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Oskarshamn site investigation

Hydraulic interference tests in boreholes KLX06, KLX14A, KLX15A, KLX16A, KLX17A, KLX18A, KLX19A, KLX21B, KLX22A, KLX22B, KLX23A, KLX23B, KLX26A and KLX26B

Subarea Laxemar

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Abstract

This report documents the results from 14 interference tests performed in the Laxemar subarea between February 2005 and May 2007. The boreholes used for pumping are KLX06, KLX14A, KLX15A, KLX16A, KLX17A, KLX18A, KLX19A, KLX21B, KLX22A, KLX22B, KLX23A, KLX23B, KLX26A and KLX26B. At each pumping the pressure response in a number of observation boreholes have been evaluated.

The main purposes of the interference tests was to document how different fracture zones of the rock are connected hydraulically, to quantify their hydraulic properties and to clarify whether there are any hydraulic boundaries in the area.

The interference tests were performed by creating a drawdown in the pumping borehole while registering the pressure responses in some adjacent observation sections. The drawdown in the pumping boreholes was created by PFL (Posiva Flow Log) – pumping, air-lift pumping and pumping with the PSS (Pipe String System) – equipment. Totally 14 boreholes were used as pumping boreholes and totally 98 observation sections in 29 boreholes were monitored.

The flow period in the interference tests lasted for between 19h and 10days and several responses were detected. All observation boreholes with a detected response as well as the pumping boreholes were evaluated quantitatively using methods for transient evaluation. Due to the sometimes long distances from, and/or relatively bad hydraulic connection to the pumping borehole, the results from the transient evaluation of the observation sections may bee uncertain. It is possible that the evaluated transmissivity values reflect the hydraulic conditions close to the pumping borehole rather than the conditions around the evaluated observation boreholes. However, the estimated hydraulic diffusivity based on the response times for the selected sections was in good agreement with the corresponding estimates from the performed transient analysis.

Several observation sections were influenced by tidal effects, and probably to some extent also by changes of the sea level. Primarily due to the tidal effects the pressure data from certain observation sections exhibit an oscillating behaviour. Many observation sections are also influenced by precipitation which complicates the evaluation.

Sammanfattning

Denna rapport innehåller resultaten från 14 interferenstest som har genomförts i Laxemarområdet mellan februari 2005 och maj 2007. De borrhål som använts som pumphål är KLX06, KLX14A, KLX15A, KLX16A, KLX17A, KLX18A, KLX19A, KLX21B, KLX22A, KLX22B, KLX23A, KLX23B, KLX26A and KLX26B. Vid varje pumpning har ett antal observationshål undersökts.

Syftet med de utförda interferenstesterna är att dokumentera hur spricksystemen i berget hänger ihop hydrauliskt, kvantifiera bergets hydrauliska egenskaper samt att klargöra om det finns några hydrauliska gränser inom området.

Interferenstesterna utfördes genom att en tryckavsänkning skapades i pumphålet samtidigt som tryckresponser registrerades i olika observationssektioner i ett flertal omgivande borrhål. Tryckavsänkningen genererades genom PFL (Posiva Flow Log)-pumpningar, mammutpumpning eller pumpning med PSS (Pipe String System)- utrustning. Totalt pumpades det i 14 borrhål och sammanlagt 98 observationssektioner i 29 borrhål övervakades och ingick i interfenstesten.

Pumpfasen pågick i mellan 19h och 10dagar för de olika pumpningarna och ett flertal responser detekterades. Alla pumphål samt de observationssektioner där respons detekterades har utvärderats kvantitativt med metoder för transient utvärdering. Resultaten från den transienta utvärderingen av observationshålen kan vara osäkra på grund av de ibland långa avstånden till, och/eller den relativt dåliga hydrauliska kontakten med pumphålet. Det är möjligt att de utvärderade transmissiviteterna återspeglar de hydrauliska förhållandena i närheten av pumphålet snarare än förhållandena runt de utvärderade observationshålen.

Många observationssektioner är påverkade av tidaleffekter, samt troligen även effekter orsakade av ändrat vattenstånd i havet. Vissa berörda sektioner uppvisar ett oscillerande beteende beroende på framförallt tidaleffekterna. Många observationssektioner är också påverkade av nederbörd under pumpperioden vilket försvårar utvärderingen.

Contents

1 Introduction

A general program for site investigations presenting survey methods has been prepared /25/, as well as a site-specific program for the investigations in the Simpevarp area /26/. The interference and tracer testing form part of the site characterization program under item 1.1.5.9 in the work breakdown structure of the execution programme /27/.

This report documents the results from 14 hydraulic interference tests performed within the site investigation in the subarea Laxemar at Oskarshamn. Interference test are performed in order to study how different fracture zones are connected hydraulically, to quantify their hydraulic properties and to clarify whether there are any major hydraulic boundaries in the area. The locations of the boreholes involved in the interference tests are shown in Figure 1-1. The tests were carried out in between February 2005 and May 2007.

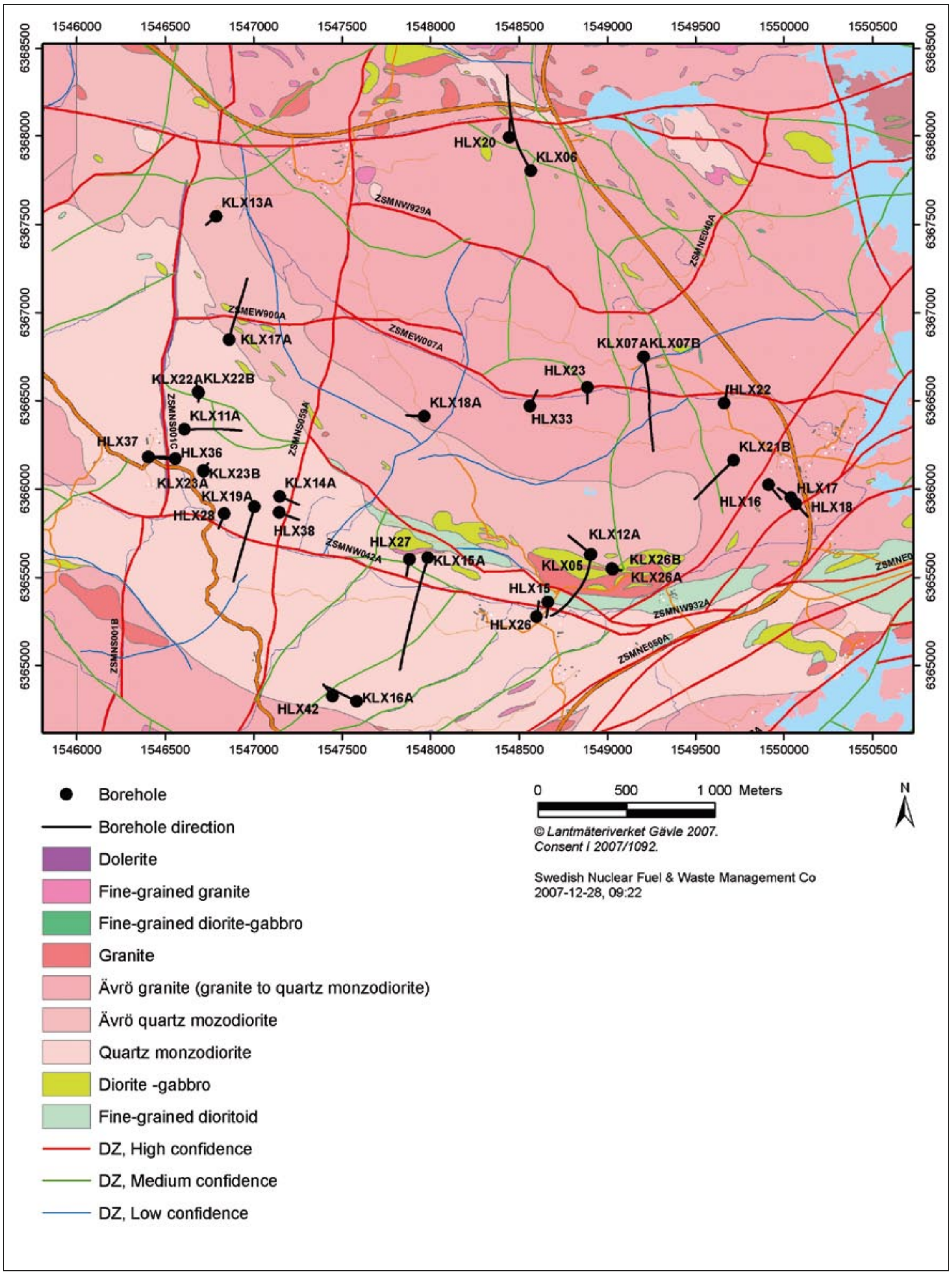

Figure 1-1. *The investigation area at Oskarshamn including part of the candidate area Laxemar selected for more detailed investigations. The positions of the boreholes included in the interference tests are displayed.*

The interference tests and evaluations have been made according to the activity plans and method descriptions listed in Table 1-1. Both the activity plans and method descriptions are internal controlling documents of SKB.

The 14 boreholes used as pumping boreholes and the surrounding boreholes served as observation wells are listed in Table 1-2.

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

Pumping borehole	Activity plan number (execution)	Activity plan number (evaluation)
KLX14A	AP PS 400-06-85	AP PS 400-07-25
KLX21B	AP PS 400-06-120	AP PS 400-07-25
KLX26A	AP PS 400-06-105	AP PS 400-07-25
KLX26B	AP PS 400-06-105	AP PS 400-07-25
KLX22A	AP PS 400-06-92	AP PS 400-07-25
KLX22B	AP PS 400-06-92	AP PS 400-07-25
KLX23A	AP PS 400-06-92	AP PS 400-07-25
KLX23B	AP PS 400-06-92	AP PS 400-07-25
KLX16A	AP PS 400-06-150	AP PS 400-07-25
KLX15A	AP PS 400-06-151	AP PS 400-07-25
KLX19A	AP PS 400-06-86	AP PS 400-07-25
KLX17A	AP PS 400-06-73	AP PS 400-07-25
KLX06	AP PS 400-06-116	AP PS 400-06-116
KLX18A	AP PS 400-06-11	AP PS 400-07-071
Method documents	**Number**	**Version**
Instruktion för analys av injektions- och enhålspumptester	SKB MD 320.004	1.0
Metodbeskrivning för interferenstester	SKB MD 330.003	1.0

Table 1-2. Performed tests.

Pumping borehole	Observation borehole	Test start date and time (YYYY-MM-DD tt:mm)	Test stop date and time (YYYY-MM-DD tt:mm)
KLX14A	HLX38	2006-11-16 12:29	2006-11-19 09:49
KLX21B	KLX07A, KLX07B, KLX12, KLX05, HLX22, HLX23, HLX18	2007-03-11 13:37	2007-03-18 18:23
KLX26A	KLX26B	2007-02-16 15:30	2007-02-18 09:42
KLX26B	KLX26A	2007-02-19 16:21	2007-02-20 11:31
KLX22A	KLX22B	2006-07-18 15:37	2006-07-21 10:13
KLX22B	KLX22A	2006-07-26 16:41	2006-07-29 13:59
KLX23A	KLX23B	2006-08-03 15:25	2006-08-05 14:44
KLX23B	KLX23A	2006-07-30 15:38	2006-08-01 13:02
KLX16A	HLX42, KLX12A, KLX05, HLX15, HLX26, HLX28	2007-02-24 15:20	2007-03-02 11:53
KLX15A	KLX19A, HLX38, KLX05	2007-05-08 16:47	2007-05-17 18:41
KLX19A	HLX38, HLX36, HLX37, KLX11A	2006-11-12 18:35	2006-11-18 12:36
KLX17A	KLX13A	2006-10-28 09:58	2006-10-29 09:22
KLX06	HLX20	2005-02-18 16:52	2005-02-28 13:47
KLX18A	KLX11A	2006-05-05 13:10	2006-05-08 08:34

2 Objectives

The main aim of hydraulic interference tests is to get support for interpretations of geologic structures in regard to their hydraulic and geometric properties. Furthermore, an interference test also provide information about the hydraulic connectivity and possibly hydraulic boundary conditions within the tested area. Finally, interference tests make up the basis for calibration of numerical models of the area.

The interference tests were performed by pumping in altering boreholes and monitoring pressure responses in different observation sections in surrounding boreholes. All boreholes monitored for responses are part of the Oskarshamn HMS, the Hydro Monitoring System. In total, 98 observation sections in 29 observation boreholes were included in the interference tests.

3 Scope

3.1 Boreholes tested

Technical data of the boreholes tested are presented in Table 3-1. Some of the boreholes that, according to the activity plans, were intended to be included in the interference tests did not supply any pressure data and were therefore excluded from the tests. These boreholes are not presented in this report except for in the listing in chapter 5.6.

The reference point in the boreholes is always top of casing (ToC). The Swedish National coordinate system (RT90 2.5 gon V 0:-15) is used in the x-y-direction together with RHB70 in the z-direction. The coordinates of the boreholes at ground surface are shown in Table 3-2. All section positions are given as length along the borehole (not vertical distance from ToC). All times presented are Swedish summer times, i.e. adjustment for daylight saving time has been made for any reported times.

Table 3-1. Pertinent technical data of the boreholes included in the interference tests. (From Sicada).

Borehole data							
Bh ID	**Elevation of top of casing (ToC) (m.a.s.l.)**	**Borehole interval from ToC (m)**	**Casing/ Bh-diam. (m)**	**Inclination-top of bh (from horizontal plane) (°)**	**Dip-direction-top of borehole (from local N) (°)**	**Remarks**	**Drilling finished Date (YYYY-MM-DD)**
KLX14A	16.35	0.30–3.20	0.116	–49.96	111.95	Borehole	2006-09-04
”		3.20–6.45	0.096			Borehole	
”		6.45–176.27	0.076			Borehole	
”		0.00–6.45	0.077			Casing ID	
KLX21B	10.68	0.30–6.35	0.340	–70.86	225.05	Borehole	2006-11-29
”		6.35–11.85	0.248			Borehole	
”		11.85–99.30	0.198			Borehole	
”		99.30–99.41	0.158			Borehole	
”		99.41–100.00	0.086			Borehole	
”		100.85–858.78	0.076			Borehole	
”		0.00–11.85	0.200			Casing ID	
”		0.30–6.35	0.311			Casing ID	
KLX26A	15.63	0.30–2.64	0.096	–60.45	93.47	Borehole	2006-08-11
”		2.64–101.14	0.076			Borehole	
”		0.00–2.64	0.077			Casing ID	
KLX26B	15.82	0.30–2.31	0.096	–60.01	137.42	Borehole	2006-08-17
”		2.31–50.37	0.076			Borehole	
”		0.00–2.31	0.077			Casing ID	
KLX22A	21.97	0.30–2.00	0.096	–59.93	179.19	Borehole	2006-05-12
”		2.00–100.45	0.076			Borehole	
”		0.00–2.00	0.077			Casing ID	
KLX22B	21.57	0.30–2.00	0.096	–61.25	343.97	Borehole	2006-05-18
”		2.00–100.25	0.076			Borehole	
”		0.00–2.00	0.077			Casing ID	
KLX23A	22.26	0.30–2.35	0.096	–61.24	28.73	Borehole	2006-05-27

Borehole data							
Bh ID	**Elevation of top of casing (ToC) (m.a.s.l.)**	**Borehole interval from ToC (m)**	**Casing/ Bh-diam. (m)**	**Inclination-top of bh (from horizontal plane) (°)**	**Dip-direction-top of borehole (from local N) (°)**	**Remarks**	**Drilling finished Date (YYYY-MM-DD)**
”		2.35–100.15	0.076			Borehole	
”		0.00–2.30	0.077			Casing ID	
KLX23B	22.32	0.30–2.30	0.096	–60.54	121.36	Borehole	2006-05-31
”		2.30–50.27	0.076			Borehole	
”		0.00–2.30	0.077			Casing ID	
KLX16A	18.85	0.30–11.25	0.096	–64.98	294.37	Borehole	2007-01-09
”		11.25–433.55	0.076			Borehole	
”		0.00–11.25	0.077			Casing ID	
KLX15A	14.59	0.30–6.00	0.341	–54.42	198.83	Borehole	2007-02-25
”		6.00–11.65	0.233			Borehole	
”		11.65–76.03	0.198			Borehole	
”		76.03–76.13	0.165			Borehole	
”		76.13–76.71	0.086			Borehole	
”		76.71–77.58	0.086			Borehole	
”		77.58–1,000.43	0.076			Borehole	
”		0.00–11.65	0.210			Casing ID	
”		0.30–6.00	0.310			Casing ID	
KLX19A	16.87	0.20–6.30	0.339	–57.78	197.13	Borehole	2006-09-20
”		6.30–70.00	0.254			Borehole	
”		70.00–99.33	0.253			Borehole	
”		99.33–100.73	0.086			Borehole	
”		100.73–800.07	0.076			Borehole	
”		520.30–522.50	0.084			Borehole	
”		0.00–92.75	0.200			Casing ID	
”		0.20–6.20	0.310			Casing ID	
”		6.20–6.30	0.280			Casing ID	
”		92.75–98.70	0.200			Casing ID	
”		98.70–98.75	0.170			Casing ID	
”		520.40–522.40	0.076			Casing ID	
KLX17A	27.63	0.15–2.60	0.339	–61.34	11.21	Borehole	2006-10-23
”		2.60–11.95	0.248			Borehole	
”		11.95–65.35	0.197			Borehole	
”		65.35–65.42	0.159			Borehole	
		65.42–66.76	0.086			Borehole	
		66.76–701.08	0.076			Borehole	
”		0.00–11.95	0.200			Casing ID	
		0.15–2.50	0.310			Casing ID	
		2.50–2.60	0.280			Casing ID	
KLX06	17.68	0.10–9.10	0.341	–65.02	330.21	Borehole	2004-11-25
”		9.10–11.88	0.253			Borehole	
”		11.88–100.30	0.195			Borehole	
		100.29–101.88	0.086			Borehole	
		101.88–994.94	0.076			Borehole	
”		0.00–11.88	0.200			Casing ID	
”		0.10–9.10	0.310			Casing ID	

Borehole data							
Bh ID	**Elevation of top of casing (ToC) (m.a.s.l.)**	**Borehole interval from ToC (m)**	**Casing/ Bh-diam. (m)**	**Inclination-top of bh (from horizontal plane) (°)**	**Dip-direction-top of borehole (from local N) (°)**	**Remarks**	**Drilling finished Date (YYYY-MM-DD)**
KLX18A	21.01	0.30–9.30	0.340	–82.04	271.40	Borehole	2006-05-02
”		9.30–11.83	0.254			Borehole	
”		11.83–99.83	0.198			Borehole	
”		99.83–99.93	0.163			Borehole	
”		99.93–101.35	0.086			Borehole	
		101.35–611.28	0.076			Borehole	
		0.00–11.83	0.200			Casing ID	
		0.30–9.30	0.311			Casing ID	
HLX38	11.53	0.00–15.10	0.190	–59.39	110.04	Borehole	2004-04-24
”		15.10–103.20	0.140			Borehole	
”		103.20–199.50	0.139			Borehole	
”		0.00–14.93	0.160			Casing ID	
”		14.93–15.02	0.143			Casing ID	
HLX28	13.42	0.00–6.10	0.190	–59.49	201.38	Borehole	2004-10-02
”		6.10–154.20	0.136			Borehole	
”		0.00–5.94	0.160			Casing ID	
”		5.94–6.03	0.147			Casing ID	
KLX07A	18.47	0.20–8.90	0.343	–60.04	174.18	Borehole	2005-05-04
”		8.90–11.80	0.252			Borehole	
”		11.80–100.30	0.198			Borehole	
		100.30–100.46	0.165			Borehole	
		100.46–101.98	0.086			Borehole	
		101.98.844.73	0.076			Borehole	
”		0.00–11.80	0.200			Casing ID	
”		0.20–8.90	0.310			Casing ID	
KLX07B	18.38	0.00–9.64	0.096	–85.00	174.33	Borehole	2005-06-03
”		9.64–200.13	0.076			Borehole	
”		0.00–9.64	0.077			Casing ID	
KLX12A	17.74	0.15–15.10	0.343	–75.07	315.92	Borehole	2006-03-04
”		15.10–17.92	0.248			Borehole	
”		17.92–100.40	0.197			Borehole	
		100.40–100.57	0.161			Borehole	
		100.57–102.13	0.086			Borehole	
		102.13–602.29	0.076			Borehole	
”		0.00–17.92	0.200			Casing ID	
”		0.15–15.10	0.310			Casing ID	
KLX05	17.63	0.00.12.60	0.343	–65.12	189.72	Borehole	2005-01-22
”		12.60–15.00	0.250			Borehole	
”		15.00–75.10	0.195			Borehole	
”		75.10–108.01	0.086			Borehole	
		108.01–1,000.16	0.076			Borehole	
		0.00–15.00	0.200			Casing ID	
”		0.10–12.60	0.310			Casing ID	
HLX22	10.06	0.00–9.10	0.190	–59.44	13.45	Borehole	2004-08-26
”		9.10–163.20	0.138			Borehole	

Borehole data							
Bh ID	**Elevation of top of casing (ToC) (m.a.s.l.)**	**Borehole interval from ToC (m)**	**Casing/ Bh-diam. (m)**	**Inclination-top of bh (from horizon-tal plane) (°)**	**Dip-direction-top of borehole (from local N) (°)**	**Remarks**	**Drilling finished Date (YYYY-MM-DD)**
”		0.00–8.94	0.160			Casing ID	
”		8.94–9.03	0.147			Casing ID	
HLX23	14.69	0.00–6.10	0.190	–58.18	182.89	Borehole	2004-09-16
”		6.10–160.20	0.139			Borehole	
”		0.00–5.94	0.160			Casing ID	
”		5.94–6.03	0.147			Casing ID	
HLX18	4.04	0.00–15.12	0.190	–57.60	135.91	Borehole	2004-07-06
”		15.12–181.20	0.139			Borehole	
”		0.00–14.94	0.160			Casing ID	
”		14.94–15.03	0.147			Casing ID	
HLX42	12.88	0.30–9.10	0.180	–57.11	321.51	Borehole	2006-11-16
”		9.10–152.60	0.139			Borehole	
”		0.00–9.01	0.160			Casing ID	
”		9.01–9.10	0.143			Casing ID	
HLX15	4.81	0.00–12.24	0.190	–58.37	184.65	Borehole	2004-04-29
”		12.24–151.90	0.137			Borehole	
”		0.00–11.95	0.160			Casing ID	
”		11.95–12.04	0.147			Casing ID	
HLX26	6.48	0.00–9.10	0.190	–60.42	12.37	Borehole	2004-09-28
”		9.10–151.20	0.137			Borehole	
”		0.00–8.94	0.160			Casing ID	
”		8.94–9.03	0.147			Casing ID	
HLX36	15.56	0.00–6.10	0.190	–59.30	270.61	Borehole	2005-09-22
”		6.10–121.50	0.140			Borehole	
”		121.50–199.80	0.140			Borehole	
”		0.00–5.94	0.160			Casing ID	
”		5.94–6.03	0.142			Casing ID	
HLX37	15.19	0.00–12.10	0.190	–59.25	86.18	Borehole	2005-09-28
”		12.10–121.50	0.140			Borehole	
”		121.50–199.80	0.139			Borehole	
”		0.00–11.94	0.160			Casing ID	
”		11.94–12.03	0.142			Casing ID	
KLX11A	27.14	0.43–9.60	0.343	–76.43	89.84	Borehole	2006-03-02
”		9.60–12.05	0.248			Borehole	
”		12.05–99.96	0.195			Borehole	
”		99.96–100.06	0.160			Borehole	
”		100.06–101.53	0.086			Borehole	
”		101.53–992.29	0.076			Borehole	
”		0.00–12.05	0.200			Casing ID	
”		0.43–9.60	0.310			Casing ID	
KLX13A	24.15	0.15–6.15	0.341	–82.25	224.48	Borehole	2006-08-16
”		6.15–11.75	0.252			Borehole	
”		11.75–99.76	0.197			Borehole	
”		99.76–99.86	0.160			Borehole	
”		99.86–101.21	0.086			Borehole	

Borehole data							
Bh ID	Elevation of top of casing (ToC) (m.a.s.l.)	Borehole interval from ToC (m)	Casing/ Bh-diam. (m)	Inclination-top of bh (from horizontal plane) (°)	Dip-direction-top of borehole (from local N) (°)	Remarks	Drilling finished Date (YYYY-MM-DD)
”		101.21–595.85	0.076			Borehole	
”		0.00–11.75	0.200			Casing ID	
”		0.15–6.15	0.301			Casing ID	
HLX20	11.18	0.00–9.12	0.190	–60.38	0.41	Borehole	2004-06-21
”		9.12–202.20	0.138			Borehole	
”		0.00–8.94	0.160			Casing ID	
”		8.94–9.03	0.147			Casing ID	

Table 3-2. Coordinates of the boreholes included in the interference tests. (From Sicada).

Borehole data		
Bh ID	Northing (m)	Easting (m)
KLX14A	6,365,959.69	1,547,146.87
KLX21B	6,366,164.00	1,549,715.10
KLX26A	6,365,546.49	1,549,029.90
KLX26B	6,365,550.66	1,549,025.61
KLX22A	6,366,548.35	1,546,688.60
KLX22B	6,366,553.13	1,546,685.41
KLX23A	6,366,106.89	1,546,715.74
KLX23B	6,366,101.90	1,546,717.33
KLX16A	6,364,797.69	1,547,584.06
KLX15A	6,365,614.17	1,547,987.47
KLX19A	6,365,901.42	1,547,004.62
KLX17A	6,366,848.75	1,546,862.09
KLX06	6,367,806.64	1,548,566.88
KLX18A	6,366,413.39	1,547,966.35
HLX38	6,365,868.86	1,547,146.08
HLX28	6,365,861.70	1,546,834.47
KLX07A	6,366,752.09	1,549,206.86
KLX07B	6,366,753.13	1,549,206.76
KLX12A	6,365,630.78	1,548,904.44
KLX05	6,365,633.34	1,548,909.41
HLX22	6,366,487.83	1,549,661.54
HLX23	6,366,578.00	1,548,888.67
HLX18	6,365,919.12	1,550,067.64
HLX42	6,364,827.04	1,547,446.73
HLX15	6,365,361.97	1,548,664.02
HLX26	6,365,278.71	1,548,600.52
HLX36	6,366,172.93	1,546,558.45
HLX37	6,366,183.66	1,546,406.21
KLX11A	6,366,339.72	1,546,608.49
KLX13A	6,367,547.14	1,546,787.36
HLX20	6,367,996.26	1,548,446.09

3.2 Tests performed

12 separate hydraulic interference tests were actually performed and are presented in this report. All borehole sections involved in the interference tests are listed in Table 3-3 to Table 3-16 and the times referred to in these tables are the chosen start and stop times of the flow period. The amount of data extracted from HMS, the Hydro Monitoring System, from the observation boreholes was chosen so as to receive an appropriate amount of data that would give adequate information about the pressure conditions prior to as well as during and after the performed interference test. HMS is registering pressure continuously.

The column "Test section" in Table 3-3 to Table 3-16 reports the hydraulically active section length. In most boreholes the upper part of the upper section is cased to some depth and the casing length is not included in the "Test section". The casing length of each borehole can be found in Table 3-1.

The interpreted points of application, see explanation below, and lengths of the borehole sections involved in the interference test are presented in Table 3-17 to Table 3-30. The distances between the pumping borehole and the observation borehole sections are shown in Table 3-17 to Table 3-30. This distance is calculated as the distance between the points of application in the pumping borehole and the points of application in respective observation section using the Sicada database.

During these evaluations the estimations of the points of application in the pumping borehole and in the different observation borehole sections respectively were selected as the midpoint of the section. This is true for all boreholes except for the pumping borehole KLX06 and its observation borehole HLX20, in these boreholes the point of application is an estimation of the position of the anomaly that contributed to the major part of the transmissivity in the section. Or, if several parts of the section have comparable values of transmissivity, a point of balance calculation was made to estimate the point of application.

Table 3-3. Borehole sections involved in the interference test in KLX14A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX14A	6.5–176.3	1B	Open borehole
HLX38	15.0–199.5	2	Open borehole

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-4. Borehole sections involved in the interference test in KLX21B, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX21B	11.9– 858.8	1B	Open borehole
KLX07A:1	781.0–844.7	2	Below packer
KLX07A:2	753.0–780.0	2	Between packers
KLX07A:3	612.0–752.0	2	Between packers
KLX07A:4	457.0–611.0	2	Between packers
KLX07A:5	333.0–456.0	2	Between packers
KLX07A:6	204.0–332.0	2	Between packers
KLX07A:7	104.0–203.0	2	Between packers
KLX07A:8	11.8–103.0	2	Above packer
KLX07B:1	95.0–200.0	2	Below packer
KLX07B:2	9.6–94.0	2	Above packer
HLX22	9.0–163.2	2	Open borehole
KLX12A:1	546.0–602.3	2	Below packer
KLX12A:2	535.0–545.0	2	Between packers
KLX12A:3	426.0–534.0	2	Between packers
KLX12A:4	386.0–425.0	2	Between packers
KLX12A:5	291.0–385.0	2	Between packers
KLX12A:6	160.0–290.0	2	Between packers
KLX12A:7	142.0–159.0	2	Between packers
KLX12A:8	104.0–141.0	2	Between packers
KLX12A:9	17.9–103.0	2	Above packer
KLX05:1	721.0–1,000.16	2	Below packer
KLX05:2	634.0–720.0	2	Between packers
KLX05:3	625.0–633.0	2	Between packers
KLX05:4	501.0–624.0	2	Between packers
KLX05:5	361.0–500.0	2	Between packers
KLX05:6	256.0–360.0	2	Between packers
KLX05:7	241.0–255.0	2	Between packers
KLX05:8	220.0–240.0	2	Between packers
KLX05:9	128.0–219.0	2	Between packers
KLX05:10	15.0–127.0	2	Above packer
HLX23:1	61.0–160.2	2	Below packer
HLX23:2	6.0–60.0	2	Above packer
HLX18:1	90.0–181.2	2	Below packer
HLX18:2	15.0–89.0	2	Above packer

1) 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-5. Borehole sections involved in the interference test in KLX26A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX26A	2.6–101.1	1B	Open borehole
KLX26B:1	47.0–50.4	2	Below packer
KLX26B:2	21.0–46.0	2	Between packer
KLX26B:3	2.3–20.0	2	Above packer

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-6. Borehole sections involved in the interference test in KLX26B, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX26B	2.3–50.4	1B	Open borehole
KLX26A:1	48.0–101.1	2	Below packer
KLX26A:2	22.0–47.0	2	Between packers
KLX26A:3	2.6–21.0	2	Above packer

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-7. Borehole sections involved in the interference test in KLX22A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX22A	2.0–100.5	1B	Open borehole
KLX22B	2.0–100.3	2	Open borehole

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-8. Borehole sections involved in the interference test in KLX22B, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX22A	2.0–100.45	1B	No test data due to equipment failure
KLX22B	2.0–100.25	1B	Open borehole

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-9. Borehole sections involved in the interference test in KLX23A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX23A	2.3–100.2	1B	Open borehole
KLX23B	2.3–50.3	2	Open borehole

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-10. Borehole sections involved in the interference test in KLX23B, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX23B	2.3–50.3	1B	Open borehole
KLX23A	2.3–100.2	2	Open borehole

1) 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-11. Borehole sections involved in the interference test in KLX16A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX16A	11.3–433.5	1B	Open borehole
HLX42:2	9.1–29.0	2	Above packer
KLX12A:1	546.0–602.3	2	Below packer
KLX12A:2	535.0–545.0	2	Between packers
KLX12A:3	426.0–534.0	2	Between packers
KLX12A:4	386.0–425.0	2	Between packers
KLX12A:5	291.0–385.0	2	Between packers
KLX12A:6	160.0–290.0	2	Between packers
KLX12A:7	142.0–159.0	2	Between packers
KLX12A:8	104.0–141.0	2	Between packers
KLX12A:9	17.9–103.0	2	Above packer
KLX05:1	721.0–1,000.2	2	Below packer
KLX05:2	634.0–720.0	2	Between packers
KLX05:3	625.0–633.0	2	Between packers
KLX05:4	501.0–624.0	2	Between packers
KLX05:5	361.0–500.0	2	Between packers
KLX05:6	256.0–360.0	2	Between packers
KLX05:7	241.0–255.0	2	Between packers
KLX05:8	220.0–240.0	2	Between packers
KLX05:9	128.0–219.0	2	Between packers
KLX05:10	15.0–127.0	2	Above packer
HLX15	12.0–151.9	2	Open borehole
HLX26	11.0–151.2	2	Open borehole
HLX28	6.0–154.2	2	Open borehole

1) 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-12. Borehole sections involved in the interference test in KLX15A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX15A	11.7–1,000.4	1B	Open borehole
HLX38	15.0–199.5	2	Open borehole
KLX05:1	721.0–1,000.2	2	Below packer
KLX05:2	634.0–720.0	2	Between packers
KLX05:3	625.0–633.0	2	Between packers
KLX05:4	501.0–624.0	2	Between packers
KLX05:5	361.0–500.0	2	Between packers
KLX05:6	256.0–360.0	2	Between packers
KLX05:7	241.0–255.0	2	Between packers
KLX05:8	220.0–240.0	2	Between packers
KLX05:9	128.0–219.0	2	Between packers
KLX05:10	15.0–127.0	2	Above packer
KLX19A:1	661.0–800.1	2	Below packer
KLX19A:2	518.0–660.0	2	Between packers
KLX19A:3	509.0–517.0	2	Between packers
KLX19A:4	481.5–508.0	2	Between packers
KLX19A:5	311.0–480.5	2	Between packers
KLX19A:6	291.0–310.0	2	Between packers
KLX19A:7	136.0–290.0	2	Between packers
KLX19A:8	98.8–135.0	2	Above packer

1) 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-13. Borehole sections involved in the interference test in KLX19A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX19A	98.8–800.1	1B	Open borehole
HLX37:1	149.0–199.8	2	Below packer
HLX37:2	118.0–148.0	2	Between packers
HLX37:3	12.0–117.0	2	Above packer
KLX11A	12.0–992.3	2	Open borehole
HLX36:1	50.0–199.8	2	Below packer
HLX36:2	6.0–49.0	2	Above packer
HLX38	15.0–199.5	2	Open borehole

1) 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-14. Borehole sections involved in the interference test in KLX17A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX17A	12.0–701.1	1A	Open borehole
KLX13A:1	469.0–595.5	2	Below packer
KLX13A:2	340.0–468.0	2	Between packers
KLX13A:3	11.8–339.0	2	Above packer

1) 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-15. Borehole sections involved in the interference test in KLX06, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX06	11.9–994.9	1B	Open borehole
HLX20	9.1–202.2	2	Open borehole

1) 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-16. Borehole sections involved in the interference test in KLX18A, see Figure 1-1.

Bh ID	Test section (m)	Test type[1]	Test config.
KLX18A	312.0–611.3	1C	Between packers
KLX11A:1	12.05–992.3	2	Open borehole

1) 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 3-17. Points of application and lengths of the test sections in the interference test in KLX14A.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX14A (m)
KLX14A	6.5–176.3	91.4	169.8	
HLX38	15.0–199.5	107.3	184.5	192.6

Table 3-18. Points of application and lengths of the test sections in the interference test in KLX21B.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX21B (m)
KLX21B	11.9– 858.8	435.3	846.9	
KLX07A:1	781.0–844.7	812.9	63.7	449
KLX07A:2	753.0–780.0	766.5	27.0	447
KLX07A:3	612.0–752.0	682.0	140.0	455
KLX07A:4	457.0–611.0	534.0	154.0	504
KLX07A:5	333.0–456.0	394.5	123.0	585
KLX07A:6	204.0–332.0	268.0	128.0	675
KLX07A:7	104.0–203.0	153.5	99.0	768
KLX07A:8	11.8–103.0	57.4	91.2	855
KLX07B:1	95.0–200.0	147.5	105.0	830
KLX07B:2	9.6–94.0	51.8	84.4	875
HLX22	9.0–163.2	86.1	154.2	581
KLX12A:1	546.0–602.3	574.2	56.3	896
KLX12A:2	535.0–545.0	540.0	10.0	887
KLX12A:3	426.0–534.0	480.0	108.0	874
KLX12A:4	386.0–425.0	405.5	39.0	864
KLX12A:5	291.0–385.0	338.0	94.0	859
KLX12A:6	160.0–290.0	225.0	130.0	863
KLX12A:7	142.0–159.0	150.5	17.0	874
KLX12A:8	104.0–141.0	122.5	37.0	880
KLX12A:9	17.9–103.0	60.5	85.1	900
KLX05:1	721.0–1,000.2	860.5	279.0	1,205
KLX05:2	634.0–720.0	677.0	86.0	1,086
KLX05:3	625.0–633.0	629.0	8.0	1,059
KLX05:4	501.0–624.0	562.5	123.0	1,023
KLX05:5	361.0–500.0	430.5	139.0	964
KLX05:6	256.0–360.0	308.0	104.0	926
KLX05:7	241.0–255.0	248.0	14.0	913
KLX05:8	220.0–240.0	230.0	20.0	910
KLX05:9	128.0–219.0	173.5	91.0	904
KLX05:10	15.0–127.0	71.0	112.0	904
HLX23:1	61.0–160.2	110.6	99.2	–
HLX23:2	6.0–60.0	33.0	54.0	–
HLX18:1	90.0–181.2	135.6	91.2	–
HLX18:2	15.0–89.0	52.0	74.0	–

Table 3-19. Points of application and lengths of the test sections in the interference test in KLX26A.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX26A (m)
KLX26A	2.6–101.1	49.3	98.5	
KLX26B:1	47.0–50.4	48.7	3.4	17
KLX26B:2	21.0–46.0	33.5	25.0	21
KLX26B:3	2.3–20.0	11.15	17.7	42

Table 3-20. Points of application and lengths of the test sections in the interference test in KLX26B.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX26B (m)
KLX26B	2.3–50.4	26.4	48.1	
KLX26A:1	48.0–101.1	74.6	53.1	57
KLX26A:2	22.0–47.0	34.5	25.0	19
KLX26A:3	2.6–21.0	11.8	18.4	13

Table 3-21. Points of application and lengths of the test sections in the interference test in KLX22A.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX22A (m)
KLX22A	2.0–100.45	51.2	98.5	
KLX22B	2.0–100.25	51.1	98.3	55.5

Table 3-22. Points of application and lengths of the test sections in the interference test in KLX22B.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX22B (m)
KLX22B	2.0–100.25	51.1	98.3	

Table 3-23. Points of application and lengths of the test sections in the interference test in KLX23A.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX23A (m)
KLX23A	2.3–100.2	51.25	97.9	
KLX23B	2.3–50.3	26.3	48	37

Table 3-24. Points of application and lengths of the test sections in the interference test in KLX23B.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX23B (m)
KLX23B	2.3–50.3	26.3	48	
KLX23A	2.3–100.2	51.3	97.9	37

Table 3-25. Points of application and lengths of the test sections in the interference test in KLX16A.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX16A (m)
KLX16A	11.3–433.5	216.8	433.6	
HLX42:2	9.1–29.0	19.1	19.9	187
KLX12A:1	546.0–602.3	574.2	56.3	1,604
KLX12A:2	535.0–545.0	540.0	10.0	1,599
KLX12A:3	426.0–534.0	480.0	108.0	1,593
KLX12A:4	386.0–425.0	405.5	39.0	1,588
KLX12A:5	291.0–385.0	338.0	94.0	1,587
KLX12A:6	160.0–290.0	225.0	130.0	1,593
KLX12A:7	142.0–159.0	150.5	17.0	1,600
KLX12A:8	104.0–141.0	122.5	37.0	1,603
KLX12A:9	17.9–103.0	60.5	85.1	1,614
KLX05:1	721.0–1,000.2	860.5	279.0	1,444
KLX05:2	634.0–720.0	677.0	86.0	1,457
KLX05:3	625.0–633.0	629.0	8.0	1,462
KLX05:4	501.0–624.0	562.5	123.0	1,473
KLX05:5	361.0–500.0	430.5	139.0	1,500
KLX05:6	256.0–360.0	308.0	104.0	1,531
KLX05:7	241.0–255.0	248.0	14.0	1,548
KLX05:8	220.0–240.0	230.0	20.0	1,553
KLX05:9	128.0–219.0	173.5	91.0	1,570
KLX05:10	15.0–127.0	71.0	112.0	1,606
HLX15	12.0–151.9	82.0	139.9	1,260
HLX26	11.0–151.2	80.1	142.2	1,210
HLX28	6.0–154.2	80.1	148.2	1,208

Table 3-26. Points of application and lengths of the test sections in the interference test in KLX15A.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX15A (m)
KLX15A	11.7–1,000.4	506.1	988.7	
HLX38	15.0–199.5	107.25	184.5	952
KLX05:1	721.0–1,000.2	860.5	279.0	912
KLX05:2	634.0–720.0	677.0	86.0	913
KLX05:3	625.0–633.0	629.0	8.0	926
KLX05:4	501.0–624.0	562.5	123	938
KLX05:5	361.0–500.0	430.5	139.0	974
KLX05:6	256.0–360.0	308.0	104.0	1,015
KLX05:7	241.0–255.0	248.0	14.0	1,038
KLX05:8	220.0–240.0	230.0	20.0	1,045
KLX05:9	128.0–219.0	173.5	91.0	1,067
KLX05:10	15.0–127.0	71.0	112.0	1,119
KLX19A:1	661.0–800.1	730.5	139	1,046
KLX19A:2	518.0–660.0	589	142	1,031
KLX19A:3	509.0–517.0	513	8	1,030
KLX19A:4	481.5–508.0	494.5	27	1,031
KLX19A:5	311.0–480.5	395.75	169.5	1,039
KLX19A:6	291.0–310.0	300.5	19	1,056
KLX19A:7	136.0–290.0	213	154	1,078
KLX19A:8	98.8–135.0	116.9	36.2	1,112

Table 3-27. Points of application and lengths of the test sections in the interference test in KLX19A.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX19A (m)
KLX19A	98.8–800.1	449.4	701.2	
HLX37:1	149.0–199.8	174.4	50.8	710
HLX37:2	118.0–148.0	133.0	30.0	737
HLX37:3	12.0–117.0	64.5	105.0	794
KLX11A	12.0–992.3	502.2	980.3	701
HLX36:1	50.0–199.8	124.9	149.8	728
HLX36:2	6.0–49.0	27.5	43.0	728
HLX38	15.0–199.5	107.3	184.5	425

Table 3-28. Points of application and lengths of the test sections in the interference test in KLX17A.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX17A (m)
KLX17A	12.0–701.1	356.6	689.1	
KLX13A:1	469.0–595.5	532.5	126.9	567
KLX13A:2	340.0–468.0	404.0	128.0	535
KLX13A:3	11.8–339.0	175.4	327.2	552

Table 3-29. Points of application and lengths of the test sections in the interference test in KLX06.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX06 (m)
KLX06	11.9–994.9	503.4	983.0	–
HLX20	9.0–202.2	105.6	193.2	246

Table 3-30. Points of application and lengths of the test sections in the interference test in KLX18.

Bh ID	Test section (m)	Point of application (m below TOC)	Section length (m)	Distance to KLX18 (m)
KLX18A	312.0–611.3	461.65	299.3	–
KLX11A:1	12.05–992.3	502.175	980.25	–

4 Description of equipment

4.1 Overview

For all but KLX17A and KLX18A pumping was performed in conjunction with the PFL difference flow logging for each borehole, see /8/– /17/. The equipment and methodology is the same for all of these boreholes, see e.g. /17/.

The test in KLX17A was done in conjunction with drilling through airlift pumping. Airlift pumping is described in the drilling report for KLX17A /19/.

The test in KLX18A was done in conjunction with drilling through the wireline probe system. Its methodology and equipment is described in /21/.

All the observation sections included in the interference test are part of the SKB hydro monitoring system (HMS), where pressure is recorded continuously. Description of this system and its equipment is found in /18/.

4.2 Measurement sensors

Groundwater level in the pumped borehole was measured with a pressure transducer with a range of 0–0.1 MPa and an accuracy of +/– 1% full-scale. The pumped flow from the borehole was measured manually by clocking the time to fill a container of known volume, 35L.

The boreholes connected to the HMS are fitted with stationary equipment for measuring pressure in the different sections. Some observation boreholes were installed with MiniTroll Advance, an integrated logger/absolute pressure transducer with a measurement range of 0–300 PSIA (In-Situ Inc.).

5 Execution

5.1 Preparations

Before installation of the equipment in the pumped borehole, the equipment was cleaned and dummy logging performed.

5.2 Procedure

The whole borehole was pumped for up to c. 10d with a constant drawdown of 5–10 m, depending of how permeable the aquifer was and the limited capacity of the pumps. It was occasionally and briefly interrupted to allow change of logging equipment. Upon completion of pumping a recovery of one day was allowed. The exception to this is the interference test performed in KLX17A which was done in conjunction with the drilling through airlift pumping.

