve closed: 980716 15:26.40
Flowing time : 65.2 min Tot. Pr. Build-up time: 120 min

Pressure just before closing the valve (Pp, kPa): 9.6
Pressure at the end of the recovery (Pf, kPa) : 2987.9

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3566G02, 18.0 - 21.0 m

Time	Flow rate (l/min)
14:27	0.023
14:33	0.023
14:39	0.0225
14:45	0.0225
14:56.30	0.022
15:05	0.022
15:11	0.022
15:17	0.021
15:23	0.021

Borehole KA3566G02, section 21.0 m - 24.0 m

Date: 98-07-16 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980716 17:31.30 Valve closed: 980716 18:36.39
Flowing time : 65.2 min Tot. Pr. Build-up time: 160.4 min

Pressure just before closing the valve (Pp, kPa): 9.4
Pressure at the end of the recovery (Pf, kPa) : 3298.1

The pressure transducer used was lying 0.17 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3566G02, 21.0 - 24.0 m

Time	Flow rate (l/min)
17:36	0.020
17:41.30	0.0195
17:47	0.020
17:53	0.020
17:59	0.020
18:09	0.020
18:21.30	0.0195
18:25	0.019
18:31	0.0194
18:35	0.019

Borehole KA3554G02, section 8.0 m - 9.0 m

Date: 98-07-20 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980720 17:20.23 Valve closed: 980720 18:25.38
Flowing time : 65.2 min Tot. Pr. Build-up time: 132.6 min

Pressure just before closing the valve (Pp, kPa): 11.0
Pressure at the end of the recovery (Pf, kPa) : 3372.3

The pressure transducer used was lying 0.14 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G02, 8.0 - 9.0 m

Time	Flow rate (l/min)
17:27	0.0495
17:33	0.0465
17:40	0.0455
17:47.30	0.045
17:55	0.045
18:05	0.044
18:11	0.044
18:17	0.044
18:23	0.044

Borehole KA3554G02, section 11.0 m - 12.0 m

Date: 98-07-20 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980720 22:00.37 Valve closed: 980720 23:05.39
Flowing time : 65.0 min Tot. Pr. Build-up time: 488.0 min

Pressure just before closing the valve (Pp, kPa): 10.5
Pressure at the end of the recovery (Pf, kPa) : 3170.4

The pressure transducer used was lying 0.14 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G02, 11.0 - 12.0 m

Time	Flow rate (l/min)
22:04	0.128
22:10	0.128
22:16	0.128
22:22	0.128
22:30	0.128
22:38	0.128
22:46	0.127
22:52	0.127
22:58	0.127
23:04	0.128

Borehole KA3554G02, section 12.0 m - 15.0 m

Date: 98-07-21 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980721 10:49.27 Valve closed: 980721 13:51.21
Flowing time : 181.9 min Tot. Pr. Build-up time: 127.4 min

Pressure just before closing the valve (Pp, kPa): 10.8
Pressure at the end of the recovery (Pf, kPa) : 3132.7

The pressure transducer used was lying 0.14 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G02, 12.0 - 15.0 m

Time	Flow rate (l/min)	Comment
10:53	0.326	
10:59	0.337	
11:05	0.334	
11:11	0.334	
11:19	0.334	
11:27	0.336	
11:36	0.336	
11:43	0.336	
11:53.30	0.335	
13:10	0.334	Water sampling 13:11-13:48

Borehole KA3554G02, section 15.0 m - 18.0 m

Date: 98-07-21 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980721 16:06.10 Valve closed: 980721 17:11.12
Flowing time : 65 min Tot. Pr. Build-up time: 152.8 min

Pressure just before closing the valve (Pp, kPa): 11.9
Pressure at the end of the recovery (Pf, kPa) : 3114.3

The pressure transducer used was lying 0.14 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G02, 15.0 - 18.0 m

Time	Flow rate (l/min)	Comment
16:11	0.026	
16:17	0.0262	
16:23	0.0259	
16:29	0.0252	
16:37	0.025	
16:45	0.025	
16:53	0.0247	
16:59	0.0245	
17:05	0.0243	

Borehole KA3554G02, section 27.0 m - 30.0 m, first attempt

Date: 98-07-22 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980722 08:10.52 Valve closed: 980722 09:16.14
Flowing time : 65.4 min Tot. Pr. Build-up time: 123.8 min

Pressure just before closing the valve (Pp, kPa): 11.2
Pressure at the end of the recovery (Pf, kPa) : 866.6

The pressure transducer used was lying 0.12 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G02, 27.0 - 30.0 m

Time	Flow rate (l/min)
8.13	0.035
8:19	0.035
8:26	0.035
8:32	0.035
8:39	0.035
8:50	0.035
8:56	0.035
9:01	0.0348
9.08	0.035
9:14	0.0344

Due to the high pressure in the interval between the packer and the borehole bottom, the packer moved, causing leakage and too low pressure. The test was interrupted and a new attempt was conducted 98-07-24

Borehole KA3554G02, section 27.0 m - 30.0 m, second attempt

Date:	98-07-24	Field Crew:	J. Onkenhout
Borehole length:	30.01 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980724 14:36.36	Valve closed:	980724 14:40.56
Flowing time :	4.3 min	Tot. Pr. Build-up time:	10.4 min

Pressure just before closing the valve (Pp, kPa): 9.4
Pressure at the end of the recovery (Pf, kPa) : 748.5

The pressure transducer used was lying 0.12 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

No flow measurements were conducted during this test.

Also during this second attempt the packer moved and the test was interrupted.

Borehole KA3554G01, section 18.0 m - 21.0 m

Date:	98-07-23	Field Crew:	J. Onkenhout
Borehole length:	30.01 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980723 13:28.11	Valve closed:	980723 14:33.33
Flowing time :	65.4 min	Tot. Pr. Build-up time:	120.4 min

Pressure just before closing the valve (Pp, kPa): 11.9
Pressure at the end of the recovery (Pf, kPa) : 3519.5

The pressure transducer used was lying 0.12 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G01, 18.0 - 21.0 m

Time	Flow rate (l/min)
13:22	0.143
13:38	0.142
13:44	0.141
13:50	0.141
13:58	0.141
14:08	0.141
14:16	0.141
14:22	0.142
14:28	0.140

Borehole KA3554G01, section 21.0 m - 24.0 m

Date: 98-07-23 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980723 16:40.02 Valve closed: 980723 17:45.44
Flowing time : 65.7 min Tot. Pr. Build-up time: 124.3 min

Pressure just before closing the valve (Pp, kPa): 19.7
Pressure at the end of the recovery (Pf, kPa) : 3692.1

The pressure transducer used was lying 0.12 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G01, 21.0 - 24.0 m

Time	Flow rate (l/min)
16:42.30	1.55
16:49	1.54
16:56.30	1.53
17:02	1.54
17:09	1.54
17:17	1.54
17:25	1.52
17:31	1.54
17:37	1.53
17:43	1.53

Borehole KA3554G01, section 24.0 m - 27.0 m

Date: 98-07-23(-24) Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980723 19:56.21 Valve closed: 980723 21:02.14
Flowing time : 65.9 min Tot. Pr. Build-up time: 701.9 min