During the tests the pressure interference was recorded in totally 98 sections in 29 observation boreholes, both cored and percussion drilled, using the HMS (Hydro Monitoring System). The boreholes connected to the HMS are fitted with stationary equipment for measuring pressure in the different sections. In some of the observation boreholes the stationary installations were set to log more frequently than usual.

5.3 Data handling

Data from pressure gauges was corrected with respect to atmospheric pressure and converted to hydraulic head expressed in metre above sea level with RHB70 as reference. All data and field protocols are stored in the site characterisation database (SICADA) traceable through the activity plan number.

For the observation sections, quality controlled data from the HMS were collected from the SKB database Sicada. The pressure and flow data from the pumping boreholes were collected from the HMS or DMS (Drilling monitoring system) or received from the activity leader in form of .csv, .dat or .txt files.

5.4 Transient analysis and interpretation

5.4.1 General

When performed, both qualitative and quantitative analyses have been carried out in accordance with the methodology descriptions for interference tests, SKB MD 330.003. Standard methods for constant-flow rate tests in an equivalent porous medium were used by the transient analyses and interpretation of the tests.

The main objective of the interference tests was to document how different conductive zones are connected hydraulically; to quantify their hydraulic properties and to clarify whether there are any major hydraulic boundaries in the area. Transient evaluation of all responding observation sections was performed. All responding observation sections are also included in the response analysis. In addition, the responses in the pumping boreholes were evaluated as single-hole pumping tests according to the methods described in /1/.

In the primary qualitative analyses, data from all observation sections included in each interference test were studied in linear time versus pressure diagrams to deduce the responding sections. Linear diagrams of pressure versus time are presented in Chapter 6 for each borehole included in the interference tests.

The qualitative evaluation of the dominating transient flow regimes (pseudo-linear, pseudo-radial and pseudo-spherical flow, respectively) and possible outer boundary conditions was mainly based on the drawdown and recovery responses in logarithmic diagrams. In particular, pseudo-radial flow is reflected by a constant (horizontal) derivative in the diagrams, whereas no-flow- and constant head boundaries are characterized by a rapid increase and decrease of the derivative, respectively. Based on the qualitative evaluation relevant models were selected for the quantitative transient evaluation.

In the drawdown and recovery diagrams different values on the filter coefficient (step length) by the calculation of the pressure derivative were applied to investigate the effect on the pressure derivative. It is desired to achieve maximum smoothing of the derivative without altering the original shape of the test data.

The quantitative transient analysis was performed by the test analysis software AQTESOLV v4.0 /23/ except for the KLX06 interference tests where software Saphir v4.0 /24/ was utilised. This software enables both visual and automatic type curve matching. The transient evaluation was carried out as an iterative process of type curve matching and automatic non-linear regression. The transient interpretation of the hydraulic test parameters is in most cases based on the identified pseudo-radial flow regime appearing during the tests and plotted in log-log and lin-log data diagrams.

5.4.2 Pumping boreholes

For the single-hole pumping tests the storativity was calculated using, see Equation 5-1, from SKB (2006) /2/. Firstly, the transmissivity and skin factor were obtained by type curve matching using a fixed storativity value of 10^{-6} according to the instruction SKB MD 320.004. The storativity was then re-calculated from an empirical regression relationship between storativity and transmissivity according to Equation 5-1. The type curve matching was then repeated. In most cases the change of storativity does not significantly alter the transmissivity value in the new type curve matching, but only the estimated skin factor is altered correspondingly. This described way of estimating the storativity is true for all pumping boreholes except for pumping borehole KLX06 which was evaluated based on a constant storativity.

$$S = 0.0007 \cdot T^{0.5} \qquad \text{5-1}$$

S = storativity (–)
T = transmissivity (m^2/s)

In addition to the transient analysis, an interpretation based on the assumption of stationary conditions in the pumping boreholes was performed as described by Moye (1967) /28/.

The wellbore storage coefficient (C) in the pumping borehole section can be obtained from the parameter estimation of a fictive casing radius, r(c) in an equivalent open test system according to Equation 5-2.

$$C = \frac{\pi \cdot r(c)^2}{\rho \cdot g} \qquad \text{5-2}$$

The radius of influence at a certain time during the test may be estimated from Jacob's approximation of the Theis' well function according to Equation 5-3:

$$r_i = \sqrt{\frac{2.25 \cdot T \cdot t}{S}} \qquad \text{5-3}$$

T = representative transmissivity from the test (m^2/s)
S = storativity estimated from Equation 5-1
ri = radius of influence at time t (m)
t = time after start of pumping (s)

Furthermore, a r_i-index (–1, 0 or 1) is defined to characterize the hydraulic conditions by the end of the test. The r_i-index is defined as shown below. It is assumed that a certain time interval of PRF can be identified between t_1 and t_2 during the test.

- r_i-index = 0: The transient response indicates that the size of the hydraulic feature tested is greater than the radius of influence based on the actual test time ($t_2 = t_p$), i.e. the PRF is continuing at stop of the test. This fact is reflected by a flat derivative at this time.
- r_i-index = 1: The transient response indicates that the hydraulic feature tested is connected to a hydraulic feature with lower transmissivity or an apparent barrier boundary (NFB). This fact is reflected by an increase of the derivative. The size of the hydraulic feature tested is estimated as the radius of influence based on t_2.
- r_i-index = –1: The transient response indicates that the hydraulic feature tested is connected to a hydraulic feature with higher transmissivity or an apparent constant head boundary (CHB). This fact is reflected by a decrease of the derivative. The size of the hydraulic feature tested is estimated as the radius of influence based on t_2.

If a certain time interval of PRF cannot be identified during the test, the ri-indices –1 and 1 are defined as above. In such cases the radius of influence is estimated using the flow time t_p in Equation 5-3.

5.5 Response analysis and estimation of the hydraulic diffusivity

5.5.1 Response analysis

Calculation of the response indices

In responding observation sections the response time (dt_L) and the maximum drawdown (s_p) were calculated. The response time is defined as the time lag after start of pumping until a draw-down response of 0.1 m respectively 0.01 m was observed in the actual observation section. The maximum drawdown does not always occur at stop of pumping, e.g. due to heavy precipitation by the end of the flow period. In such cases the transient analysis is based on the response prior to the precipitation. The response time dt_L is here defined as the time delay after start of pumping when a drawdown of 0.1 m was observed in the actual observation section.

The 3D distances between the point of application in the pumping borehole and all the observation borehole sections (r_s) were calculated. These parameters combined with the pumping flow rate (Q_p) are the variables used to calculate the response indices, which characterize the hydraulic connectivity between the pumping and the observed section. The parameters and the calculated hydraulic connectivity parameters are shown in the tables in Section 6 and Appendix 1. The response indices are calculated as follows:

Index 1:

r_s^2/dt_L = normalised distance r_s with respect to the response time (dp = 0.1m) [m^2/s]

Index 2:

s_p/Q_p = normalised drawdown s_p with respect to the pumping rate [s/m^2].

Additionally, a third index was calculated including drawdown and distance. This index is calculated as follows:

Index 2 new:

$(s_p/Q_p)*\ln(r_s/r_0)$ assuming r_0=1. For the pumped borehole $r_s=e^1$ (i.e. a fictive borehole radius of 2.718.

The classification based on the indices is given as follows:

Index 1 (r_s^2/dt_L)		**Colour code**
r_s^2/dt_L > 100 m²/s	Excellent	red
10 < $r_s^2/dt_L \leq$ 100 m²/s	High	yellow
1 < $r_s^2/dt_L \leq$ 10 m²/s	Medium	green
$r_s^2/dt_L \leq$ 1 m²/s	Low	blue

Index 2 (s_p/Q_p)		**Colour code**
$s_p/Q_p > 1\cdot10^5$ s/m²	Excellent	red
$3\cdot10^4 < s_p/Q_p \leq 1\cdot10^5$ s/m²	High	yellow
$1\cdot10^4 < s_p/Q_p \leq 3\cdot10^4$ s/m²	Medium	green
$s_p/Q_p \leq 1\cdot10^4$ s/m²	Low	blue
s_p < 0.1 m	No response	grey

Index 2 new (s_p/Q_p) · ln(r_s/r_0)		**Colour code**
$(s_p/Q_p)\cdot\ln(r_s/r_0) > 5\cdot10^5$ s/m²	Excellent	red
$5\cdot10^4 < (s_p/Q_p)\cdot\ln(r_s/r_0) \leq 5\cdot10^5$ s/m²	High	yellow
$5\cdot10^3 < (s_p/Q_p)\cdot\ln(r_s/r_0) \leq 5\cdot10^4$ s/m²	Medium	green
$(s_p/Q_p)\cdot\ln(r_s/r_0) \leq 5\cdot10^3$ s/m²	Low	blue
s_p < 0.1 m	No response	grey

In some cases it is not clear if the section responds to the pumping or if the drawdown is based on natural processes solely. In uncertain cases, the data sets were regarded all together to better differentiate between these effects. By looking at the pressure responses before and after the pumping period, it may be possible to distinguish between natural fluctuations and those induced by pumping. Furthermore, it should be pointed out, that some of the responses could be caused by the drawdown in the section above or below in the same observation borehole.

All observation data are influenced by natural fluctuations of the groundwater level such as tidal effects and long term trends. The pressure changes due to tidal effects are different for the observation boreholes.

5.5.2 Estimation of hydraulic diffusivity

The distances r_s between different borehole sections have been calculated as the spherical distance using the co-ordinates for the midpoint of each section. The calculation of the hydraulic diffusivity is based on radial flow according to /6/.

$$T / S = r_s^2 / [4 \cdot dt_L \cdot (1 + dt_L / tp) \cdot \ln(1 + tp / dt_L)] \qquad 5\text{-}4$$

The time lag dt_L is here defined as the time when the pressure response in an observation section is 0.01 m. The pumping time is included as tp. The estimates of the hydraulic diffusivity according to above should be seen as approximate values of the hydraulic diffusivity.

5.6 Nonconformities

16 of the observation boreholes originally intended to be included in the interference test did for various reasons not provide any pressure data and were therefore excluded from the interference test. These boreholes are:

- Observation borehole HLX28 and HLX32 during the pumping in KLX14A. No data were sampled in these boreholes during the test period since SKB terminated the sampling prior to the test.
- Observation borehole HLX16, HLX17 and HLX33 during the pumping in KLX21B. No data were sampled in these boreholes during the test period since SKB terminated the sampling prior to the test.
- Observation borehole KLX22A during the pumping in KLX22B. No data were sampled in this borehole during the test period since the data logger in KLX22A failed during pumping in borehole KLX22B.
- Observation borehole HLX28 during the pumping in HLX27. No data were sampled in this borehole during the test period.
- Observation borehole HLX27 during the pumping in HLX28. No data were sampled in this borehole during the test period since the logger was full.
- Observation borehole HLX27 and Section 1 in observation borehole HLX42 during the pumping in KLX16A. No data were sampled in these sections during the test period since the logger in HLX27 was full and the logger in Section 1 of HLX42 had a breakdown.
- Observation borehole HLX28, KLX14A and KLX16A during the pumping in KLX15A. No data were sampled in these boreholes during the test period. KLX16A provided some pressure data but was also vey disturbed by the pumping in HLX42.
- Observation borehole KLX14A and KLX20A during the pumping in KLX19A. No data were sampled in this borehole during the test period.
- Observation borehole HLX43 during the pumping in KLX17A. No data were sampled in this borehole during the test period.

6 Results

6.1 General comments and assumptions

It is assumed that the flow rate is constant between two adjoining flow rate values. It is also assumed that the start and stop of pumping is defined as the time of the first and last flow value, respectively in the flow rate data file. The drawdown data files in all the observation sections are terminated at stop of pumping although the drawdown continued in some sections.

All pressure data for observation boreholes presented in this report have been corrected for atmospheric pressure changes by subtraction from the measured (absolute) pressure. The pressure in several of the observation sections included in the interference test was displaying an oscillating behaviour. This is naturally caused by so called tidal fluctuations or earth tides in combination with changes of the sea water level. These phenomena have, to some extent, been investigated previously in /3/. It should be observed that no further corrections of the measured drawdown have been made, e.g. due to natural trends, precipitation or tidal effects.

In the transient evaluation of the responses in the pumping borehole and selected observation sections, the models described in /4/, /5/ and /7/ respectively was used. The transient evaluation of the tests were analysed as variable flow rate tests. The nomenclature and symbols used for the results of the single-hole and interference test are according to the Instruction for analysis of single-hole injection- and pumping tests (SKB MD 320.004) and the methodology description for interference tests (SKB MD 330.003), respectively (both are SKB internal controlling documents). Additional symbols used are explained in the text.

The linear plots of the pumping and observation sections are presented in this chapter The measured drawdown (s_p) at the end of the flow periods and the estimated response time lags (dt_L) in responding observation sections are shown in Tables 6-53 and 6-54, respectively. Test summary sheets of all responding observation boreholes are presented in Appendix 1. Transient, quantitative interpretation of the drawdown and recovery period is shown in log-log and lin-log diagram in Appendix 2. The results are also summarized in Table 6-58. The locations of all boreholes are shown in Figure 1-1. Abbreviations of flow regimes and hydraulic boundaries that may appear in the text are listed below.

WBS = Wellbore storage
PRF = Pseudo-radial Flow regime
PLF = Pseudo-linear flow regime
PSF = Pseudo-spherical flow regime
PSS = Pseudo-stationary flow regime
NFB = No-flow boundary
CHB = Constant –head boundary

6.2 Interference test in KLX14A

The test was performed with only one observation borehole as shown in Figure 6-1. The objective was to test and characterise deformation zone NS059A.

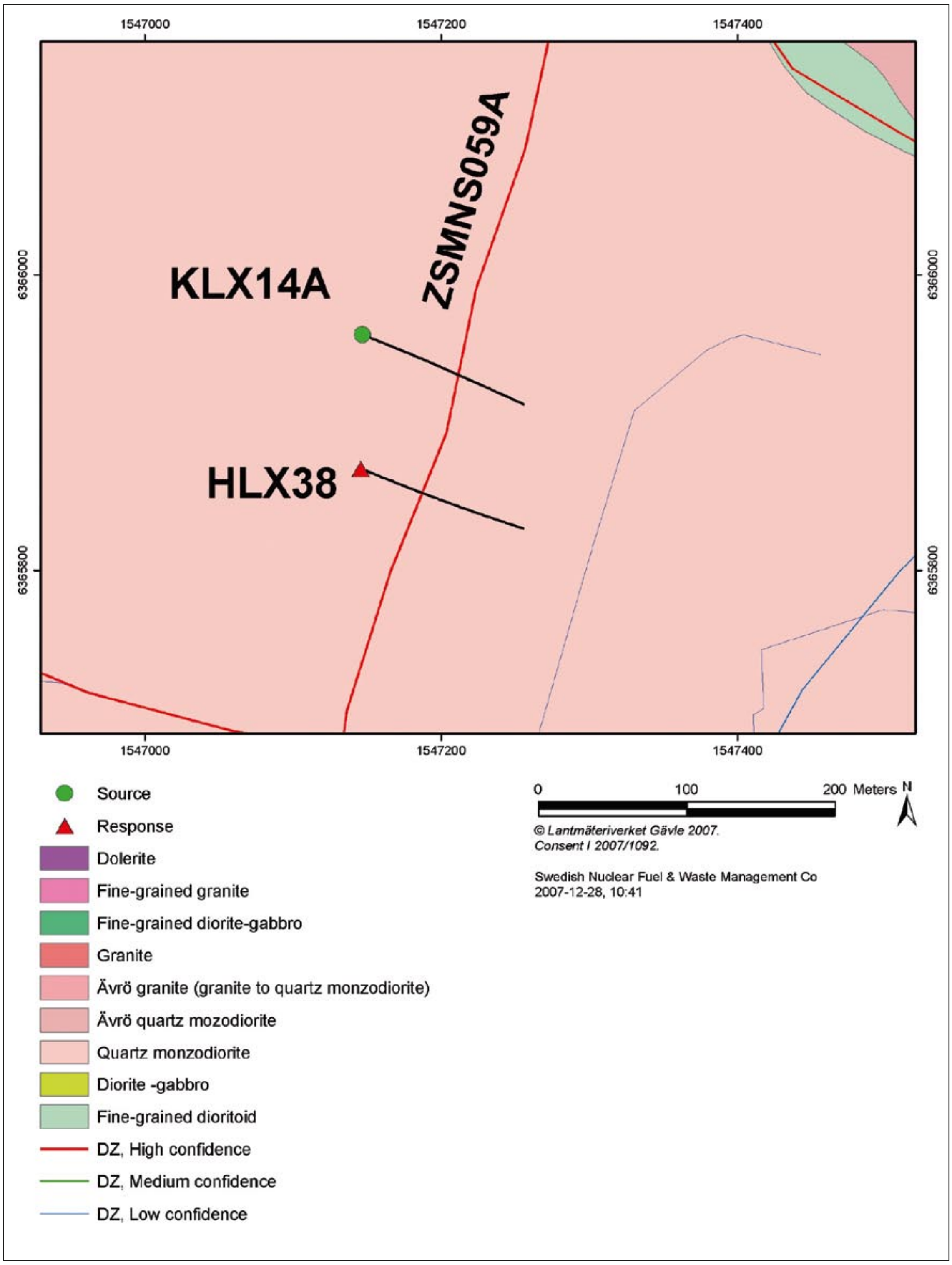

Figure 6-1. *Location of pumped borehole KLX14A and observation hole HLX38.*

6.2.1 Pumping borehole KLX14A

General test data for the pumping test in KLX14A are presented in Table 6-1. The borehole is cased to 6.5 m. The uncased interval of the borehole is thus c. 6.5–176.3 m.

Table 6-1. General test data for the pumping test in KLX14A: 6.5–176.3 m.

General test data			
Pumping borehole	KLX14A		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	176.3
Casing length	L_c	m	6.5
Test section- secup	Secup	m	6.5
Test section- seclow	Seclow	m	176.3
Test section length	L_w	m	169.8
Test section diameter[2)]	$2{\cdot}r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	061116 12:29
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	061116 12:29:02
Stop of flow period		yymmdd hh:mm:ss	061119 09:49:01
Test stop (stop of flow period)		yymmdd hh:mm	061119 09:49
Total flow time	t_p	min	4,160
Total recovery time	t_F	min	1,295
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	58.4
Relative pressure in test section before stop of flow period	p_p	kPa	8.2
Relative pressure in test section at stop of recovery period	p_F	kPa	55.6
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	50.2
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.000523
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.000523
Total volume discharged during flow period	V_p	m^3	131

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

Comments on the test

The test was performed as a constant drawdown pumping test with slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 31 L/min and the duration of the flow period was c. 3 days. About 24 hours into the flow period the pumping is being interrupted and the evaluation is made on the first part of the curve. A total drawdown during the flow period of 5.12 m and a total recovery at the end of the recovery period of 4.83 m was observed. Several flow rate changes occurred during the flow period. Only a few flow rate data are available. Pressure data are lacking between c. 1,800–3,000 min during the flow period (cf. Figure 6-2).

Flow regime and calculated parameters

After initial WBS during the first c. 1 min of the flow period a period of approximate PRF was developed between c. 2–30 min. At c. 30 min the flow rate was increased c. 3 times. A second PRF developed between c. 50–600 min. A nearly pseudo-stationary pressure (PSS) was achieved after c. 1,400 min. After initial WBS during the first c. 1 min a first PRF is developed between c. 1–30 min of equivalent time during the recovery period. A second PRF is indicated between c. 100–1,000 min. Alternatively, an apparent no-flow boundary (NFB) may be assumed after c. 30 min.

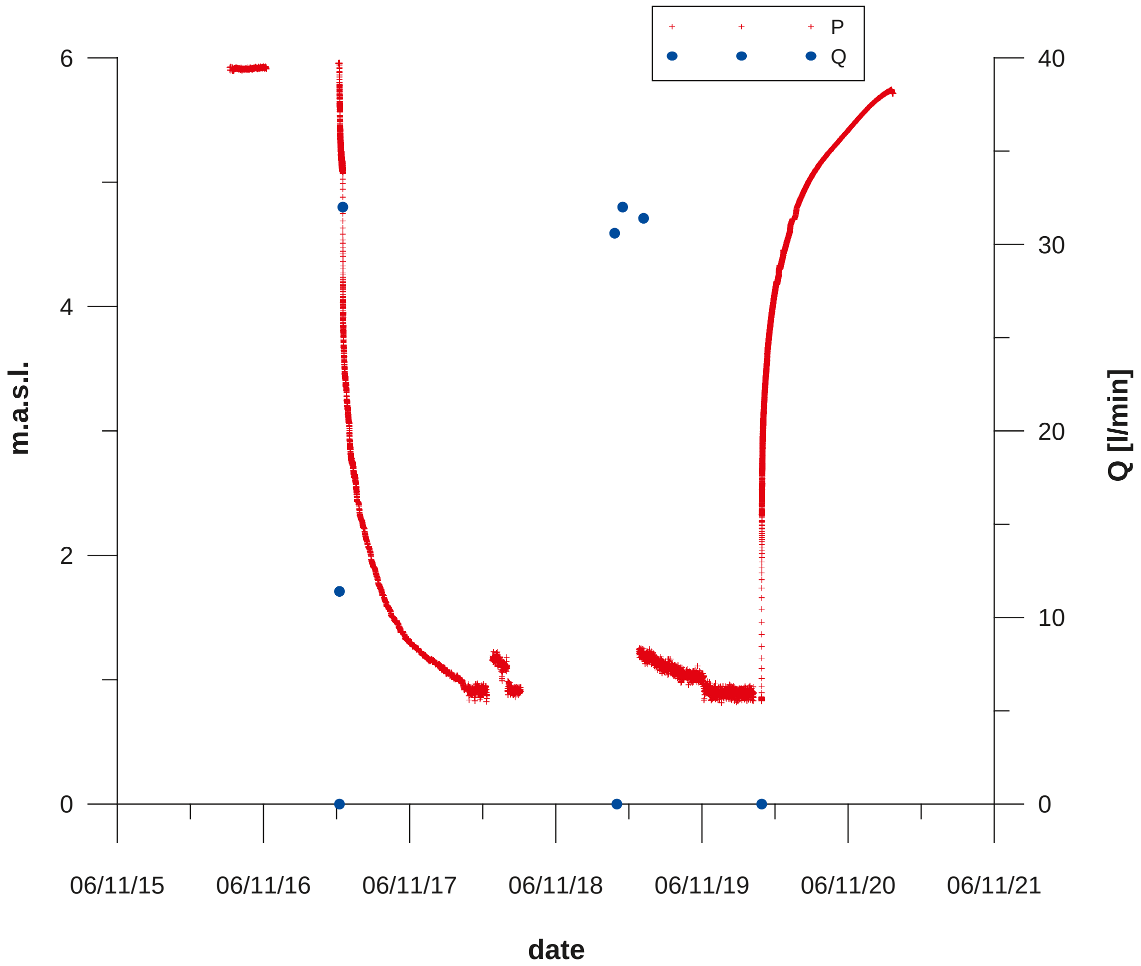

***Figure 6-2.** Linear plot of flow rate and pressure versus time in the pumping borehole KLX14A.*

Selected representative parameters

The representative parameters were selected from the flow period. Evaluation was performed by applying the Moench (Case 1) solution to a leaky aquifer model. Selected representative transmissivity value is $5.5 \cdot 10^{-5}$ m²/s for an estimated storativity of $5.2 \cdot 10^{-6}$.

6.2.2 Observation borehole HLX38

In Figure 6-3 an overview of the pressure response in observation borehole HLX38 is shown. General test data from the observation section HLX38, 15.0–199.5 m, are presented in Table 6-2. The borehole is cased to 15.0 m. The uncased interval of this section is thus c. 15.0–199.5 m.

Comments on the test

The disturbance of the flow rate from the pumping section can clearly be seen as a distinct response in the pressure data in the observation section. A total drawdown during the flow period of 1.90 m was observed but the evaluation is based on a drawdown of 1.8 m since the

Table 6-2. General test data from the observation section HLX38: 15.0–199.5 m during the interference test in KLX14A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	5.56
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	3.66
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	5.69
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	1.8

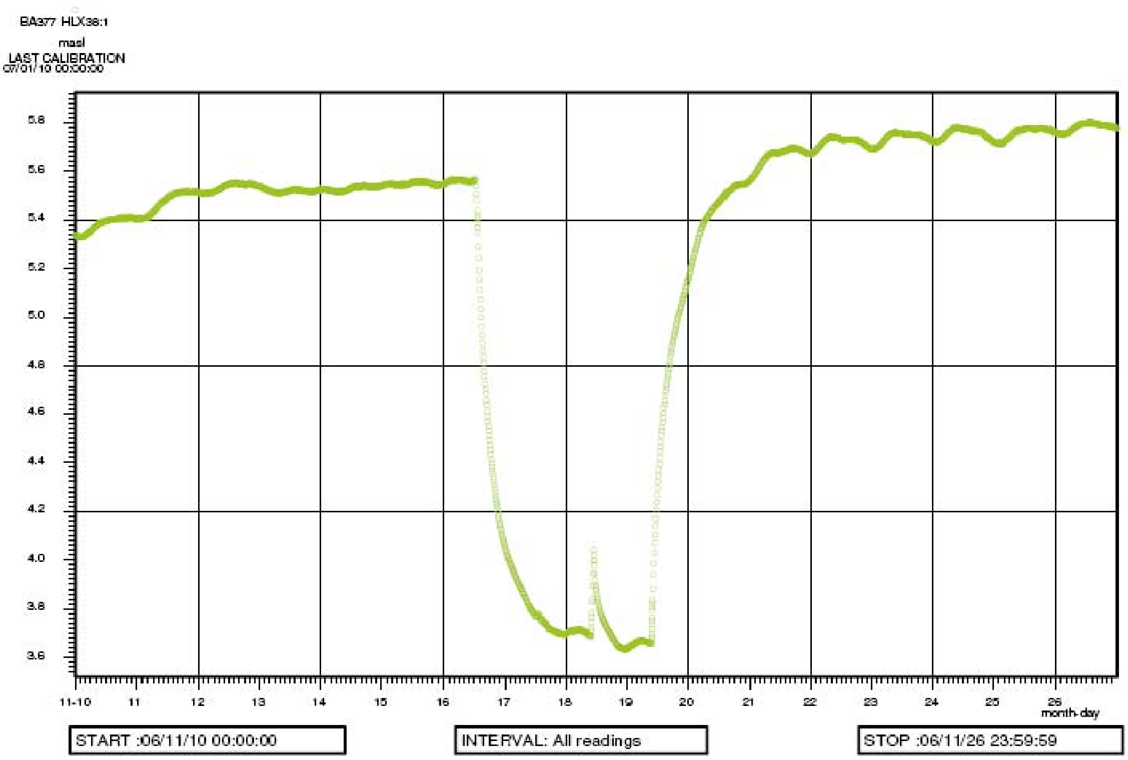

Figure 6-3. Linear plot of pressure versus time in the observation borehole HLX38 during pumping in borehole KLX14A.

head is disturbed after the time of that drawdown. At the end of the recovery period the total recovery exceeded the total drawdown due to influences of external effects. Total recovery at the end of the recovery period was 2.03 m. The calculated Index 1 (r_s^2/t_L) is rated as “high”, Index 2 (s_p/Q_p) as “medium” and the new Index 2 ($s_p/Q_p)\cdot\ln(r_s/r_0)$ as “medium”.

Flow regime and calculated parameters

The flow period is dominated by PRF during c. 200–600 min, transitioning to PSF by the end. The recovery period also shows PRF during c. 200–600 min, transitioning to PSF by the end. The responses during the flow and recovery period respectively are consistent. Initial WBS is indicated during both periods in this long section.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $6.7\cdot10^{-5}$ m^2/s and representative storativity of $1.3\cdot10^{-5}$.

6.3 Interference test in KLX15A

The objective with this interference test was to test and characterise deformation zone NW042A. A borehole response map is shown in Figure 6-4.

6.3.1 Pumping borehole KLX15A

General test data for the pumping test in KLX15A are presented in Table 6-3. The borehole is cased to 11.7 m. The uncased interval of this section is thus c. 11.7–1,000.4 m.

Comments on the test

The test was performed as a constant drawdown pumping test with slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 29.4 L/min and the duration of the flow period was c. 9 days. A total drawdown during the flow period of 7.07 m and a total recovery at the end of the recovery period of 5.34 m was observed.

Flow regime and calculated parameters

During both the flow and recovery period, wellbore storage effects are followed by dominating pseudo-radial flow. By the end of the flow period an almost pseudo-steady state occurred. During the recovery period an approximate pseudo-radial flow regime was indicated. The test was evaluated as a variable flow rate test. The agreement in evaluated parameter values between the flow and recovery period is good.

Selected representative parameters

The parameter values from the flow period are selected as the most representative. Evaluation of the flow period was performed by applying the Moench (Case 1) solution to a leaky aquifer model. Selected representative transmissivity value is $4.1\cdot10^{-5}$ m^2/s for an estimated storativity of $4.5\cdot10^{-6}$.

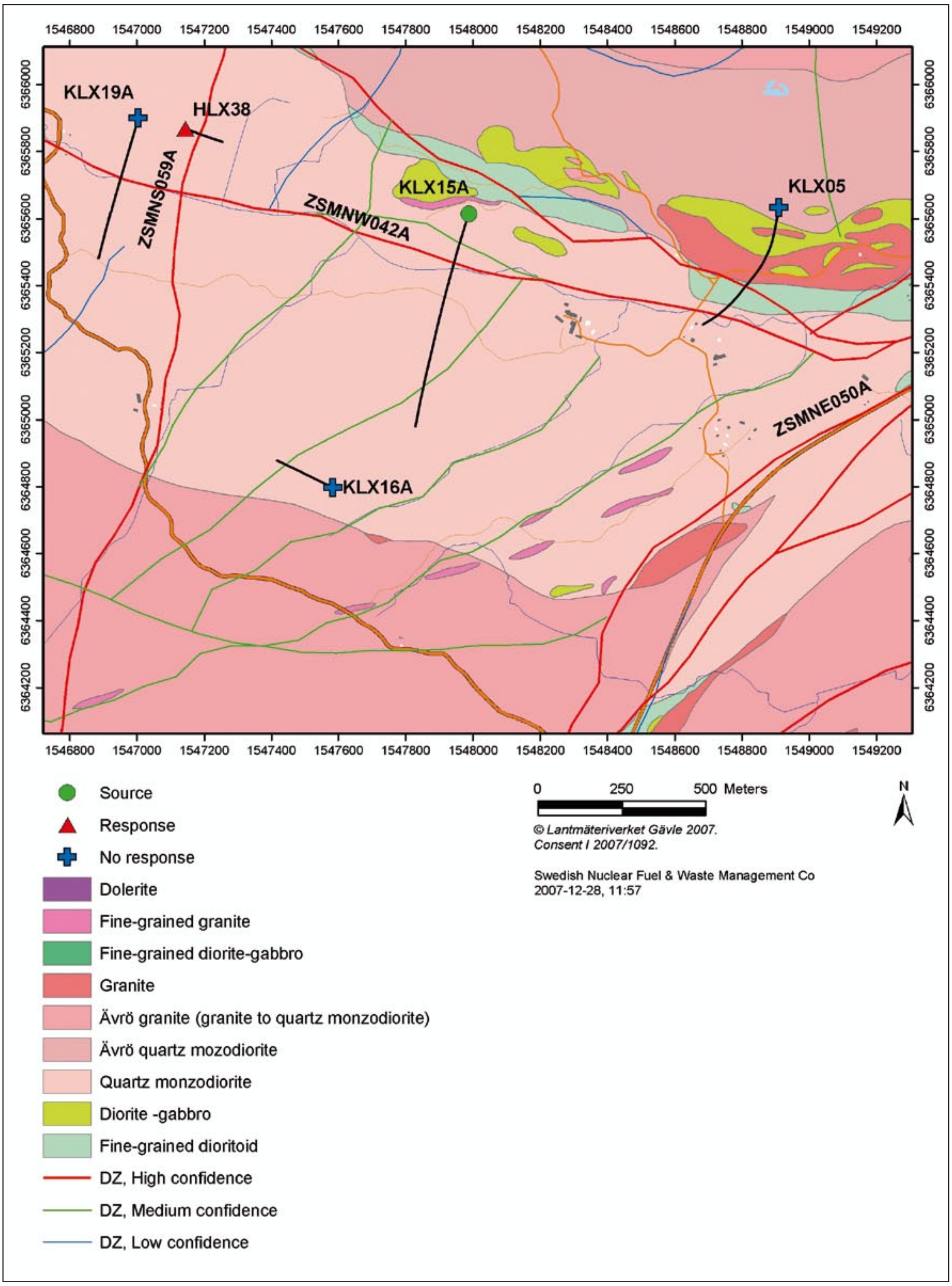

Figure 6-4. *Borehole response map when pumping KLX15A.*

Table 6-3. General test data for the pumping test in KLX15A: 11.7–1,000.4 m.

General test data			
Pumping borehole	KLX15A		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	1,000.4
Casing length	L_c	m	11.7
Test section- secup	Secup	m	11.7
Test section- seclow	Seclow	m	1,000.4
Test section length	L_w	m	988.7
Test section diameter[2)]	$2 \cdot r_w$	mm	76–198
Test start (start of flow period)		yymmdd hh:mm	070508 16:47
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	070508 16:47:00
Stop of flow period		yymmdd hh:mm:ss	070517 18:41:00
Test stop (stop of flow period)		yymmdd hh:mm	070517 18:41
Total flow time	t_p	min	13,074
Total recovery time	t_F	min	907
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	66.2
Relative pressure in test section before stop of flow period	p_p	kPa	–3.0
Relative pressure in test section at stop of recovery period	p_F	kPa	49.4
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	69.2
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.00049
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.00049
Total volume discharged during flow period	V_p	m^3	388

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

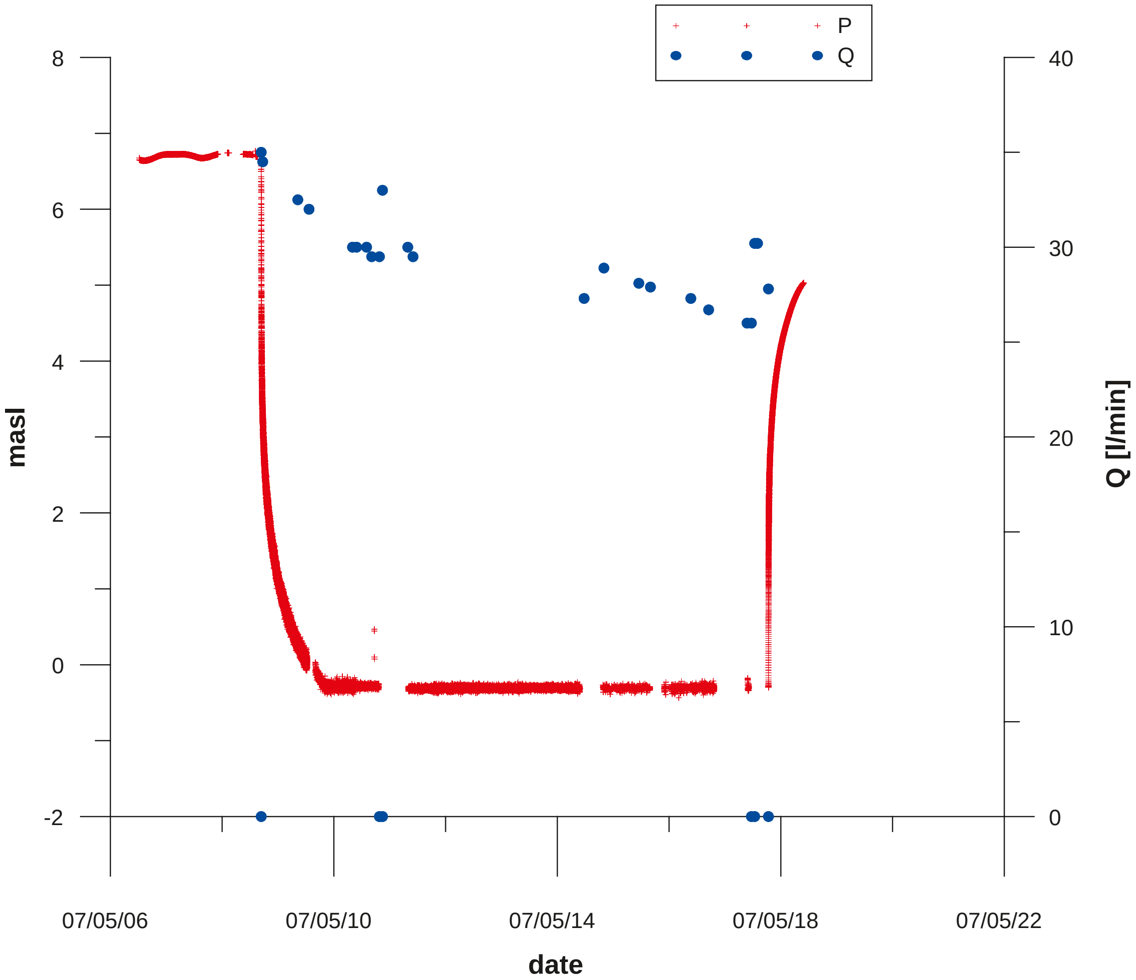

Figure 6-5. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX15A.*

6.3.2 Observation borehole HLX38

In Figure 6-6 an overview of the pressure responses in observation borehole HLX38 is shown. General test data from the observation section HLX38: 15.0–199.5 m, are presented in Table 6-4. The borehole is cased to 15.0 m. The uncased interval of this section is thus c. 15.0–199.5 m.

Table 6-4. General test data from the observation section HLX38: 15.0–199.5 m during the interference test in KLX15A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	5.7
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	5.6
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	5.7
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.1

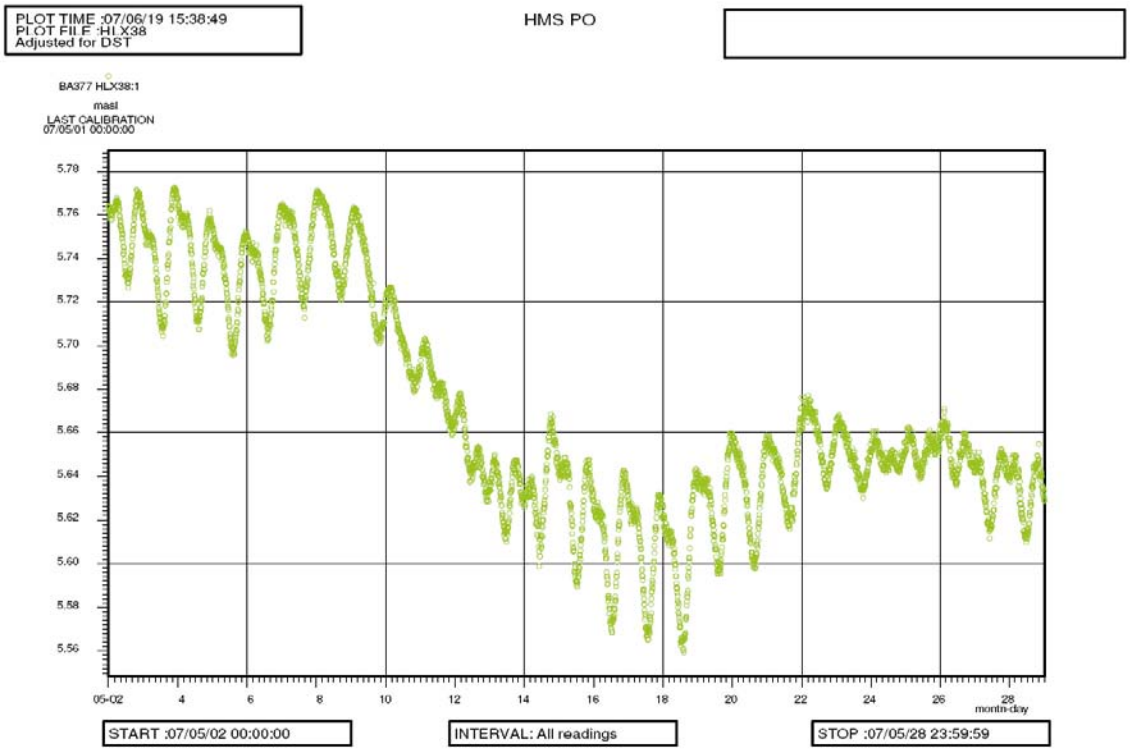

Figure 6-6. *Linear plot of pressure versus time in the observation borehole HLX38 during pumping in borehole KLX15A.*

Comments on the test

Only a very small response is deduced during the flow period in this section. The response during the recovery period is regarded as very uncertain and affected by tidal effects. A total drawdown during the flow period of c. 0.1 m and a total recovery at the end of the recovery period of less than 0.1 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 ($s_p/Q_p)\cdot\ln(r_s/r_0$) as "low".

Flow regime and calculated parameters

The transient evaluations during both the flow and recovery period are considered as very uncertain due to the weak response in combination with external effects.

Selected representative parameters

The parameter values estimated from the flow period are selected as the most representative. Evaluation was performed by applying the Theis solution to a confined aquifer model. Selected representative transmissivity value is $7.7\cdot10^{-5}$ m^2/s and a representative storativity of $1.9\cdot10^{-4}$.

6.3.3 Observation borehole KLX05A

All the ten sections in this borehole appear to be virtually unaffected by the pumping in KLX15A, Figure 6-7. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping. The borehole is cased to 15.0 m, the uncased interval of the borehole is thus c. 15.0–1,000.2 m.

6.3.4 Observation borehole KLX19A

All the eight sections in this borehole appear to be virtually unaffected by the pumping in KLX15A, Figure 6-8. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping. The borehole is cased to 98.75 m, the uncased interval of the borehole is thus c. 98.75–800.0 m.

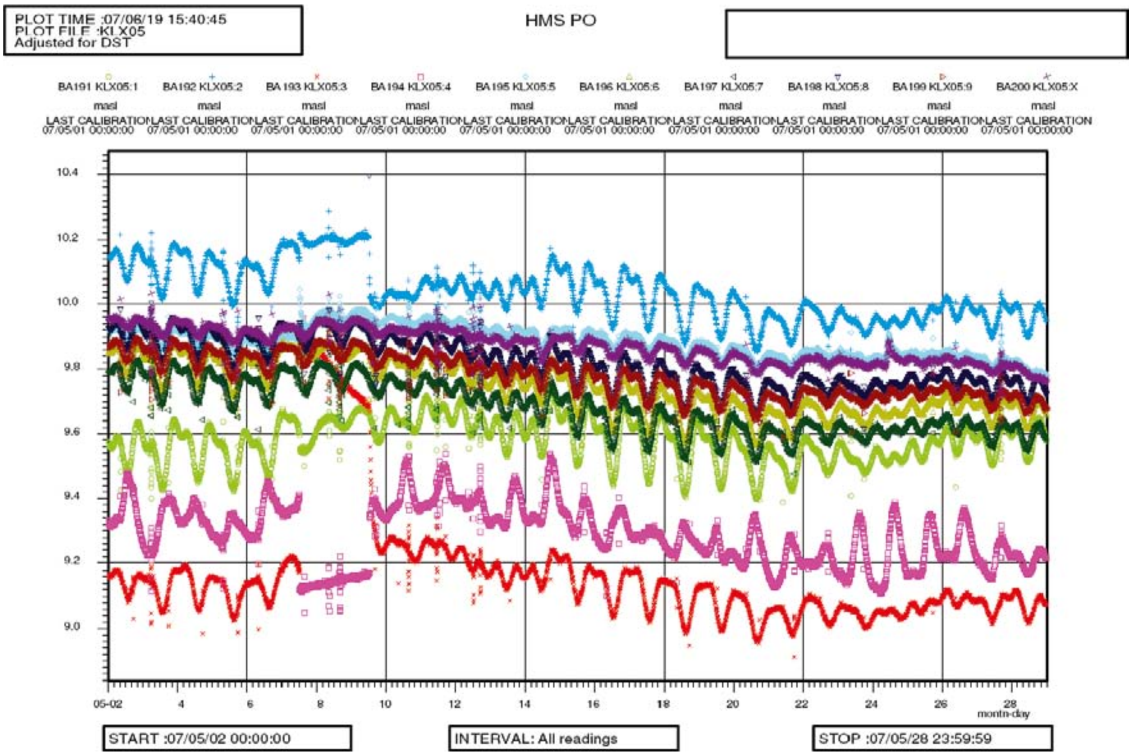

Figure 6-7. *Linear plot of ground water level in the observation borehole KLX05 during pumping in borehole KLX15A. The figure shows that the levels in KLX05 seems to be unaffected by the pumping in KLX15A, performed 2007-05-08–2007-05-17.*

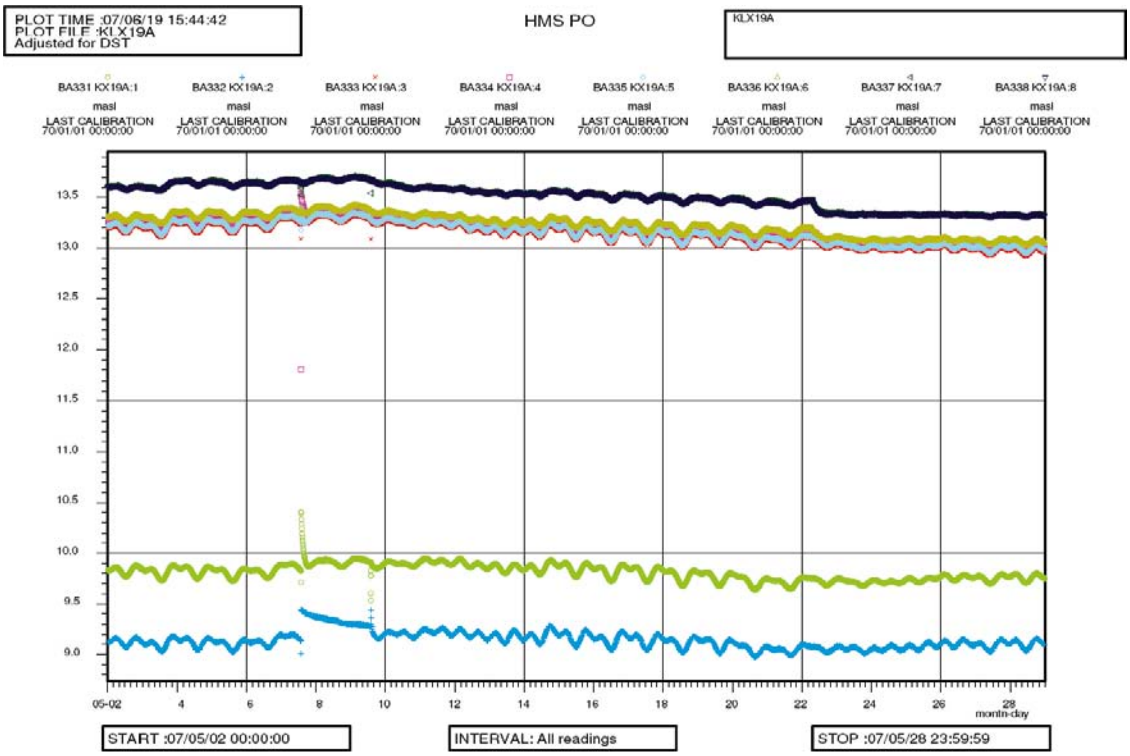

Figure 6-8. *Linear plot of ground water level in the observation borehole KLX19A during pumping in borehole KLX15A. The figure shows that the levels in KLX19A seems to be unaffected by the pumping in KLX15A, performed 2007-05-08–2007-05-17.*

6.4 Interference test in KLX16A

The objective with this interference test was to assess the contact between the KLX16A and HLX42. The Former if drilled through a north east trending deformation zone, NE107A and the latter is sited in a zone free rock unit. A borehole response map is shown in Figure 6-9.

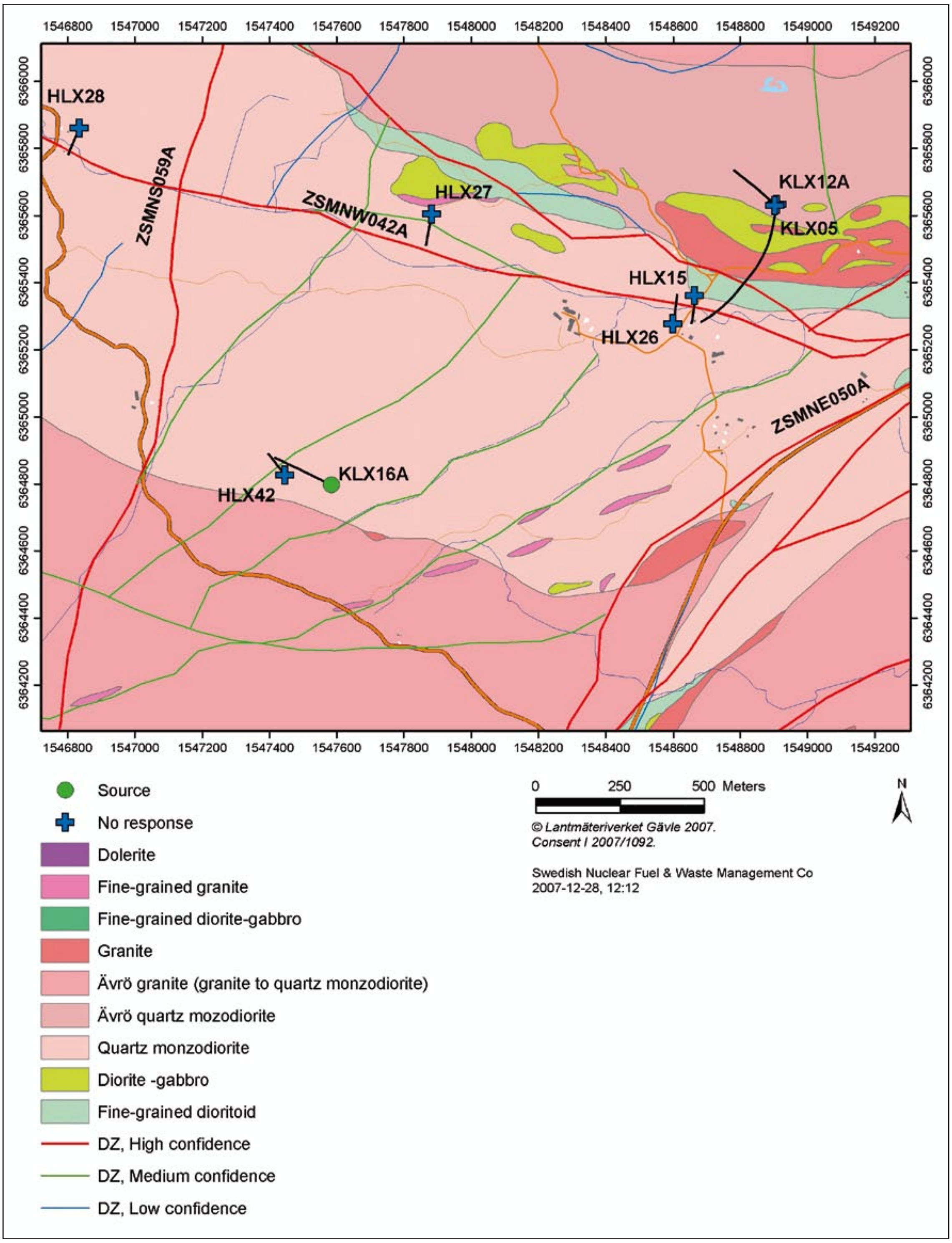

Figure 6-9. *Borehole response map when pumping KLX16A.*

6.4.1 Pumping borehole KLX16A

General test data for the pumping test in KLX16A are presented in Table 6-5. The borehole is cased to 11.3 m. The uncased interval of this section is thus c. 11.3–433.5 m.

Table 6-5. General test data for the pumping test in KLX16A: 11.3–433.5 m.

General test data			
Pumping borehole	KLX16A		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	433.5
Casing length	L_c	m	11.3
Test section- secup	Secup	m	11.3
Test section- seclow	Seclow	m	433.5
Test section length	L_w	m	422.2
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	070224 15:20
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	070224 15:20:00
Stop of flow period		yymmdd hh:mm:ss	070302 11:53:00
Test stop (stop of flow period)		yymmdd hh:mm	070302 11:53
Total flow time	t_p	min	8,433
Total recovery time	t_F	min	1,515
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	84.2
Relative pressure in test section before stop of flow period	p_p	kPa	35.5
Relative pressure in test section at stop of recovery period	p_F	kPa	75.1
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	48.7
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.000468
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.000468
Total volume discharged during flow period	V_p	m^3	237

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

Comments on the test

The test was performed as a constant drawdown pumping test with a slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 28.1 L/min and the duration of the flow period was c. 6 days. Several changes of flow rate occurred during the flow period. A total drawdown during the flow period of 4.96 m and a total recovery at the end of the recovery period of 4.04 m was observed.

Flow regime and calculated parameters

After initial WBS during the first c. 0.5 min a period of approximate PRF was developed between c. 5–300 min. A nearly pseudo-stationary pressure (PSS) was achieved after c. 1,400 min. After initial WBS during the first c. 0.5 min a first PRF is developed between c. 10–80 min of equivalent time during the recovery period. A second PRF is weakly indicated between c. 500–1,100 min. Alternatively, an apparent no-flow boundary (NFB) may be assumed after c. 100 min.

Selected representative parameters

The representative parameters were selected from the flow period. Evaluation of the flow period was performed by applying the Moench (Case 1) solution to a leaky aquifer model. Selected representative transmissivity value is $4.3 \cdot 10^{-5}$ m²/s for an estimated storativity of $4.6 \cdot 10^{-6}$.

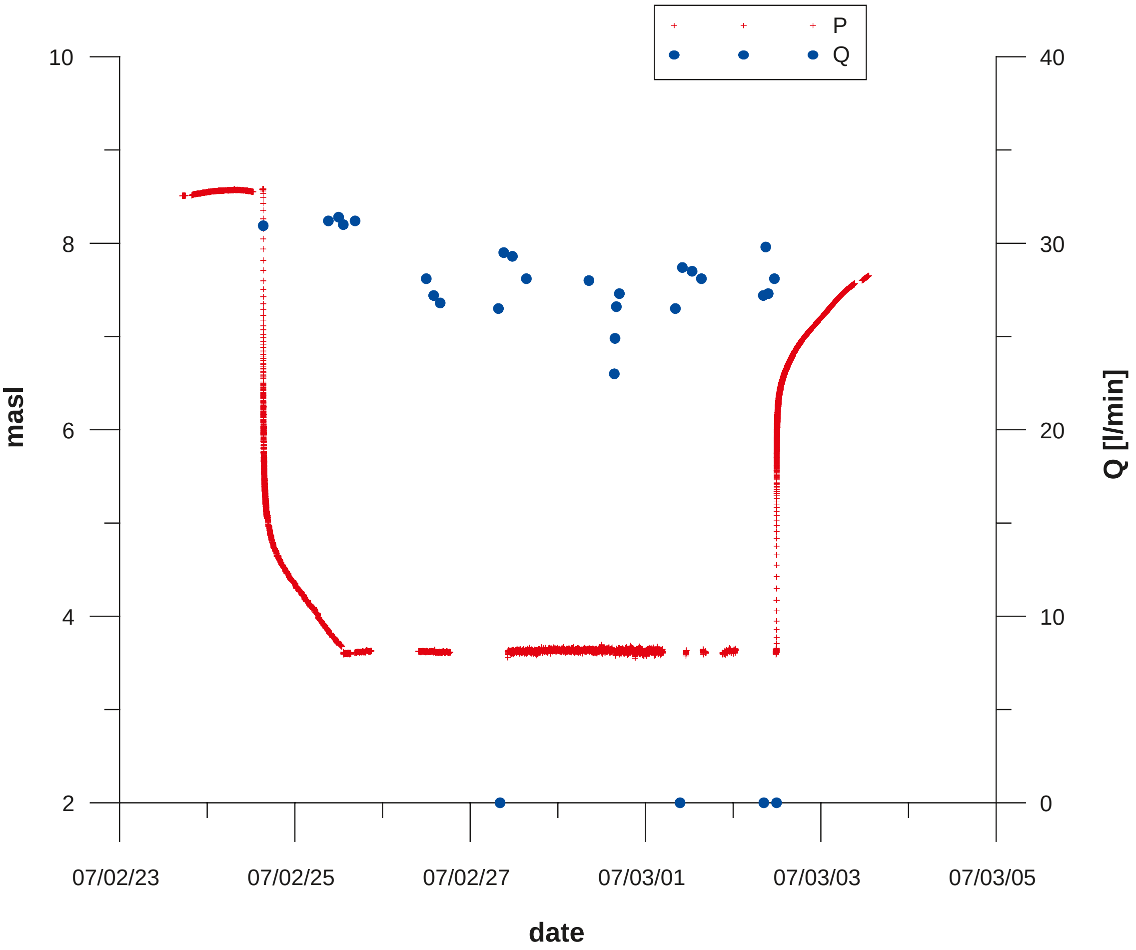

Figure 6-10. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX16A.*

6.4.2 Observation borehole HLX42

Section 2 in the observation borehole HLX42 appear to be virtually unaffected by the pumping in KLX16A, Figure 6-11 (no data available from Section 1). The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping. The borehole is cased to 9.1 m, the uncased interval of the upper section of this borehole is thus c. 9.1–29.0 m. No data was available from Section 1.

6.4.3 Observation borehole KLX12A

All the nine sections of this borehole appear to be virtually unaffected by the pumping in KLX16A, Figure 6-12. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping.

6.4.4 Observation borehole KLX05

All the ten sections in this borehole appear to be virtually unaffected by the pumping in KLX16A, Figure 6-13. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping.

6.4.5 Observation borehole HLX15

This borehole appears to be virtually unaffected by the pumping in KLX16A, Figure 6-14. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping. The borehole is cased to 12.0 m, the uncased interval of this borehole is thus c. 12.0–151.9 m.

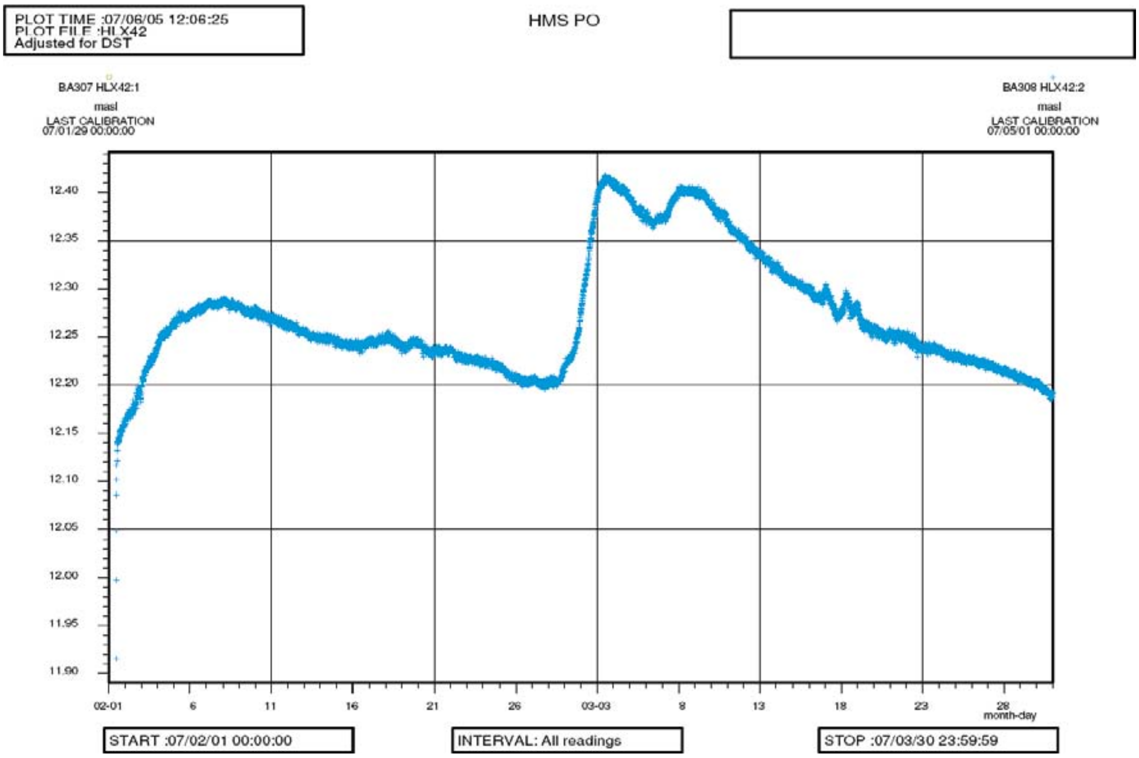

Figure 6-11. *Linear plot of ground water level in Section 1 in the observation borehole HLX42 during pumping in borehole KLX16A. The figure shows that the level variations in HLX42 seems to be unaffected by the pumping in KLX16A, performed 2007-02-24–2007-03-02.*

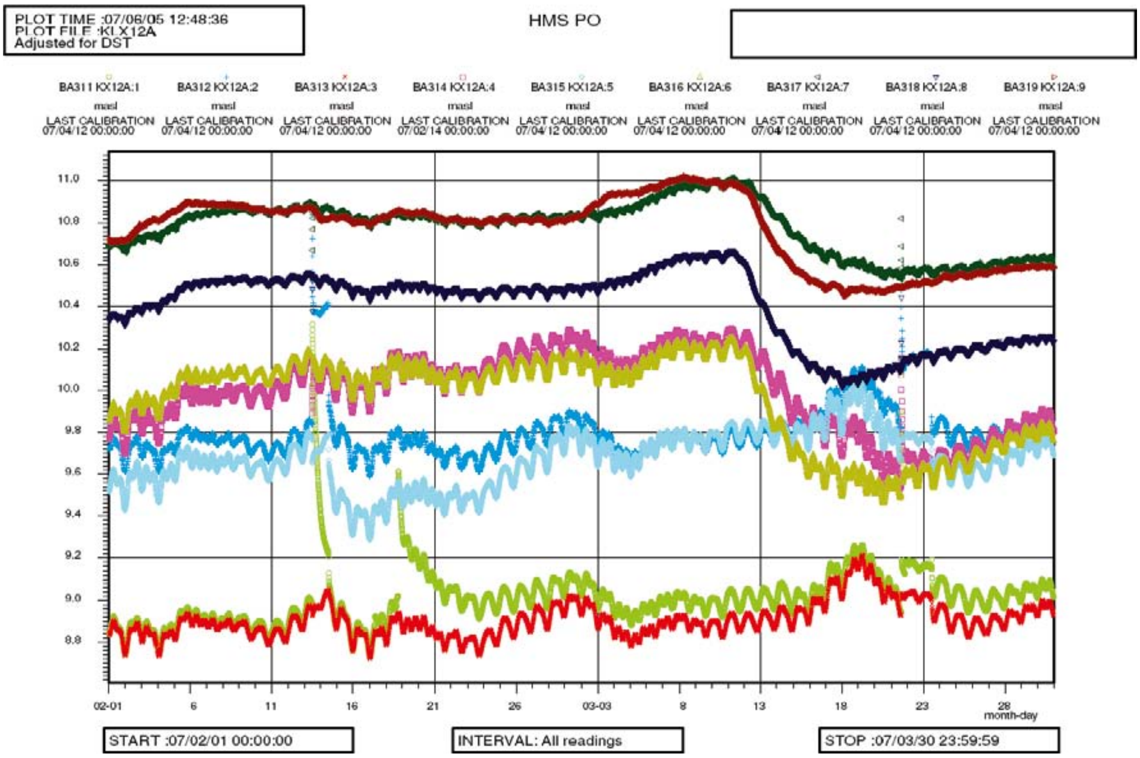

Figure 6-12. *Linear plot of ground water level in the observation borehole KLX12 during pumping in borehole KLX16A. The figure shows that the level variations in KLX12 are part of a pressure trend which seems to be unaffected by the pumping in KLX16A, performed 2007-02-24–2007-03-02.*

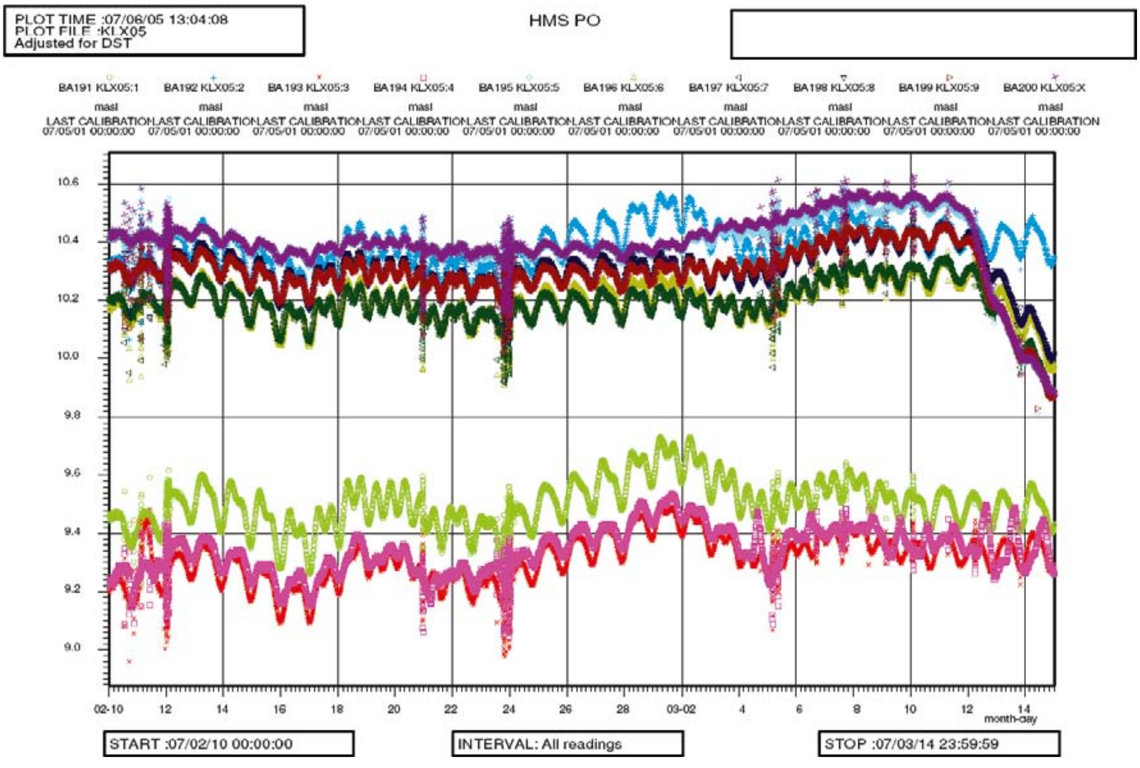

Figure 6-13. *Linear plot of ground water level in the observation borehole KLX05 during pumping in borehole KLX16A. The figure shows that the level variations in KLX05 are part of a pressure trend which seems to be unaffected by the pumping in KLX16A, performed 2007-02-24–2007-03-02.*

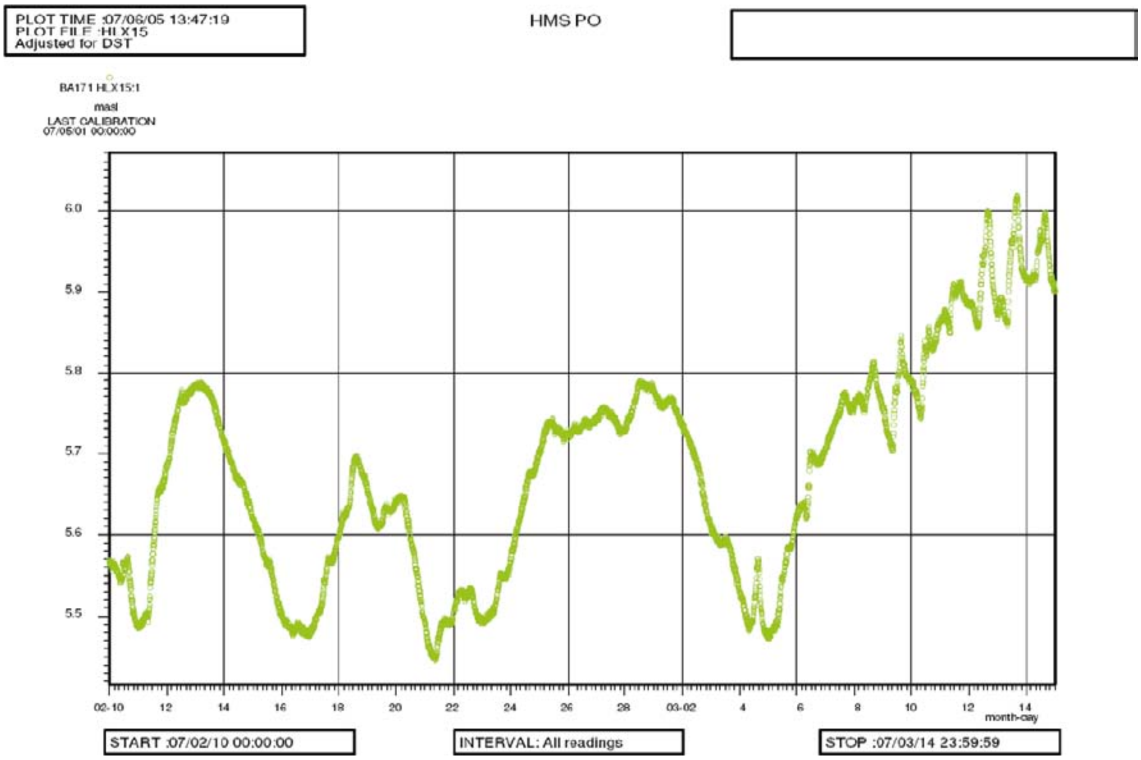

Figure 6-14. *Linear plot of ground water level in the observation borehole HLX15 during pumping in borehole KLX16A. The figure shows that the level variations in HLX15 are part of a pressure trend which seems to be unaffected by the pumping in KLX16A, performed 2007-02-24–2007-03-02.*

6.4.6 Observation borehole HLX26:1

This borehole appears to be virtually unaffected by the pumping in KLX16A, Figure 6-15. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping. The borehole is cased to 9.0 m, the uncased interval of this borehole is thus c. 9.0–151.2 m. Observation borehole HLX26 had two sections separated by a packer at 10.0–11.0 m. Only the lower section, HLX26:1 (11.0–151.2 m) was monitored by HMS and included in interference test.

6.4.7 Observation section HLX28

This borehole appears to be virtually unaffected by the pumping in KLX16A, Figure 6-16. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping. The borehole is cased to 6.0 m, the uncased interval of this borehole is thus c. 6.0–154.2 m.

6.5 Interference test in KLX17A

This test was specifically designed to test the connectivity between a fracture at c. 435 m in KLX17A and borehole KLX13A. It was performed in conjunction with the drilling where airlift pumping was utilised. A borehole response map is shown in Figure 6-17.

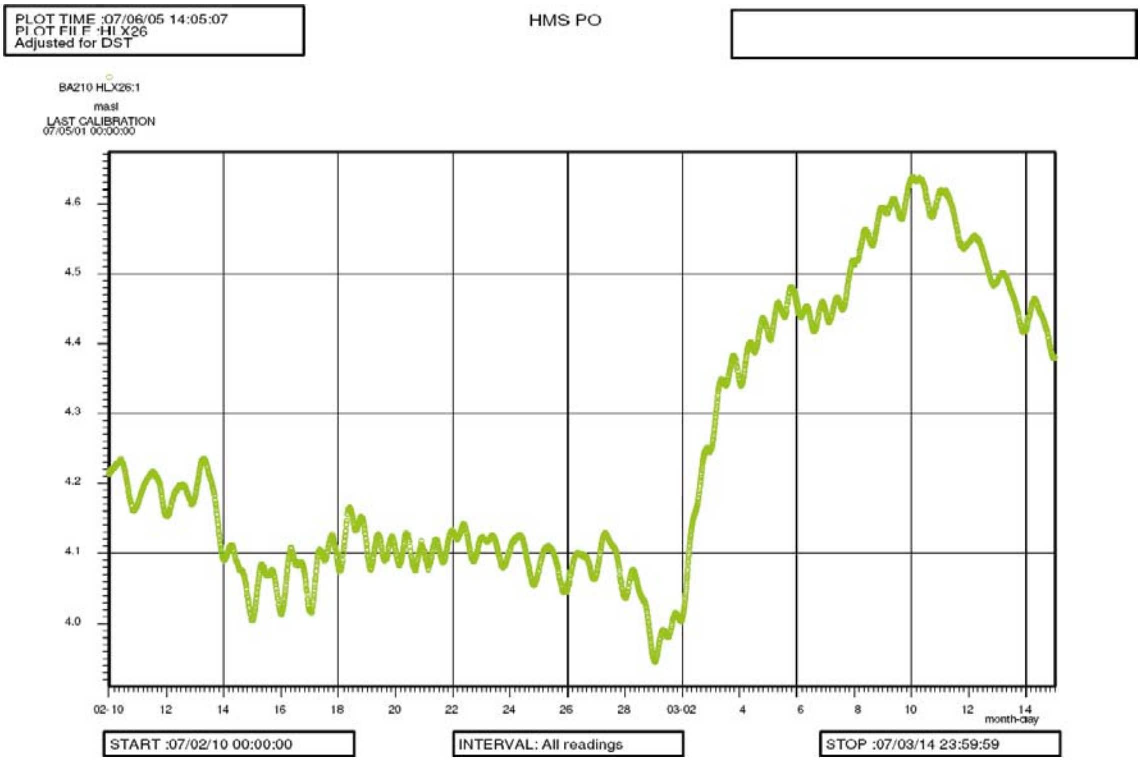

Figure 6-15. *Linear plot of ground water level in the observation borehole HLX26 during pumping in borehole KLX16A. The figure shows that the level variations in HLX26 are part of a pressure trend which seems to be unaffected by the pumping in KLX16A, performed 2007-02-24–2007-03-02.*

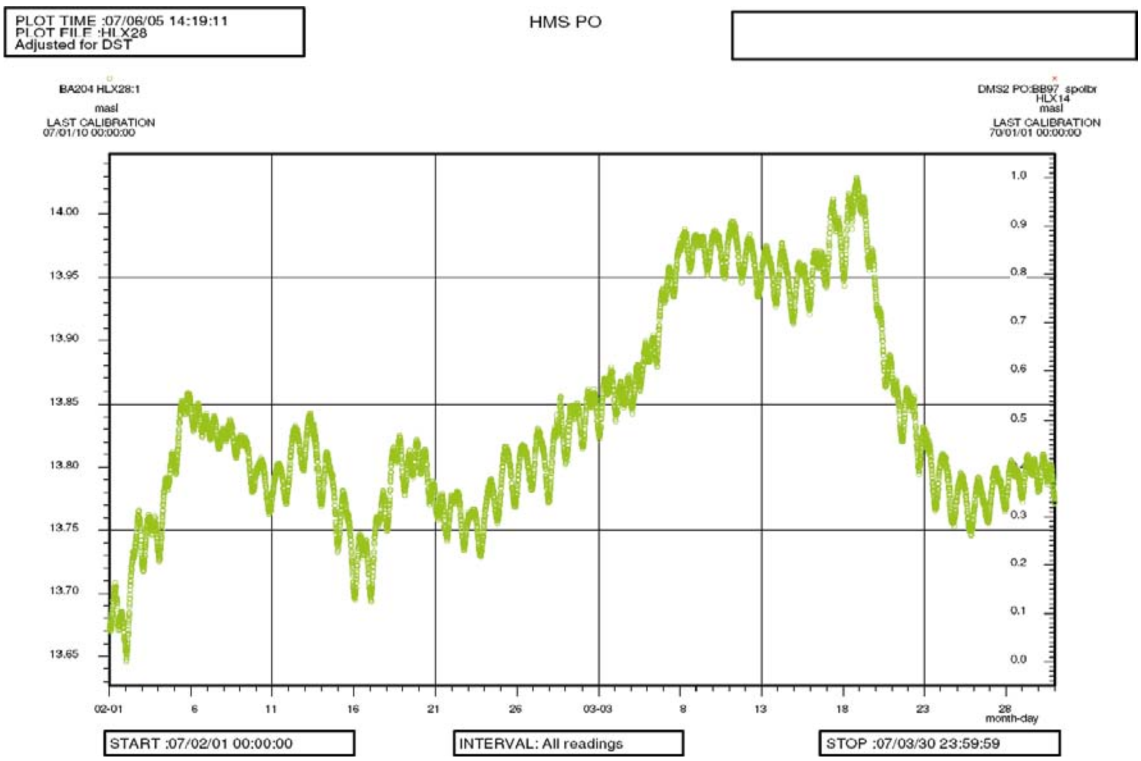

Figure 6-16. *Linear plot of ground water level in the observation borehole HLX28 during pumping in borehole KLX16A. The figure shows that the level variations in HLX28 are part of a pressure trend which seems to be unaffected by the pumping in KLX16A, performed 2007-02-24–2007-03-02.*

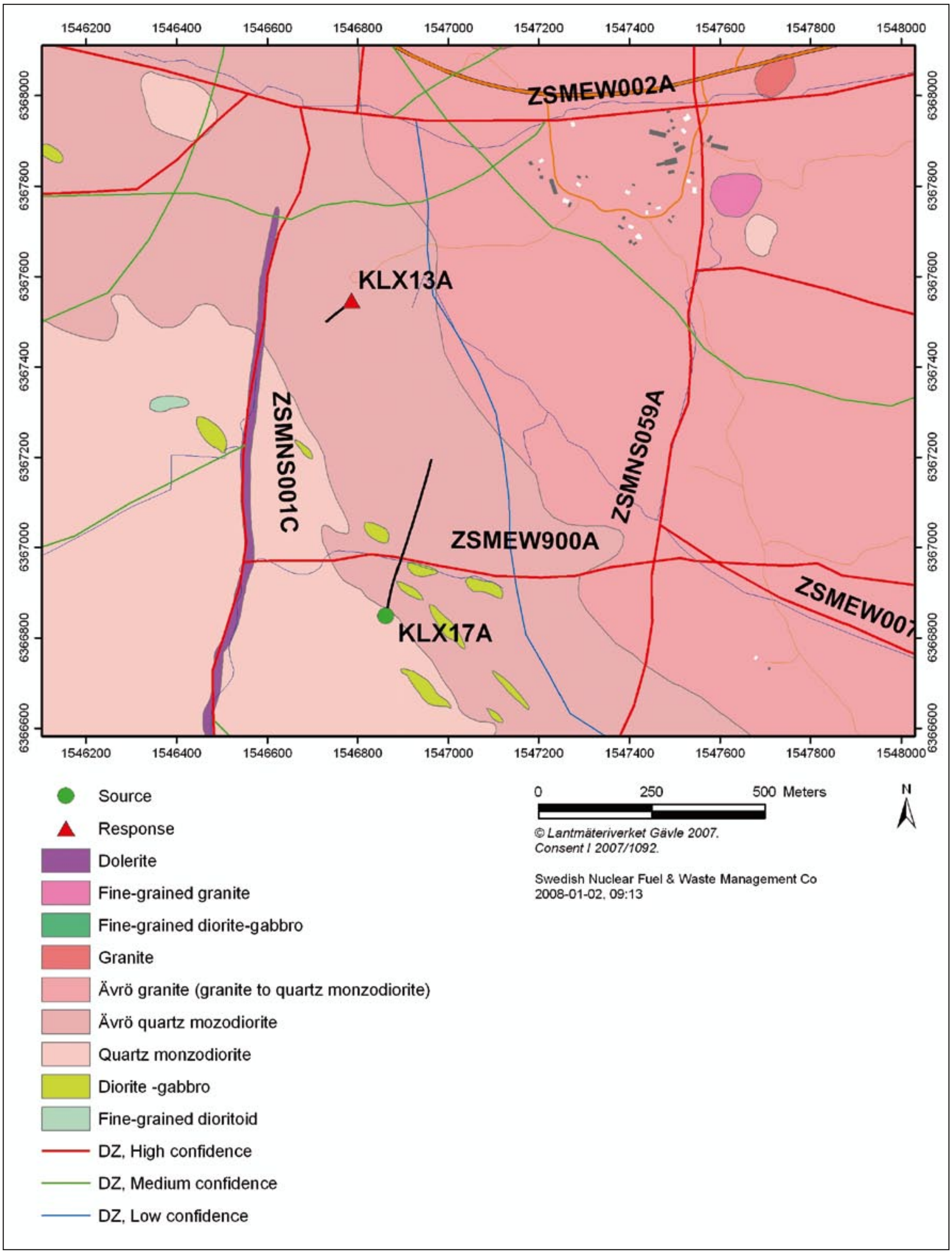

***Figure 6-17.** Borehole response map when pumping KLX17A.*

6.5.1 Pumping borehole KLX17A

General test data for the pumping test in KLX17A are presented in Table 6-6. The borehole is cased to 12.0 m. The uncased interval of this section is thus c. 12.0–701.1 m.

Table 6-6. General test data for the pumping test in KLX17A: 12.0–701.1 m.

General test data			
Pumping borehole	KLX17A		
Test type[1)]	Constant Rate withdrawal and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	Unit	Value
Borehole length	L	m	701.1
Casing length	L_c	m	12.0
Test section- secup	Secup	m	12.0
Test section- seclow	Seclow	m	701.1
Test section length	L_w	m	689.1
Test section diameter[2)]	$2 \cdot r_w$	mm	76–197
Test start (start of flow period)		yymmdd hh:mm	061028 09:58
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	061028 09:58:00
Stop of flow period		yymmdd hh:mm:ss	061029 09:22:00
Test stop (stop of flow period)		yymmdd hh:mm	061029 09:22
Total flow time	t_p	min	1,404
Total recovery time	t_F	min	877

Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	393.5
Relative pressure in test section before stop of flow period	p_p	kPa	157.5
Relative pressure in test section at stop of recovery period	p_F	kPa	373.4
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	236
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.0004
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.0004
Total volume discharged during flow period	V_p	m^3	33.7

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

Comments on the test

The test was performed as a constant- rate pumping test in conjunction with air-lift pumping. The flow rate was uncertain during the beginning of the flow period. A rather constant flow rate of c. 24 L/min was maintained during the rest of the period. Pumping was conducted during c. 1 day.

Flow regime and calculated parameters

Both the flow and recovery period exhibit effects of initial WBS rapidly transitioning to a pseudo-steady state by the end. No unambiguous transient evaluation could be made on either the flow or recovery period. Examples of possible transient evaluations are shown.

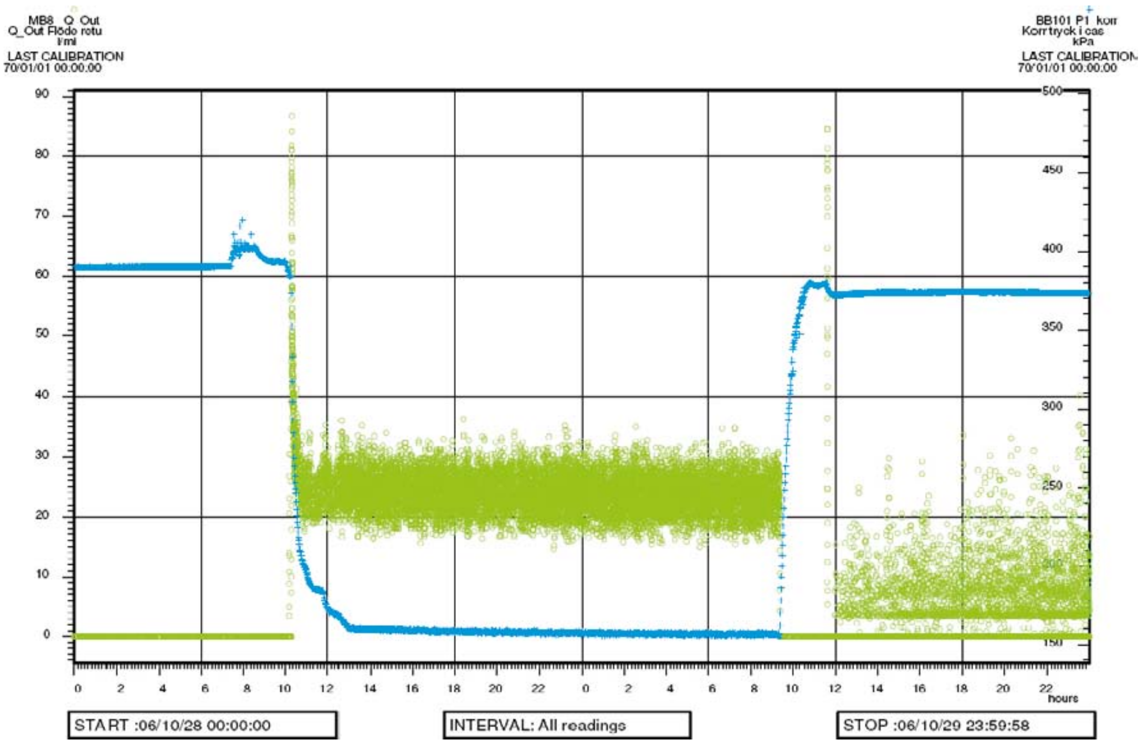

Figure 6-18. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX17A.*

Selected representative parameters

No representative parameters selected, only examples of possible evaluation are shown in Appendix 1 and Appendix 2.

6.5.2 Observation borehole KLX13A

Section 1 and 2 in this borehole appear to be virtually unaffected by the pumping in KLX15A. Section 3 shows a quite clear response, Figure 6-19.

Unaffected observation sections in KLX13A

Both Section 1, 469.0–595.5 m and Section 2, 340.0–468.0 m appear to be virtually unaffected by the pumping in KLX17A, Figure 6-15. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping.

Observation section KLX13A:3

In Figure 6-19 an overview of the pressure responses in observation borehole KLX13A is shown. General test data from the observation section KLX13A:3: 11.8–339.0 m, are presented in Table 6-7.

Comments on the test

Rather distinct responses were obtained in this section during the flow and recovery period. A total drawdown during the flow period of 0.5 m and a total recovery at the end of the recovery period of 0.2 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

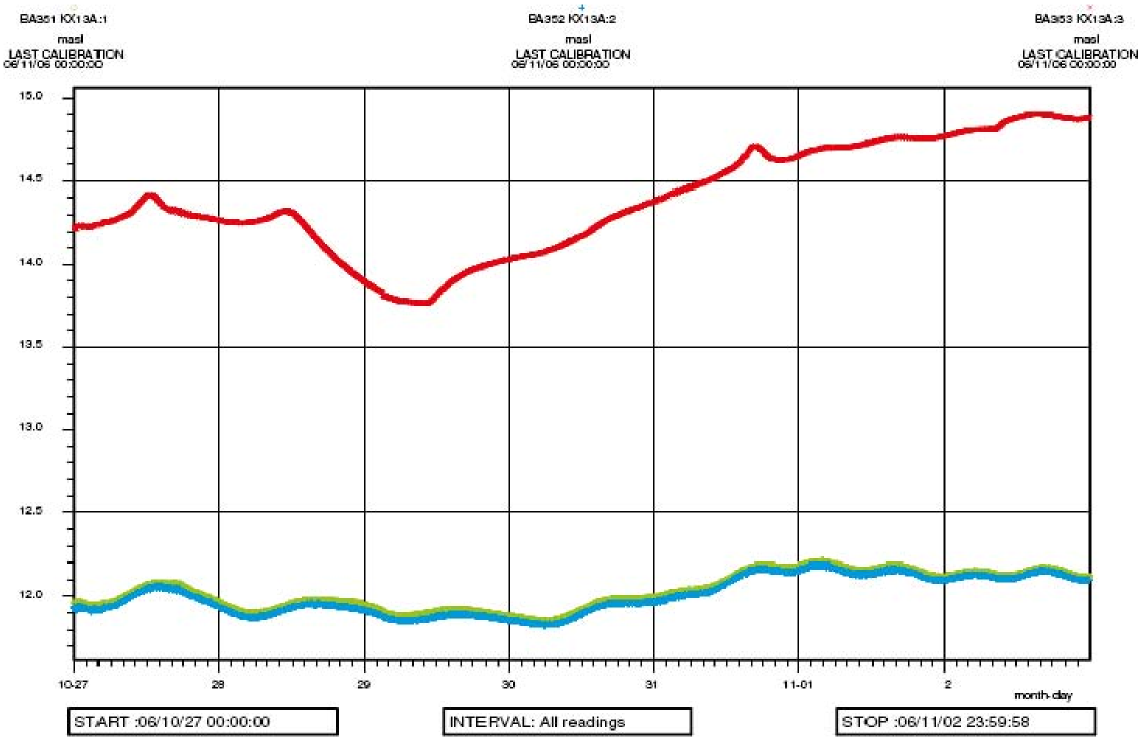

Figure 6-19. *Linear plot of pressure versus time in the observation borehole KLX13A during pumping in borehole KLX17A. The levels in KLX13A:1 and KLX13A:2 seems to be unaffected by the pumping in KLX17A.*

Table 6-7. General test data from the observation section KLX13A:3: 11.8–339.0 m during the interference test in KLX17A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	14.3
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	13.8
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	14.0
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.5

Flow regime and calculated parameters

Both the flow and recovery period is dominated by nearly pseudo-radial flow transitioning to pseudo-spherical (leaky) flow by the end. Rather consistent results of evaluated parameter values are obtained from the flow and recovery period respectively.