Pressure just before closing the valve (Pp, kPa): 20.2
Pressure at the end of the recovery (Pf, kPa) : 3823.5

The pressure transducer used was lying 0.12 m above the borehole.
The height of the water flow outlet was 0.79 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G01, 24.0 - 27.0 m

Time	Flow rate (l/min)
19:59	6.8
20:05	6.8
20:13	6.7
20:20	6.8
20:27	6.8
20:34	6.8
20:41	6.8
20:48	6.8
20:55	6.80[1]

1 The higher precision were due to the use of a more precise cylinder

Borehole KA3554G01, section 27.0 m - 30.0 m

Date: 98-07-24 Field Crew: J. Onkenhout
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980724 10:58.52 Valve closed: 980724 12.04.15
Flowing time : 65.4 min Tot. Pr. Build-up time: 128.8 min

Pressure just before closing the valve (Pp, kPa): 9.2
Pressure at the end of the recovery (Pf, kPa) : 3645.7

The pressure transducer used was lying 0.12 m above the borehole.
The height of the water flow outlet was 0.86 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3554G01, 27.0 - 30.0 m

Time	Flow rate (l/min)
11:04	0.011
11:10	0.012
11:16.30	0.011
11:23	0.011
11:30	0.012
11:37	0.011
11:44	0.011
11:51	0.011
11:58	0.011

Borehole KA3542G02, section 3.0 m - 4.0 m

Date: 98-07-27 Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980727 10:32.01 Valve closed: 980727 13:03.04
Flowing time : 151.0 min Tot. Pr. Build-up time: 120.0 min

Pressure just before closing the valve (Pp, kPa): 10.8
Pressure at the end of the recovery (Pf, kPa) : 1909.7

The pressure transducer used was lying 0.10 m above the borehole.
The height of the water flow outlet was 0.97 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 3.0 - 4.0 m

Time	Flow rate (l/min)	Comment
10:40	0.128	
10.47	0.127	
10:55	0.126	
11:02	0.127	
11:09	0.127	
11:20	0.126	
11:30	0.126	
11:42	0.125	
12:00	0.125	Water sampling 12:05-12:51
12:53	0.125	

Borehole KA3542G02, section 5.0 m - 6.0 m

Date: 98-07-27 Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980727 15.09.48 Valve closed: 980727 16:47.03
Flowing time : 97.2 min Tot. Pr. Build-up time: 121.0 min

Pressure just before closing the valve (Pp, kPa): 14.7
Pressure at the end of the recovery (Pf, kPa) : 2776.3

The pressure transducer used was lying 0.10 m above the borehole.
The height of the water flow outlet was 0.97 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 5.0 - 6.0 m

Time	Flow rate (l/min)	Comment
15:14	2.522	
15:22	2.537	
15:30	2.542	
15:38	2.530	
15:47	2.545	
15:57	2.522	
16:11	2.529	Water sampling 16:15-16:40
16:41	2.535	

Borehole KA3542G02, section 4.0 m - 5.0 m

Date: 98-07-27 Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980727 19:44.18 Valve closed: 980727 20:51.04
Flowing time : 66.8 min Tot. Pr. Build-up time: 701.0 min

Pressure just before closing the valve (Pp, kPa): 11.4
Pressure at the end of the recovery (Pf, kPa) : 2868.7

The pressure transducer used was lying 0.10 m above the borehole.
The height of the water flow outlet was 0.97 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 4.0 - 5.0 m

Time	Flow rate (l/min)
19:50	0.116
19:57.30	0.117
20:04	0.116
20:11	0.119
20:19	0.120
20:27	0.116
20:35	0.120
20:43	0.121
20:49	0.121

Borehole KA3542G02, section 10.0 m - 11.0 m

Date:	98-07-28	Field Crew:	B. Gentzschein
Borehole length:	30.01 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980728 11:15.56	Valve closed:	980728 12:21.02
Flowing time :	65.0 min	Tot. Pr. Build-up time:	121.0 min

Pressure just before closing the valve (Pp, kPa): 11.0
Pressure at the end of the recovery (Pf, kPa) : 2629.2

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 10.0 - 11.0 m

Time	Flow rate (l/min)
11:20.30	0.036
11:26	0.041
11:33	0.046
11:40	0.049
11:47	0.0515
11:55	0.053
12:03	0.054
12:10	0.055
12:18	0.056

Borehole KA3542G02, section 11.0 m - 12.0 m

Date:	98-07-28	Field Crew:	B. Gentzschein
Borehole length:	30.01 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980728 14:25.13	Valve closed:	980728 15:46.04
Flowing time :	80.9 min	Tot. Pr. Build-up time:	133.0 min

Pressure just before closing the valve (Pp, kPa): 4.1
Pressure at the end of the recovery (Pf, kPa) : 2495.9

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 11.0 - 12.0 m

Time	Flow rate (l/min)	Comment
14:28	1.01	
14:33	0.95	
14:40	0.95	
14:52	0.92	
14:59	0.90	
15:06	0.87	
15:13	0.85	
15:19	0.85	Water sampling 15:17-15:38
15:40	0.76	

Borehole KA3542G02, section 12.0 m - 15.0 m

Date: 98-07-28(-29) Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980728 18:54.17 Valve closed: 980728 19:59.03
Flowing time : 64.8 min Tot. Pr. Build-up time: 723.5 min

Pressure just before closing the valve (Pp, kPa): 10.3
Pressure at the end of the recovery (Pf, kPa) : 2273.2

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 12.0 - 15.0 m

Time	Flow rate (l/min)
19:02	0.021
19:10	0.021
19:17	0.0215
19:25	0.021
19:33	0.021
19:40	0.021
19:47	0.0213
19:56	0.021

Borehole KA3542G02, section 15.0 m - 18.0 m

Date: 98-07-29 Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980729 08:09.43 Valve closed: 980729 09:19.03
Flowing time : 69.3 min Tot. Pr. Build-up time: 120.1 min

Pressure just before closing the valve (Pp, kPa): 10.8
Pressure at the end of the recovery (Pf, kPa) : 2342.0

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 15.0 - 18.0 m

Time	Flow rate (l/min)
08:16	0.086
08:20	0.086
08:27	0.085
08:35	0.0825
08:45	0.080
08:54	0.080
09:02	0.077
09:11	0.078
09:17	0.077

Borehole KA3542G02, section 18.0 m - 21.0 m

Date: 98-07-29 Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980729 11:24.04 Valve closed: 980729 12:29.03
Flowing time : 65 min Tot. Pr. Build-up time: 120 min

Pressure just before closing the valve (Pp, kPa): 10.5
Pressure at the end of the recovery (Pf, kPa) : 2109.2

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 18.0 - 21.0 m

Time	Flow rate (l/min)
11:31	0.042
11:39	0.038
11:45	0.037
11:52	0.0365
11:59	0.036
12:06	0.0358
12:13	0.0355
12:20	0.0345
12:27	0.035

Borehole KA3542G02, section 24.0 m - 27.0 m

Date: 98-07-29 Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980729 15:13.28 Valve closed: 980729 16:19.03
Flowing time : 65.6 min Tot. Pr. Build-up time: 122.0 min

Pressure just before closing the valve (Pp, kPa): 12.4
Pressure at the end of the recovery (Pf, kPa) : 2057.5

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G02, 24.0 - 27.0 m

Time	Flow rate (l/min)
15:18	0.015
15:23	0.015
15:30	0.015
15:37	0.0147
15:45	0.0145
15:53	0.015
16:00	0.0145
16:08	0.0145
16:16	0.0145

Borehole KA3542G01, section 12.0 m - 15.0 m

Date: 98-07-30 Field Crew: B. Gentzschein
Borehole length: 30.04 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980730 16:01.14 Valve closed: 980730 17:06.03
Flowing time : 64.8 min Tot. Pr. Build-up time: 127.0 min

Pressure just before closing the valve (Pp, kPa): 9.8
Pressure at the end of the recovery (Pf, kPa) : 2593.4

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G01, 12.0 - 15.0 m

Time	Flow rate (l/min)
16:06	0.042
16:12	0.044
16:19	0.045
16:25	0.044
16:32	0.044
16:40	0.044
16:47	0.044
16:55	0.0445
17:01	0.044
17:04	0.044

Borehole KA3542G01, section 15.0 m - 18.0 m

Date: 98-07-30(-31) Field Crew: B. Gentzschein
Borehole length: 30.04 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980730 19:17.04 Valve closed: 980730 20:23.05
Flowing time : 65.0 min Tot. Pr. Build-up time: 696.2 min

Pressure just before closing the valve (Pp, kPa): 11.2
Pressure at the end of the recovery (Pf, kPa) : 3199.6

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G01, 15.0 - 18.0 m

Time	Flow rate (l/min)
19:22	0.533
19:28	0.537
19:35	0.532
19:43	0.535
19:50	0.539
19:57	0.538
20:05	0.539
20:13	0.538
20:20	0.538

Borehole KA3542G01, section 18.0 m - 21.0 m

Date: 98-07-31 Field Crew: B. Gentzschein
Borehole length: 30.04 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980731 09:37.06 Valve closed: 980731 11:05.03
Flowing time : 87.9 min Tot. Pr. Build-up time: 119.9 min

Pressure just before closing the valve (Pp, kPa): 13.7
Pressure at the end of the recovery (Pf, kPa) : 3386.9

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G01, 18.0 - 21.0 m

Time	Flow rate (l/min)	Comment
09:43	1.24	
09:46	1.24	
09:53	1.236	
10:00	1.23	
10:10	1.236	
10:18	1.23	
10:26	1.23	
10:34	1.232	
10:43	1.221	Water sampling 10:42-11:01
11:00	1.220	
11:03	1.238	

Borehole KA3542G01, section 21.0 m - 24.0 m

Date:	98-07-31	Field Crew:	B. Gentzschein
Borehole length:	30.04 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980731 13:10.31	Valve closed:	980731 14:56.03
Flowing time :	105.5 min	Tot. Pr. Build-up time:	121.4 min

Pressure just before closing the valve (Pp, kPa): 13.7
Pressure at the end of the recovery (Pf, kPa) : 3213.2

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G01, 21.0 - 24.0 m

Time	Flow rate (l/min)	Comment
13:15	1.205	
13:22	1.201	
13:29	1.195	
13:36	1.191	
13:43	1.190	
13:50	1.190	
13:57	1.192	
14:05	1.193	
14:20	1.19	
14:25	1.19	Water sampling 14:30-14:49
14:31	1.17	
14:51	1.19	

Borehole KA3542G01, section 27.0 m - 30.04 m, first attempt

Date:	98-07-31	Field Crew:	B. Gentzschein
Borehole length:	30.04 m	Borehole diameter:	76 mm , (inclination 45°)
Packer inflation:	980731 18:39.33	Valve closed:	980731 19:45.03
Flowing time :	65.5 min	Tot. Pr. Build-up time:	2.0 min

Pressure just before closing the valve (Pp, kPa): 11.0
Pressure at the end of the recovery (Pf, kPa) : 857.6

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Due to the high pressure in the interval between the packer and the borehole bottom, the packer moved, causing leakage and too low pressure. The test was interrupted and a new attempt was conducted immediately after the end of the first attempt.

Manually measured flow rates during pressure build-up test in KA3542G01, 27.0 - 30.04 m (the first attempt)

Time	Flow rate (l/min)
18:43	0.406
18:46	0.409
18:51	0.407
18:58	0.407
19:06	0.407
19:13	0.407
19:20	0.407
19:28	0.407
19:35	0.407
19:43	0.407

Borehole KA3542G01, section 27.0 m - 30.04 m

Date: 98-07-31 Field Crew: B. Gentzschein
Borehole length: 30.04 m Borehole diameter: 76 mm , (inclination 45°)

Packer inflation: 980731 19:54.50 Valve closed: 980731 21:01.03
Flowing time : 66.2 min Tot. Pr. Build-up time: 11.5 min

Pressure just before closing the valve (Pp, kPa): 9.8
Pressure at the end of the recovery (Pf, kPa) : 3679.0

The pressure transducer used was lying 0.0 m above the borehole.
The height of the water flow outlet was 0.96 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3542G01, 27.0 - 30.0 m

Time	Flow rate (l/min)
20:00	0.408
20:07	0.408
20:15	0.408
20:23	0.407
20:30	0.407
20:38	0.407
20:51	0.408
20:58	0.407

Prior to this second attempt, the packer was anchored by means of a rock bolt and a wire. However, due to the high forces of the ground water pressure, the rock bolt was pulled off and the test was interrupted once again. But before the break there was a short stabilisation of the section pressure.

Borehole KA3539G, section 11.0 m - 12.0 m

Date:	98-08-01	Field Crew:	B. Gentzschein
Borehole length:	30.01 m	Borehole diameter:	76 mm
Packer inflation:	980801 11:22.17	Valve closed:	980801 12:29.04
Flowing time :	66.7 min	Tot. Pr. Build-up time:	130.3 min

Pressure just before closing the valve (Pp, kPa): 10.1
Pressure at the end of the recovery (Pf, kPa) : 1599.2

The pressure transducer used was lying 0.10 m above the borehole.
The height of the water flow outlet was 0.85 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3539G, 11.0 - 12.0 m

Time	Flow rate (l/min)
12:25	0.090
12:28	0.089
12:35.30	0.088
12:43	0.088
12:50	0.088
12:58	0.088
13:05	0.088
13:13	0.088
13:20	0.088
13:27	0.088

Borehole KA3539G, section 12.0 m - 15.0 m

Date:	98-08-01	Field Crew:	B. Gentzschein
Borehole length:	30.01 m	Borehole diameter:	76 mm
Packer inflation:	980801 15:33.47	Valve closed:	980801 16:39.03
Flowing time :	65.3 min	Tot. Pr. Build-up time:	120.0 min

Pressure just before closing the valve (Pp, kPa): 10.1
Pressure at the end of the recovery (Pf, kPa) : 1615.5

The pressure transducer used was lying 0.10 m above the borehole.
The height of the water flow outlet was 0.85 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3539G, 12.0 - 15.0 m

Time	Flow rate (l/min)
15:41	0.035
15:47	0.036
15:55	0.036
16:03	0.0355
16:11	0.035
16:18	0.0352
16:25	0.0352
16:33	0.035
16:37	0.035