Selected representative parameters

The parameter values estimated from the flow period are selected as the most representative for the test section. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $4.3 \cdot 10^{-5}$ m²/s and representative storativity is $1.0 \cdot 10^{-5}$.

6.6 Interference test in KLX18A

This test was specifically designed to test whether a reflector, M1, seen with refraction seismic /20/ have any structural and hydraulic relevance. It was performed in conjunction with the core drilling of KLX18A and utilised the wireline probe system. A borehole response map is shown in Figure 6-20.

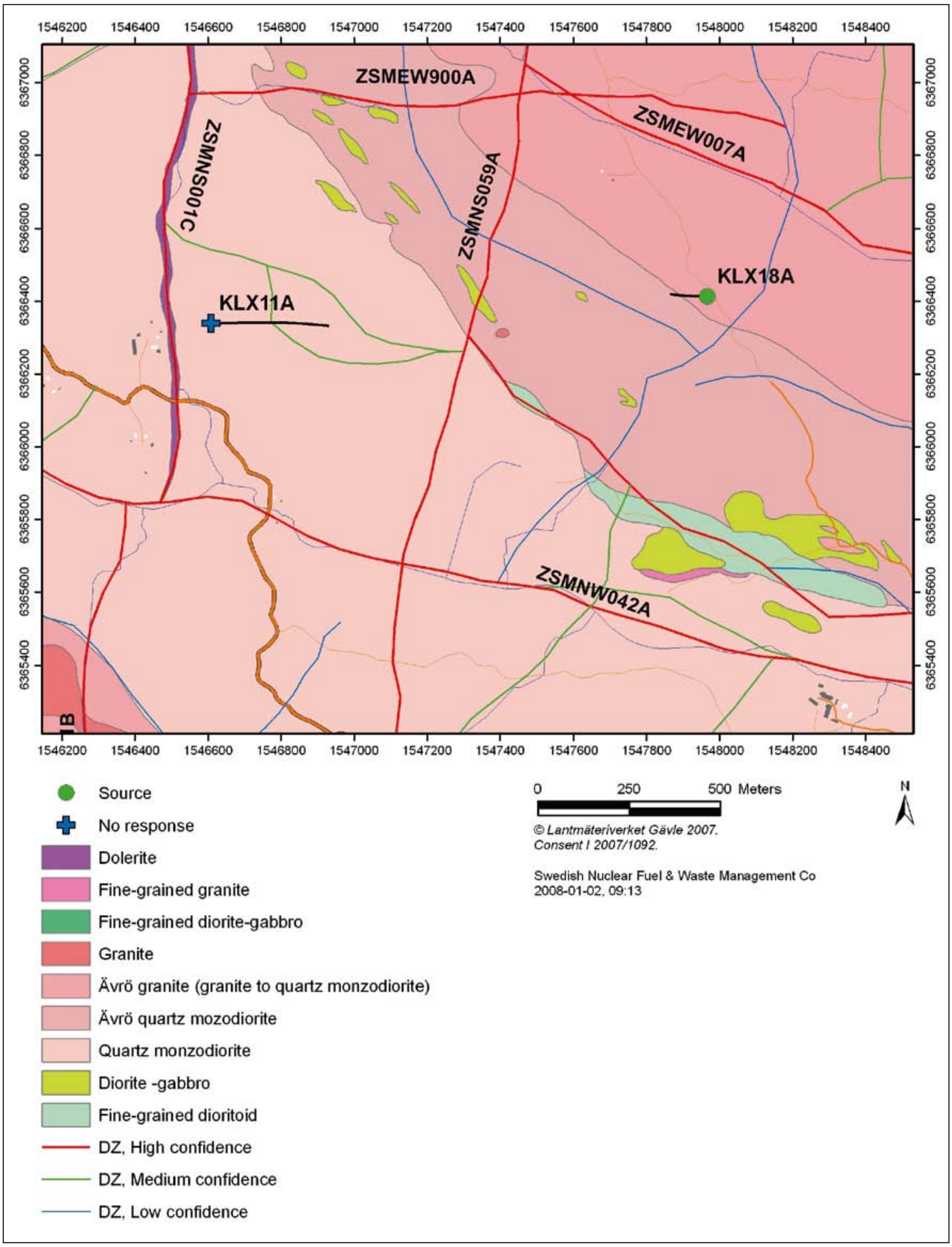

***Figure 6-20.** Borehole response map when pumping KLX18A.*

6.6.1 Pumping borehole KLX18A

General test data for the pumping test in KLX18A are presented in Table 6-8. The borehole is cased to 11.8 m. The interval of the pumped section is c. 312.0–611.3 m.

Comments on the test

The test was performed as a pumping test with constant drawdown. The mean flow rate was c. 4.5 L/min and the duration of the flow period was c. 3 days, Figure 6-20a. The packers were released shortly after the stop of pumping and therefore the recovery data are unreliable. There is a change of flow at 2006-05-07 which causes a slightly increased pressure.

Table 6-8. General test data for the pumping test in KLX18A: 312.0–611.3 m.

General test data			
Pumping borehole	KLX18A		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	packed-off section		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	611.3
Casing length	L_c	m	11.8
Test section- secup	Secup	m	312.0
Test section- seclow	Seclow	m	611.3
Test section length	L_w	m	299.3
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period) (start of pressure registration)		yymmdd hh:mm	060505 13:09:58
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	060505 13:09:58
Stop of flow period		yymmdd hh:mm:ss	060508 08:34:36
Test stop (stop of flow period) (stop of pressure registration)		yymmdd hh:mm	060508 08:34:36
Total flow time	t_p	min	4,045
Total recovery time	t_F	min	
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	2,952
Relative pressure in test section before stop of flow period	p_p	kPa	2,808
Relative pressure in test section at stop of recovery period	p_F	kPa	
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	144
Flow data			
Flow rate from test section just before stop of flow period[3)]	Q_p	m^3/s	0.000077
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	7.42E-5
Total volume discharged during flow period	V_p	m^3	17.99

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

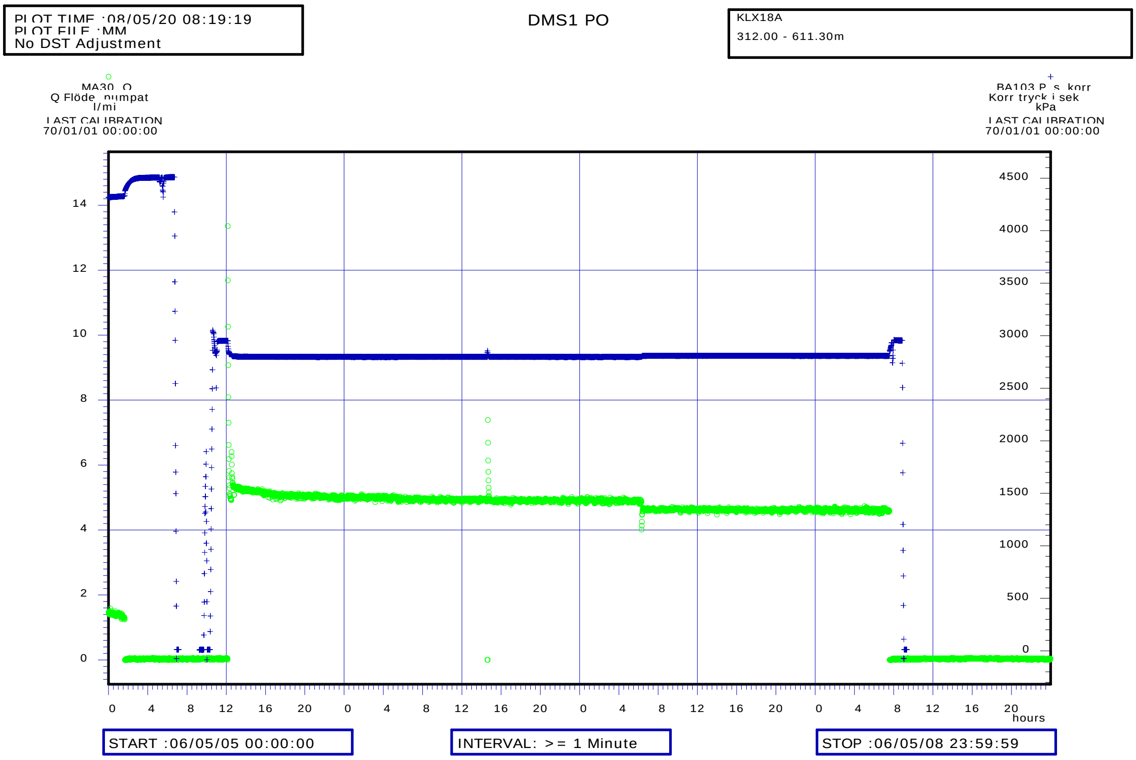

Figure 6-20a. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX18A.*

Flow regime and calculated parameters

During the flow period initial wellbore storage effects are followed by a short period of pseudo-radial flow transitioning to pseudo-spherical flow by the end. No representative response was obtained during the recovery period. Transient evaluation from the flow period was based on variable flow rate. No transient evaluation could be made from the recovery period.

Selected representative parameters

The parameter values from the flow period are selected as the most representative for the test. Evaluation was performed by applying the Moench (Case 1) solution to a leaky aquifer model. Selected representative transmissivity value is $7.6 \cdot 10^{-6}$ m^2/s for an estimated storativity of $1.9 \cdot 10^{-6}$.

6.6.2 Observation borehole KLX11A

The borehole is cased to 12.05 m, the uncased interval of this borehole is thus c. 12.05–992.3 m. The borehole appear to be unaffected by the pumping in KLX18A, Figure 6-21.

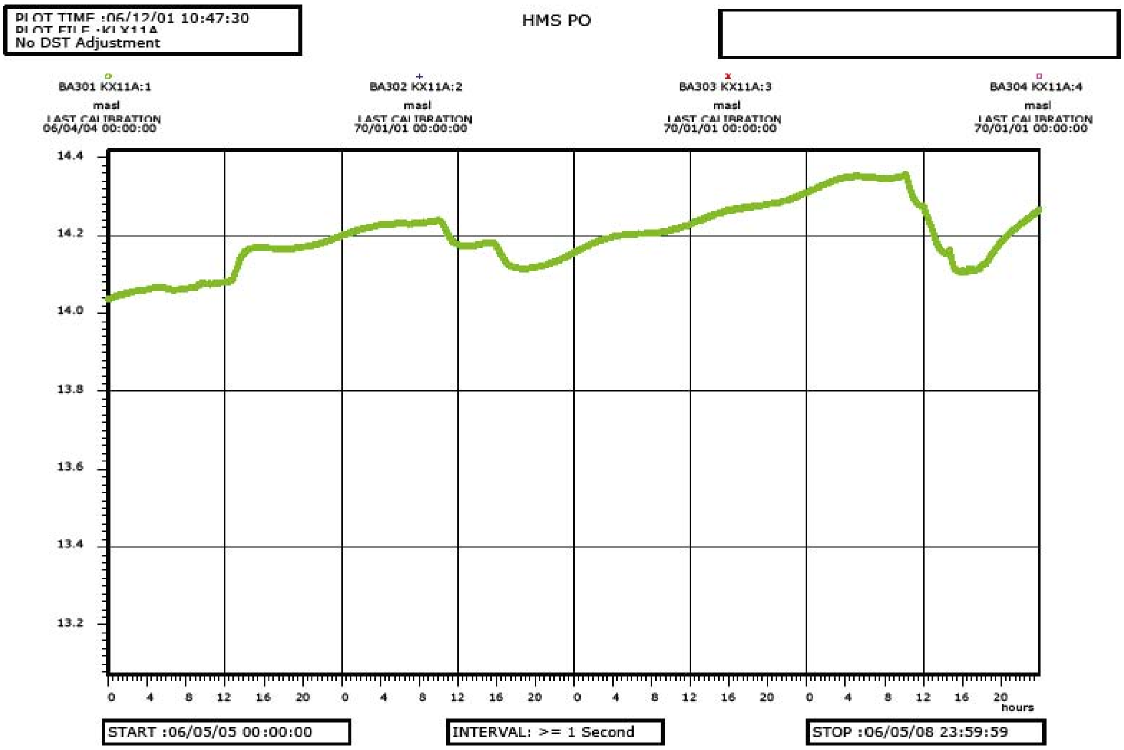

Figure 6-21. *Linear plot of pressure versus time in the observation borehole KLX11A:1 during pumping in borehole KLX18A. The levels in KLX11A:1 seems to be unaffected by the pumping in KLX18A.*

6.7 Interference test in KLX19A

This test was performed in conjunction with the PFL difference flow logging with the purpose to provide generall information about hydraulic connectivity in this area. The borehole responses are shown in Figure 6-22.

6.7.1 Pumping borehole KLX19A

General test data for the pumping test in KLX19A are presented in Table 6-9. The borehole is cased to 98.8 m. The uncased interval of this section is thus c. 98.8–800.1 m.

Comments on the test

The test was performed as a pumping test with constant drawdown and with slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 58.1 L/min and the duration of the flow period was c. 6 days. The flow rate curve is uncertain with several changes of flow rate. A total drawdown during the flow period of 9.88 m and a total recovery at the end of the recovery period of 9.32 m was observed.

Flow regime and calculated parameters

During the flow period initial effects of WBS occurred. The drawdown curve was distorted by an increase of flow rate after c. 5 min. After c. 20 min a pseudo-steady state flow regime was achieved and indicated throughout the flow period. The recovery was not consistent with the response during the flow period. After initial WBS a short period of PRF occurred. After c. 60 min an apparent no-flow boundary (NFB) was indicated.

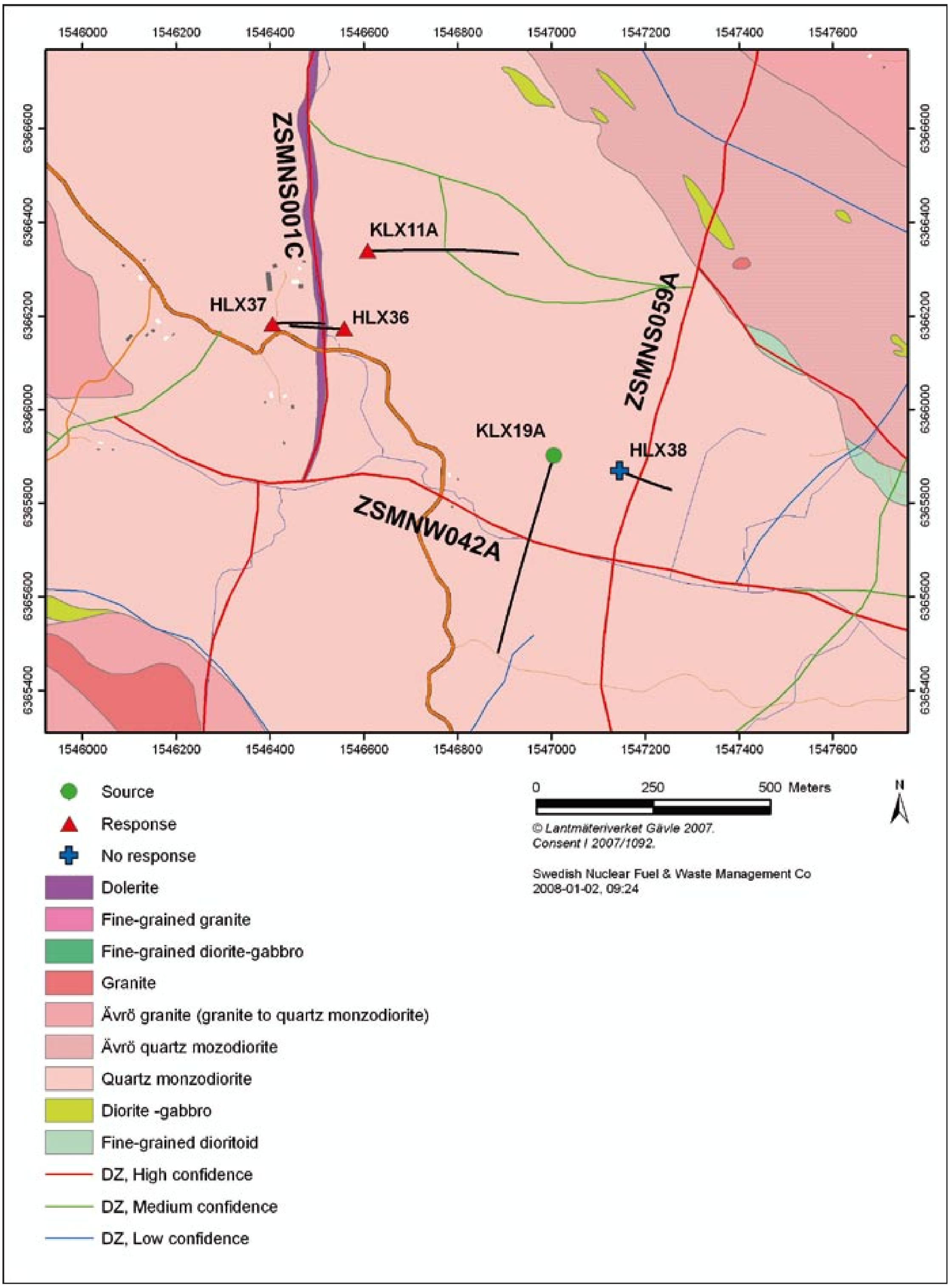

Figure 6-22. *Borehole response map when pumping KLX19A.*

Selected representative parameters

The estimated parameter values from the flow period are selected as representative for the test. Evaluation was performed by applying the Moench (Case 1) solution to a leaky aquifer model. Selected representative transmissivity value is $1.6 \cdot 10^{-4}$ m^2/s for an estimated storativity of $8.8 \cdot 10^{-6}$.

Table 6-9. General test data for the pumping test in KLX19A: 98.8–800.1 m.

General test data			
Pumping borehole	KLX19A		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	800.1
Casing length	L_c	m	98.8
Test section- secup	Secup	m	98.8
Test section- seclow	Seclow	m	800.1
Test section length	L_w	m	701.3
Test section diameter[2)]	$2·r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	061112 18:35
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	061112 18:35:04
Stop of flow period		yymmdd hh:mm:ss	061118 12:36:00
Test stop (stop of flow period)		yymmdd hh:mm	061118 12:36
Total flow time	t_p	min	8,281
Total recovery time	t_F	min	5,522
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	126.0
Relative pressure in test section before stop of flow period	p_p	kPa	29.0
Relative pressure in test section at stop of recovery period	p_F	kPa	120.5
Pressure change during flow period ($p_i – p_p$)	dp_p	kPa	97
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.000968
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.000968
Total volume discharged during flow period	V_p	m^3	481

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

6.7.2 Observation borehole HLX37

In Figure 6-24 an overview of the observed head versus time in the sections in observation borehole HLX37 is shown. Clear responses were observed in sections 1 and 2. No responses from the pumping in KLX19A can be detected in sections 3 and no analysis is performed in this section.

Observation section HLX37:1: 149.0–199.8 m

In Figure 6-19 an overview of the pressure responses in observation borehole HLX37 is shown. General test data from the observation section HLX37:1: 149.0–199.8 m, are presented in Table 6-10.

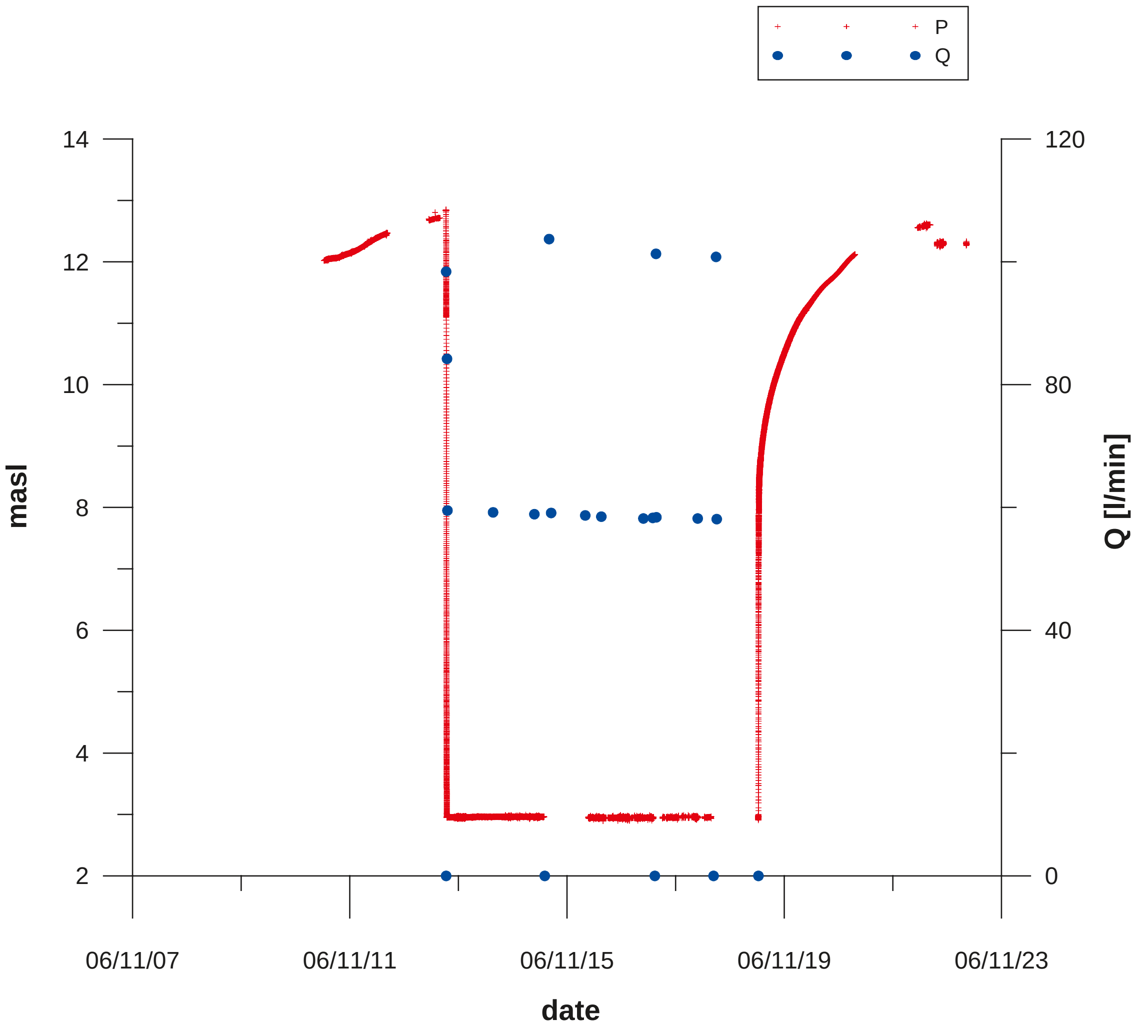

Figure 6-23. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX19A.*

Table 6-10. General test data from the observation section HLX37: 1: 149.0–199.8 m during the interference test in KLX19A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	12.9
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.5
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	13.6
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	3.4

Comments on the test

Distinct response were obtained during the flow and recovery period. A total drawdown during the flow period of 3.4 m and a total recovery at the end of the recovery period of 4.1 m was observed. The fact that the total recovery is larger than total drawdown is explained by external effects. The calculated Index 1 (r_s^2/t_L) is rated as “excellent”, Index 2 (s_p/Q_p) as “low” and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as “medium”.

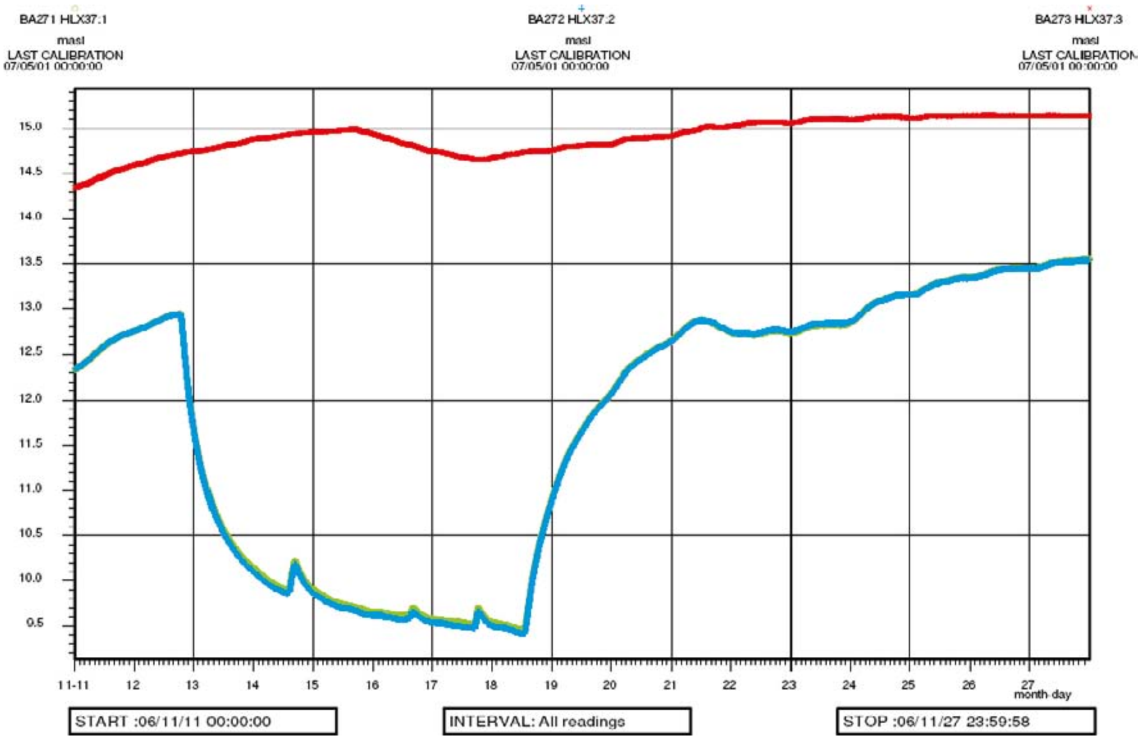

Figure 6-24. *Linear plot of pressure versus time in the observation borehole HLX37 during pumping in borehole KLX19A.*

Flow regime and calculated parameters

The flow period is dominated by nearly pseudo-radial flow transitioning to pseudo-spherical (leaky) flow. During the recovery period a transition to pseudo-radial flow occurred. Consistent results of evaluated parameter values are obtained from the flow and recovery period respectively.

Selected representative parameters

The parameter values estimated from the flow period are selected as the most representative for the test section. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $5.9 \cdot 10^{-5}$ m^2/s and representative storativity is $2.6 \cdot 10^{-6}$.

Observation section HLX37:2: 118.0–148.0 m

In Figure 6-24 an overview of the pressure responses in observation borehole HLX37 is shown. General test data from the observation section HLX37:2: 118.0–148.0 m, are presented in Table 6-11.

Table 6-11. General test data from the observation section HLX37:2: 118.0–148.0 m during the interference test in KLX19A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	12.9
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.4
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	13.5
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	3.5

Comments on the test

Distinct respons were obtained during the flow and recovery period. A total drawdown during the flow period of 3.5 m and a total recovery at the end of the recovery period of 4.1 m was observed. The fact that the total recovery is larger than total draw down is explained by external effects. The calculated Index 1 (r_s^2/t_L) is rated as "excellent", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

Flow regime and calculated parameters

The flow period is dominated by nearly pseudo-radial flow transitioning to pseudo-spherical (leaky) flow. During the recovery period a transition to pseudo-radial flow occurred. Consistent results of evaluated parameter values are obtained from the flow and recovery period respectively.

Selected representative parameters

The parameter values estimated from the flow period are selected as the most representative for the test section. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $5.8 \cdot 10^{-5}$ m^2/s and representative storativity is $2.4 \cdot 10^{-6}$.

Observation section HLX37:3: 12.0–117.0 m

This section appears to be virtually unaffected by the pumping in KLX19A, Figure 6-24. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping.

6.7.3 Observation borehole KLX11A

In Figure 6-25 an overview of the pressure response in observation borehole KLX11A is shown. General test data from the observation section KLX11A: 12.0–992.3 m, are presented in Table 6-12. The borehole is cased to 12.0 m, the uncased interval of this borehole is thus c. 12.0–992.3 m.

Comments on the test

Only limited pressure data are available from the flow period. The pressure recovery data record for evaluation was terminated at the peak value on 06/11/21 when a total recovery of 1.9 m was observed. Response indexes were calculated assuming an initial head of 13.2 m and a response time estimated from recovery data. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

Table 6-12. General test data from the observation section KLX11A: 12.0–992.3 m during the interference test in KLX19A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	11.3
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	13.2
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	

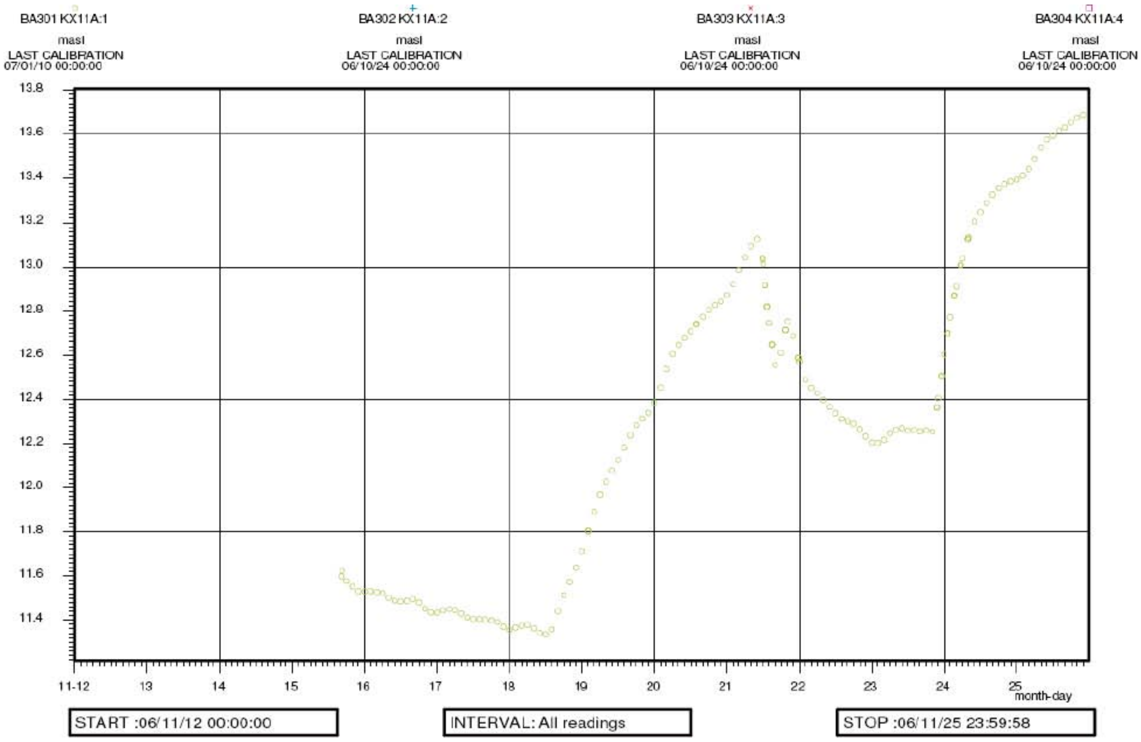

Figure 6-25. *Linear plot of ground water level in the observation borehole KLX11A during pumping in borehole KLX19A.*

Flow regime and calculated parameters

A preliminary evaluation was made including available data from the flow period together with recovery data (assuming an initial head of c. 13.2 m). An individual evaluation was also made from the recovery period solely. Due to lack of data no separate transient evaluation can be made from the flow period. An evaluation with data from the flow and recovery period was made. Sparse data were available from the recovery period. The latter period indicates a transition period towards possible pseudo-radial flow.

Selected representative parameters

The parameter values estimated from the recovery period are selected as representative. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $5.1 \cdot 10^{-5}$ m^2/s and representative storativity is $1.5 \cdot 10^{-5}$.

6.7.4 Observation borehole HLX36

In Figure 6-26 an overview of the observed head versus time in the sections in observation borehole HLX36 is shown. A response was observed in sections 1. No responses from the pumping in KLX19A can be detected in sections 2 and no analysis is performed in this section.

Observation section HLX36:1: 50.0–199.8 m

In Figure 6-26 an overview of the pressure responses in observation borehole HLX36 is shown. General test data from the observation section HLX36:1: 50.0–199.8 m, are presented in Table 6-13.

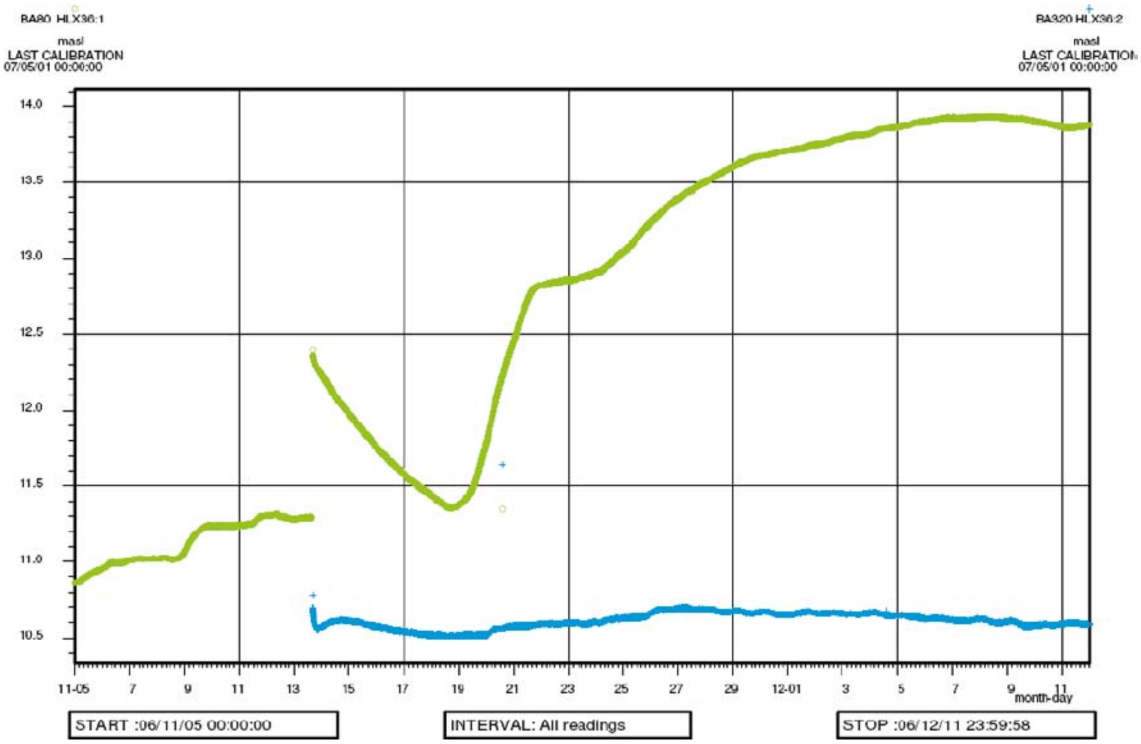

Figure 6-26. *Linear plot of ground water level in the observation borehole HLX36 during pumping in borehole KLX19A. The pressure disturbance 2006-11-13 is due to installation of a packer in the borehole. The figure shows that the level in HLX36:2 is unaffected by the pumping in KLX19A, performed 2006-11-12–2006-11-18.*

Table 6-13. General test data from the observation section HLX36:1: 50.0–199.8 m during the interference test in KLX19A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	11.4
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	13.9
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	

Comments on the test

Only limited and partly disturbed pressure data are available from the flow period. A total recovery at the end of the recovery period of 2.5 m was observed. Response indexes were calculated assuming a total drawdown of 2.53 m and a response time based on time for recovery data. The calculated Index 1 (r_s^2/t_L) is rated as “medium”, Index 2 (s_p/Q_p) as “low” and the new Index 2 $(s_p/Q_p)\cdot\ln(r_s/r_0)$ as “medium”.

Flow regime and calculated parameters

Due to lack of data no individual transient evaluation can be made from the flow period.
A combined evaluation with data from the flow and recovery period was made. The latter period indicates a transition period towards possible pseudo-radial flow.

Selected representative parameters

The parameter values estimated from the recovery period are selected as representative. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.8 \cdot 10^{-5}$ m^2/s and representative storativity is $1.7 \cdot 10^{-5}$.

Observation section HLX36:2: 6.0–49.0 m

This section appears to be virtually unaffected by the pumping in KLX19A, Figure 6-26. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping.

6.7.5 Observation borehole HLX38

This section appears to be virtually unaffected by the pumping in KLX19A, Figure 6-27. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping. The borehole is cased to 15.0 m, The uncased interval of this borehole is thus c. 15.0–199.5 m.

6.8 Interference test in KLX21B

This test was performed in conjunction with the PFL difference flow logging with the purpose to provide general information about hydraulic connectivity in this area. The borehole responses are shown in Figure 6-28.

The pressure responses during both the flow and recovery period are considered as uncertain in several observation sections due to natural pressure variations including precipitation and tidal effects during the test period. Shortly before start of pumping, precipitation caused

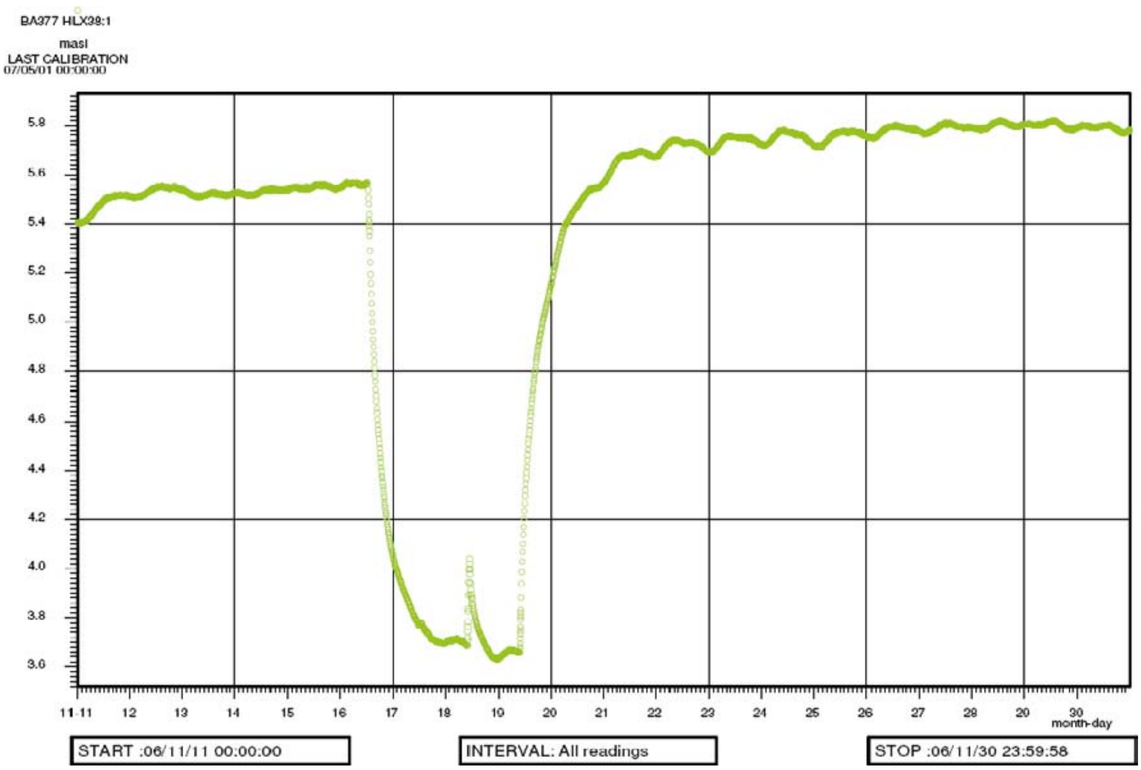

Figure 6-27. Linear plot of ground water level in the observation borehole HLX38 during pumping in borehole KLX19A. The figure shows that the level in HLX38 is unaffected by the pumping in KLX19A, performed 2006-11-12–2006-11-18.

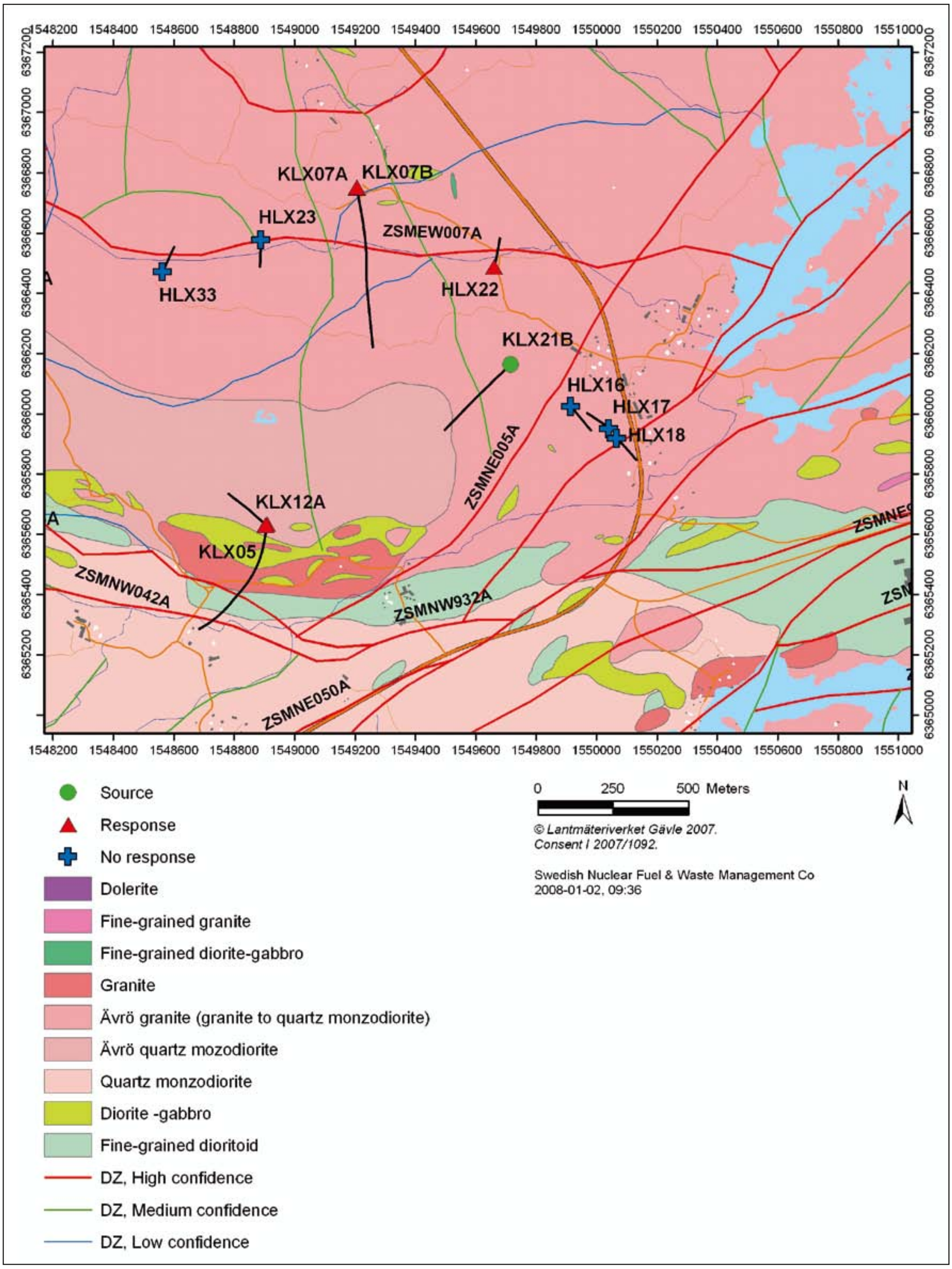

Figure 6-28. *Borehole response map when pumping KLX21B.*

increased heads in all boreholes. An example from sections 6-8 in borehole KLX07A is shown in Figure 6-30. The natural decline of heads after precipitation almost coincided with start of pumping. This fact makes it difficult to separate the head decline due to pumping from the natural head decline after the precipitation in several observation sections. Similar diagrams for selected observation boreholes are shown at the end of the Test diagram section (Figures 93–96). The pressure continued to decrease after stop of pumping in several observation sections. Only a small pressure recovery (c. 0.1 m) was generally achieved after stop of pumping in these sections.

Due to these facts, both the magnitude of the responses and thus the transient evaluations of both the flow period, and particularly the recovery period, are considered as uncertain for this interference test. Specific comments to each test section are given in the Test Summary Sheets.

6.8.1 Pumping borehole KLX21B

General test data for the pumping test in KLX21B are presented in Table 6-14. The borehole is cased to 11.9 m. The uncased interval of this section is thus c. 11.9–858.8 m.

Table 6-14. General test data for the pumping test in KLX21B: 11.9–858.8 m.

General test data			
Pumping borehole	KLX21B		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	858.8
Casing length	L_c	m	11.9
Test section- secup	Secup	m	11.9
Test section- seclow	Seclow	m	858.8
Test section length	L_w	m	846.9
Test section diameter[2)]	$2 \cdot r_w$	mm	76–198
Test start		yymmdd hh:mm	070311 13:37
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	070311 13:37:00
Stop of flow period		yymmdd hh:mm:ss	070318 18:23:00
Test stop		yymmdd hh:mm	070318 18:23
Total flow time	t_p	min	10,366
Total recovery time	t_F	min	5,225
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	70.2
Relative pressure in test section before stop of flow period	p_p	kPa	35.8
Relative pressure in test section at stop of recovery period	p_F	kPa	67.2
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	34.4
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.000908
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.000908
Total volume discharged during flow period	V_p	m^3	565

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

Comments on the test

The test was performed as a pumping test with a constant drawdown and slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 54.5 L/min and the duration of the flow period was c. 7 days. A total drawdown during the flow period of 3.51 m and a total recovery at the end of the recovery period of 3.20 m was observed. Pressure data are lacking from the beginning of the flow period.

Flow regime and calculated parameters

Due to lack of data no transient evaluation of the flow period is possible. After initial WBS a first PRF is developed between c. 1–50 min of equivalent time during the recovery period. After a transition period a second PRF is weakly indicated between c. 300–1,100 min. Alternatively, an apparent no-flow boundary (NFB) may be assumed after c. 50 min. The first PRF is assumed to represent the hydraulic properties of the rock in the vicinity of the borehole. The second PRF (or NFB) is considered as representative of the rock conditions at a certain distance from the borehole.

Selected representative parameters

The first PRF is selected as representative for the test. Evaluation was performed by applying the Dougherty-Babu solution to a confined aquifer model. Selected representative transmissivity value is 4.5 $\cdot 10^{-4}$ m^2/s for an estimated storativity of $1.5 \cdot 10^{-5}$.

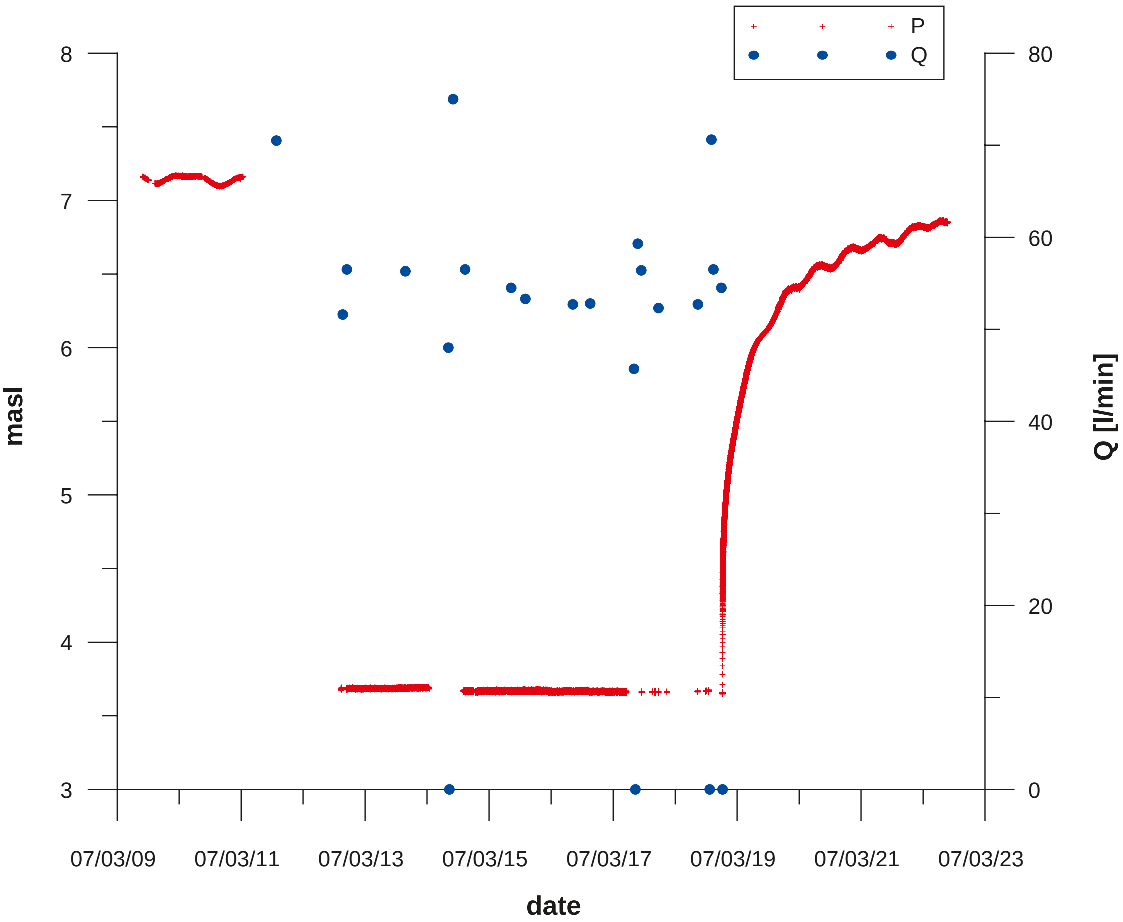

***Figure 6-29.** Linear plot of flow rate and pressure versus time in the pumping borehole KLX21B.*

6.8.2 Observation borehole KLX07A

In Figure 6-30 an overview of the observed head versus time in the sections in observation borehole KLX07A is shown. All sections show a more or less clear response to the pumping in borehole KLX21B.

The response in this borehole is partly disturbed by precipitation which may affect both the drawdown and recovery as discussed above, se Figure 6-31.

Observation section KLX7A:1: 781.0–844.7 m

In Figure 6-30 an overview of the pressure responses in observation borehole KLX7A is shown. General test data from the observation section KLX7A:1, 781.0–844.7 m, are presented in Table 6-15.

Comments on the test

A total drawdown during the flow period of 1.09 m and a total recovery at the end of the recovery period of 0.84 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

Table 6-15. General test data from the observation section KLX07A:1: 781.0–844.7 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	5.83
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	4.74
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	5.58
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	1.09

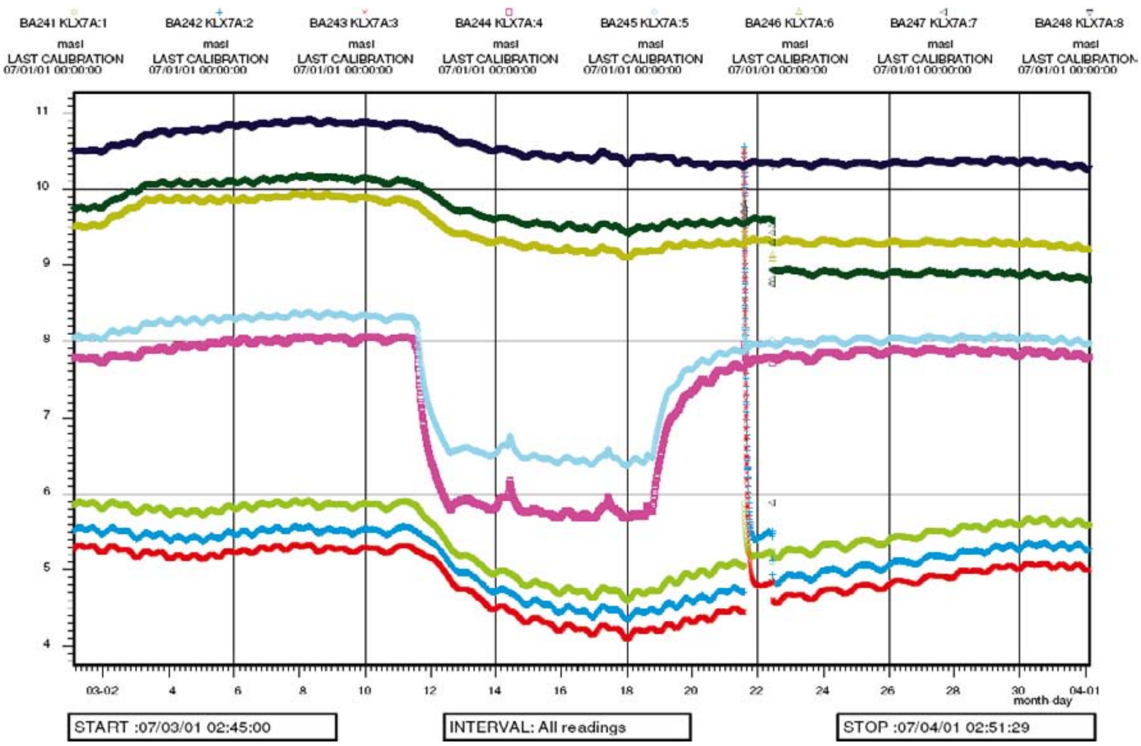

Figure 6-30. Linear plot of pressure versus time in the observation borehole KLX07A during pumping in borehole KLX21B.

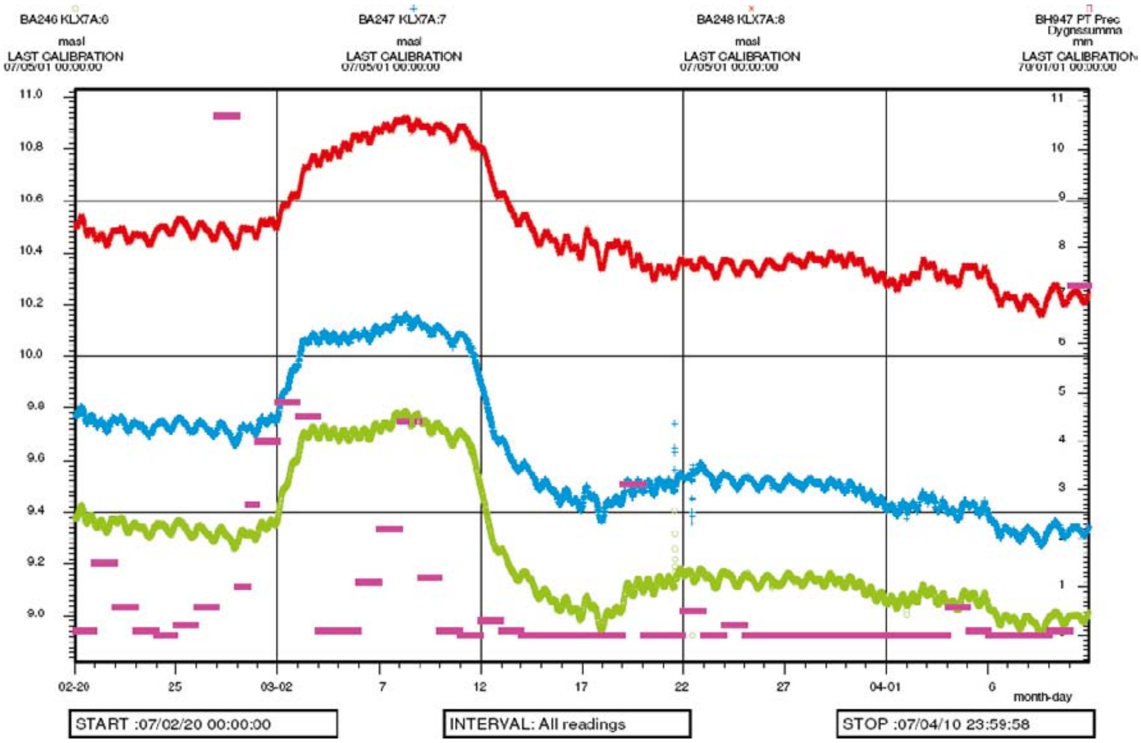

Figure 6-31. *Linear plot of precipitation and ground water level in the observation borehole KLX07A sections 6, 7 and 8 during pumping in borehole KLX21B.*

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.1 \cdot 10^{-4}$ m^2/s and selected representative storativity is $8.4 \cdot 10^{-5}$.

Observation section KLX7A:2: 753.0–780.0 m

In Figure 6-30 an overview of the pressure responses in observation borehole KLX7A is shown. General test data from the observation section KLX7A:2: 753.0–780.0 m, are presented in Table 6-16.

Table 6-16. General test data from the observation section KLX07A:2: 753.0–780.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	5.5
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	4.5
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	5.3
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	1.02

Comments on the test

A total drawdown during the flow period of 1.02 m and a total recovery at the end of the recovery period of 1.1 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $8.8 \cdot 10^{-5}$ m^2/s and selected representative storativity is $1.0 \cdot 10^{-4}$.

Observation section KLX07A:3: 612.0–752.0 m

In Figure 6-30 an overview of the pressure responses in observation borehole KLX07A is shown. General test data from the observation section KLX07A:3: 612.0–752.0 m, are presented in Table 6-17.

Comments on the test

A total drawdown during the flow period of 1.01 m and a total recovery at the end of the recovery period of 0.8 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $7.3 \cdot 10^{-5}$ m^2/s and selected representative storativity is $1.0 \cdot 10^{-4}$.

Table 6-17. General test data from the observation section KLX07A:3: 612.0–752.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	5.2
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	4.2
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	5.0
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	1.01

Observation section KLX07A:4: 457.0–611.0 m

In Figure 6-30 an overview of the pressure responses in observation borehole KLX07A is shown. General test data from the observation section KLX07A:4: 457.0–611.0 m, are presented in Table 6-18.

Comments on the test

A distinct response occurred in this observation section. A total drawdown during the flow period of 2.1 m and a total recovery at the end of the recovery period of 2 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "excellent", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

Flow regime and calculated parameters

Both the flow and recovery period are dominated by PRF transitioning to PSF by the end.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.2 \cdot 10^{-4}$ m^2/s and selected representative storativity is $6.2 \cdot 10^{-6}$.

Observation section KLX07A:5: 333.0–456.0 m

In Figure 6-30 an overview of the pressure responses in observation borehole KLX07A is shown. General test data from the observation section KLX07A:5: 333.0–456.0 m, are presented in Table 6-19.

Table 6-18. General test data from the observation section KLX07A:4: 457.0–611.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	7.9
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	5.8
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	7.8
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	2.17

Table 6-19. General test data from the observation section KLX07A:5: 333.0–456.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	8.2
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	6.5
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	8.0
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	1.75

Comments on the test

A distinct response occurred in this observation section. A total drawdown during the flow period of 1.75 m and a total recovery at the end of the recovery period of 1.5 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "excellent", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

Flow regime and calculated parameters

Both the flow and recovery period are dominated by PRF transitioning to PSF by the end.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.4 \cdot 10^{-4}$ m^2/s and selected representative storativity is $6.5 \cdot 10^{-6}$.

Observation section KLX07A:6: 204.0–332.0 m

In Figure 6-30 an overview of the pressure responses in observation borehole KLX07A is shown. General test data from the observation section KLX07A:6: 204.0–332.0 m, are presented in Table 6-20.

Comments on the test

A weak response is indicated in this section. A total drawdown during the flow period of 0.61 m and a total recovery at the end of the recovery period of 0.1 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "low".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PSF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $2.7 \cdot 10^{-4}$ m^2/s and selected representative storativity is $5.5 \cdot 10^{-5}$.

Table 6-20. General test data from the observation section KLX07A:6: 204.0–332.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	9.8
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.2
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	9.3
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.61

Observation section KLX07A:7: 104.0–203.0 m

In Figure 6-30 an overview of the pressure responses in observation borehole KLX07A is shown. General test data from the observation section KLX07A:7: 104.0–203.0 m, are presented in Table 6-21.

Comments on the test

A weak response is indicated in this section. A total drawdown during the flow period of 0.54 m. During the recovery period a small recovery of c. 0.1 m was followed by an abrupt drop in head (cf. Figure 6-24).

The pressure drop was equipment related and not a reflection of the properties of the rock formation. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 $(s_p/Q_p)\cdot\ln(r_s/r_0)$ as "low".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to the instrumental failure. No unambiguous transient evaluation could be made on the recovery period.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $2.5\cdot10^{-4}$ m^2/s and selected representative storativity is $5.1\cdot10^{-5}$.

Observation section KLX07A:8: 11.8–103.0 m

In Figure 6-30 an overview of the pressure responses in observation borehole KLX07A is shown. General test data from the observation section KLX07A:8: 11.8–103.0 m, are presented in Table 6-22. The borehole is cased to 11.8 m, the uncased interval of this upper section is thus c. 11.8–103.0 m.

Table 6-21. General test data from the observation section KLX07A:7: 104.0–203.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.0
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.5
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	8.9
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.54

Table 6-22. General test data from the observation section KLX07A:8: 11.8–103.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.8
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	10.4
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.3
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.38

Comments on the test

A weak response is indicated in this section. A total drawdown during the flow period of 0.38 m. A further decrease in hydraulic head after the end of the flow period is due to a natural declining head coinciding with the test. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 $(s_p/Q_p)\cdot\ln(r_s/r_0)$ as "low".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.4\cdot10^{-4}$ m²/s and selected representative storativity is $2.5\cdot10^{-5}$.

6.8.3 Observation borehole KLX07B

In Figure 6-32 an overview of the observed head versus time in the sections in observation borehole KLX07B is shown. Both sections show a possible response to the pumping in borehole KLX21B. The response in this borehole is partly disturbed by precipitation which may affect both the drawdown and recovery as discussed above, se Figure 6-33.

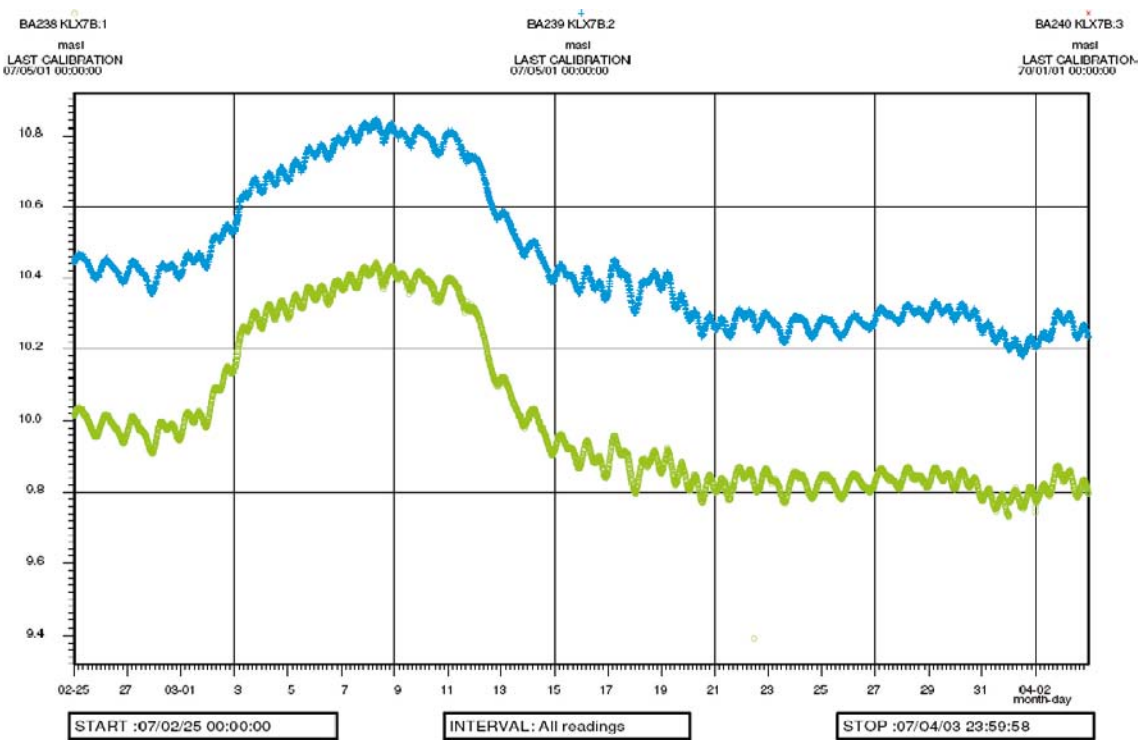

Figure 6-32. Linear plot of pressure versus time in the observation borehole KLX07B during pumping in borehole KLX21B.

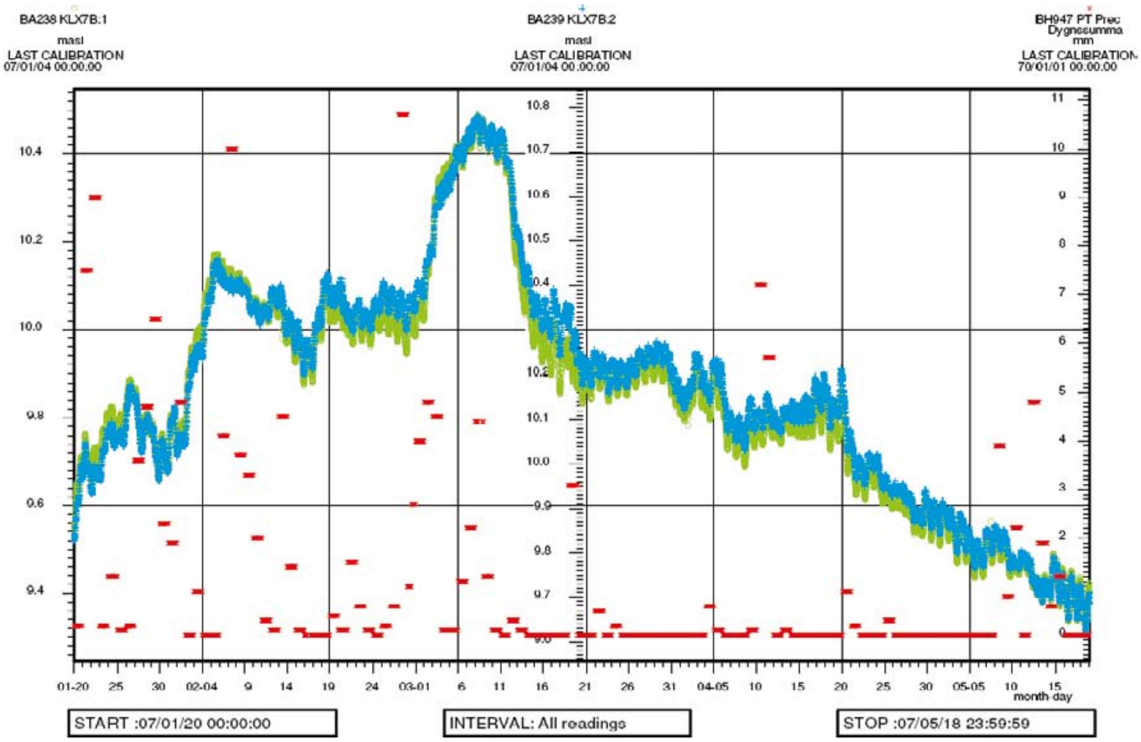

Figure 6-33. *Linear plot of precipitation and ground water level in the observation borehole KLX07B during pumping in borehole KLX21B.*

Observation section KLX07B:1: 95.0–200.0 m

In Figure 6-32 an overview of the pressure responses in observation borehole KLX07B is shown. General test data from the observation section KLX07B:1: 95.0–200.0 m, are presented in Table 6-23.

Comments on the test

A total drawdown during the flow period of 0.43 m was registered. A further decrease in hydraulic head after the stop of the flow period is due to a natural declining head coinciding with the test. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "low".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Table 6-23. General test data from the observation section KLX7B:1: 95.0–200.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.3
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.9
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	9.7
Hydraulic head change during flow period ($h_i – h_p$)	dh_p	m	0.43

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.6 \cdot 10^{-4}$ m²/s and selected representative storativity is $6.7 \cdot 10^{-5}$.

Observation section KLX07B:2: 9.6–94.0 m

In Figure 6-32 an overview of the pressure responses in observation borehole KLX07B is shown. General test data from the observation section KLX07B:2: 9.6–94.0 m, are presented in Table 6-24.

Comments on the test

A total drawdown during the flow period of 0.34 m. A further decrease in hydraulic head after the stop of the flow period is due to a natural declining head coinciding with the test. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 ($s_p/Q_p) \cdot \ln(r_s/r_0)$ as "low".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.2 \cdot 10^{-4}$ m²/s and selected representative storativity is $6.4 \cdot 10^{-5}$.

6.8.4 Observation borehole HLX22

In Figure 6-34 an overview of the pressure responses in observation borehole HLX22 is shown. General test data from the observation section HLX22: 9.0–163.2 m, are presented in Table 6-25. The borehole is cased to 9.0 m, the uncased interval of this upper section is thus c. 9.0–163.2 m.

Comments on the test

A total drawdown during the flow period of 1.13 m and a total recovery at the end of the recovery period of 1.0 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 ($s_p/Q_p) \cdot \ln(r_s/r_0)$ as "medium".

Table 6-24. General test data from the observation section KLX70B:2: 9.6–94.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.7
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	10.4
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.2
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.34

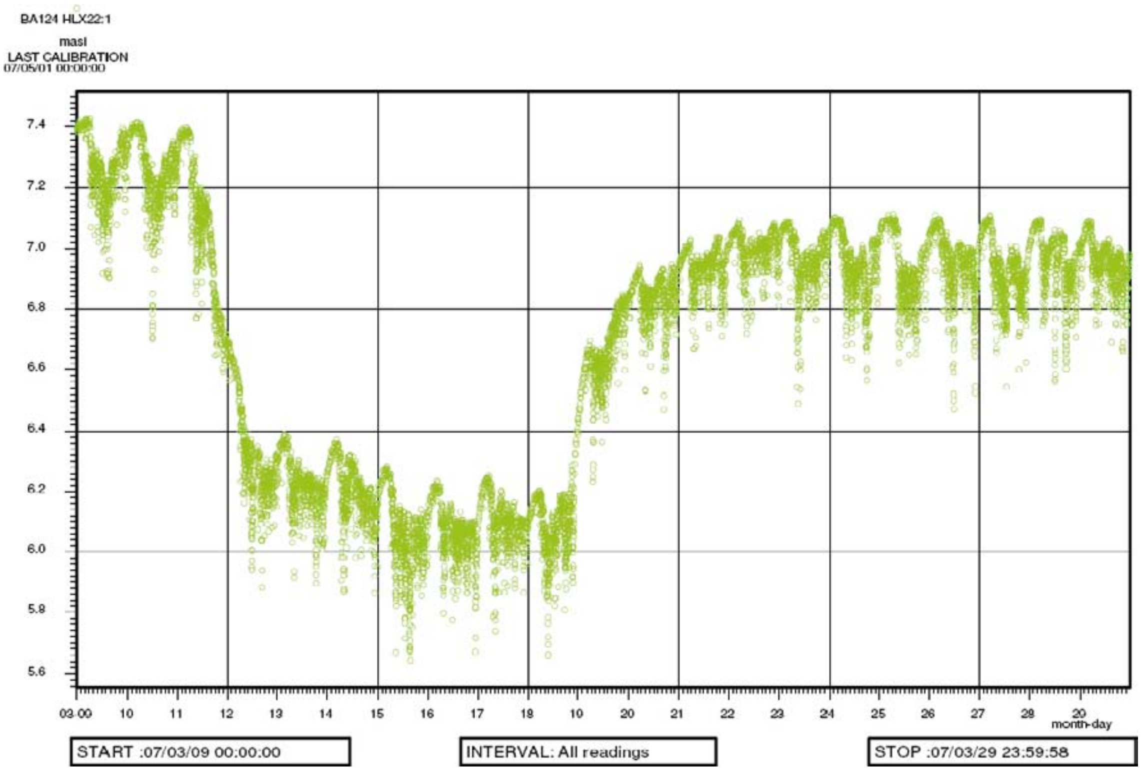

Figure 6-34. *Linear plot of pressure versus time in the observation borehole HLX22 during pumping in borehole KLX21B.*

Table 6-25. General test data from the observation section HLX22: 9.0–163.2 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	7.1
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	6.0
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	7.0
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	1.13

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. During the recovery period a transition to PSF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $2.0 \cdot 10^{-4}$ m²/s and selected representative storativity is $1.8 \cdot 10^{-5}$.

6.8.5 Observation borehole KLX12A

In Figure 6-35 and Figure 6-36 an overview of the observed head versus time in the sections in observation borehole KLX12A is shown. No responses were observed in sections 1, 2, 3 and 5. In sections 4, 6, 7, 8 and 9 a response to the pumping in borehole KLX21B was indicated.

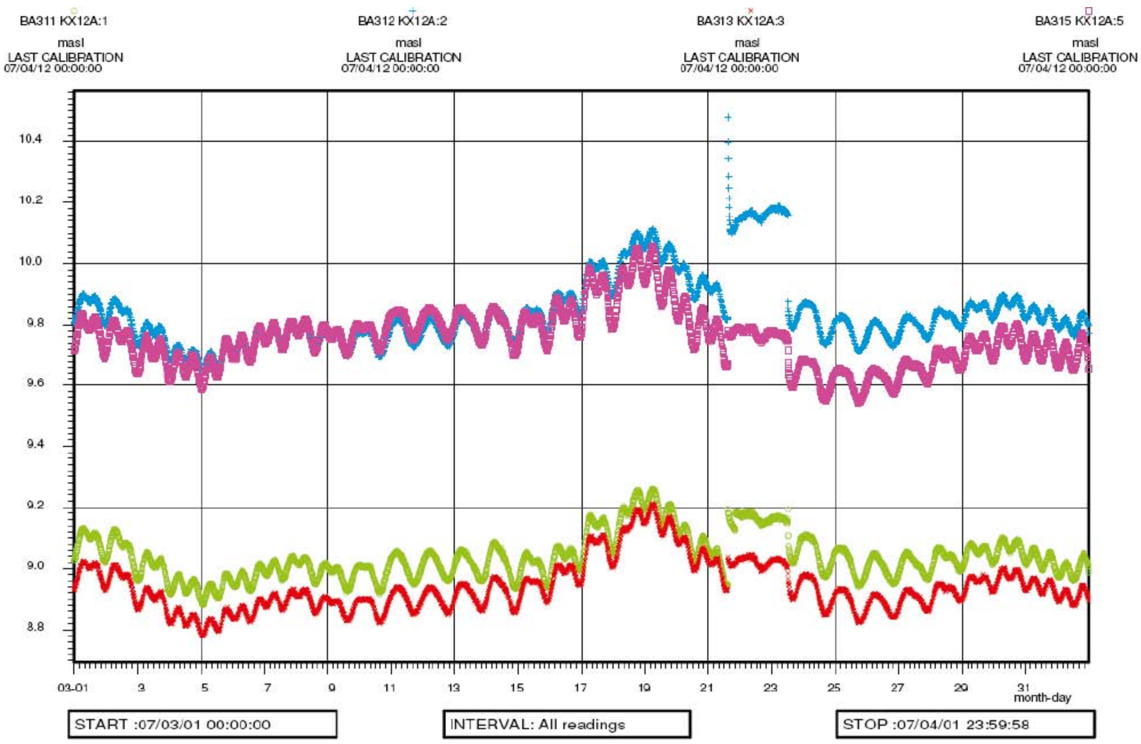

Figure 6-35. *Linear plot of ground water levels in the observation borehole KLX12A sections 1, 2, 3 and 5 during pumping in borehole KLX21B. The figure shows that the levels in these sections in KLX12A seems to be unaffected by the pumping in KLX21B, performed 2007-03-11–2007-03-18.*

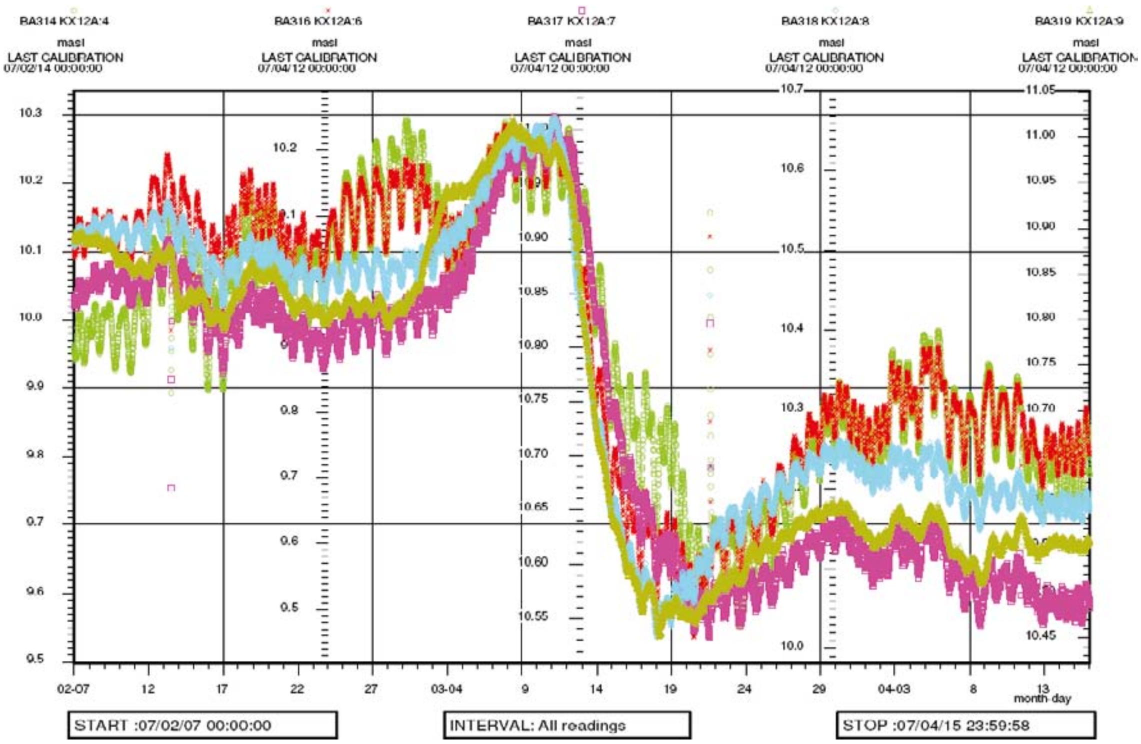

Figure 6-36. *Linear plot of pressure versus time in the observation borehole KLX12A, sections 4, 6, 7, 8 and 9, during pumping in borehole KLX21B.*

The response in this borehole is partly disturbed by precipitation which may affect both the drawdown and recovery as discussed above, se Figure 6-36.

Unaffected sections in borehole KLX12A

The three sections 1, 2, 3 and 5 (546.0–602.29 m, 535.0–545.0 m, 426.0–535.0 m and 291.0–385.0 m respectively) in this borehole appear to be virtually unaffected by the pumping in KLX21B, Figure 6-29. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping.

Observation section KLX12A:4: 386.0–425.0 m

In Figure 6-36 an overview of the pressure response in observation borehole KLX12A:4 is shown. General test data from the observation section KLX12A:4: 386.0–425.0 m are presented in Table 6-26.

Table 6-26. General test data from the observation section KLX12A:4: 386.0–425.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.2
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.9
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	9.8
Hydraulic head change during flow period ($h_i – h_p$)	dh_p	m	0.34

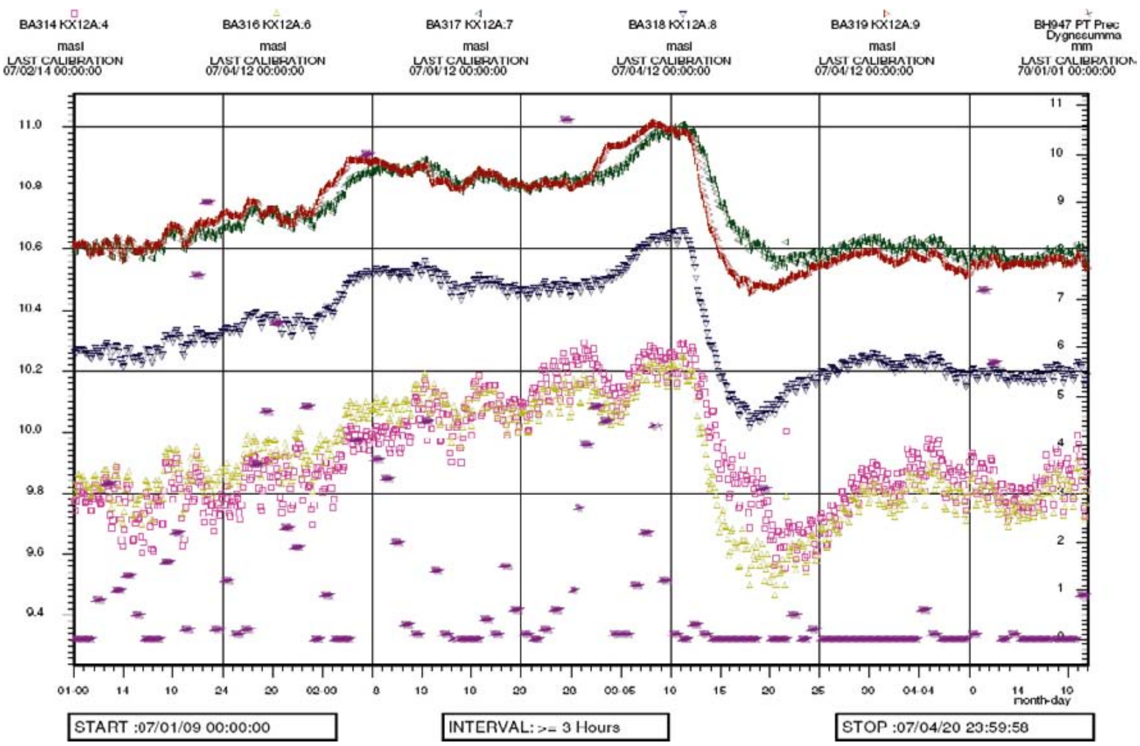

Figure 6-37. *Linear plot of precipitation and ground water level in the observation borehole KLX12A during pumping in borehole KLX21B.*

Comments on the test

The total drawdown during the flow period was 0.34 m. After an initial rise of the hydraulic head after the end of the flow period a decrease in hydraulic is observed due to a natural declining head coinciding with the test. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "low".

Flow regime and calculated parameters

The flow period is dominated by a transition to PSF by the end. The responses during both the flow and recovery period are considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.5 \cdot 10^{-5}$ m^2/s and selected representative storativity is $2.9 \cdot 10^{-5}$.

Observation section KLX12A:6: 160.0–290.0 m

In Figure 6-36 an overview of the pressure response in observation borehole KLX12A:6 is shown. General test data from the observation section KLX12A:6: 160.0–290.0 m are presented in Table 6-27.

Comments on the test

A total drawdown during the flow period of 0.54 m was registred. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "low".

Flow regime and calculated parameters

The flow period is dominated by a short PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $4.8 \cdot 10^{-5}$ m^2/s and selected representative storativity is $4.5 \cdot 10^{-5}$.

Table 6-27. General test data from the observation section KLX12A:6: 160.0–290.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.2
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.6
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	9.7
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.54

Observation section KLX12A:7: 142.0–159.0 m

In Figure 6-36 an overview of the pressure response in observation borehole KLX12A:7 is shown. General test data from the observation section KLX12A:7: 142.0–159.0 m are presented in Table 6-28.

Comments on the test

A total drawdown during the flow period of 0.37 m and a total recovery at the end of the recovery period of 0.03 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "low".

Flow regime and calculated parameters

The flow period is dominated by a short PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $6.3 \cdot 10^{-5}$ m²/s and selected representative storativity is $8.4 \cdot 10^{-5}$.

Observation section KLX12A:8: 104.0–141.0 m

In Figure 6-36 an overview of the pressure response in observation borehole KLX12A:8 is shown. General test data from the observation section KLX12A:8: 104.0–141.0 m are presented in Table 6-29.

Table 6-28. General test data from the observation section KLX12A:7: 142.0–159.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	11.0
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	10.6
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.6
Hydraulic head change during flow period ($h_i – h_p$)	dh_p	m	0.37

Table 6-29. General test data from the observation section KLX12A:8: 104.0–141.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.6
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	10.1
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.2
Hydraulic head change during flow period ($h_i – h_p$)	dh_p	m	0.57

Comments on the test

A total drawdown during the flow period of 0.57 m and a total recovery at the end of the recovery period of 0.1 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "low".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.4 \cdot 10^{-4}$ m^2/s and selected representative storativity is $6.4 \cdot 10^{-5}$.

Observation section KLX12A:9: 17.9–103.0 m

In Figure 6-36 an overview of the pressure response in observation borehole KLX12A:9 is shown. General test data from the observation section KLX12A:9: 17.9–103.0 m are presented in Table 6-30. The borehole is cased to 17.9 m, The uncased interval of this upper section is thus c. 17.9–103.0 m.

Comments on the test

A total drawdown during the flow period of 0.50 m and a total recovery at the end of the recovery period of 0.1 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "low".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $7.5 \cdot 10^{-5}$ m^2/s and selected representative storativity is $5.5 \cdot 10^{-5}$.

Table 6-30. General test data from the observation section KLX12A:9: 17.9–103.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	11.0
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	10.5
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.6
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.50

6.8.6 Observation borehole KLX05

In Figure 6-38 and Figure 6-39 an overview of the observed head versus time in the sections in observation borehole KLX05 is shown. No responses were observed in sections 1, 2, 3 and 4. In sections 5, 6, 7, 8, 9 and 10 a response to the pumping in borehole KLX21B was indicated.

The response in this borehole is partly disturbed by precipitation which may affect drawdown and recovery as discussed above, se Figure 6-34.

Unaffected sections in borehole KLX05

The four sections 1, 2, 3 and 4 (721.0–1,000.2 m, 634.0–720.0 m, 625.0–633.0 m and 501.0–624.0 m respectively) in this borehole appear to be virtually unaffected by the pumping in KLX21B, Figure 6-38. The oscillating behaviour, discussed previously, makes it hard to distinguish any influence from the pumping.

Observation section KLX05:5: 361.0–500.0 m

In Figure 6-39 an overview of the pressure responses in observation borehole KLX05 is shown. General test data from the observation section KLX05:5: 361.0–500.0 m are presented in Table 6-31.

Comments on the test

A total drawdown during the flow period of 0.69 m and a total recovery at the end of the recovery period of 0.3 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 $(s_p/Q_p)\cdot\ln(r_s/r_0)$ as "medium".

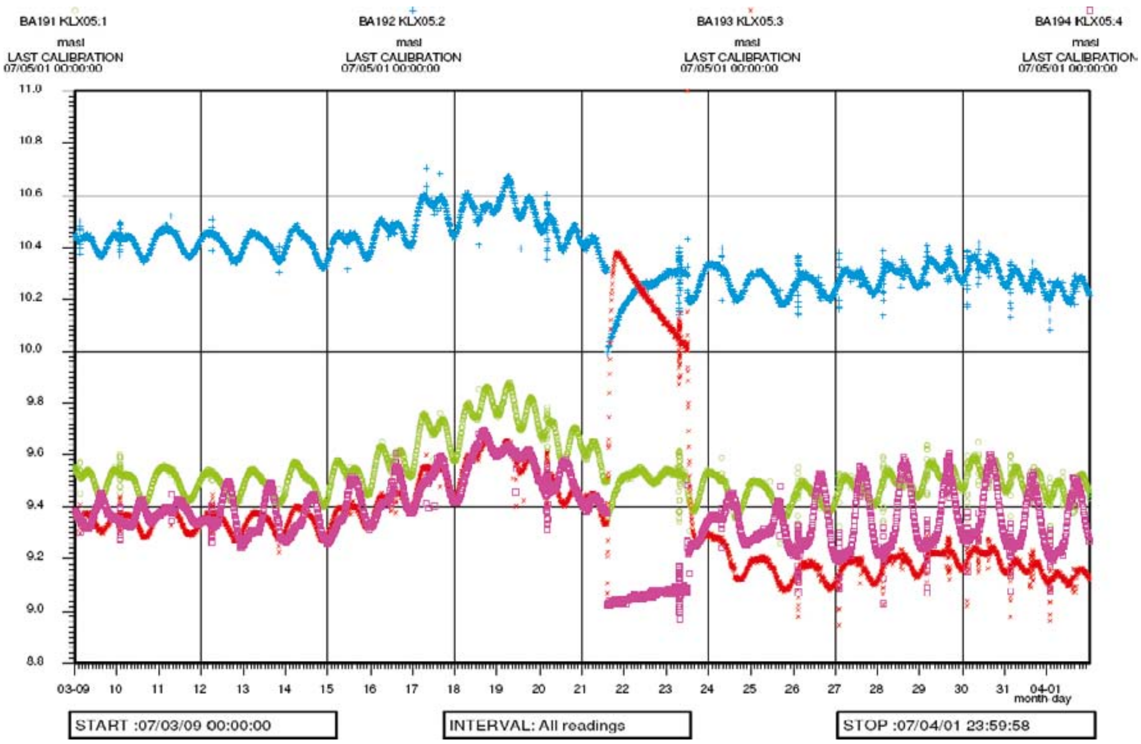

Figure 6-38. Linear plot of ground water level in the observation borehole KLX05 sections 1, 2, 3 and 4 during pumping in borehole KLX21B. The figure shows that the levels in these sections in KLX05 seems to be unaffected by the pumping in KLX21B, performed 2007-03-11–2007-03-18.