Borehole KA3539G, section 15.0 m - 18.0 m

Date: 98-08-01(-02) Field Crew: B. Gentzschein
Borehole length: 30.01 m Borehole diameter: 76 mm

Packer inflation: 980801 18:42.36 Valve closed: 980801 19:49.02
Flowing time : 66.5 min Tot. Pr. Build-up time: 744.0 min

Pressure just before closing the valve (Pp, kPa): 14.2
Pressure at the end of the recovery (Pf, kPa) : 2671.2

The pressure transducer used was lying 0.10 m above the borehole.
The height of the water flow outlet was 0.85 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3539G, 15.0 - 18.0 m

Time	Flow rate (l/min)
18:54	4.078
19:01	4.069
19:10	4.064
19:17	4.062
19:28	4.071
19:33	4.055
19:40	4.063
19:47	4.062

Borehole KA3539G, section 18.0 m - 21.0 m

Date:	98-08-02	Field Crew:	B. Gentzschein
Borehole length:	30.01 m	Borehole diameter:	76 mm
Packer inflation:	980802 08:20.34	Valve closed:	980802 09:25.03
Flowing time :	64.5 min	Tot. Pr. Build-up time:	121.1 min

Pressure just before closing the valve (Pp, kPa): 8.0
Pressure at the end of the recovery (Pf, kPa) : 1068.3

The pressure transducer used was lying 0.10 m above the borehole.
The height of the water flow outlet was 0.85 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3539G, 18.0 - 21.0 m

Time	Flow rate (l/min)
08:26	0.059
08:31	0.056
08.37	0.053
08:45	0.0525
08:52	0.050
09:00	0.048
09:07	0.0475
09:15	0.047
09:23	0.046

Borehole KA3539G, section 21.0 m - 24.0 m

Date:	98-08-02	Field Crew:	B. Gentzschein
Borehole length:	30.01 m	Borehole diameter:	76 mm
Packer inflation:	980802 11:30.15	Valve closed:	980802 12:35.03
Flowing time :	64.9 min	Tot. Pr. Build-up time:	120.0 (45) min

Pressure just before closing the valve (Pp, kPa): 10.3
Pressure at the end of the recovery (Pf, kPa) : 1124.0

The pressure transducer used was lying 0.10 m above the borehole.
The height of the water flow outlet was 0.90 m above the tunnel floor.

Manually measured flow rates during pressure build-up test in KA3539G, 21.0 - 24.0 m

Time	Flow rate (l/min)
11:35	0.027
11:40	0.027
11:46	0.0265
11:53	0.026
12:00	0.026
12:07	0.026
12:16	0.026
12:24	0.026
12:31	0.026
12:33	0.026

Borehole KA3548A01, section 5.0 m - 6.0 m

Date:	98-08-04	Field Crew:	J. Olausson
Borehole length:	30.00 m	Borehole diameter:	76 mm
Packer inflation:	980804 13:42	Valve closed:	980804 14:49.00
Flowing time :	67 min	Tot. Pr. Build-up time:	126 min

After 45 minutes of the recovery period pressure in the section declined, hence 45 minutes are actual pressure build-up time and Pf (below) is the associated maximum registered pressure.

Pressure just before closing the valve (Pp, kPa): 2.26
Pressure at the end of the recovery (Pf, kPa) : 2528

The pressure transducer used was lying 0.06 m above the borehole.
The height of the water flow outlet was same as the borehole.

Manually measured flow rates during pressure build-up test in KA3548A01, 5.0 - 6.0 m

Time	Flow rate (l/min)
13:49	—
13:56	0.126
14:03	0.126
14:12	0.126
14:24	0.126
14:32	0.126
14.39	0.129
14.46	0.126

Borehole KA3548A01, section 6.0 m - 7.0 m

Date:	98-08-05	Field Crew:	J. Olausson
Borehole length:	30.00 m	Borehole diameter:	76 mm
Packer inflation:	980805 10:13	Valve closed:	980805 11:24.58
Flowing time :	72 min	Tot. Pr. Build-up time:	120 min

Pressure just before closing the valve (Pp, kPa): 2.7
Pressure at the end of the recovery (Pf, kPa) : 1134.5

The pressure transducer used was lying 0.06 m above the borehole.
The height of the water flow outlet was same as the borehole.

Manually measured flow rates during pressure build-up test in KA3548A01, 6.0 - 7.0 m

Time	Flow rate (l/min)
10:25	0.031
10:32	0.029
10:39	0.028
10:46	0.028
10:53	0.028
11:00	0.028
11:07	0.027
11:14	0.027
11:21	0.027

Borehole KA3548A01, section 9.0 m – 10.0 m

Date:	98-08-05	Field Crew:	J. Olausson
Borehole length:	30.00 m	Borehole diameter:	76 mm
Packer inflation:	980805 14:52	Valve closed:	980805 13:56.59
Flowing time :	65 min	Tot. Pr. Build-up time:	972 min

Pressure just before closing the valve (Pp, kPa): 1.8
Pressure at the end of the recovery (Pf, kPa) : 3627.7

The pressure transducer used was lying 0.06 m above the borehole.
The height of the water flow outlet was same as the borehole.

Manually measured flow rates during pressure build-up test in KA3548A01, 9.0 - 10.0 m

Time	Flow rate (l/min)
14:57	1.71
15:04	1.73
15:11	1.77
15:28	1.83
15:32	1.85
15:39	1.88
15:46	1.89
15:53	1.91

Borehole KA3548A01, section 12.0 m - 15.0 m

Date: 98-08-06 Field Crew: J. Olausson
Borehole length: 30.00 m Borehole diameter: 76 mm

Packer inflation: 980806 12:08 Valve closed: 980806 13:15.59
Flowing time : 68 min Tot. Pr. Build-up time: 120 min

Pressure just before closing the valve (Pp, kPa): 3.4
Pressure at the end of the recovery (Pf, kPa) : 3663.1

The pressure transducer used was lying 0.06 m above the borehole.
The height of the water flow outlet was same as the borehole.

Manually measured flow rates during pressure build-up test in KA3548A01, 12.0 - 15.0 m

Time	Flow rate (l/min)
12:14	0.051
12:21	0.051
12:28	0.053
12:35	0.052
12:42	0.052
12:49	0.054
12:56	0.053
13:03	0.053
13:10	0.053

Borehole KA3548A01, section 15.0 m - 18.0 m

Date:	98-08-06	Field Crew:	J. Olausson
Borehole length:	30.00 m	Borehole diameter:	76 mm
Packer inflation:	980806 15:23	Valve closed:	980806 16:27.58
Flowing time :	65 min	Tot. Pr. Build-up time:	117 min

Pressure just before closing the valve (Pp, kPa): 4.1
Pressure at the end of the recovery (Pf, kPa) : 3673.7

The pressure transducer used was lying 0.06 m above the borehole.
The height of the water flow outlet was the same as the borehole.