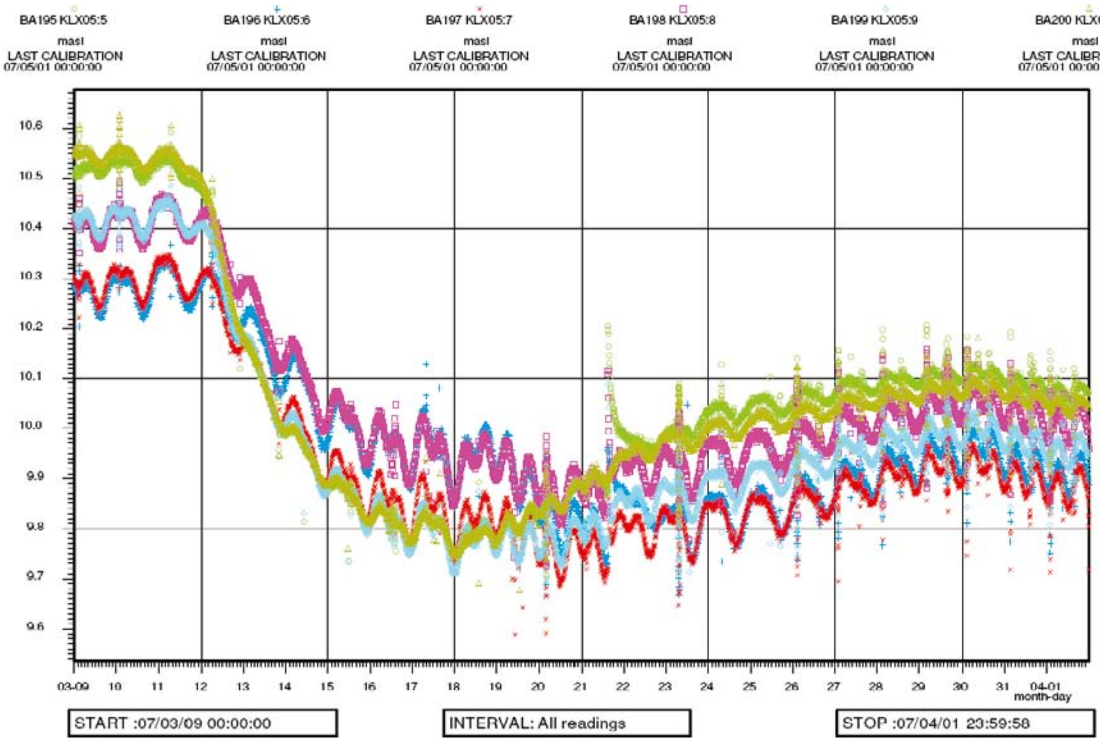

Figure 6-39. *Linear plot of pressure versus time in the observation borehole KLX05, sections 5, 6, 7, 8, 9 and 10, during pumping in borehole KLX21B.*

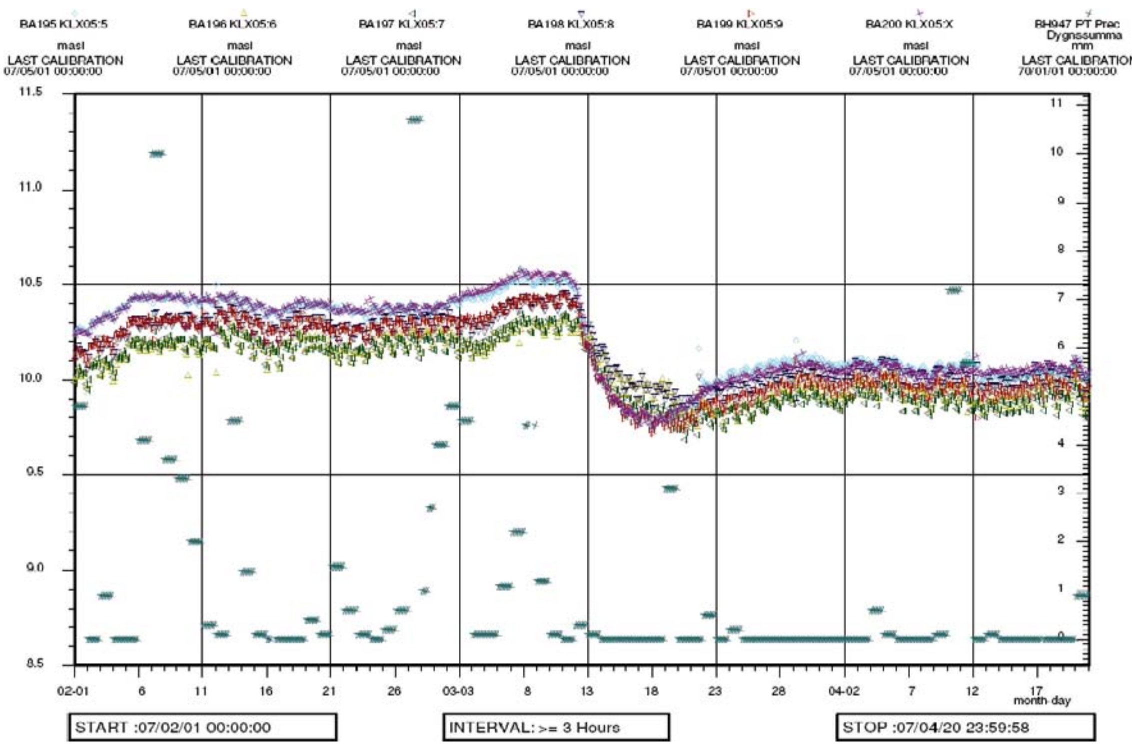

Figure 6-40. *Linear plot of precipitation and ground water level in the observation borehole KLX05 during pumping in borehole KLX21B.*

Table 6-31. General test data from the observation section KLX05:5: 361.0–500.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.4
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.8
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.1
Hydraulic head change during flow period ($h_i – h_p$)	dh_p	m	0.69

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $7.0 \cdot 10^{-5}$ m^2/s and selected representative storativity is $3.0 \cdot 10^{-5}$.

Observation section KLX05:6: 256.0–360.0 m

In Figure 6-39 an overview of the pressure responses in observation borehole KLX05 is shown. General test data from the observation section KLX05:6: 256.0–360.0 m are presented in Table 6-32.

Comments on the test

A total drawdown during the flow period of 0.26 m was registered. A further decrease in hydraulic head after stop of the flow period is due to a natural declining head coinciding with the test. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "low".

Flow regime and calculated parameters

The flow period is dominated by a transition to PSF by the end. The responses during both the flow and recovery period are considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Table 6-32. General test data from the observation section KLX05:6: 256.0–360.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.3
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	10.0
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	9.9
Hydraulic head change during flow period ($h_i – h_p$)	dh_p	m	0.26

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.2 \cdot 10^{-5}$ m^2/s and selected representative storativity is $2.2 \cdot 10^{-5}$.

Observation section KLX05:7: 241.0–255.0 m

In Figure 6-39 an overview of the pressure responses in observation borehole KLX05 is shown. General test data from the observation section KLX05:7: 241.0–255.0 m are presented in Table 6-33.

Comments on the test

The total drawdown during the flow period was 0.42 m. A further decrease in hydraulic head after the stop of the flow period is due to a natural declining head coinciding with the test. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 $(s_p/Q_p) \cdot \ln(r_s/r_0)$ as "low".

Flow regime and calculated parameters

The flow period is dominated by a short PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $4.0 \cdot 10^{-5}$ m^2/s and selected representative storativity is $4.2 \cdot 10^{-5}$.

Observation section KLX05:8: 220.0–240.0 m

In Figure 6-39 an overview of the pressure responses in observation borehole KLX05 is shown. General test data from the observation section KLX05:8: 220.0–240.0 m are presented in Table 6-34.

Comments on the test

A total drawdown during the flow period of 0.59 m and a total recovery at the end of the recovery period of 0.2 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "low" and the new Index 2 $(s_p/Q_p) \cdot \ln(r_s/r_0)$ as "low".

Table 6-33. General test data from the observation section KLX05:7: 241.0–255.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.3
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.9
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	9.8
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.42

Table 6-34. General test data from the observation section KLX05:8: 220.0–240.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.4
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.8
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.0
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.59

Flow regime and calculated parameters

The flow period is dominated by a short PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. No unambiguous transient evaluation could be made on the recovery period.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $4.0 \cdot 10^{-5}$ m^2/s and selected representative storativity is $4.2 \cdot 10^{-5}$.

Observation section KLX05:9: 128.0–219.0 m

In Figure 6-39 an overview of the pressure responses in observation borehole KLX05 is shown. General test data from the observation section KLX05:9: 128.0–219.0 m are presented in Table 6-35.

Comments on the test

A total drawdown during the flow period of 0.60 m and a total recovery at the end of the recovery period of 0.2 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "low" and the new Index 2 $(s_p/Q_p) \cdot \ln(r_s/r_0)$ as "low".

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated. The transient evaluation of the recovery period is uncertain.

Table 6-35. General test data from the observation section KLX05:9: 128.0–219.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.4
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.8
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.0
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.60

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $6.3 \cdot 10^{-5}$ m^2/s and selected representative storativity is $4.2 \cdot 10^{-5}$.

Observation section KLX05:10: 15.0–127.0 m

In Figure 6-39 an overview of the pressure responses in observation borehole KLX05 is shown. General test data from the observation section KLX05:10: 15.0–127.0 m are presented in Table 6-36. The borehole is cased to 15.0 m, the uncased interval of this upper section is thus c. 15.0–127.0 m.

Comments on the test

A total drawdown during the flow period of 0.72 m and a total recovery at the end of the recovery period of 0.3 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as “high”, Index 2 (s_p/Q_p) as “low” and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as “medium”.

Flow regime and calculated parameters

The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated. The transient evaluation of the recovery period is uncertain.

Selected representative parameters

The transient evaluation of the flow period is selected as representative for the test. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $7.6 \cdot 10^{-5}$ m^2/s and selected representative storativity is $3.4 \cdot 10^{-5}$.

6.8.7 Observation borehole HLX23

Both the sections in this borehole (61.0–160.2 m and 6.0–60.0 m appear to be virtually unaffected by the pumping in KLX21B, Figure 6-41. The oscillating behaviour, discussed previously, in combination with other external effects makes it hard to distinguish any influence from the pumping.

6.8.8 Observation borehole HLX18

Both sections in this borehole (90.0–181.2 m and 15.0–89.0 m) appears to be virtually unaffected by the pumping in KLX21B, Figure 6-42. The oscillating behaviour, discussed previously, in combination with other external effects makes it hard to distinguish any influence from the pumping.

Table 6-36. General test data from the observation section KLX05:10: 15.0–127.0 m during the interference test in KLX21B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.5
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	9.8
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.1
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.72

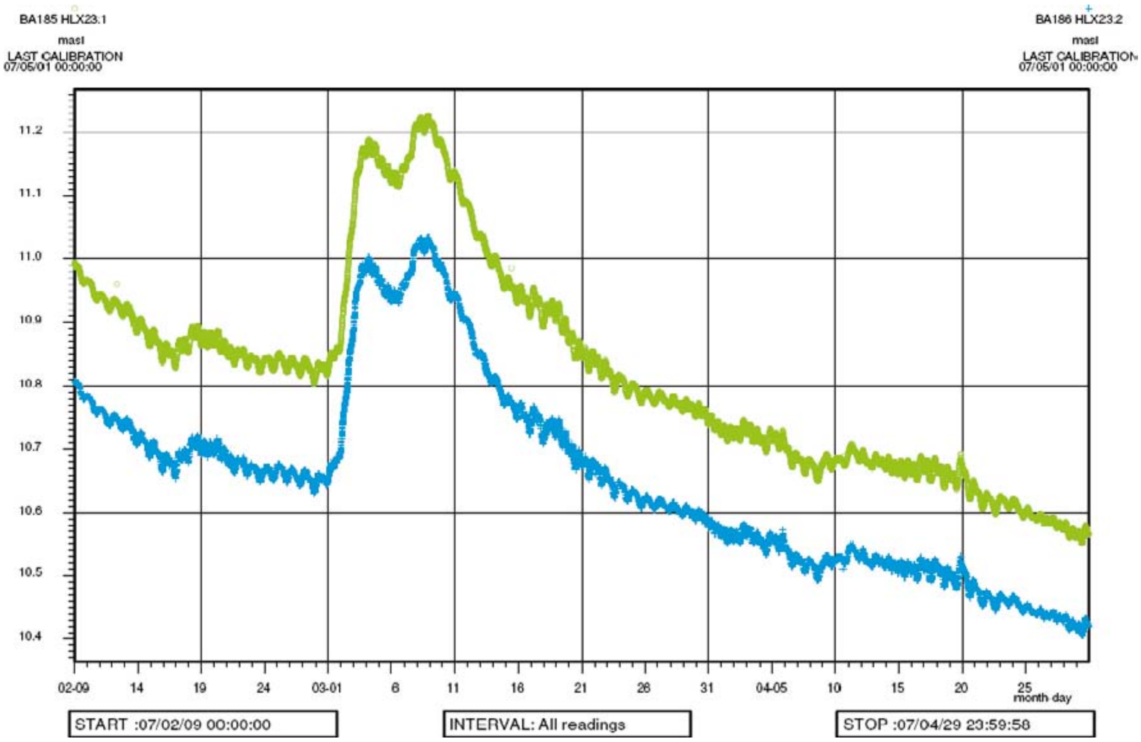

Figure 6-41. *Linear plot of ground water level in the observation borehole HLX23 during pumping in borehole KLX21B. The figure shows that the levels in HLX23 seems to be unaffected by the pumping in KLX21B, performed 2007-03-11–2007-03-18.*

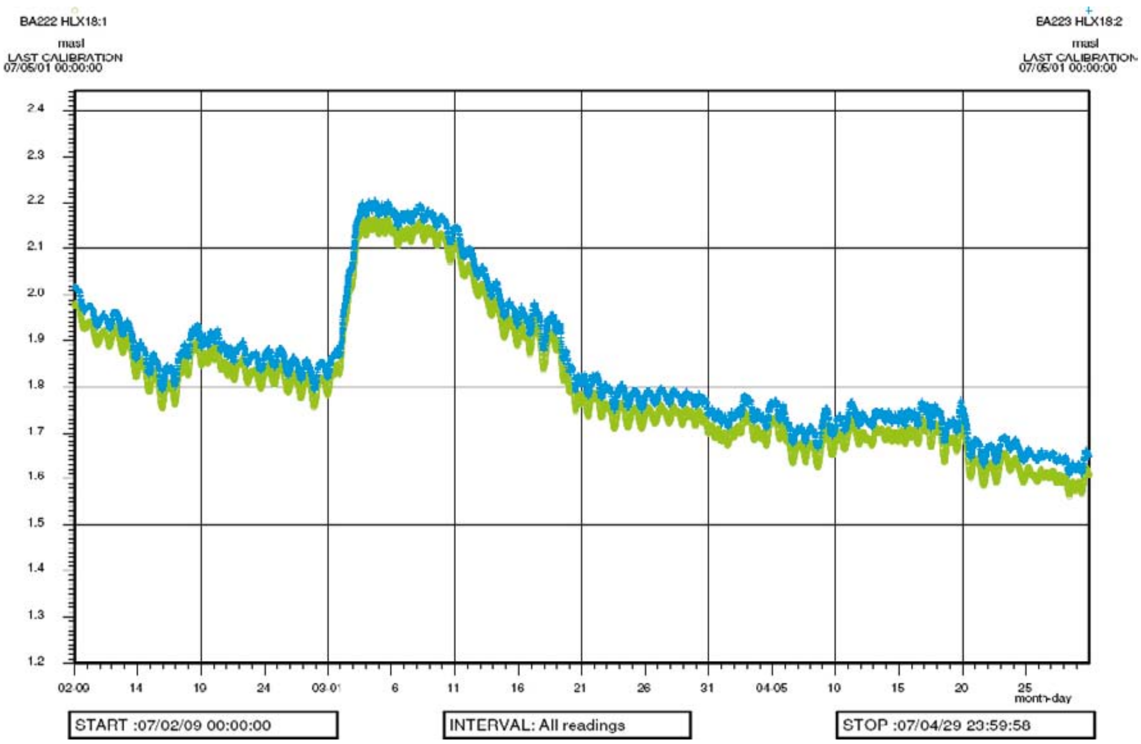

Figure 6-42. *Linear plot of ground water level in the observation borehole HLX18 during pumping in borehole KLX21B. The figure shows that the levels in HLX18 seems to be unaffected by the pumping in KLX21B, performed 2007-03-11–2007-03-18.*

6.9 Interference test in KLX22A

This borehole was drilled in the framework of a programme to investigate local minor deformation zones (MDZ) /22/. The objective with this interference tests form part of the characterization of zone XSM000008 and its connectivity with zone XSM000009 where KLX22B is drilled. The test was permorde in conjunction with the PFL difference flow logging. A borehole response map is shown in Figure 6-43.

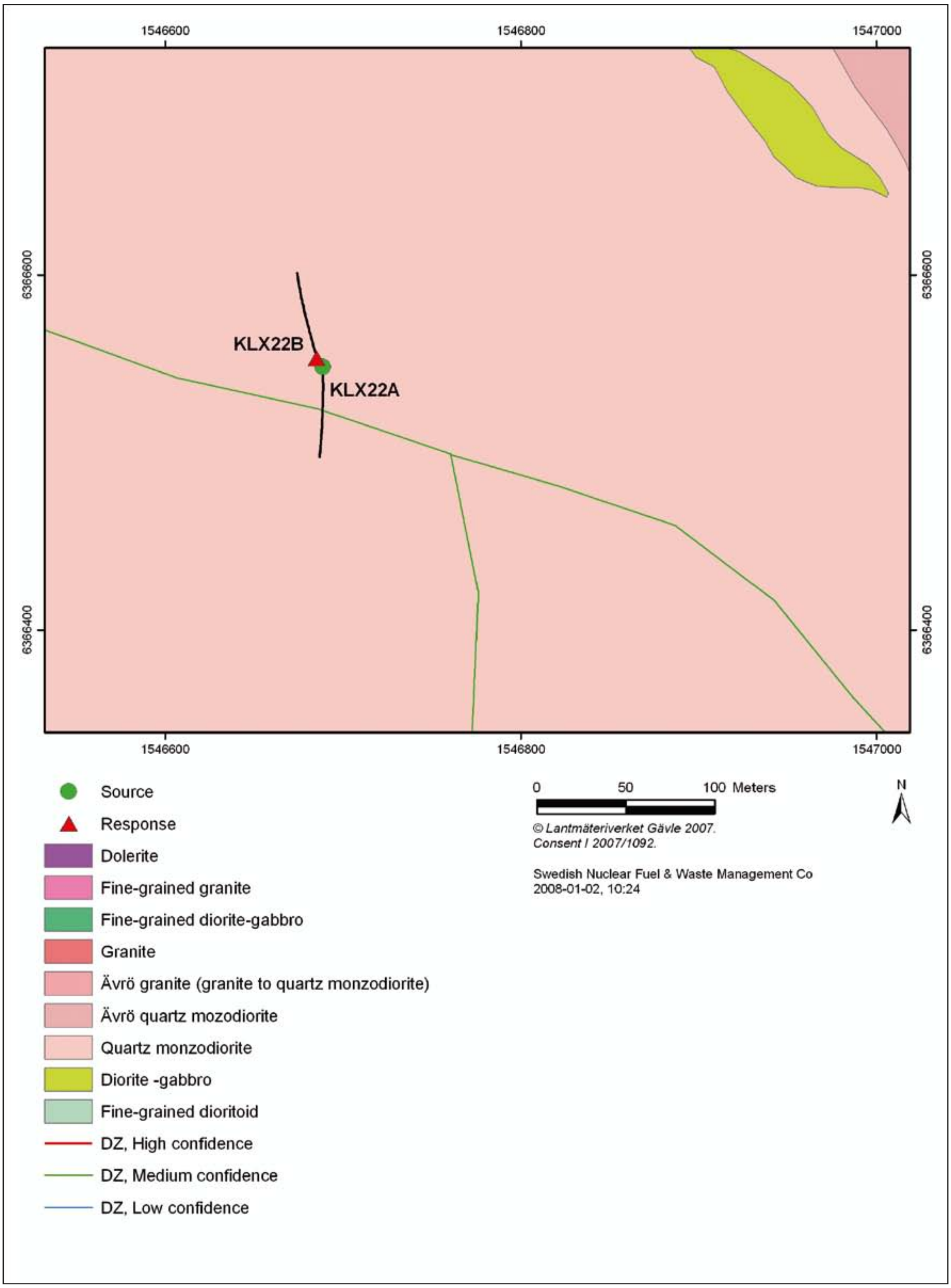

Figure 6-43. *Borehole response map when pumping KLX22A.*

6.9.1 Pumping borehole KLX22A

General test data for the pumping test in KLX22A are presented in Table 6-37. The borehole is cased to 2.0 m. The uncased interval of this section is thus c. 2.0–100.45 m.

Comments on the test

The test was performed as a pumping test with constant drawdown and slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 8.7 L/min and the duration of the flow period was c. 3 days. The flow rate history during the flow period is rather uncertain. A total drawdown during the flow period of 10.03 m and a total recovery at the end of the recovery period of 9.47 m was observed.

Table 6-37. General test data for the pumping test in KLX22A: 2.0–100.45 m.

General test data			
Pumping borehole	KLX22A		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	100.45
Casing length	L_c	m	2.0
Test section- secup	Secup	m	2.0
Test section- seclow	Seclow	m	100.45
Test section length	L_w	m	98.45
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	060718 15:37
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	060718 15:37:00
Stop of flow period		yymmdd hh:mm:ss	060721 10:13:00
Test stop (stop of flow period)		yymmdd hh:mm	060721 10:13
Total flow time	t_p	min	3,996
Total recovery time	t_F	min	2,981
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	133.7
Relative pressure in test section before stop of flow period	p_p	kPa	35.3
Relative pressure in test section at stop of recovery period	p_F	kPa	128.2
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	98.4
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.000145
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.000145
Total volume discharged during flow period	V_p	m^3	35.8

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

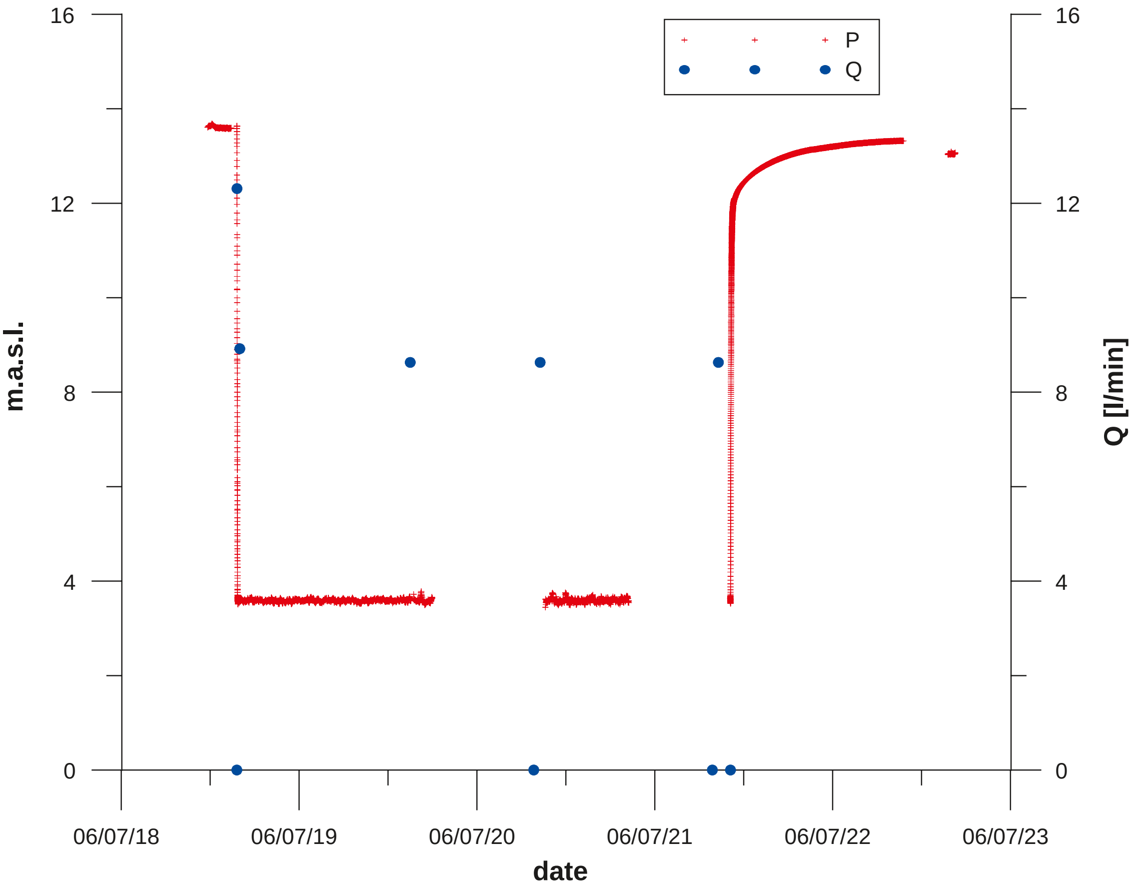

***Figure 6-44.** Linear plot of flow rate and pressure versus time in the pumping borehole KLX22A.*

Flow regime and calculated parameters

The transient evaluation is based on varying flow rate during the flow period initial wellbore storage effects are followed by a distinct transition to a pseudo-steady state after c. 5 min. During the recovery period initial wellbore storage effects are followed by a transition to approximate pseudo-radial flow regime between c. 20–600 min.

Selected representative parameters

The parameter values from evaluation of the recovery period are selected as the most representative. Evaluation was performed by applying the Dougherty-Babu solution to a confined aquifer model. Selected representative transmissivity value is $3.3 \cdot 10^{-5}$ m^2/s for an estimated storativity of $4.0 \cdot 10^{-6}$.

6.9.2 Observation borehole KLX22B

In Figure 6-45 an overview of the pressure responses in observation borehole KLX22B is shown. General test data from the observation section KLX22B: 2.0–100.25 m, are presented in Table 6-38. The borehole is cased to 2.0 m, the uncased interval of this borehole is thus c. 2.0–100.25 m.

Comments on the test

A total drawdown during the flow period of 0.8 m and a total recovery at the end of the recovery period of 0.6 m was observed. Some abrupt flow changes causes the head variations. The total drawdown is in this section the evaluated maximal head which in this case not is equal to the difference between the head at flow stop and head at flow start. The calculated Index 1 (r_s^2/t_L) is rated as "low", Index 2 (s_p/Q_p) as "medium" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "medium".

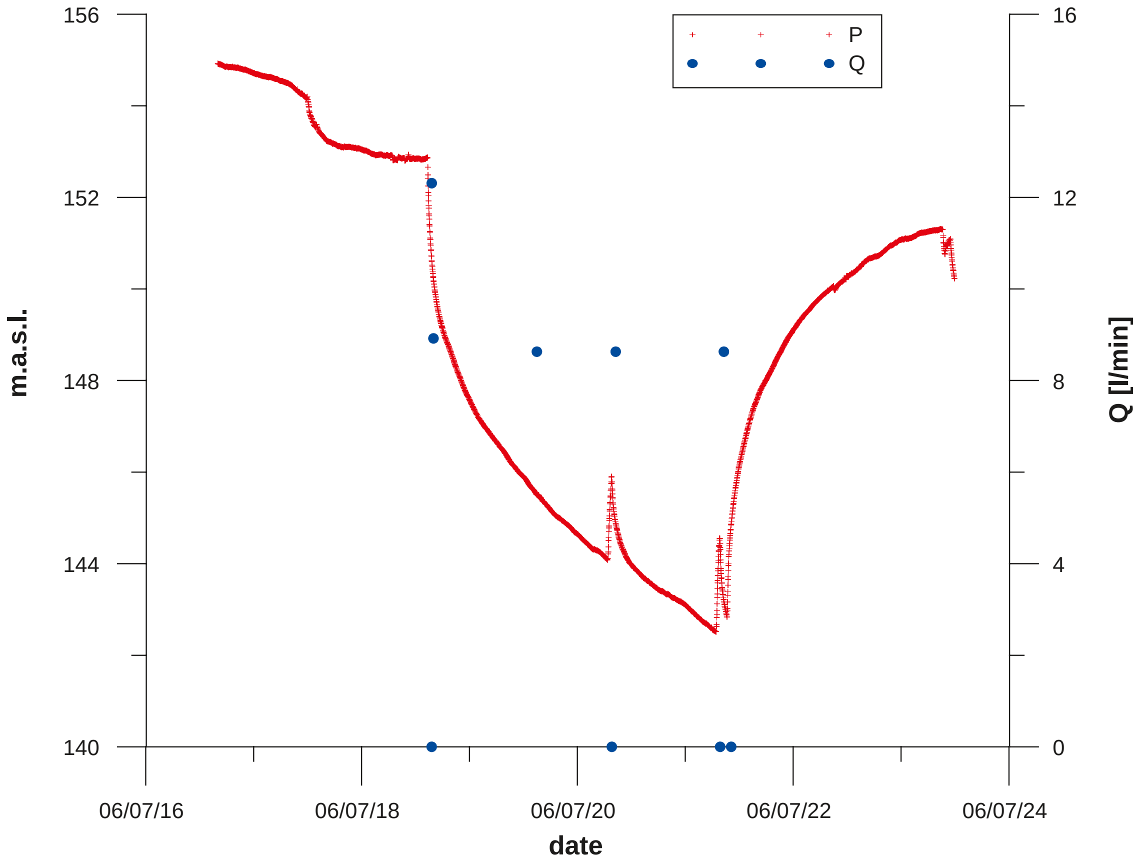

Figure 6-45. Linear plot of pressure versus time in the observation borehole KLX22B during pumping in borehole KLX22A. Flow data for the pumping borehole KLX22A are also plotted to highlight the quick pressure response.

Table 6-38. General test data from the observation section KLX22B: 2.0–100.25 m during the interference test in KLX22A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	15.4
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	14.8
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	15.4
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.8

Flow regime and calculated parameters

The transient evaluation is based on varying flow rate. During both the flow and recovery period a transition towards a possible pseudo-radial flow regime occurred. The agreement of the estimated transmissivity from the flow and recovery period respectively is good.

Selected representative parameters

The parameter values from the flow period are selected as the most representative. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $5.2 \cdot 10^{-5}$ m^2/s and representative storativity of $2.9 \cdot 10^{-4}$.

6.10 Interference test in KLX22B

This test was performed with KLX22A as observation borehole. However, data from KLX22A could not be analysed since no data was sampled in this borehole during the test period due to failure of the data logger.

6.10.1 Pumping borehole KLX22B

General test data for the pumping test in KLX22B are presented in Table 6-39. The borehole is cased to 2.0 m. The uncased interval of this section is thus c. 2.0–100.25 m.

Table 6-39. General test data for the pumping test in KLX22B: 2.0–100.25 m.

General test data			
Pumping borehole	KLX22B		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	100.25
Casing length	L_c	m	2.0
Test section- secup	Secup	m	2.0
Test section- seclow	Seclow	m	100.25
Test section length	L_w	m	98.25
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	060726 16:41
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	060726 16:41:00
Stop of flow period		yymmdd hh:mm:ss	060729 13:59:00
Test stop (stop of flow period)		yymmdd hh:mm	060729 13:59
Total flow time	t_p	min	4,158
Total recovery time	t_F	min	1,184
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	159.9
Relative pressure in test section before stop of flow period	p_p	kPa	59.8
Relative pressure in test section at stop of recovery period	p_F	kPa	149.6
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	100.1
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.0000583
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.0000583
Total volume discharged during flow period	V_p	m^3	14.5

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

Comments on the test

The test was performed as a drawdown pumping test with slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 3.5 L/min and the duration of the flow period was c. 3 days. The reported flow rate is very uncertain especially at the end of the flow period and pressure data are lacking for some periods (cf. Figure 6-39). A total drawdown during the flow period of 10.20 m and a total recovery at the end of the recovery period of 9.15 m was observed.

Flow regime and calculated parameters

The transient evaluation is based on variable rate. During the flow period, initial wellbore storage effects are transitioning to a near pseudo-steady state after c. 10 minutes. During the recovery period initial wellbore storage effects are transitioning to pseudo-radial flow regime. The agreement in estimated parameter values is good between the flow and recovery period.

Selected representative parameters

The parameter values from the recovery period are selected as the most representative. Evaluation was performed by applying the Dougherty-Babu solution to a confined aquifer model. Selected representative transmissivity value is $3.4 \cdot 10^{-6}$ m^2/s for an estimated storativity of $1.1 \cdot 10^{-6}$.

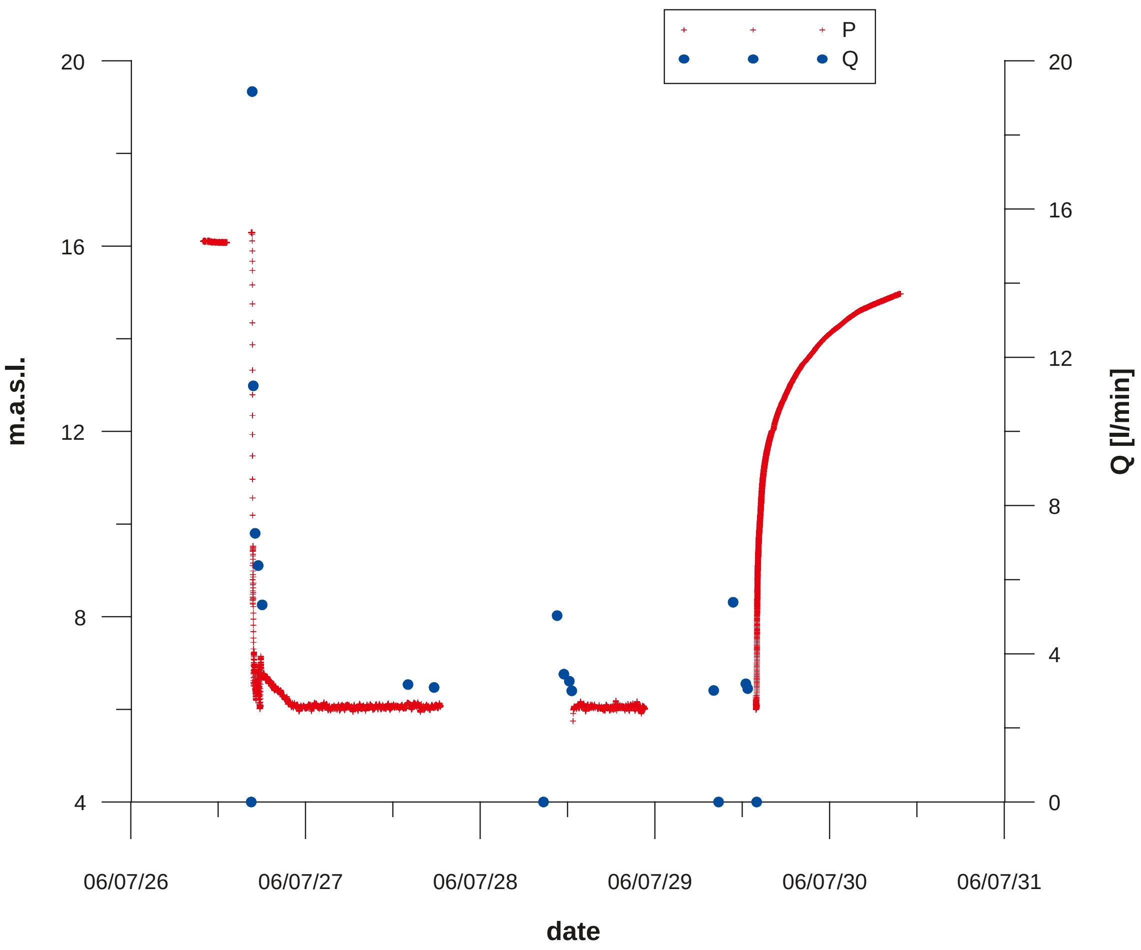

Figure 6-46. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX22B.*

6.11 Interference test in KLX23A

This borehole was drilled in the framework of a programme to investigate local minor deformation zones (MDZ) /22/. The objective with this interference tests form part of the characterization of zone XSM000001 and its connectivity with zone XSM000003 where KLX23B is drilled. The test was performed in conjunction with the PFL difference flow logging. A borehole response map is shown in Figure 6-47.

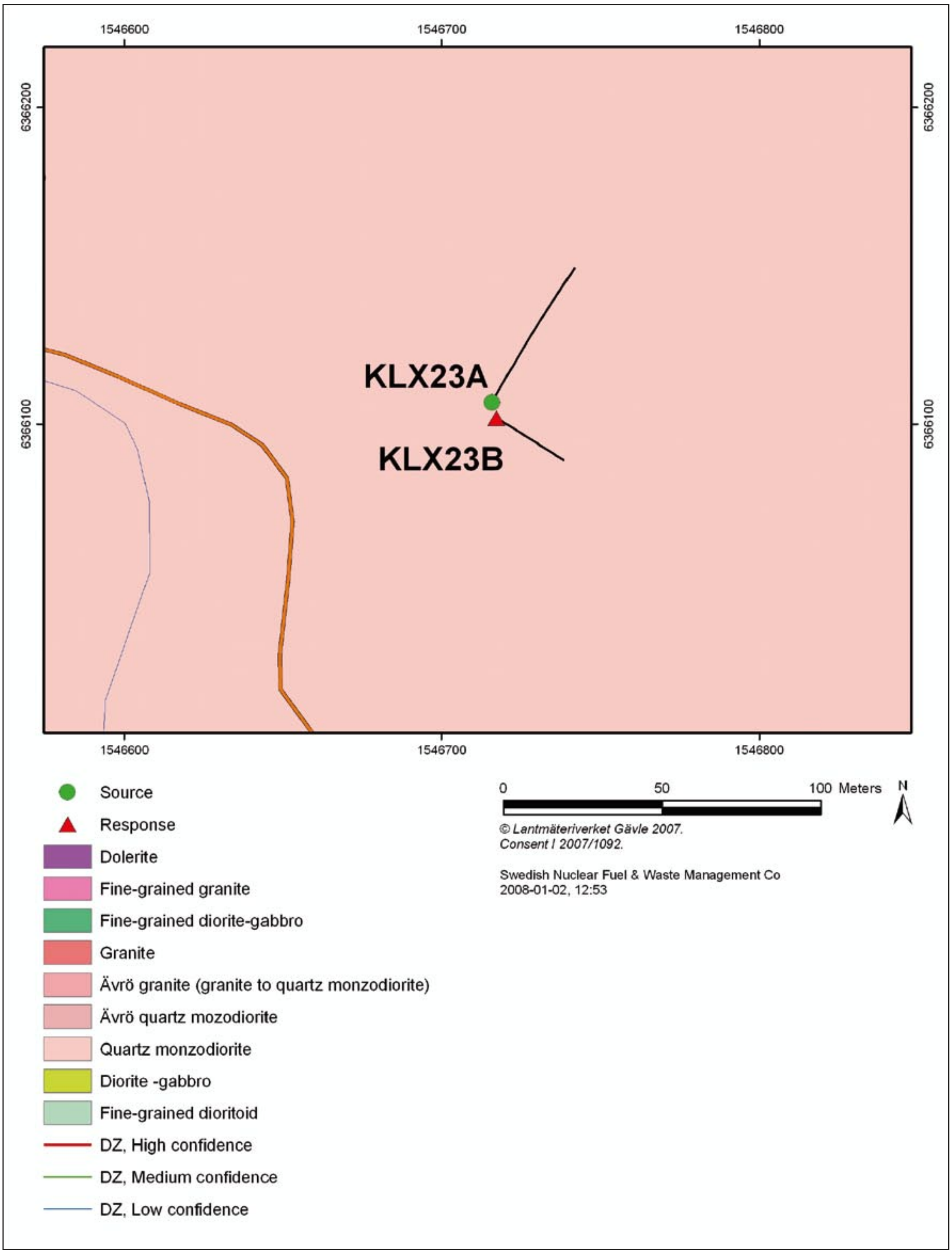

Figure 6-47. *Borehole response map when pumping KLX23A.*

6.11.1 Pumping borehole KLX23A

General test data for the pumping test in KLX23A are presented in Table 6-40. The borehole is cased to 2.3 m. The uncased interval of this section is thus c. 2.3–100.2 m.

Comments on the test

The test was performed as a drawdown pumping test with slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 6.6 L/min and the duration of the flow period was c. 2 days. In the middle of the flow period the drawdown increased due to increasing flow rate and the flow rate varied throughout the flow period. A total drawdown during the flow period of 10.35 m and a total recovery at the end of the recovery period of 9.51 m was observed.

Table 6-40. General test data for the pumping test in KLX23A: 2.3–100.2 m.

General test data			
Pumping borehole	KLX23A		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	100.2
Casing length	L_c	m	2.3
Test section- secup	Secup	m	2.3
Test section- seclow	Seclow	m	100.2
Test section length	L_w	m	97.9
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	060803 15:25
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	060803 15:25:02
Stop of flow period		yymmdd hh:mm:ss	060805 14:44:00
Test stop (stop of flow period)		yymmdd hh:mm	060805 14:44
Total flow time	t_p	min	2,839
Total recovery time	t_F	min	1,089

Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	109.3
Relative pressure in test section before stop of flow period	p_p	kPa	7.7
Relative pressure in test section at stop of recovery period	p_F	kPa	101.0
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	101.6
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.00011
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.00011
Total volume discharged during flow period	V_p	m^3	18.9

1) Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

2) Nominal diameter.

3) The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

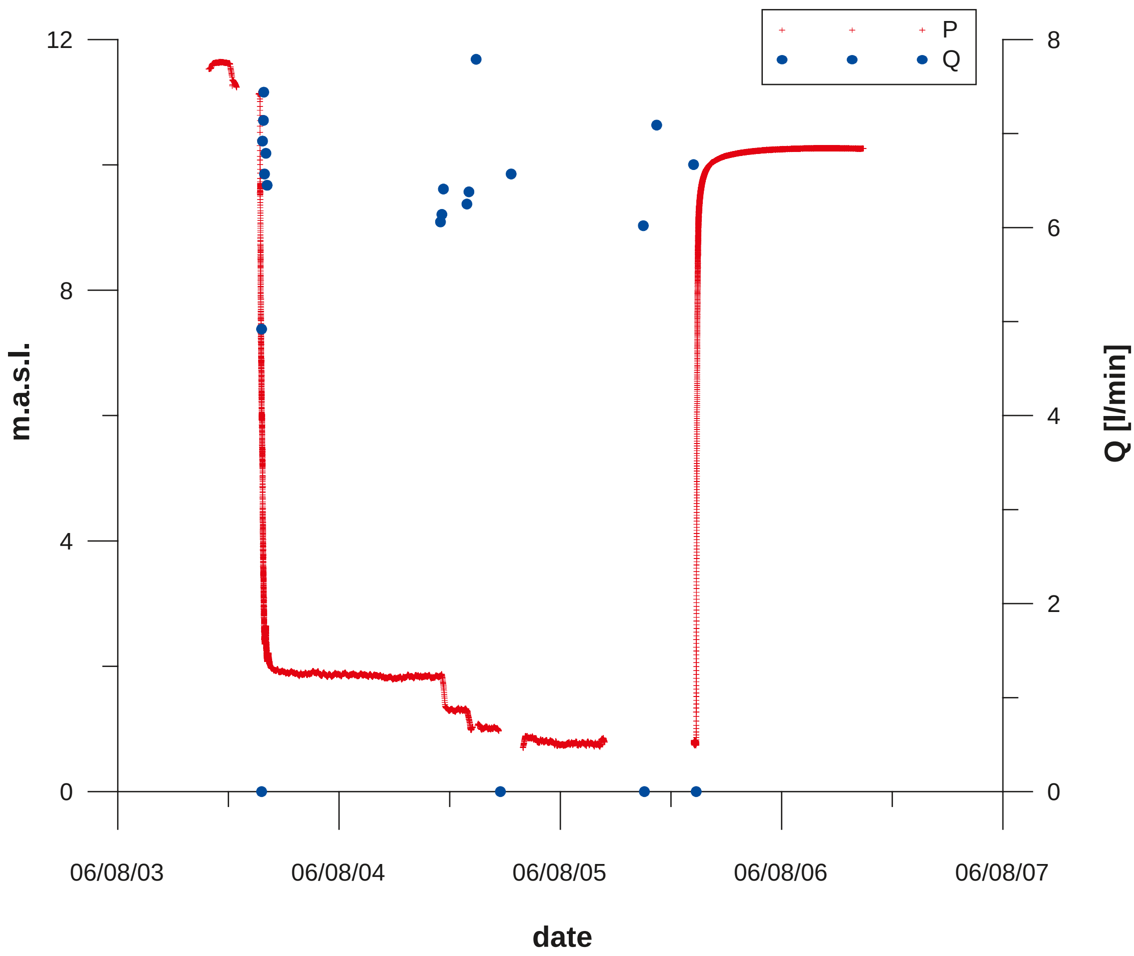

Figure 6-48. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX23A.*

Flow regime and calculated parameters

The transient evaluation is based on a varying flow rate. During both the flow and recovery period, initial wellbore storage effects are followed by a transition to pseudo-spherical (leaky) flow after c. 20 minutes. The agreement in evaluated parameter values between the flow and recovery period is good.

Selected representative parameters

The parameter values from the flow period are selected as the most representative. Evaluation was performed by applying the Moench (Case 1) solution to a leaky aquifer model. Selected representative transmissivity value is $3.0 \cdot 10^{-5}$ m^2/s for an estimated storativity of $3.8 \cdot 10^{-6}$.

6.11.2 Observation borehole KLX23B

In Figure 6-49 an overview of the pressure responses in observation borehole KLX23B is shown. General test data from the observation section KLX23B: 2.3–50.3 m, are presented in Table 6-41.

Comments on the test

A total drawdown during the flow period of 2.1 m and a total recovery at the end of the recovery period of 2.2 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as “medium”, Index 2 (s_p/Q_p) as “medium” and the new Index 2 $(s_p/Q_p) \cdot \ln(r_s/r_0)$ as “high”.

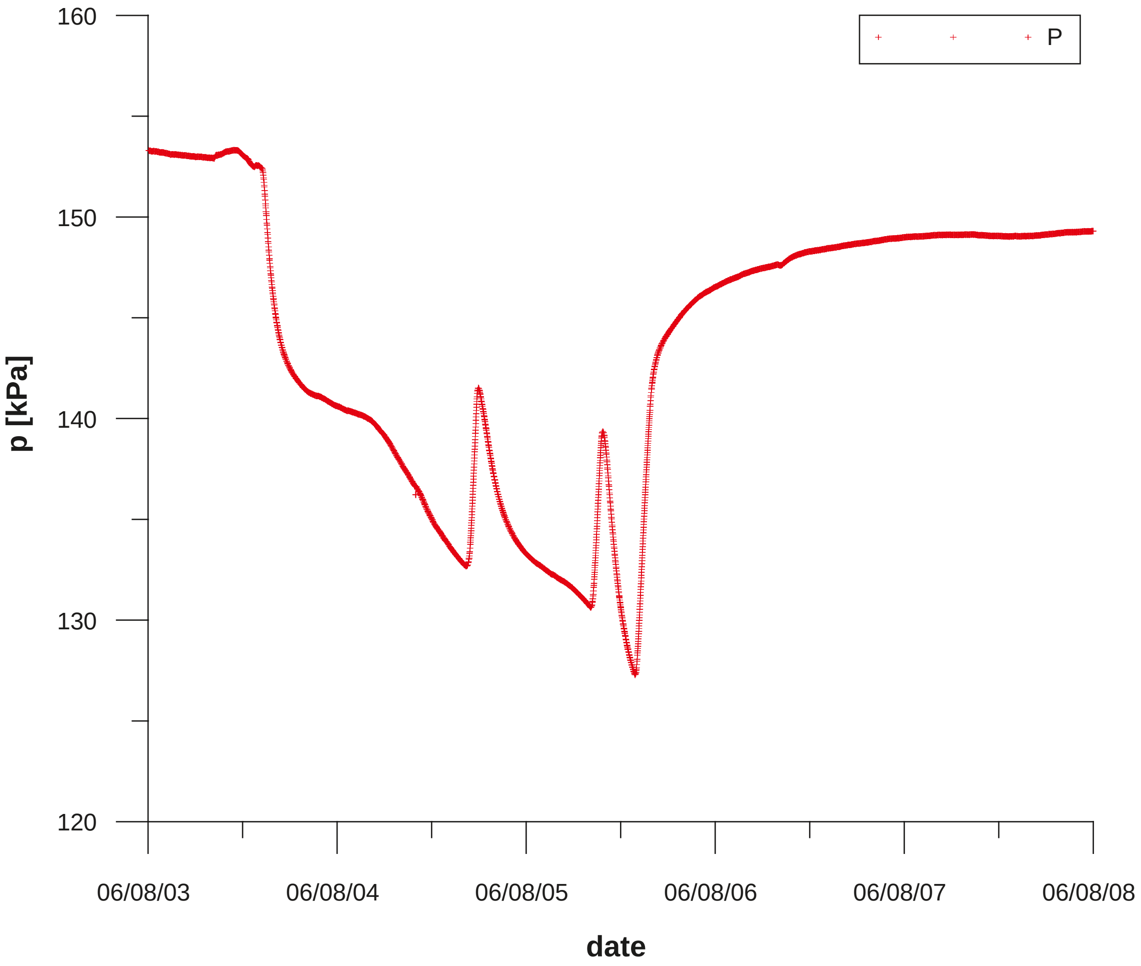

__Figure 6-49.__ Linear plot of pressure versus time in the observation borehole KLX23B during pumping in borehole KLX23A.

Table 6-41. General test data from the observation section KLX23B 2.3–50.3 m during the interference test in KLX23A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	15.1
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	13.0
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	15.2
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	2.1

Flow regime and calculated parameters

The transient evaluation is based on varying flow rate. During the flow period an apparent pseudo-radial flow regime is indicated although large variations in the flow rate occurred by the end. The recovery period indicates a pseudo-radial flow regime between c. 200–800 min. By the end a slight leakage flow is indicated.

Selected representative parameters

The parameter values from the recovery period are selected as the most representative in this case due to the variations in the flow rate during the flow period. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.9 \cdot 10^{-5}$ m^2/s and representative storativity of $1.0 \cdot 10^{-5}$.

6.12 Interference test in KLX23B

This borehole was drilled in the framework of a programme to investigate local minor deformation zones (MDZ) /22/. The objective with this interference tests form part of the characterization of zone XSM000003 and its connectivity with zone XSM000001 where KLX23A is drilled. The test was performed in conjunction with the PFL difference flow logging. A borehole response map is shown in Figure 6-50.

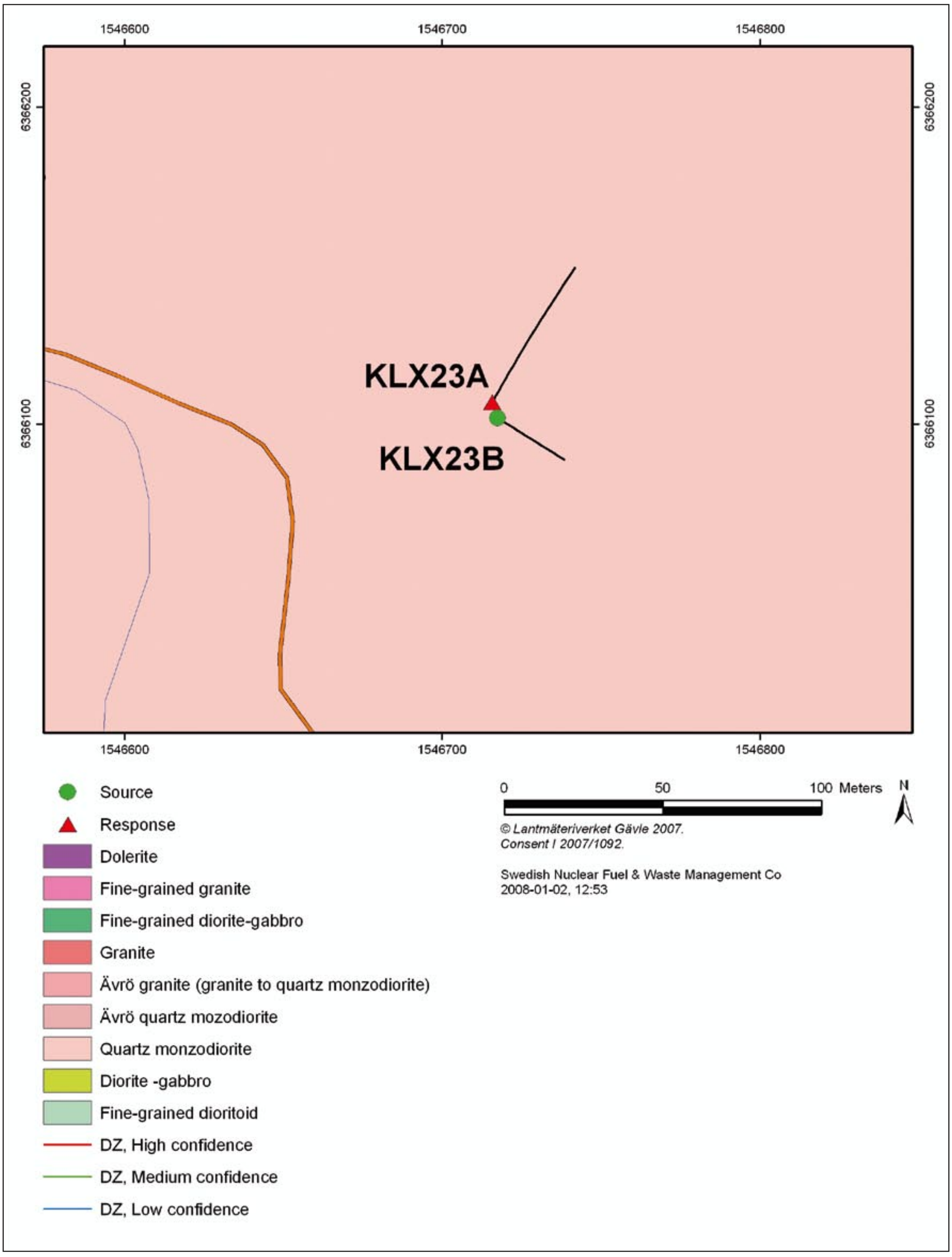

Figure 6-50. *Borehole response map when pumping KLX23B.*

6.12.1 Pumping borehole KLX23B

General test data for the pumping test in KLX23B are presented in Table 6-42. The borehole is cased to 2.3 m. The uncased interval of this section is thus c. 2.3–50.3 m.

Comments on the test

The test was performed as a drawdown pumping test with slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 1.0 L/min and the duration of the flow period was c. 2 days. The flow rate varied during the flow period. A total drawdown during the flow period of 13.32 m and a total recovery at the end of the recovery period of 9.83 m was observed.

Table 6-42. General test data for the pumping test in KLX23B: 2.3–50.3 m.

General test data			
Pumping borehole	KLX23B		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	50.3
Casing length	L_c	m	2.3
Test section- secup	Secup	m	2.3
Test section- seclow	Seclow	m	50.3
Test section length	L_w	m	48.0
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	060730 15:38
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	060730 15:38:02
Stop of flow period		yymmdd hh:mm:ss	060801 13:02:00
Test stop (stop of flow period)		yymmdd hh:mm	060801 13:02
Total flow time	t_p	min	2,724
Total recovery time	t_F	min	1,148
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	128.9
Relative pressure in test section before stop of flow period	p_p	kPa	27.6
Relative pressure in test section at stop of recovery period	p_F	kPa	124.1
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	101.3
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.000017
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.000017
Total volume discharged during flow period	V_p	m^3	2.73

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

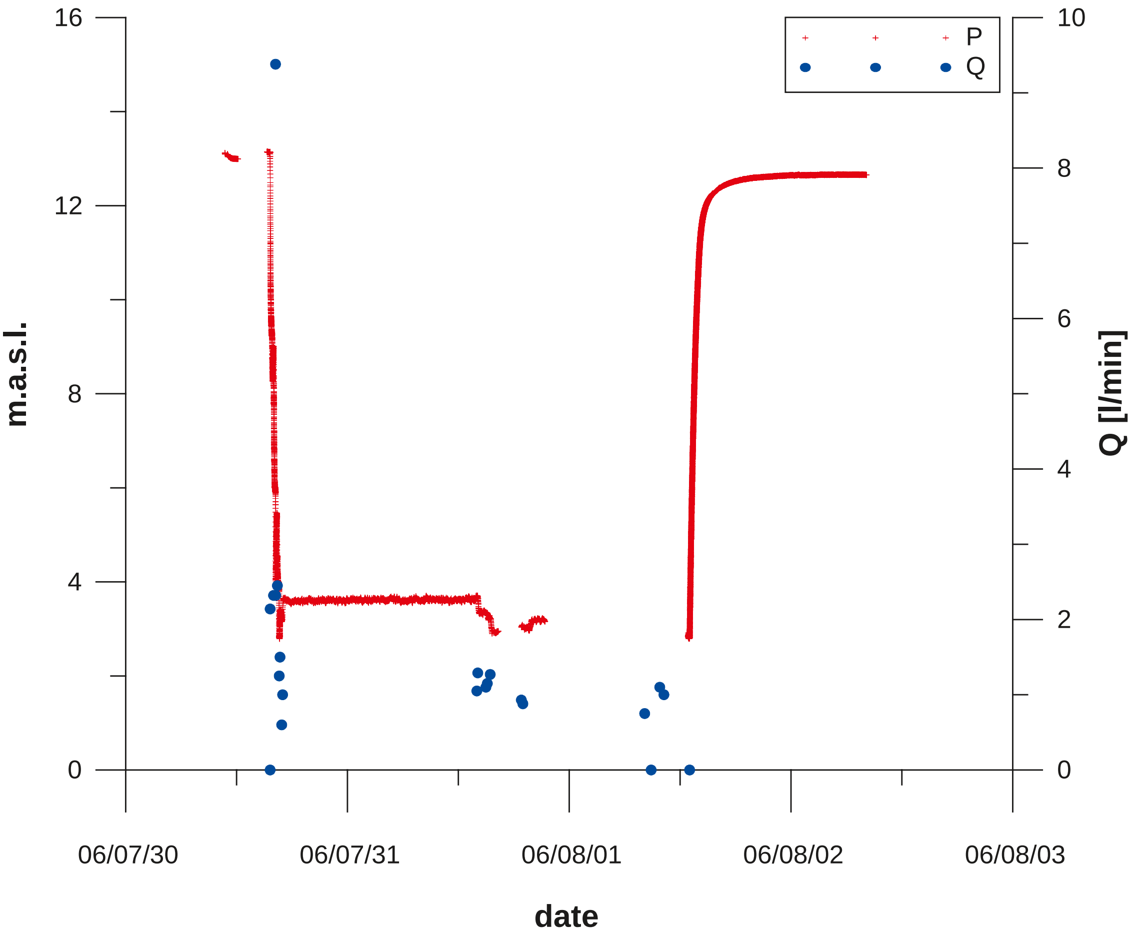

***Figure 6-51.** Linear plot of flow rate and pressure versus time in the pumping borehole KLX23B.*

Flow regime and calculated parameters

The transient evaluation is based on varying flow rate. During both the flow and recovery period, initial wellbore storage effects are followed by a transition to nearly pseudo-steady state flow by the end. No unambiguous transient evaluation during the flow period.

Selected representative parameters

The parameter values from the recovery period are selected as the most representative. Evaluation was performed by applying the Moench (Case 1) solution to a leaky aquifer model. Selected representative transmissivity value is $4.5 \cdot 10^{-6}$ m^2/s for an estimated storativity of $1.6 \cdot 10^{-6}$.

6.12.2 Observation borehole KLX23A

In Figure 6-52 an overview of the pressure responses in observation borehole KLX23A is shown. General test data from the observation section KLX23A: 2.3–100.2 m, are presented in Table 6-43.

Comments on the test

Only a small drawdown response was observed in this section. A total drawdown during the flow period of ca 0.1 m was observed. Another pumping started in the nearby borehole HLX28 which may have caused the disturbance that can be seen before the stop of pumping at 2006-08-01 13:02 (cf. Figure 6-52). No representative recovery data are available from KLX23A.

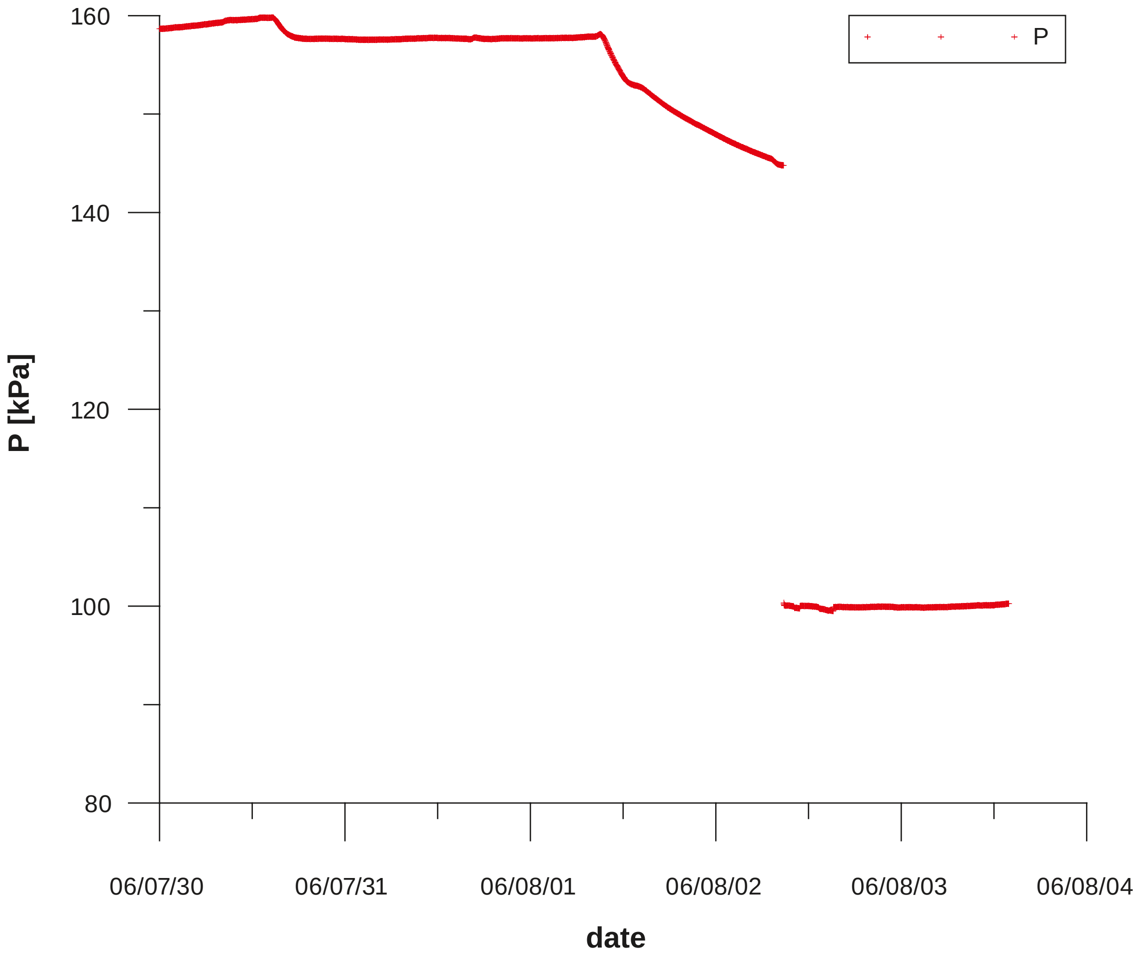

Figure 6-52. Linear plot of pressure versus time in the observation borehole KLX23A during pumping in borehole KLX23B. At 2006-08-01 09:00, another pumping started in the nearby borehole HLX28 which may have caused the disturbance that can be seen before the stop of pumping at 2006-08-01 13:02. No representative recovery data are available from KLX23A.

Table 6-43. General test data from the observation section KLX23A: 2.3–100.2 m during the interference test in KLX23B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	16.2
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	0.1

Flow regime and calculated parameters

The transient evaluation is based on varying flow rate. An apparent pseudo-spherical (leaky) flow regime is indicated during the flow period. No representative data from the recovery period are available.

Selected representative parameters

Transient evaluation from the flow period was considered as the most representative. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $1.3 \cdot 10^{-5}$ m²/s and representative storativity is $8.8 \cdot 10^{-5}$.

6.13 Interference test in KLX26A

This borehole was drilled in the framework of a programme to investigate local minor deformation zones (MDZ) /22/. The objective with this interference tests form part of the characterization of zone XSM000015 and XSM000016. The test was performed in conjunction with the PFL difference flow logging. A borehole response map is shown in Figure 6-53.

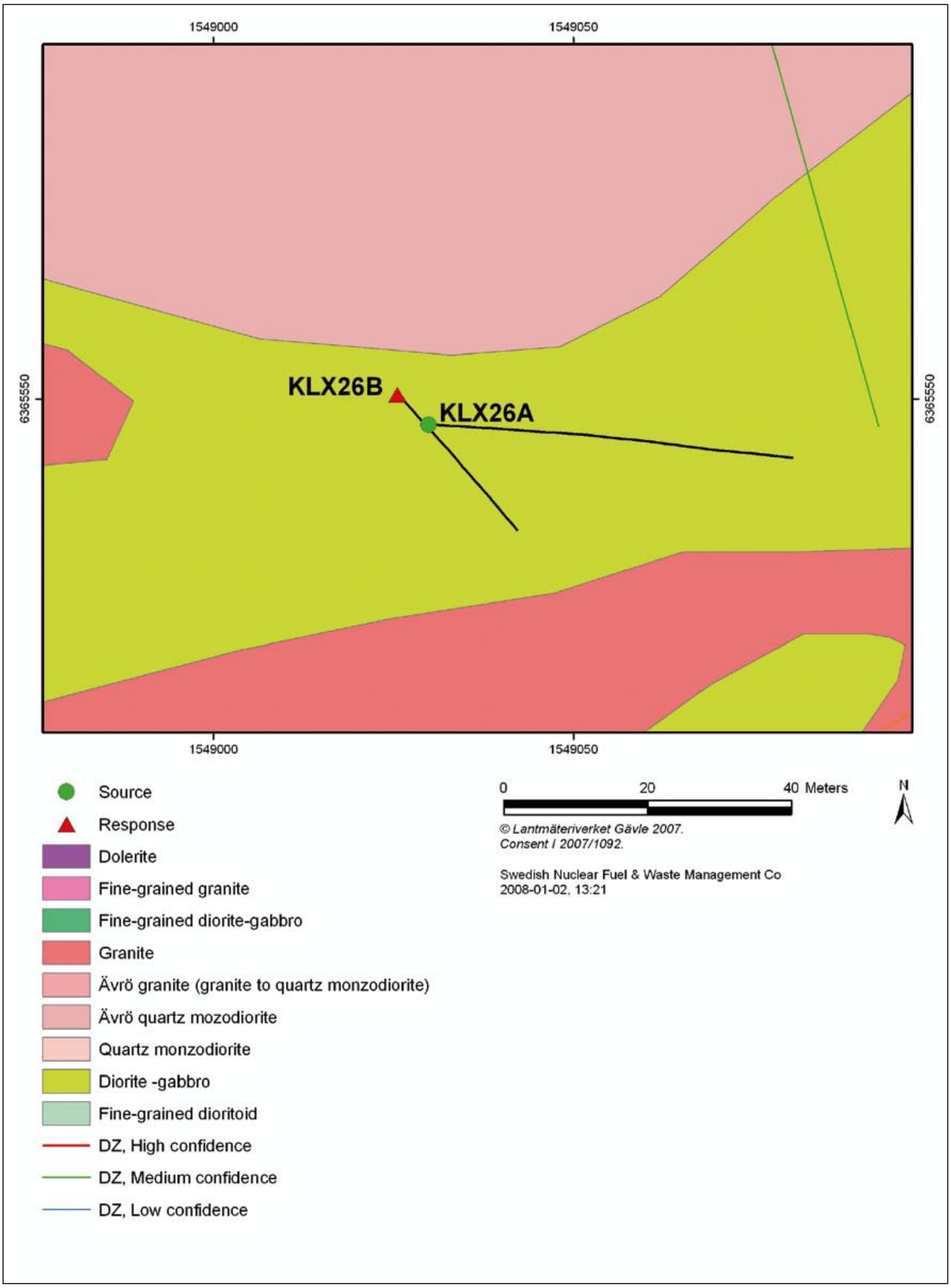

Figure 6-53. *Borehole response map when pumping KLX26A.*

6.13.1 Pumping borehole KLX26A

General test data for the pumping test in KLX26A are presented in Table 6-44. The borehole is cased to 2.6 m. The uncased interval of this section is thus c. 2.6–101.1 m.

Comments on the test

The test was performed as a drawdown pumping test with slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 1.1 L/min and the duration of the flow period was c. 2 days. Uncertain flow rate history during the flow period and data are available from the recovery period. A total drawdown during the flow period of 5.0 m was observed. Pressure data are lacking between c. 2,000 min to stop of pumping at 2,532 min.

Table 6-44. General test data for the pumping test in KLX26A: 2.6–101.1 m

General test data			
Pumping borehole	KLX26A		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	101.1
Casing length	L_c	m	2.6
Test section- secup	Secup	m	2.6
Test section- seclow	Seclow	m	101.1
Test section length	L_w	m	98.5
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	070216 15:30
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	070216 15:30:00
Stop of flow period		yymmdd hh:mm:ss	070218 09:42:00
Test stop (stop of flow period)		yymmdd hh:mm	070218 09:42
Total flow time	t_p	min	2,532
Total recovery time	t_F	min	
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	113.0
Relative pressure in test section before stop of flow period	p_p	kPa	63.9
Relative pressure in test section at stop of recovery period	p_F	kPa	
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	49.1
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.0000175
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.0000175
Total volume discharged during flow period	V_p	m^3	2.6

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

[3)] The flow meter was out of order for the last days and the number given is an estimation of the actual flow.

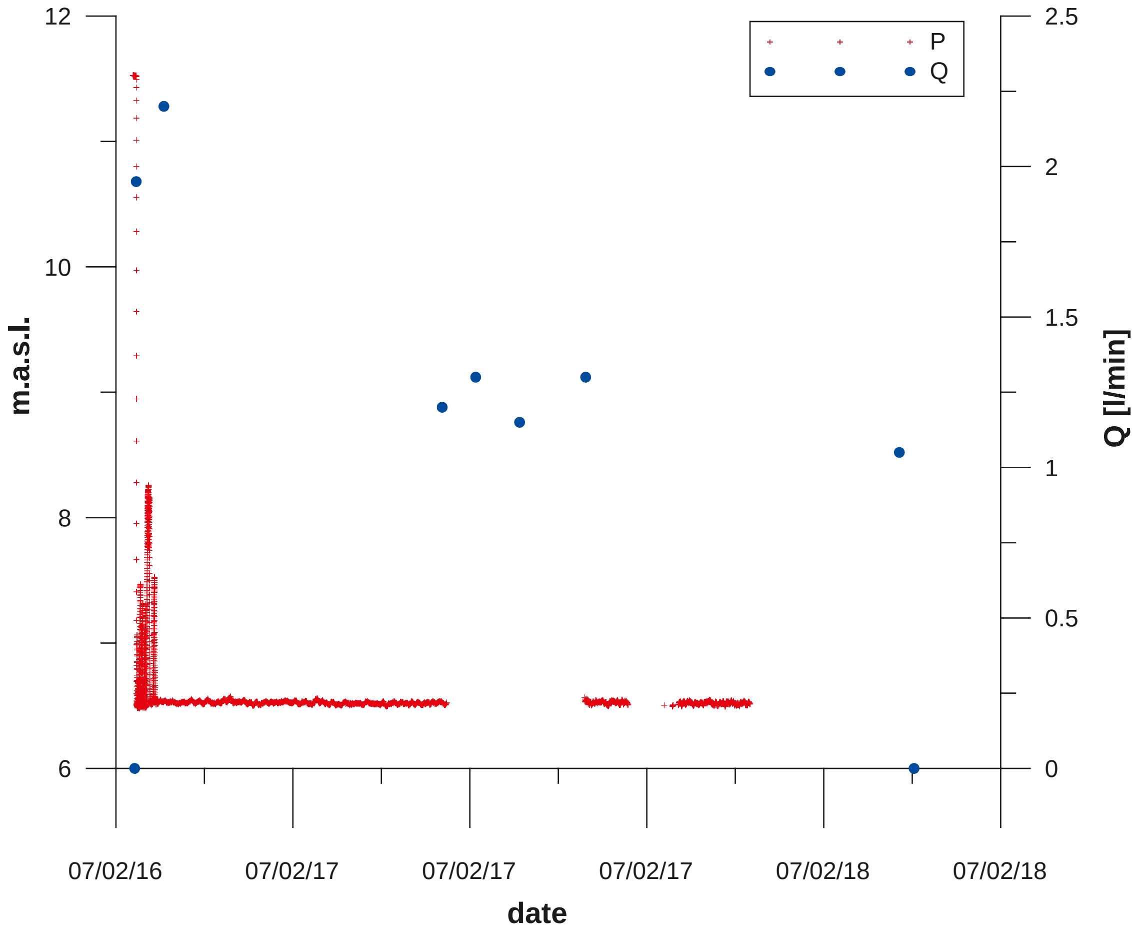

Figure 6-54. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX26A.*

Flow regime and calculated parameters

A constant flow rate was assumed by the transient evaluation of the flow period. After initial effects of WBS a distinct transition to a pseudo-steady state occurred. No unambiguous transient evaluation could be made on the flow period.

Selected representative parameters

The steady-state evaluation of transmissivity, TM, of $4.6 \cdot 10^{-6}$ m^2/s is selected as representative.

6.13.2 Observation borehole KLX26B

In Figure 6-55 an overview of the observed head versus time in the sections in observation borehole KLX26B is shown. Responses to the pumping in borehole KLX26A were observed in all three sections.

Observation section KLX26B:1: 47.0–50.4 m

In Figure 6-55 an overview of the pressure responses in observation borehole KLX26B is shown. General test data from the observation section KLX26B:1: 47.0–50.4 m, are presented in Table 6-45.

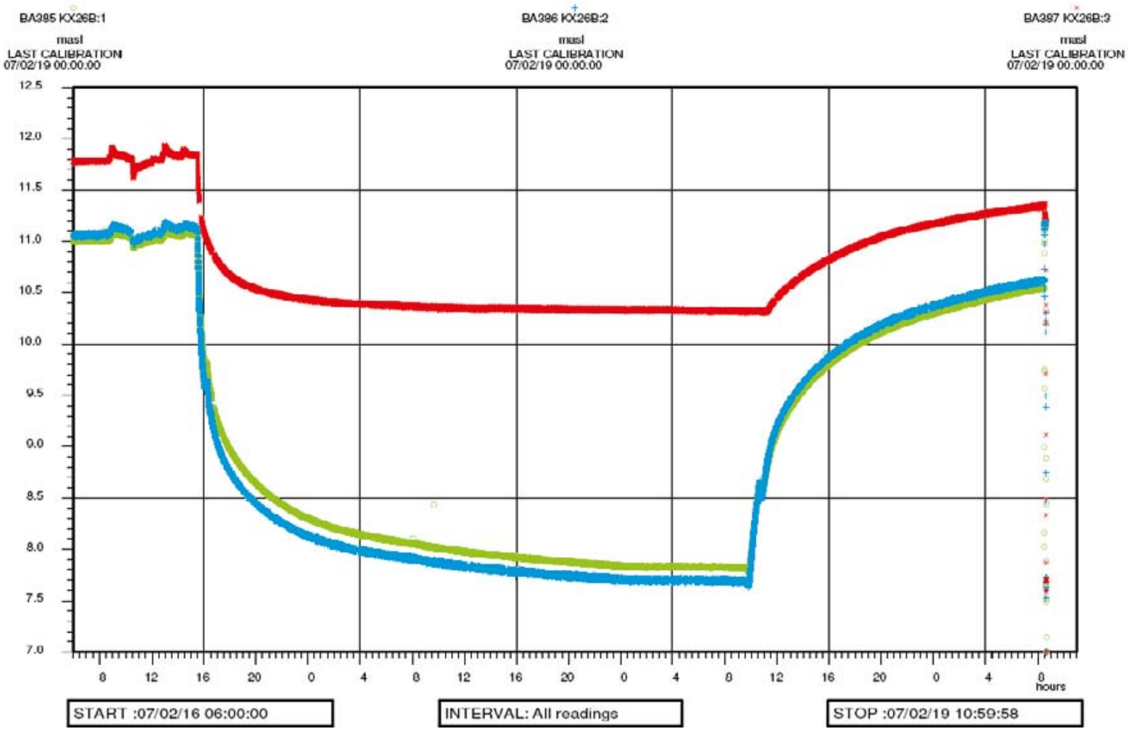

Figure 6-55. *Linear plot of pressure versus time in the observation borehole KLX26B during pumping in borehole KLX26A.*

Table 6-45. General test data from the observation section KLX26B:1: 47.0–50.4 m during the interference test in KLX26A.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	11.06
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	7.81
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.54
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	3.25

Comments on the test

A total drawdown during the flow period of 3.25 m and a total recovery at the end of the recovery period of 2.73 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "excellent" and the new Index 2 $(s_p/Q_p)\cdot\ln(r_s/r_0)$ as "excellent".

Flow regime and calculated parameters

During the flow period, pseudo-radial flow is dominating between c. 50–400 min transitioning to pseudo-spherical (leaky) flow by the end. The recovery period is dominated by pseudo-radial flow between c. 200–2,000 min. The agreement of the estimated transmissivity from the flow and recovery period respectively is good.

Selected representative parameters

The parameter values from the flow period are selected as the most representative. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $2.9\cdot10^{-6}$ m²/s and representative storativity is $5.6\cdot10^{-6}$.

Observation section KLX26B:2: 21.0–46.0 m

In Figure 6-55 an overview of the pressure responses in observation borehole KLX26B is shown. General test data from the observation section KLX26B:2: 21.0–46.0 m, are presented in Table 6-46.

Comments on the test

A total drawdown during the flow period of 3.45 m and a total recovery at the end of the recovery period of 2.94 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "excellent" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "excellent".

Flow regime and calculated parameters

During the flow period, pseudo-radial flow is dominating between c. 20–200 min transitioning to pseudo-spherical (leaky) flow by the end. The recovery period is dominated by pseudo-radial flow between c. 200–2,000 min. The agreement of the estimated transmissivity from the flow and recovery period respectively is good.

Selected representative parameters

The parameter values from the flow period are selected as the most representative. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $2.8 \cdot 10^{-6}$ m^2/s and representative storativity is $2.5 \cdot 10^{-6}$.

Observation section KLX26B:3: 2.3–20.0 m

In Figure 6-55 an overview of the pressure responses in observation borehole KLX26A is shown. General test data from the observation section KLX26B:3: 2.3–20.0 m, are presented in Table 6-47. The borehole is cased to 2.3 m, the uncased interval of this upper section is thus c. 2.3–20.0 m.

Table 6-46. General test data from the observation section KLX26B:2: 21.0–46.0 m during the interference test in KLX26B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	11.13
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	7.68
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.62
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	3.45

Table 6-47. General test data from the observation section KLX26B:3: 2.3–20.0 m during the interference test in KLX26B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	11.84
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	10.31
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	11.34
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	1.53

Comments on the test

A total drawdown during the flow period of 1.53 m and a total recovery at the end of the recovery period of 1.03 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as "high", Index 2 (s_p/Q_p) as "high" and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as "high".

Flow regime and calculated parameters

During the flow period, pseudo-radial flow is dominating between c. 20–100 min transitioning to pseudo-spherical (leaky) flow by the end. The recovery period is dominated by pseudo-radial flow between c. 500–2,000 min.

Selected representative parameters

The estimated parameter values from the flow period are selected as the most representative. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $6.1·10^{-6}$ m^2/s and representative storativity is $9.9·10^{-7}$.

6.14 Interference test in KLX26B

This borehole was drilled in the framework of a programme to investigate local minor deformation zones (MDZ) /22/. The objective with this interference tests form part of the characterization of zone XSM000015. The test was performed in conjunction with the PFL difference flow logging. A borehole response map is shown in Figure 6-56.

6.14.1 Pumping borehole KLX26B

General test data for the pumping test in KLX26B are presented in Table 6-48. The borehole is cased to 2.3 m. The uncased interval of this section is thus c. 2.3–50.4 m.

Comments on the test

The test was performed as a drawdown pumping test with slightly decreasing flow rate in conjunction with difference flow logging. The mean flow rate was c. 1.4 L/min and the duration of the flow period was c. 19 hours. A total drawdown during the flow period of 5.01 m and a total recovery at the end of the recovery period of 3.23 m was observed. An extra data point (t = 3 min, Q = 1.5 L/min) was inserted in the flow rate data file to accommodate with the observed drawdown curve. The flow rate varied during the flow period and is uncertain. Pressure data are lacking between c. 40–60 min and c. 200–1,100 min.

Flow regime and calculated parameters

After initial WBS during the first c. 3 min a distinct transition to a pseudo-stationary pressure (PSS) occurred during the flow period. The pressure recovery was not entirely consistent with the drawdown response. After initial effects of WBS during the first c. 5 min a transition towards a pseudo-radial flow regime was indicated.

Selected representative parameters

The transient evaluation from the recovery period was selected as representative for KLX26B. Evaluation was performed by applying the Dougherty-Babu solution to a confined aquifer model. Selected representative transmissivity value is $5.5·10^{-6}$ m^2/s and representative storativity is $1.6·10^{-6}$.

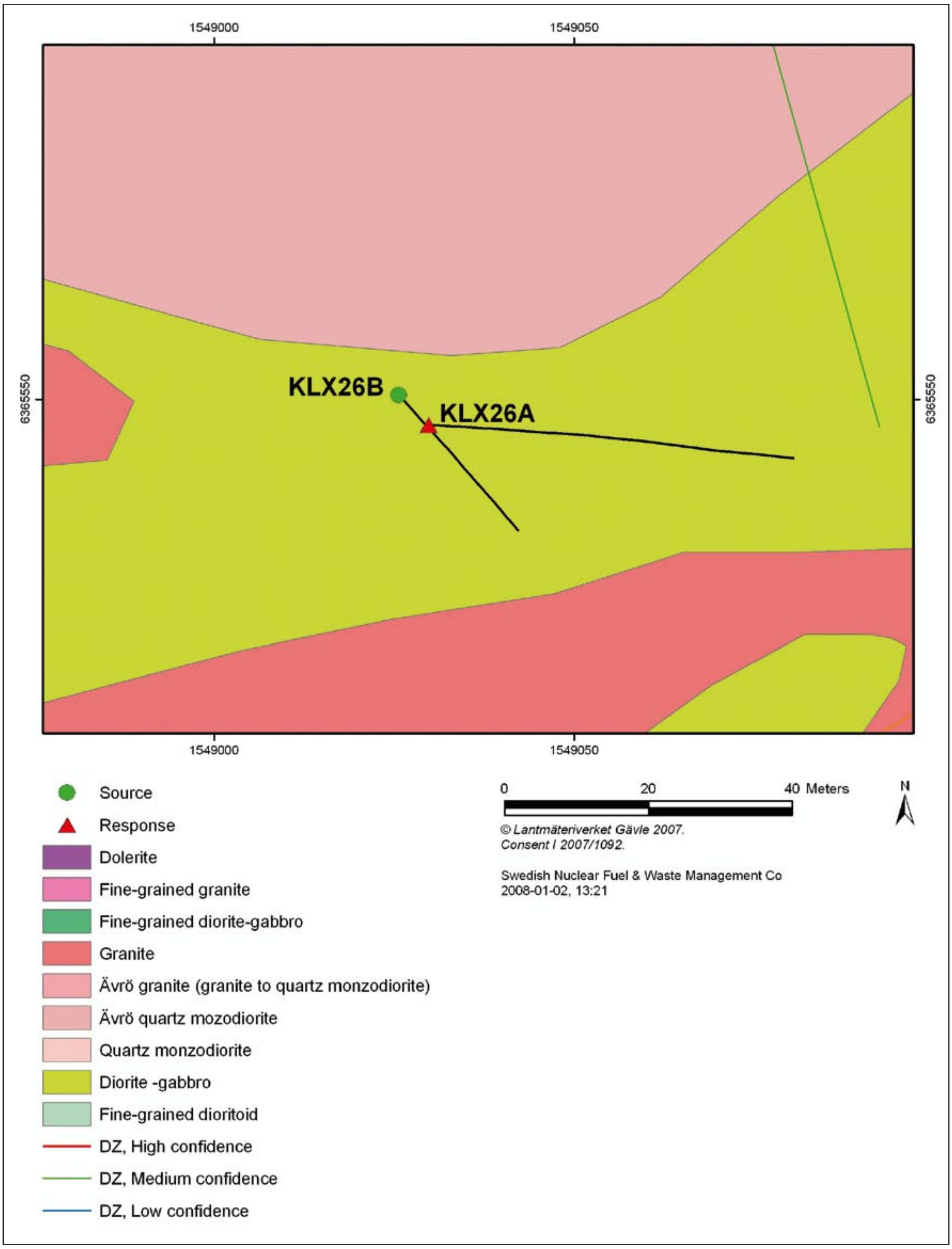

Figure 6-56. *Borehole response map when pumping KLX26B.*

Table 6-48. General test data for the pumping test in KLX26B: 2.3–50.4 m.

General test data			
Pumping borehole	KLX26B		
Test type[1)]	Constant Drawdown and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	SKB		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	50.4
Casing length	L_c	m	2.3
Test section- secup	Secup	m	2.3
Test section- seclow	Seclow	m	50.4
Test section length	L_w	m	48.1
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period)		yymmdd hh:mm	070219 16:21
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	070219 16:21:00
Stop of flow period		yymmdd hh:mm:ss	070220 11:31:47
Test stop (stop of flow period)		yymmdd hh:mm	070220 11:31
Total flow time	t_p	min	1,150
Total recovery time	t_F	min	149
Pressure data			
Relative pressure in test section before start of flow period	p_i	kPa	112.2
Relative pressure in test section before stop of flow period	p_p	kPa	63.0
Relative pressure in test section at stop of recovery period	p_F	kPa	94.7
Pressure change during flow period ($p_i - p_p$)	dp_p	kPa	49.2
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.0000233
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	0.0000233
Total volume discharged during flow period	V_p	m^3	1.61

[1)] Constant Head injection and recovery, Constant Rate withdrawal and recovery or Constant Drawdown and recovery.

[2)] Nominal diameter.

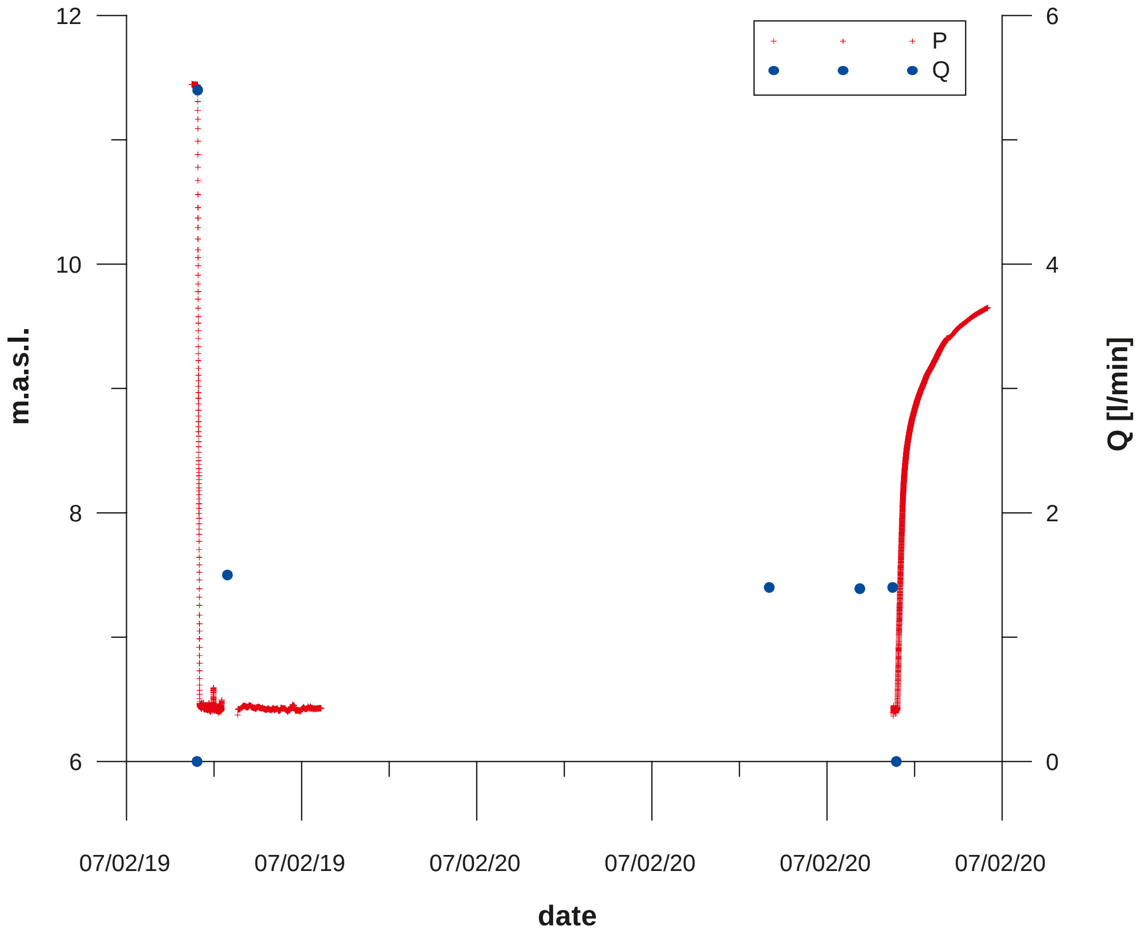

Figure 6-57. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX26B.*

6.14.2 Observation borehole KLX26A

In Figure 6-58 an overview of the observed head versus time in the sections in observation borehole KLX26A is shown. No responses were observed in Section 1. In sections 2 and 3 responses to the pumping in borehole KLX26B was indicated.