Manually measured flow rates during pressure build-up test in KA3548A01, 15.0 - 18.0 m

Time	Flow rate (l/min)
15:28	0.211
15:35	0.212
15:44	0.212
15:49	0.212
15:56	0.213
16:03	0.213
16:10	0.212
16:17	0.211
16:24	0.212

Borehole KA3548A01, section 18.0 m - 21.0 m

Date:	98-08-07	Field Crew:	J. Olausson
Borehole length:	30.00 m	Borehole diameter:	76 mm
Packer inflation:	980807 08:44	Valve closed:	980807 09:49.58
Flowing time :	66 min	Tot. Pr. Build-up time:	133 min

Pressure just before closing the valve (Pp, kPa): 2.3
Pressure at the end of the recovery (Pf, kPa) : 3763.8

The pressure transducer used was lying 0.06 m above the borehole.
The height of the water flow outlet was same as the borehole.

Manually measured flow rates during pressure build-up test in KA3548A01, 18.0 - 21.0 m

Time	Flow rate (l/min)
08:49	3.40
08:56	3.45
9:03	3.39
09:13	3.41
09:17	3.41
09:24	3.40
09:31	3.40
09:45	3.40

Borehole KA3548A01, section 21.0 m - 24.0 m

Date: 98-08-07(-08) Field Crew: J. Olausson
Borehole length: 30.00 m Borehole diameter: 76 mm

Packer inflation: 980807 13:33 Valve closed: 980807 14:37.58
Flowing time : 65 min Tot. Pr. Build-up time: 1056 min

Pressure just before closing the valve (Pp, kPa): 2.5
Pressure at the end of the recovery (Pf, kPa) : 3756.7

The pressure transducer used was lying 0.06 m above the borehole.
The height of the water flow outlet was same as the borehole.

Manually measured flow rates during pressure build-up test in KA3548A01, 21.0 - 24.0 m

Time	Flow rate (l/min)
13:38	0.112
13:45	0.114
13:52	0.117
13:59	0.115
14:06	0.117
14:13	0.115
14:21	0.117
14:31	0.117
14:35	0.116

Borehole KA3548A01, section 24.0 m - 27.0 m

Date:	98-08-08	Field Crew:	J. Olausson
Borehole length:	30.00 m	Borehole diameter:	76 mm
Packer inflation:	980808 08:21	Valve closed:	980808 09:40.57
Flowing time :	80 min	Tot. Pr. Build-up time:	150 min

Pressure just before closing the valve (Pp, kPa): 1.8
Pressure at the end of the recovery (Pf, kPa) : 3826.1

The pressure transducer used was lying 0.06 m above the borehole.
The height of the water flow outlet was same as the borehole.

Manually measured flow rates during pressure build-up test in KA3548A01, 24.0 - 27.0 m

Time	Flow rate (l/min)
08:40	0.018
08:47	0.018
08:54	0.0175
09:01	0.017
09:08	0.017
09:15	0.017
09:22	0.017
09:29	0.017
09:36	0.017

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APPENDICES

APPENDIX A1 Diagrams of the interference test in exploratory hole **KA3590G02, 0.39-30.05 m,** and diagrams of pressure responses in KA3590G01,KA3593G, KA3588G01, KA3566G01, KA3566G02, KA3548A01, KA3586G01, KA3587G, KA3581G, KA3579G, KA3510A, KA3573A and KA3600F**.**

APPENDIX A2 Diagrams of the interference test in exploratory hole **KA3590G01, 0.39-30.065 m,** and diagrams of pressure responses in KA3590G02,KA3593G, KA3588G01, KA3566G01, KA3566G02, KA3548A01, KA3586G01, KA3587G, KA3581G, KA3579G, KA3510A, KA3573A and KA3600F.

APPENDIX A3 Diagrams of the interference test in exploratory hole **KA3593G, 0.39-30.02 m,** and diagrams of pressure responses in KA3590G01, KA3590G02, KA3588G01, KA3566G01, KA3566G02, KA3548A01, KA3586G01, KA3587G, KA3581G, KA3579G, KA3510A, KA3573A and KA3600F.

APPENDIX A4 Diagrams of the interference test in exploratory hole **KA3566G02, 0.39-30.01 m,** and diagrams of pressure responses in KA3566G01,KA3590G01, KA3590G02, KA3574G01, KA3554G01, KA3554G02, KA3548A01, KA3569G, KA3557G, KA3563G, KA3572G01, KA3510A, KA3573A and KA3600F.

APPENDIX A5 Diagrams of the interference test in exploratory hole **KA3566G01, 0.39-30.01 m,** and diagrams of pressure responses in KA3566G02,KA3590G01, KA3590G02, KA3574G01, KA3554G01, KA3554G02, KA3548A01, KA3569G, KA3557G, KA3563G, KA3572G01, KA3510A, KA3573A and KA3600F.

APPENDIX A6 Diagrams of the interference test in exploratory hole **KA3554G01, 0.39-30.01 m**, and diagrams of pressure responses in KA3554G02,KA3566G01, KA3566G02, KA3557G, KA3552G01, KA3550G01, KA3548A01, KA3551G, KA3548G01, KA3542G01, KA3542G02, KA3510A, KA3573A and KA3600F.

APPENDIX A7 Diagrams of the interference test in exploratory hole **KA3554G02, 0.39-30.01 m,** and diagrams of pressure responses in KA3554G01,KA3566G01, KA3566G02, KA3557G, KA3552G01, KA3550G01, KA3548A01, KA3551G, KA3548G01, KA3542G01, KA3542G02, KA3510A, KA3573A and KA3600F.

APPENDIX A8 Diagrams of the interference test in exploratory hole **KA3542G02, 0.39-30.01 m,** and diagrams of pressure responses in KA3542G01, KA3554G01, KA3554G02, KA3551G, KA3550G01, KA3548A01, KA3548G01, KA3546G01, KA3544G01, KA3545G, KA3539G, KA3510A, KA3573A and KA3600F.

APPENDIX A9 Diagrams of the interference test in exploratory hole **KA3542G01, 0.39-30.04 m,** and diagrams of pressure responses in KA3542G02, KA3554G01, KA3554G02, KA3551G, KA3550G01, KA3548A01, KA3548G01, KA3546G01, KA3544G01, KA3545G, KA3539G, KA3510A, KA3573A and KA3600F.

APPENDIX A10 Diagrams of the interference test in exploratory hole **KA3539G, 0.39-30.01 m,** and diagrams of pressure responses in KA3554G01, KA3554G02, KA3542G01, KA3542G02, KA3550G01, KA3548A01, KA3548G01, KA3546G01, KA3544G01, KA3551G, KA3545G, KA3510A, KA3573A and KA3600F.

APPENDIX A11 Diagrams of the pressure build-up test in exploratory hole **KA3557G01, 0.39 - 30.04 m ,**

APPENDIX A12 Diagrams of the pressure build-up test in exploratory hole **KA3574G01, 0.39 – 12.00 m**

APPENDIX A13 Diagrams of the pressure build-up test in exploratory hole **KA3576G01, 0.39 – 12.01 m**

APPENDIX A14 Diagrams of the interference test in exploratory hole **KA3548A01, 2.56-30.00 m,** and diagrams of pressure responses in KA3554G01, KA3554G02, KA3542G01, KA3542G02, KA3552G01, KA3550G01, KA3548G01, KA3546G01, KA3544G01, KA3545G, KA3539G, KA3510A, KA3573A and KA3600F.

APPENDIX A15 Diagrams of the pressure build-up test in exploratory hole **KA3563G, 0.39 – 30.00 m**

APPENDIX B 1 Diagrams of the pressure build-up test in 4 intervals of the exploratory borehole **KA3590G02**

APPENDIX B 2 Diagrams of the pressure build-up test in 6 intervals of the exploratory borehole **KA3590G01**

APPENDIX B 3 Diagrams of the pressure build-up test in one interval of the exploratory borehole **KA3593G**

APPENDIX B 4 Diagrams of the pressure build-up test in 3 intervals of the exploratory borehole **KA3566G01**

APPENDIX B 5 Diagrams of the pressure build-up test in 3 intervals of the exploratory borehole **KA3566G02**

APPENDIX B 6 Diagrams of the pressure build-up test in 5 intervals of the exploratory borehole **KA3554G02**

APPENDIX B 7 Diagrams of the pressure build-up test in 4 intervals of the exploratory borehole **KA3554G01**

APPENDIX B 8 Diagrams of the pressure build-up test in 9 intervals of the exploratory borehole **KA3542G02**

APPENDIX B 9 Diagrams of the pressure build-up test in 5 intervals of the exploratory borehole **KA3542G01**

APPENDIX B10 Diagrams of the pressure build-up test in 5 intervals of the exploratory borehole **KA3539G**

APPENDIX B11 Diagrams of the pressure build-up test in 8 intervals of the exploratory borehole **KA3548A01**

Appendix C1

DATA FILES

Table 1 A list of data files of data stored by the Borre data loggers, during Pressure build-up tests of features conducted in the long exploratory boreholes. (Calibration file = Borre39.cal) Prototype Repository, drill campaign 3a. June, July and August 1999

Borehole Section (m)	Date	Start Time	Stop time	Test No	"*.HYF-file"	"*.BOR-file"
KA3590G02 12.0 – 15.0	980625	08:09	11:16	1	PR301_39.HYF	PR3FLO_1.BOR
KA3590G02 18.0-21.0	980625	12:00	15:07	2	PR302_39.HYF	PR3FLO_1.BOR
KA3590G02 24.0 – 27.0	980625	15:46	19:12	3	PR303_39.HYF	PR3FLO_1.BOR
KA3590G02 27.0 – 30.0	980626	10:19	13:47	4	PR304_39.HYF	PR3FLO_1.BOR
KA3590G01 1.0 – 2.0	980706	14:19	17:29	20	PR320_39.HYF	PR3FLO_2.BOR
KA3590G01 2.0 – 3.0	980706	17:35	20:40	21	PR321_39.HYF	PR3FLO_2.BOR
KA3590G01 5.0 – 6.0	980707	10:35	13:35	22	PR322_39.HYF	PR3FLO_2.BOR
KA3590G01 8.0 – 9.0	980707	14:54	17:59	23	PR323_39.HYF	PR3FLO_2.BOR
KA3590G01 9.0 – 10.0	980708	09:25	12:29	24	PR324_39.HYF	PR3FLO_2.BOR
KA3593G 11.0 – 12.0	980708	18:03	08:00	25	PR325_39.HYF	PR3FLO_2.BOR
KA3590G01 21.0 – 24.0	980709	12:11	15:23	26	PR326_39.HYF	PR3FLO_3.BOR
KA3566G01 13.0 – 16.0	980714	10:44	13:49	27	PR327_39.HYF	PR3FLO_7.BOR
KA3566G01 16.0 – 19.0	980714	13:58	17:11	28	PR328_39.HYF	PR3FLO_7.BOR
KA3566G01 19.0 – 22.0	980714	17:17	20:22	29	PR329_39.HYF	PR3FLO_7.BOR
KA3566G02 15.0 – 18.0	980716	10:57	14:09	30	PR330_39.HYF	PR3FLO_7.BOR
KA3566G02 18.0 – 21.0	980716	14:21	17:27	31	PR331_39.HYF	PR3FLO_7.BOR
KA3566G02 21.0 – 24.0	980716	17:31	21:17	32	PR332_39.HYF	PR3FLO_7.BOR
KA3554G02 8.0 – 9.0	980720	17:20	20:38	33	PR333_39.HYF	PR3FLO_7.BOR
KA3554G02 11.0 – 12.0	980720	22:00	07:14	34	PR334_39.HYF	PR3FLO_7.BOR
KA3554G02 12.0 – 15.0	980721	10:49	15:59	35	PR335_39.HYF	PR3FLO_7.BOR
KA3554G02 15.0 – 18.0	980721	16:06	19:44	36	PR336_39.HYF	PR3FLO_7.BOR
KA3554G02 27.0 – 30.0	980722	08:10	11:23	37	PR337a39.HYF	PR3FLO_7.BOR
KA3554G02 27.0 – 30.0	980724	14:36	14:52	37b	PR337b39.HYF	PR3FLO_7.BOR
KA3554G01 18.0 – 21.0	980723	13:28	16:34	38	PR338_39.HYF	PR3FLO10.BOR
KA3554G01 21.0 – 24.0	980723	16:40	19:50	39	PR339_39.HYF	PR3FLO10.BOR
KA3554G01 24.0 – 27.0	980723	19:56	08:44	40	PR340_39.HYF	PR3FLO10.BOR
KA3554G01 27.0 – 30.0	980724	10:58	14:13	41	PR341_39.HYF	PR3FLO10.BOR
KA3542G02 3.0 – 4.0	980727	10:32	15:03	42	PR342_39.HYF	PR3FLO10.BOR
KA3542G02 5.0 – 6.0	980727	15:09	18:49	43	PR343_39.HYF	PR3FLO10.BOR
KA3542G02 4.0 – 5.0	980727	19:44	08:32	44	PR344_39.HYF	PR3FLO10.BOR
KA3542G02 10.0 – 11.0	980728	11:15	14:22	45	PR345_39.HYF	PR3FLO10.BOR
KA3542G02 11.0 – 12.0	980728	14:25	18:00	46	PR346_39.HYF	PR3FLO10.BOR
KA3542G02 12.0 – 15.0	980728	18:54	08:03	47	PR347_39.HYF	PR3FLO10.BOR
KA3542G02 15.0 – 18.0	980729	08:09	11:20	48	PR348_39.HYF	PR3FLO10.BOR
KA3542G02 18.0 – 21.0	980729	11:24	14:30	49	PR349_39.HYF	PR3FLO10.BOR
KA3542G02 24.0 – 27.0	980729	15:13	18:22	50	PR350_39.HYF	PR3FLO10.BOR
KA3542G01 12.0 – 15.0	980730	16:01	19:14	51	PR351_39.HYF	PR3FLO10.BOR
KA3542G01 15.0 – 18.0	980730	19:17	08:00	52	PR352_39.HYF	PR3FLO10.BOR
KA3542G01 18.0 – 21.0	980731	09:37	13:05	53	PR353_39.HYF	PR3FLO10.BOR
KA3542G01 21.0 – 24.0	980731	13:10	16:58	54	PR354_39.HYF	PR3FLO10.BOR
KA3542G01 27.0 – 30.0	980731	18:39	19:48	55a	PR355a39.HYF	PR3FLO10.BOR
KA3542G01 27.0 – 30.0	980731	19:54	21:13	55b	PR355b39.HYF	PR3FLO10.BOR
KA3539G 11.0 – 12.0	980801	11:22	14:40	56	PR356_39.HYF	PR3FLO10.BOR

KA3539G 12.0 – 15.0	980801	15:33	18:40	57	PR357_39.HYF	PR3FLO10.BOR
KA3539G 15.0 – 18.0	980801	18:42	08:13	58	PR358_39.HYF	PR3FLO10.BOR
KA3539G 18.0 – 21.0	980802	08:20	11:27	59	PR359_39.HYF	PR3FLO10.BOR
KA3539G 21.0 – 24.0	980802	11:30	14:36	60	PR360_39.HYF	PR3FLO10.BOR
KA3548A01 5.0 – 6.0	980804	13:42	16:55	61	PR361_39.HYF	PR3FLO13.BOR
KA3548A01 6.0 – 7.0	980805	10:13	13:25	62	PR362_39.HYF	PR3FLO13.BOR
KA3548A01 9.0 – 10.0	980805	14:52	08:09	63	PR363_39.HYF	PR3FLO13.BOR
KA3548A01 12.0 – 15.0	980806	12:08	15:16	64	PR364_39.HYF	PR3FLO13.BOR
KA3548A01 15.0 – 18.0	980806	15:23	18:25	65	PR365_39.HYF	PR3FLO13.BOR
KA3548A01 18.0 – 21.0	980807	08:44	12:23	66	PR366_39.HYF	PR3FLO13.BOR
KA3548A01 21.0 – 24.0	980807	13:33	08:14	67	PR367_39.HYF	PR3FLO13.BOR
KA3548A01 24.0 – 27.0	980808	08:21	12:11	68	PR368_39.HYF	PR3FLO13.BOR

Table 2 A list of data files of data stored by the Borre data loggers, during interference Tests and Pressure Build-up Tests conducted in the entire exploratory boreholes. Prototype Repository, drill campaign 3a. June, July and August 1999

Borehole /Section (m)	Start Date	Start time	Stop time	Test No	Observa-tion Bore-hole	"*.HYF-file"	"*.BOR-file"	Calibra-tion file
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3590G02	PR305_39.HYF	PR305_39.BOR	Borre39.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3593G	PR305_44.HYF	PR305_44.BOR	Borre44.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3590G01	PR305_44.HYF	PR305_44.BOR	Borre44.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3588G01	PR305_44.HYF	PR305_44.BOR	Borre44.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3566G01	PR305_43.HYF	PR305_43.BOR	Borre43.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3566G02	PR305_43.HYF	PR305_43.BOR	Borre43.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3548A01	PR305_43.HYF	PR305_43.BOR	Borre43.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3586G01	PR305_40.HYF	PR305_40.BOR	Borre40.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3587G	PR305_40.HYF	PR305_40.BOR	Borre40.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3581G	PR305_40.HYF	PR305_40.BOR	Borre40.Cal
KA3590G02 0.39 – 30.0	980701	09:35	12:03	5	KA3579G	PR305_40.HYF	PR305_40.BOR	Borre40.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3590G01	PR306_39.HYF	PR306_39.BOR	Borre39.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3593G	PR306_44.HYF	PR306_44.BOR	Borre44.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3590G01	PR306_44.HYF	PR306_44.BOR	Borre44.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3588G01	PR306_44.HYF	PR306_44.BOR	Borre44.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3566G01	PR306_43.HYF	PR306_43.BOR	Borre43.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3566G02	PR306_43.HYF	PR306_43.BOR	Borre43.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3548A01	PR306_43.HYF	PR306_43.BOR	Borre43.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3586G01	PR306_40.HYF	PR306_40.BOR	Borre40.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3587G	PR306_40.HYF	PR306_40.BOR	Borre40.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3581G	PR306_40.HYF	PR306_40.BOR	Borre40.Cal
KA3590G01 0.39 – 30.0	980701	12:45	14:28	6	KA3579G	PR306_40.HYF	PR306_40.BOR	Borre40.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3593G	PR307_39.HYF	PR307_39.BOR	Borre39.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3590G01	PR307_44.HYF	PR307_44.BOR	Borre44.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3590G02	PR307_44.HYF	PR307_44.BOR	Borre44.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3588G01	PR307_44.HYF	PR307_44.BOR	Borre44.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3566G01	PR307_43.HYF	PR307_43.BOR	Borre43.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3566G02	PR307_43.HYF	PR306_43.BOR	Borre43.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3548A01	PR307_43.HYF	PR307_43.BOR	Borre43.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3586G01	PR307_40.HYF	PR307_40.BOR	Borre40.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3587G	PR307_40.HYF	PR307_40.BOR	Borre40.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3581G	PR307_40.HYF	PR307_40.BOR	Borre40.Cal
KA3593G 0.39 – 30.0	980701	15:00	16:43	7	KA3579G	PR307_40.HYF	PR307_40.BOR	Borre40.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3566G02	PR308_39.HYF	PR308_39.BOR	Borre39.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3590G01	PR308_44.HYF	PR308_44.BOR	Borre44.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3590G02	PR308_44.HYF	PR308_44.BOR	Borre44.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3574G01	PR308_44.HYF	PR308_44.BOR	Borre44.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3554G01	PR308_43.HYF	PR308_43.BOR	Borre43.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3554G02	PR308_43.HYF	PR308_43.BOR	Borre43.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3548A01	PR308_43.HYF	PR308_43.BOR	Borre43.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3566G01	PR308_40.HYF	PR308_40.BOR	Borre40.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3569G	PR308_40.HYF	PR308_40.BOR	Borre40.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3557G	PR308_40.HYF	PR308_40.BOR	Borre40.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3563G	PR308_40.HYF	PR308_40.BOR	Borre40.Cal
KA3566G02 0.39 – 30.0	980701	17:35	07:43	8	KA3572G01	PR308_40.HYF	PR308_40.BOR	Borre40.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3566G01	PR309_39.HYF	PR309_39.BOR	Borre39.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3590G01	PR309_44.HYF	PR309_44.BOR	Borre44.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3590G02	PR309_44.HYF	PR309_44.BOR	Borre44.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3574G01	PR309_44.HYF	PR309_44.BOR	Borre44.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3554G01	PR309_43.HYF	PR309_43.BOR	Borre43.Cal

Borehole /Section (m)	Start Date	Start time	Stop time	Test No	Observation Borehole	"*.HYF-file"	"*.BOR-file"	Calibration file
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3554G02	PR309_43.HYF	PR309_43.BOR	Borre43.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3548A01	PR309_43.HYF	PR309_43.BOR	Borre43.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3566G02	PR309_40.HYF	PR309_40.BOR	Borre40.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3569G	PR309_40.HYF	PR309_40.BOR	Borre40.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3557G	PR309_40.HYF	PR309_40.BOR	Borre40.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3563G	PR309_40.HYF	PR309_40.BOR	Borre40.Cal
KA3566G01 0.39 – 30.0	980702	09:30	11:52	9	KA3572G01	PR309_40.HYF	PR309_40.BOR	Borre40.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3554G01	PR310_39.HYF	PR310_39.BOR	Borre39.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3566G01	PR310_44.HYF	PR310_44.BOR	Borre44.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3566G02	PR310_44.HYF	PR310_44.BOR	Borre44.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3557G	PR310_44.HYF	PR310_44.BOR	Borre44.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3552G01	PR310_43.HYF	PR310_43.BOR	Borre43.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3554G02	PR310_43.HYF	PR310_43.BOR	Borre43.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3548A01	PR310_43.HYF	PR310_43.BOR	Borre43.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3548G02	PR310_40.HYF	PR310_40.BOR	Borre40.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3551G	PR310_40.HYF	PR310_40.BOR	Borre40.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3550G01	PR310_40.HYF	PR310_40.BOR	Borre40.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3542G02	PR310_40.HYF	PR310_40.BOR	Borre40.Cal
KA3554G01 0.39 – 30.0	980702	13:07	15:35	10	KA3542G01	PR310_40.HYF	PR310_40.BOR	Borre40.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3554G02	PR311_39.HYF	PR311_39.BOR	Borre39.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3566G01	PR311_44.HYF	PR311_44.BOR	Borre44.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3566G02	PR311_44.HYF	PR311_44.BOR	Borre44.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3557G	PR311_44.HYF	PR311_44.BOR	Borre44.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3552G01	PR311_43.HYF	PR311_43.BOR	Borre43.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3554G01	PR311_43.HYF	PR311_43.BOR	Borre43.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3548A01	PR311_43.HYF	PR311_43.BOR	Borre43.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3548G02	PR311_40.HYF	PR311_40.BOR	Borre40.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3551G	PR311_40.HYF	PR311_40.BOR	Borre40.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3550G01	PR311_40.HYF	PR311_40.BOR	Borre40.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3542G02	PR311_40.HYF	PR311_40.BOR	Borre40.Cal
KA3554G02 0.39 – 30.0	980702	16:15	18:07	11	KA3542G01	PR311_40.HYF	PR311_40.BOR	Borre40.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3542G02	PR312_39.HYF	PR314_39.BOR	Borre39.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3546G01	PR312_44.HYF	PR314_44.BOR	Borre44.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3545G	PR312_44.HYF	PR314_44.BOR	Borre44.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3544G01	PR312_44.HYF	PR314_44.BOR	Borre44.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3554G02	PR312_43.HYF	PR314_43.BOR	Borre43.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3554G01	PR312_43.HYF	PR314_43.BOR	Borre43.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3548A01	PR312_43.HYF	PR314_43.BOR	Borre43.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3548G01	PR312_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3551G	PR312_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3550G01	PR312_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3539G	PR312_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G02 0.39 – 30.0	980703	08:55	11:30	12	KA3542G01	PR312_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3542G01	PR313_39.HYF	PR314_39.BOR	Borre39.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3546G01	PR313_44.HYF	PR314_44.BOR	Borre44.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3545G	PR313_44.HYF	PR314_44.BOR	Borre44.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3544G01	PR313_44.HYF	PR314_44.BOR	Borre44.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3554G02	PR313_43.HYF	PR314_43.BOR	Borre43.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3554G01	PR313_43.HYF	PR314_43.BOR	Borre43.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3548A01	PR313_43.HYF	PR314_43.BOR	Borre43.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3548G01	PR313_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3551G	PR313_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3550G01	PR313_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3539G	PR313_40.HYF	PR314_40.BOR	Borre40.Cal
KA3542G01 0.39 – 30.0	980703	12:09	14:06	13	KA3542G02	PR313_40.HYF	PR314_40.BOR	Borre40.Cal

Borehole /Section (m)	Start Date	Start time	Stop time	Test No	Observa-tion Bore-hole	"*.HYF-file"	"*.BOR-file"	Calibra-tion file
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3539G	PR314_39.HYF	PR314_39.BOR	Borre39.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3546G01	PR314_44.HYF	PR314_44.BOR	Borre44.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3545G	PR314_44.HYF	PR314_44.BOR	Borre44.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3544G01	PR314_44.HYF	PR314_44.BOR	Borre44.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3554G02	PR314_43.HYF	PR314_43.BOR	Borre43.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3554G01	PR314_43.HYF	PR314_43.BOR	Borre43.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3548A01	PR314_43.HYF	PR314_43.BOR	Borre43.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3548G01	PR314_40.HYF	PR314_40.BOR	Borre40.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3551G	PR314_40.HYF	PR314_40.BOR	Borre40.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3550G01	PR314_40.HYF	PR314_40.BOR	Borre40.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3542G01	PR314_40.HYF	PR314_40.BOR	Borre40.Cal
KA3539G 0.39 – 30.0	980703	14:24	08:50	14	KA3542G02	PR314_40.HYF	PR314_40.BOR	Borre40.Cal
KA3557G 0.39 – 30.0	980704	09:35	15:54	15	KA3557G	PR315_39.HYF	PR315_39.BOR	Borre39.Cal
KA3574G01 0.39-12.0	980704	16:25	08:44	16	KA3574G01	PR316_39.HYF	PR316_39.BOR	Borre39.Cal
KA3576G01 0.39-12.0	980705	09:02	15:33	17	KA3576G01	PR317_39.HYF	PR317_39.BOR	Borre39.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3548A01	PR318_43.HYF	PR318_43.BOR	Borre43.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3546G01	PR318_44.HYF	PR318_44.BOR	Borre44.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3545G	PR318_44.HYF	PR318_44.BOR	Borre44.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3544G01	PR318_44.HYF	PR318_44.BOR	Borre44.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3554G02	PR318_43.HYF	PR318_43.BOR	Borre43.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3554G01	PR318_43.HYF	PR318_43.BOR	Borre43.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3539G	PR318_39.HYF	PR318_39.BOR	Borre39.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3548G01	PR318_40.HYF	PR318_40.BOR	Borre40.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3552G01	PR318_40.HYF	PR318_40.BOR	Borre40.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3550G01	PR318_40.HYF	PR318_40.BOR	Borre40.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3542G01	PR318_40.HYF	PR318_40.BOR	Borre40.Cal
KA3548A01 0.39 – 30.0	980705	16:43	08:29	18	KA3542G02	PR318_40.HYF	PR318_40.BOR	Borre40.Cal
KA3563G 0.39 – 30.00	980706	09:15	12:01	19	KA3563G	PR319_39.HYF	PR319_39.BOR	Borre39.Cal

Three more boreholes were monitored during the whole test period. The boreholes and the datafiles respectively are:

Borehole **KA3510B**, datafiles : KA3510B.HYF and KA3510B.BOR
Borehole **KA3573A**, datafiles : KA3573A.HYF and KA3573A.BOR
Borehole **KA3600A**, datafiles : KA3560A.HYF and KA3600A.BOR

TEXT FILES

All the datafiles of the test intervals have been transformed to textfiles (.TXT). The format of the files is described in the QA-document of test campaign 3a (Ingvar Rhén 1998-06-17)

The files are named according to:

NNVPLLLL.TXT where

NN = Test No
V = Test parameter; P = pressure, Q= Flow
P = Test Phase; D = draw down, B = recovery
LLLL = Borehole ID (position in the tunnel) (example: 12PD3542.TXT)

The Datafiles and textfiles are stored in SICADA at Aspo Hard Rock Laboratory.