Observation section KLX26A:1: 48.0–101.1 m

This section appears to be virtually unaffected by the pumping in KLX26A, Figure 6-58. It is possible to identify a very small pressure response to pumping in KLX26A in the section but other effects are dominating making quantitative evaluation impossible.

Observation section KLX26A:2: 22.0–47.0 m

In Figure 6-58 an overview of the pressure responses in observation borehole KLX26A is shown. General test data from the observation section KLX26A:2: 22.0–47.0 m, are presented in Table 6-49.

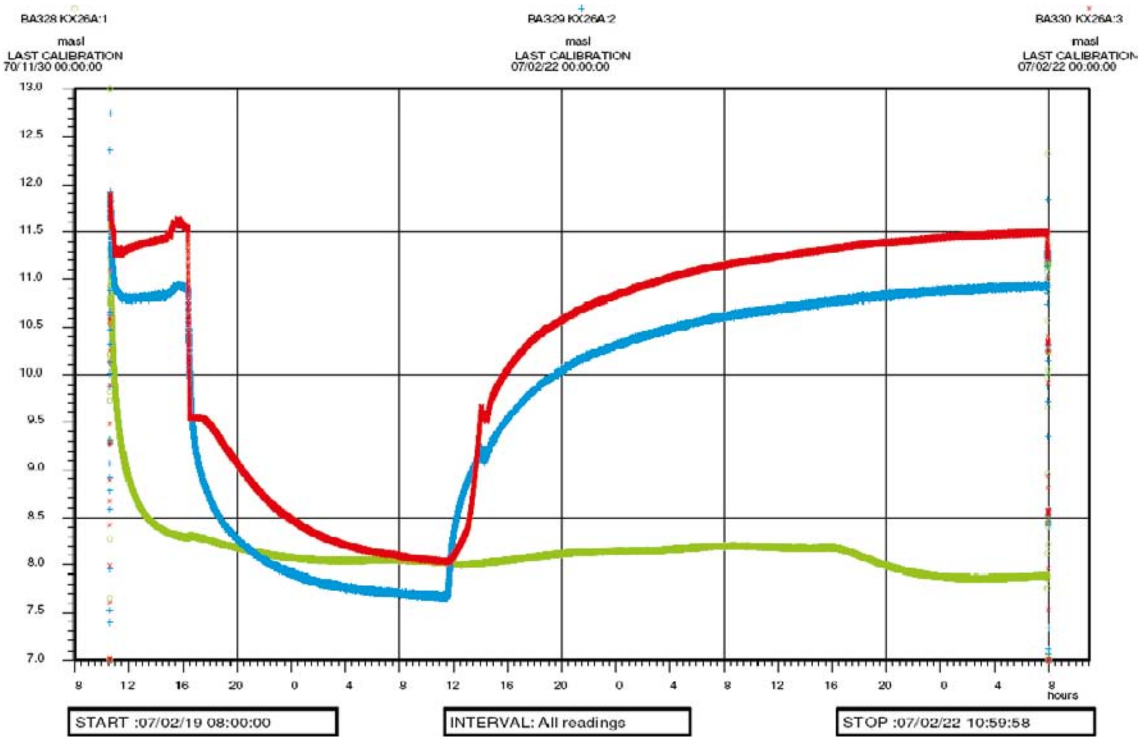

Figure 6-58. *Linear plot of pressure versus time in the observation borehole KLX26A during pumping in borehole KLX26B.*

Table 6-49. General test data from the observation section KLX26A:2: 22.0–47.0 m during the interference test in KLX26B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.9
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	7.6
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	10.9
Hydraulic head change during flow period ($h_i – h_p$)	dh_p	m	3.3

Comments on the test

A total drawdown during the flow period of 3.3 m and a total recovery at the end of the recovery period of 3.3 m was observed. The calculated Index 1 (r_s^2/t_L) is rated as “medium”, Index 2 (s_p/Q_p) as “excellent” and the new Index 2 (s_p/Q_p)·ln(r_s/r_0) as “high”.

Flow regime and calculated parameters

The transient evaluation is based on variable flow rate during the flow period. A pseudo-radial flow regime developed after c. 10 min to the end of the flow period. By the end a pseudo-spherical flow regime was developed. After a transition period a pseudo-radial flow regime developed after c. 150 min to the end of the recovery period. Consistent results of evaluated parameter values are obtained from the flow and recovery period respectively.

Selected representative parameters

The parameter values estimated from the flow period are selected as the most representative for the test section. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $2.0 \cdot 10^{-6}$ m^2/s and representative storativity is $8.3 \cdot 10^{-6}$.

Observation section KLX26A:3: 2.6–21.0 m

In Figure 6-58 an overview of the pressure responses in observation borehole KLX26A is shown. General test data from the observation section KLX26A:3: 2.6–21.0 m, are presented in Table 6-50. The borehole is cased to 2.6 m, the uncased interval of this upper section is thus c. 2.6–21.0 m.

Comments on the test

The responses during both the flow and recovery period are distorted and thus uncertain. The transient evaluations of both periods should thus be regarded as approximate. The calculated Index 1 (r_s^2/t_L) is rated as "medium", Index 2 (s_p/Q_p) as "excellent" and the new Index 2 $(s_p/Q_p) \cdot \ln(r_s/r_0)$ as "high".

Flow regime and calculated parameters

The transient evaluation is based on variable flow rate during the flow period. An apparent pseudo-radial flow regime is indicated between c. 200–400 min during the flow period. During the recovery period a pseudo-radial flow regime is indicated between c. 200–800 min.

Selected representative parameters

The parameter values estimated from the flow period are selected as the most representative. Evaluation was performed by applying the Hantush-Jacob solution to a leaky aquifer model. Selected representative transmissivity value is $3.5 \cdot 10^{-6}$ m^2/s and representative storativity is $6.0 \cdot 10^{-6}$.

6.15 Interference test in KLX06

This test was performed in conjunction with the PFL difference flow logging with the purpose to provide general information on the connectivity of deformations zone EW002A that was encountered in KLX06The borehole responses are shown in Figure 6-59.

Table 6-50. General test data from the observation section KLX26A:3: 2.6–21.0 m during the interference test in KLX26B.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	11.5
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	8.0
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	11.5
Hydraulic head change during flow period ($h_i – h_p$)	dh_p	m	3.5

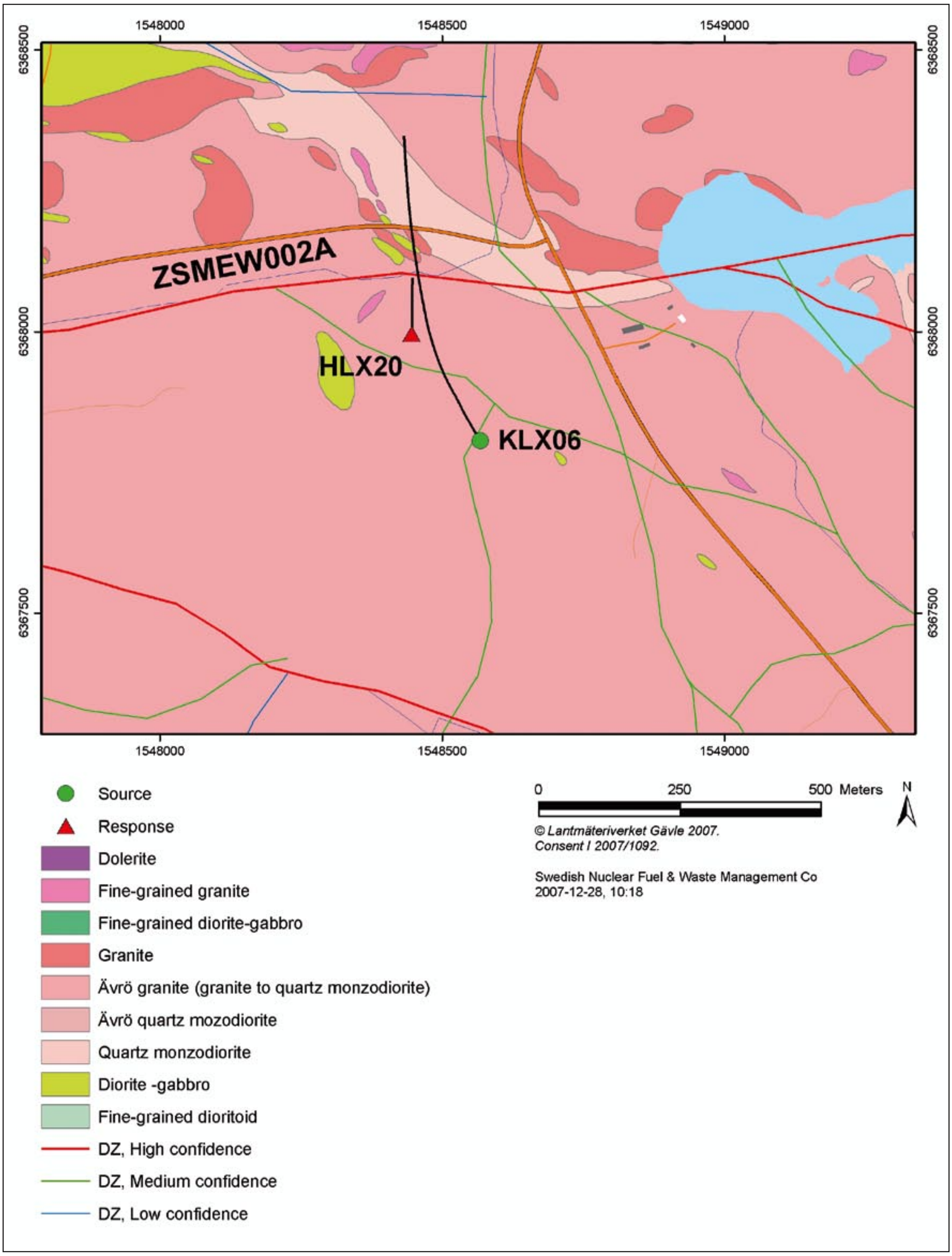

Figure 6-59. *Borehole response map when pumping KLX06.*

The test was performed as a constant drawdown pumping test in conjunction with the difference flow logging. A drawdown of 6.8 m was established and the flow rate decreased during the 8 day pumping from 100 L/min to 75 L/min which also included three pump stops of relative short duration necessitated by the changing of the logging tools. Several flow rate changes occurred during the flow period. Recovery was measured during a day in the pumped borehole KLX06 and during 12 days in the observation hole HLX20. Flow rate was measured manually at a few occasions.

6.15.1 Pumping borehole KLX06

General test data for the pumping test in KLX06 are presented in Table 6-51. The borehole is cased to 11.9 m. The uncased interval of this section is thus c. 11.9–994.9 m.

Flow regime and calculated parameters

The evaluation is only done for the recovery phase only. The initial WBS period was followed by a radial flow regime from 5 min to 15 min after pumpstop after. The radial flow period is followed by a period where flow is restricted by two intersecting impermeable boundaries with an angle of about 130 degrees. Other geometries were tried; radial composite and parallel faults, but the chosen geometry of intersecting "faults" provided the best match with measured data.

Table 6-51. General test data for the pumping test in KLX06: 11.9–994.9 m.

General test data			
Pumping borehole	KLX06		
Test type[1)]	Constant Rate withdrawal and recovery test		
Test section (open borehole/packed-off section):	open borehole		
Test No	1		
Field crew	Petri Heikkinen, Jari Pöllänen, PRG Tec Oy		
Test equipment system			
General comment	Interference test		
	Nomenclature	**Unit**	**Value**
Borehole length	L	m	994.9
Casing length	L_c	m	11.9
Test section- secup	Secup	m	11.9
Test section- seclow	Seclow	m	994.9
Test section length	L_w	m	983.0
Test section diameter[2)]	$2 \cdot r_w$	mm	76
Test start (start of flow period) (start of pressure registration)		yymmdd hh:mm	050218 16:52:00
Packer expanded		yymmdd hh:mm:ss	
Start of flow period		yymmdd hh:mm:ss	050218 16:52:00
Stop of flow period		yymmdd hh:mm:ss	050228 13:47:00
Test stop (stop of flow period) (stop of pressure registration)		yymmdd hh:mm	050228 13:47:00
Total flow time	t_p	min	14,215
Total recovery time	t_F	min	
Pressure data			
Relative pressure in test section before start of flow period	p_i	m.a.s.l.	12.9
Relative pressure in test section before stop of flow period	p_p	m.a.s.l.	6.1
Relative pressure in test section at stop of recovery period	p_F	m.a.s.l.	
Pressure change during flow period ($p_i - p_p$)	dp_p	m.a.s.l.	6.8
Flow data			
Flow rate from test section just before stop of flow period [3)]	Q_p	m^3/s	0.00125
Mean (arithmetic) flow rate during flow period	Q_m	m^3/s	
Total volume discharged during flow period	V_p	m^3	

[1)] Constant Head injection and recovery or Constant Rate withdrawal and recovery.

[2)] Nominal diameter.

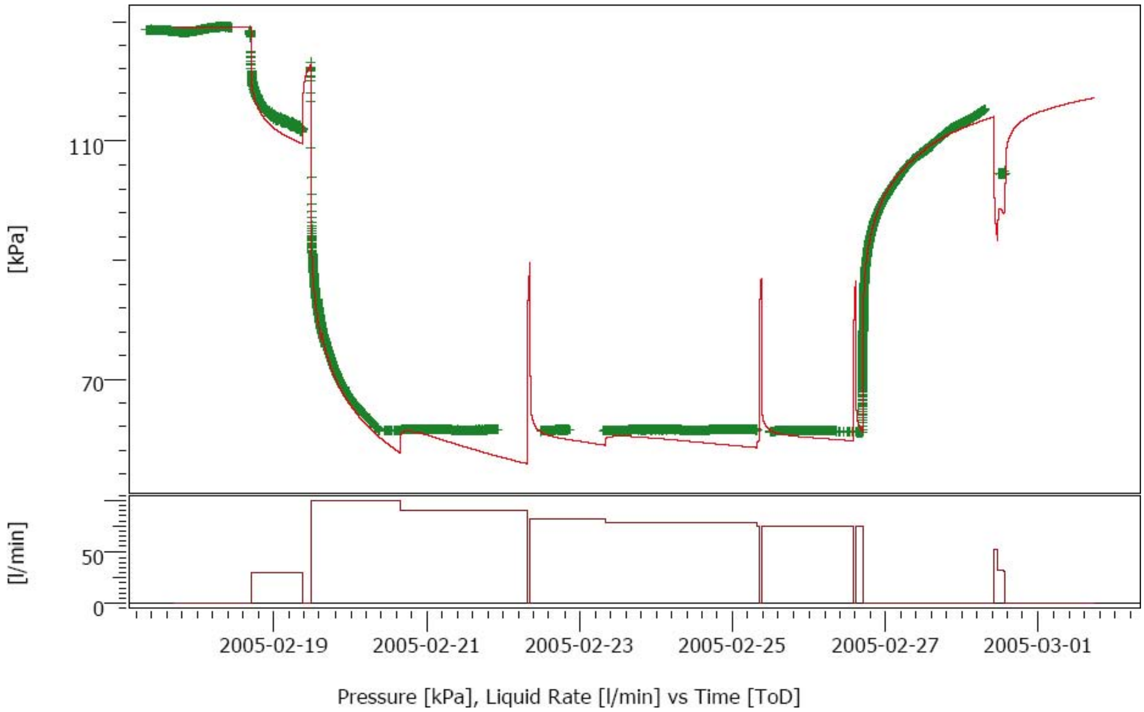

Figure 6-60. *Linear plot of flow rate and pressure versus time in the pumping borehole KLX06.*

Selected representative parameters

The parameter values estimated from the recovery period are selected as the most representative. Selected representative transmissivity value is $3.1 \cdot 10^{-4}$ m²/s utilising a storativity of $8 \cdot 10^{-6}$ derived from the HLX20 observation borehole. A skin of –6 was obtained.

Observation section HLX20

In Figure 6-61 an overview of the pressure responses in observation borehole HLX20 is shown. General test data from the observation section HLX20 9.0–202.2 m, are presented in Table 6-52.

Flow regime and calculated parameters

Both drawdown and recovery phase were evaluated where both were best fitted to a homogeneous infinite acting aquifer with radial flow. Similar T-values were obtained of $1 \cdot 10^{-4}$ m²/s for the drawdown and $2 \cdot 10^{-4}$ m²/s for the recovery.

Selected representative parameters

The parameter values estimated from the recovery period are selected as the most representative since they provide slightly better match to the measured data when simulating the complete test history.

Table 6-52. General test data from the observation section HLX20 9.0–202.2 m during the interference test in KLX06.

Pressure data	Nomenclature	Unit	Value
Hydraulic head in test section before start of flow period	h_i	m.a.s.l.	10.9
Hydraulic head in test section before stop of flow period	h_p	m.a.s.l.	8.2
Hydraulic head in test section at stop of recovery period	h_F	m.a.s.l.	
Hydraulic head change during flow period ($h_i - h_p$)	dh_p	m	2.7

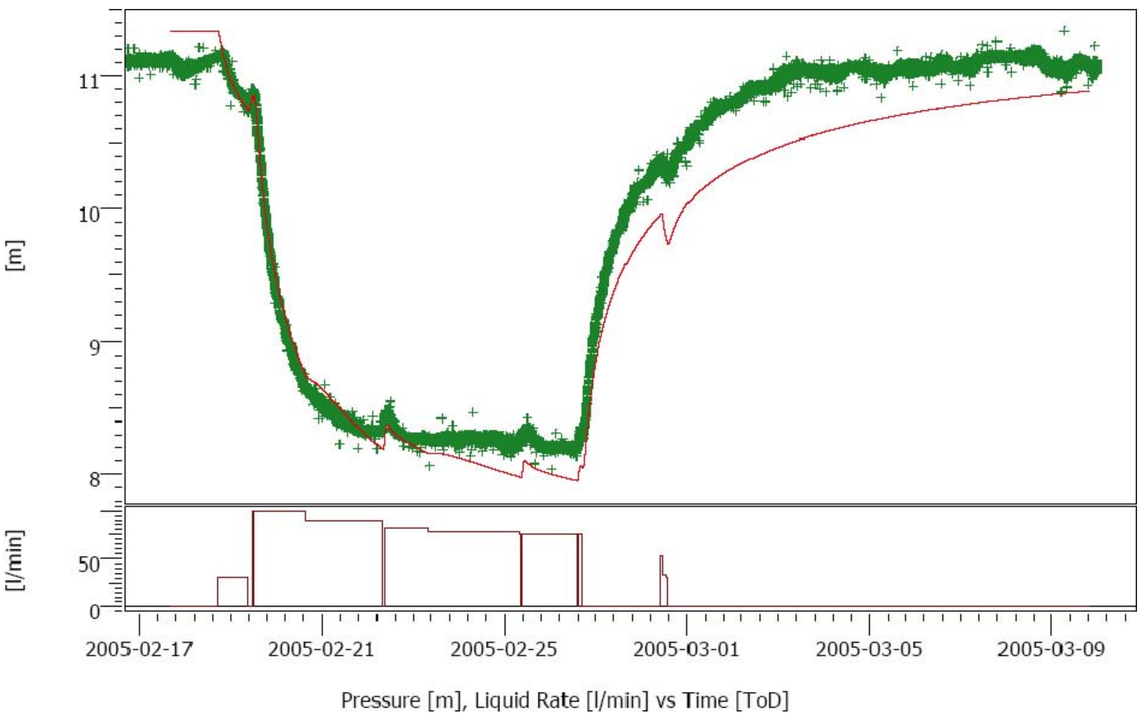

Figure 6-61. *Linear plot of pressure versus time in the observation borehole HLX20 during pumping in borehole KLX06.*

6.16 Response analysis

A response analysis including a response matrix (Appendix 3) according to the methodology description for interference tests was made. The estimated response time lags (dt_L) in the observation sections during the different interference tests are shown in Table 6-54. The lag times were derived from the drawdown curves in the observation borehole sections at an actual drawdown of 0.1 m. No corrections of the drawdown for natural trends caused by e.g. drought or precipitation have been made. Because of the oscillating behaviour of the measured pressure in some of the observation sections, it was difficult to determine the exact time to reach a 0.1 m drawdown. It was possible, however, to make an approximate estimate from the drawdown curves.

Only observation sections with an assumed, relatively clear, pressure response are included in the response analysis. In Tables 6-53 and 6-54, all observation sections are presented.

The inverse normalized response time with respect to the distance to the pumping borehole was calculated. This parameter is directly related to the hydraulic diffusivity (T/S) of the formation. In addition, the normalized drawdown with respect to the flow rate was calculated (se Table 6-53). From these parameters different response indices were calculated according to Section 5.5.1.

In the figures below, response diagrams showing the distribution of the presumptive responding observation sections are presented. In the diagrams Index 1 has been plotted versus Index 2-new as defined in Section 5.5.1. Clearly, sections located towards the upper right corner in the diagrams correspond to sections which are well connected to the pumping borehole with high hydraulic diffusivities and distinct responses. On the other hand, sections with delayed and small responses and poorly connected to the pumping sections with lower hydraulic diffusivity are located towards the lower left corner.

The following response parameters are used in Tables 6-53 and 6-54 as well as in Figures 6-50–6-60:

$r_s^2/dt_{L\,[s=0.1\,m]}$ = inverse normalized response time with respect to the distance (m^2/s)

$dt_{L\,[s=0.1\,m]}$ = time after start of pumping (s) at a drawdown s = 0.1 m in the observation section

r_s = 3D-distance between the hydraulic point of application (hydr. p.a.) in the pumping borehole and observation borehole (m)

s_p/Q_p = normalized drawdown with respect to the pumping flow rate (s/m^2)

s_p = maximal drawdown in the actual observation borehole/section (m)

Q_p = pumping flow rate by the end of the flow period (m^3/s)

The interpreted inverse normalized response time lags must be considered as rough estimates for many of the observation sections. The main reason for this fact is, as mentioned above, the difficulty to estimate this parameter due to oscillating pressure. The maximal drawdown is not always at stop of pumping, e.g. due to precipitation or other disturbances by the end of the tests. Furthermore, in some cases the drawdown must be corrected, e.g. due to natural pressure trends, e.g. during draught periods.

The response diagrams can be used to group observation sections by the strength and lag times of their responses. Observation sections with the most distinct responses can thus be identified. In some of the interference tests only one observation section responded to the pumping. These tests are also included in the figures below.

Table 6-53. Calculated response lag times and normalized response time lags for the observation sections included in the interference tests.

Pumping borehole	Observation borehole	Section (m)	$dt_{L\ [s=0.1\ m]}$ (s)	r_s (m)	$dt_{L\ [s=0.1\ m]}/r_s^2$ (s/m^2)	$r_s^2/dt_{L\ [s=0.1\ m]}$ (m^2/s) Index 1
KLX14A	HLX38	15.00–199.50	1,920	192.6	5.18E–02	1.93E+01
KLX21B	KLX07A:1	781.00–844.73	16,200	449	8.04E–02	1.24E+01
KLX21B	KLX07A:2	753.00–780.00	24,000	447	1.20E–01	8.33E+00
KLX21B	KLX07A:3	612.00–752.00	40,800	455	1.97E–01	5.07E+00
KLX21B	KLX07A:4	457.00–611.00	2,520	504	9.92E–03	1.01E+02
KLX21B	KLX07A:5	333.00–456.00	3,240	585	9.47E–03	1.06E+02
KLX21B	KLX07A:6	204.00–332.00	27,000	675	5.93E–02	1.69E+01
KLX21B	KLX07A:7	104.00–203.00	31,200	768	5.29E–02	1.89E+01
KLX21B	KLX07A:8	11.80–103.00	72,000	855	9.85E–02	1.02E+01
KLX21B	KLX07B:1	95.00–200.00	69,000	830	1.00E–01	9.98E+00
KLX21B	KLX07B:2	9.60–94.00	81,000	875	1.06E–01	9.45E+00
KLX21B	KLX12:1	546.00–602.29	–	–	–	0
KLX21B	KLX12:2	535.00–545.00	–	–	–	0
KLX21B	KLX12:3	426.00–534.00	–	–	–	0
KLX21B	KLX12:4	386.00–425.00	156,000	864	2.09E–01	4.79E+00
KLX21B	KLX12:5	291.00–385.00	–	–	–	0
KLX21B	KLX12:6	160.00–290.00	96,000	863	1.29E–01	7.76E+00
KLX21B	KLX12:7	142.00–159.00	165,000	874	2.16E–01	4.63E+00
KLX21B	KLX12:8	104.00–141.00	72,000	880	9.30E–02	1.08E+01
KLX21B	KLX12:9	17.90–103.00	96,000	900	1.19E–01	8.44E+00
KLX21B	KLX05:1	721.00–1000.16	–	–	–	0
KLX21B	KLX05:2	634.00–720.00	–	–	–	0
KLX21B	KLX05:3	625.00–633.00	–	–	–	0
KLX21B	KLX05:4	501.00–624.00	–	–	–	0
KLX21B	KLX05:5	361.00–500.00	61,200	964	6.59E–02	1.52E+01
KLX21B	KLX05:6	256.00–360.00	168,000	926	1.96E–01	5.10E+00
KLX21B	KLX05:7	241.00–255.00	120,000	913	1.44E–01	6.95E+00
KLX21B	KLX05:8	220.00–240.00	117,000	910	1.41E–01	7.08E+00
KLX21B	KLX05:9	128.00–219.00	78,000	904	9.54E–02	1.05E+01
KLX21B	KLX05:10	15.00–127.00	63,000	904	7.71E–02	1.30E+01
KLX21B	HLX22	9.00–163.20	9,600	581	2.84E–02	3.52E+01
KLX21B	HLX23:1	61.00–160.20	–	–	–	0
KLX21B	HLX23:2	6.00–60.00	–	–	–	0
KLX21B	HLX18:1	90.00–181.20	–	–	–	0
KLX21B	HLX18:2	15.00–89.00	–	–	–	0
KLX26A	KLX26B:1	47.00–50.40	66	17	2.28E–01	4.38E+00
KLX26A	KLX26B:2	21.00–46.00	60	21	1.36E–01	7.35E+00
KLX26A	KLX26B:3	2.30–20.00	60	42	3.40E–02	2.94E+01
KLX26B	KLX26A:1	48.00–101.10	–	–	–	0
KLX26B	KLX26A:2	22.00–47.00	90	19	2.49E–01	4.01E+00
KLX26B	KLX26A:3	2.60–21.00	48	13	2.84E–01	3.52E+00
KLX22A	KLX22B	2.00–100.25	3,900	55.5	1.27E+00	7.90E–01
KLX23A	KLX23B	2.30–50.30	1,350	37	9.86E–01	1.01E+00
KLX23B	KLX23A	2.30–100.20	5,040	37	3.68E+00	2.72E–01
KLX16A	HLX42:2	9.10–29.00	–	–	–	0
KLX16A	KLX12A:1	546.00–602.29	–	–	–	0
KLX16A	KLX12A:2	535.00–545.00	–	–	–	0
KLX16A	KLX12A:3	426.00–534.00	–	–	–	0

Pumping borehole	Observation borehole	Section (m)	dt_L [s=0.1 m] (s)	r_s (m)	dt_L [s=0.1 m]/r_s^2 (s/m²)	r_s^2/dt_L [s=0.1 m] (m²/s) Index 1
KLX16A	KLX12A:4	386.00–425.00	–	–	–	0
KLX16A	KLX12A:5	291.00–385.00	–	–	–	0
KLX16A	KLX12A:6	160.00–290.00	–	–	–	0
KLX16A	KLX12A:7	142.00–159.00	–	–	–	0
KLX16A	KLX12A:8	104.00–141.00	–	–	–	0
KLX16A	KLX12A:9	17.90–103.00	–	–	–	0
KLX16A	KLX05:1	721.00–1000.20	–	–	–	0
KLX16A	KLX05:2	634.00–720.00	–	–	–	0
KLX16A	KLX05:3	625.00–633.00	–	–	–	0
KLX16A	KLX05:4	501.00–624.00	–	–	–	0
KLX16A	KLX05:5	361.00–500.00	–	–	–	0
KLX16A	KLX05:6	256.00–360.00	–	–	–	0
KLX16A	KLX05:7	241.00–255.00	–	–	–	0
KLX16A	KLX05:8	220.00–240.00	–	–	–	0
KLX16A	KLX05:9	128.00–219.00	–	–	–	0
KLX16A	KLX05:10	15.00–127.00	–	–	–	0
KLX16A	HLX15	12.00–151.90	–	–	–	0
KLX16A	HLX26	11.00–151.20	–	–	–	0
KLX16A	HLX28	6.00–154.20	–	–	–	0
KLX15A	HLX38	15.00–199.50	522,000	952	5.76E–01	1.74E+00
KLX15A	KLX05:1	721.00–1000.2	–	–	–	0
KLX15A	KLX05:2	634.00–720.00	–	–	–	0
KLX15A	KLX05:3	625.00–633.00	–	–	–	0
KLX15A	KLX05:4	501.00–624.00	–	–	–	0
KLX15A	KLX05:5	361.00–500.00	–	–	–	0
KLX15A	KLX05:6	256.00–360.00	–	–	–	0
KLX15A	KLX05:7	241.00–255.00	–	–	–	0
KLX15A	KLX05:8	220.00–240.00	–	–	–	0
KLX15A	KLX05:9	128.00–219.00	–	–	–	0
KLX15A	KLX05:10	15.00–127.00	–	–	–	0
KLX15A	KLX19A:1	661.00–800.10	–	–	–	0
KLX15A	KLX19A:2	518.00–660.00	–	–	–	0
KLX15A	KLX19A:3	509.00–517.00	–	–	–	0
KLX15A	KLX19A:4	481.50–508.00	–	–	–	0
KLX15A	KLX19A:5	311.00–480.50	–	–	–	0
KLX15A	KLX19A:6	291.00–310.00	–	–	–	0
KLX15A	KLX19A:7	136.00–290.00	–	–	–	0
KLX15A	KLX19A:8	98.80–135.00	–	–	–	0
KLX19A	HLX36:1	50.00–199.80	67,800	728	1.28E–01	7.82E+00
KLX19A	HLX36:2	6.00–49.00	–	–	–	0
KLX19A	HLX37:1	149.00–199.80	3,960	710	7.86E–03	1.27E+02
KLX19A	HLX37:2	118.00–148.00	4,080	737	7.51E–03	1.33E+02
KLX19A	HLX37:3	12.00–117.00	–	–	–	0
KLX19A	HLX38	15.00–199.50	–	–	–	0
KLX19A	KLX11A	12.00–992.30	12,000	701	2.44E–02	4.10E+01
KLX17A	KLX13A:1	469.00–595.50	–	–	–	0
KLX17A	KLX13A:2	340.00–468.0	–	–	–	0
KLX17A	KLX13A:3	11.80–339.00	14,400	552	4.73E–02	2.12E+01
KLX06	HLX20	9.00–202.20	52	246	8.56E–4	1.17E+03
KLX18A	KLX11A:1	12.05–992.30	–	–	–	0

Table 6-54. Drawdown and normalized drawdown for the observation sections included in the interference test.

Pumping borehole	Flow rate Q_p (m^3/s)	Observation borehole	Section (m)	s_p (m)	s_p/Q_p (s/m^2) Index 2	$(s_p/Q_p)\cdot\ln(r_s/r_o)$ (s/m^2) Index 2 new
KLX14A	5.23E–04	HLX38	15.00–199.50	1.80	3.44E+03	1.81E+04
KLX21B	9.08E–04	KLX07A:1	781.00–844.73	1.09	1.20E+03	7.33E+03
KLX21B	9.08E–04	KLX07A:2	753.00–780.00	1.02	1.12E+03	6.85E+03
KLX21B	9.08E–04	KLX07A:3	612.00–752.00	1.01	1.11E+03	6.80E+03
KLX21B	9.08E–04	KLX07A:4	457.00–611.00	2.17	2.39E+03	1.49E+04
KLX21B	9.08E–04	KLX07A:5	333.00–456.00	1.75	1.93E+03	1.23E+04
KLX21B	9.08E–04	KLX07A:6	204.00–332.00	0.61	6.73E+02	4.39E+03
KLX21B	9.08E–04	KLX07A:7	104.00–203.00	0.54	5.95E+02	3.95E+03
KLX21B	9.08E–04	KLX07A:8	11.80–103.00	0.38	4.15E+02	2.80E+03
KLX21B	9.08E–04	KLX07B:1	95.00–200.00	0.43	4.71E+02	3.17E+03
KLX21B	9.08E–04	KLX07B:2	9.60–94.00	0.34	3.70E+02	2.51E+03
KLX21B	9.08E–04	KLX12:1	546.00–602.29	–	0	0
KLX21B	9.08E–04	KLX12:2	535.00–545.00	–	0	0
KLX21B	9.08E–04	KLX12:3	426.00–534.000	–	0	0
KLX21B	9.08E–04	KLX12:4	386.00–425.00	0.34	3.70E+02	2.50E+03
KLX21B	9.08E–04	KLX12:5	291.00–385.00	–	0	0
KLX21B	9.08E–04	KLX12:6	160.00–290.00	0.54	5.95E+02	4.02E+03
KLX21B	9.08E–04	KLX12:7	142.00–159.00	0.37	4.04E+02	2.74E+03
KLX21B	9.08E–04	KLX12:8	104.00–141.00	0.57	6.28E+02	4.26E+03
KLX21B	9.08E–04	KLX12:9	17.90–103.00	0.50	5.50E+02	3.74E+03
KLX21B	9.08E–04	KLX05:1	721.00–1000.16	–	0	0
KLX21B	9.08E–04	KLX05:2	634.00–720.000	–	0	0
KLX21B	9.08E–04	KLX05:3	6250.0–633.00	–	0	0
KLX21B	9.08E–04	KLX05:4	501.00–624.00	–	0	0
KLX21B	9.08E–04	KLX05:5	361.00–500.00	0.69	7.63E+02	5.24E+03
KLX21B	9.08E–04	KLX05:6	256.00–360.00	0.26	2.92E+02	1.99E+03
KLX21B	9.08E–04	KLX05:7	241.00–255.00	0.42	4.60E+02	3.14E+03
KLX21B	9.08E–04	KLX05:8	220.00–240.00	0.59	6.51E+02	4.43E+03
KLX21B	9.08E–04	KLX05:9	128.00–219.00	0.60	6.62E+02	4.51E+03
KLX21B	9.08E–04	KLX05:10	15.00–127.00	0.72	7.97E+02	5.42E+03
KLX21B	9.08E–04	HLX22	9.00–163.20	1.13	1.25E+03	7.93E+03
KLX21B	9.08E–04	HLX23:1	61.00–160.20	–	0	0
KLX21B	9.08E–04	HLX23:2	6.00–60.00	–	0	0
KLX21B	9.08E–04	HLX18:1	90.00–181.20	–	0	0
KLX21B	9.08E–04	HLX18:2	15.00–89.00	–	0	0
KLX26A	1.75E–05	KLX26B:1	47.00–50.40	3.25	1.86E+05	5.26E+05
KLX26A	1.75E–05	KLX26B:2	21.00–46.00	3.45	1.97E+05	6.00E+05
KLX26A	1.75E–05	KLX26B:3	2.30–20.00	1.53	8.74E+04	3.27E+05
KLX26B	2.33E–05	KLX26A:1	48.00–101.10	–	0	0
KLX26B	2.33E–05	KLX26A:2	22.00–47.00	3.25	1.39E+05	4.10E+05
KLX26B	2.33E–05	KLX26A:3	2.60–21.00	3.52	1.51E+05	3.87E+05
KLX22A	1.45E–04	KLX22B	2.00–100.25	0.80	5.52E+03	2.22E+04
KLX23A	1.11E–04	KLX23B	2.30–50.30	2.13	1.92E+04	6.92E+04
KLX23B	1.67E–05	KLX23A	2.30–100.20	0.10	5.99E+03	2.16E+04
KLX16A	4.68E–04	HLX42:2	9.10–29.00	–	0	0
KLX16A	4.68E–04	KLX12A:1	546.00–602.30	–	0	0
KLX16A	4.68E–04	KLX12A:2	535.00–545.00	–	0	0
KLX16A	4.68E–04	KLX12A:3	426.00–534.00	–	0	0

Pumping borehole	Flow rate Q_p (m^3/s)	Observation borehole	Section (m)	s_p (m)	s_p/Q_p (s/m^2) Index 2	$(s_p/Q_p)\cdot\ln(r_s/r_o)$ (s/m^2) Index 2 new
KLX16A	4.68E–04	KLX12A:4	386.00–425.00	–	0	0
KLX16A	4.68E–04	KLX12A:5	291.00–385.00	–	0	0
KLX16A	4.68E–04	KLX12A:6	160.00–290.00	–	0	0
KLX16A	4.68E–04	KLX12A:7	142.00–159.00	–	0	0
KLX16A	4.68E–04	KLX12A:8	104.00–141.00	–	0	0
KLX16A	4.68E–04	KLX12A:9	17.90–103.00	–	0	0
KLX16A	4.68E–04	KLX05:1	721.00–1000.20	–	0	0
KLX16A	4.68E–04	KLX05:2	634.00–720.00	–	0	0
KLX16A	4.68E–04	KLX05:3	625.00–633.00	–	0	0
KLX16A	4.68E–04	KLX05:4	501.00–624.00	–	0	0
KLX16A	4.68E–04	KLX05:5	361.00–500.00	–	0	0
KLX16A	4.68E–04	KLX05:6	256.00–360.00	–	0	0
KLX16A	4.68E–04	KLX05:7	241.00–255.00	–	0	0
KLX16A	4.68E–04	KLX05:8	220.00–240.00	–	0	0
KLX16A	4.68E–04	KLX05:9	128.00–219.00	–	0	0
KLX16A	4.68E–04	KLX05:10	15.00–127.00	–	0	0
KLX16A	4.68E–04	HLX15	12.00–151.90	–	0	0
KLX16A	4.68E–04	HLX26	11.00–151.20	–	0	0
KLX16A	4.68E–04	HLX28	6.00–154.20	–	0	0
KLX15A	4.94E–04	HLX38	15.00–199.50	0.11	2.27E+02	1.56E+03
KLX15A	4.94E–04	KLX05:1	721.00–1000.20	–	0	0
KLX15A	4.94E–04	KLX05:2	634.00–720.00	–	0	0
KLX15A	4.94E–04	KLX05:3	625.00–633.00	–	0	0
KLX15A	4.94E–04	KLX05:4	501.00–624.00	–	0	0
KLX15A	4.94E–04	KLX05:5	361.00–500.00	–	0	0
KLX15A	4.94E–04	KLX05:6	256.00–360.00	–	0	0
KLX15A	4.94E–04	KLX05:7	241.00–255.00	–	0	0
KLX15A	4.94E–04	KLX05:8	220.00–240.00	–	0	0
KLX15A	4.94E–04	KLX05:9	128.00–219.00	–	0	0
KLX15A	4.94E–04	KLX05:10	15.00–127.00	–	0	0
KLX15A	4.94E–04	KLX19A:1	661.00–800.10	–	0	0
KLX15A	4.94E–04	KLX19A:2	518.00–660.00	–	0	0
KLX15A	4.94E–04	KLX19A:3	509.00–517.00	–	0	0
KLX15A	4.94E–04	KLX19A:4	481.50–508.00	–	0	0
KLX15A	4.94E–04	KLX19A:5	311.00–480.50	–	0	0
KLX15A	4.94E–04	KLX19A:6	291.00–310.00	–	0	0
KLX15A	4.94E–04	KLX19A:7	136.00–290.00	–	0	0
KLX15A	4.94E–04	KLX19A:8	98.80–135.00	–	0	0
KLX19A	9.68E–04	HLX36:1	50.00–199.80	2.53	2.61E+03	1.72E+04
KLX19A	9.68E–04	HLX36:2	6.00–49.00	–	0	0
KLX19A	9.68E–04	HLX37:2	118.00–148.00	3.53	3.64E+03	2.40E+04
KLX19A	9.68E–04	HLX37:1	149.00–199.80	3.48	3.60E+03	2.36E+04
KLX19A	9.68E–04	HLX37:3	12.00–117.00	–	0	0
KLX19A	9.68E–04	HLX38	15.00–199.50	–	0	0
KLX19A	9.68E–04	KLX11A	12.00–992.30	1.87	1.93E+03	1.27E+04
KLX17A	4.00E–04	KLX13A:1	469.00–595.50	–	0	0
KLX17A	4.00E–04	KLX13A:2	340.00–468.00	–	0	0
KLX17A	4.00E–04	KLX13A:3	11.80–339.00	0.54	1.35E+03	8.52E+03
KLX06	1.25E–03	HLX20	9.00–202.20	2.7	2.16E+03	1.19E+04
KLX18A	7.70E–05	KLX11A:1	12.05–992.30	–	0	0

Figure 6-62 shows the response diagram during the interference test in KLX14A. Only borehole HLX14 responded to the pumping in KLX14A. The response was distinct and relatively large placing it in the middle of the response diagram. For index classification of the responses see Section 5.

Figure 6-63 shows the response diagram during the interference test in KLX21A. Several observation sections responded to this pumping. The most distinct responses occurred in sections KLX07A:4 and KLX07A:5. Good responses were also observed in sections KLX07B:1, KLX05A:9 and 10 and some other sections in KLX07A.

Figure 6-64 shows the response diagram during the interference test in KLX26A. Good responses were indicated in all three sections in the observation borehole KLX26B. Sections KLX26B:1 and KLX26B:2 show very similar behaviour. Observation section KLX26B:3 show a weaker response than the two underlying sections with respect to total drawdown.

Figure 6-65 shows the response diagram during the interference test in KLX26B. In the observation borehole KLX26A sections KLX26A:3 and KLX26A:2 show similar, distinct, responses. This is also clearly reflected in the response diagram.

Figure 6-66 shows the response diagram during the interference test in KLX22A. The observation borehole KLX22B: 2.0–100.25 m shows a relatively quick, but not very large, pressure response. The response is positioned to the left in the response diagram due to the proximity of the boreholes.

Figure 6-67 shows the response diagram during the interference test in KLX23A. The pressure response in KLX23B: 2.3–50.3 m is distinct and relatively large and in combination with the proximity of the boreholes, the response is placed in the left side of the response diagram.

Figure 6-68 shows the response diagram during the interference test in KLX23B. The pressure response in the observation borehole KLX23A: 2.3–100.2 m is very small (estimated to 0.1 m) but in combination with a low flow of 1.0 L/min in the pumping borehole KLX23B the response is classified as “medium” with respect to new index2 placing the response in the mid range and to the left in the response diagram.

Figure 6-69 shows the response diagram during the interference test in KLX15A. Only one of the observation boreholes HLX38, KLX05A and KLX19A showed a response strong enough for response index calculation. In HLX38: 15.0–199.5 m a response of 0.1 m was registered. The response is classified as “medium” and “low” for new index 2 and index 1 respectively.

Figure 6-70 shows the response diagram during the interference test in KLX19A. In HLX37 almost identical, distinct, responses was observed in Section 1 and 2 with a total drawdown of c. 3.5 m. In HLX37:3 no response was indicated. Observation borehole KLX11A was not affected at all of the pumping in KLX19A. Observation borehole HLX36:2 did not respond to the pumping in KLX19A but HLX36:1 showed a response classified as “medium” for both response index1 and new index 2.

Figure 6-71 shows the response diagram during the interference test in KLX17A. The lower sections KLX13A:1 and KLX13A:2 are unaffected of the pumping in KLX17A. In KLX13A:3: 11.8–339.0 m a total drawdown of 0.5 m is observed.

Figure 6-72 shows the response diagram during the interference test in KLX06A. The response in HLX20 is distinct and total drawdown relatively large. The response is classified as “excellent” for response index 1 and “medium” for the new index 2.

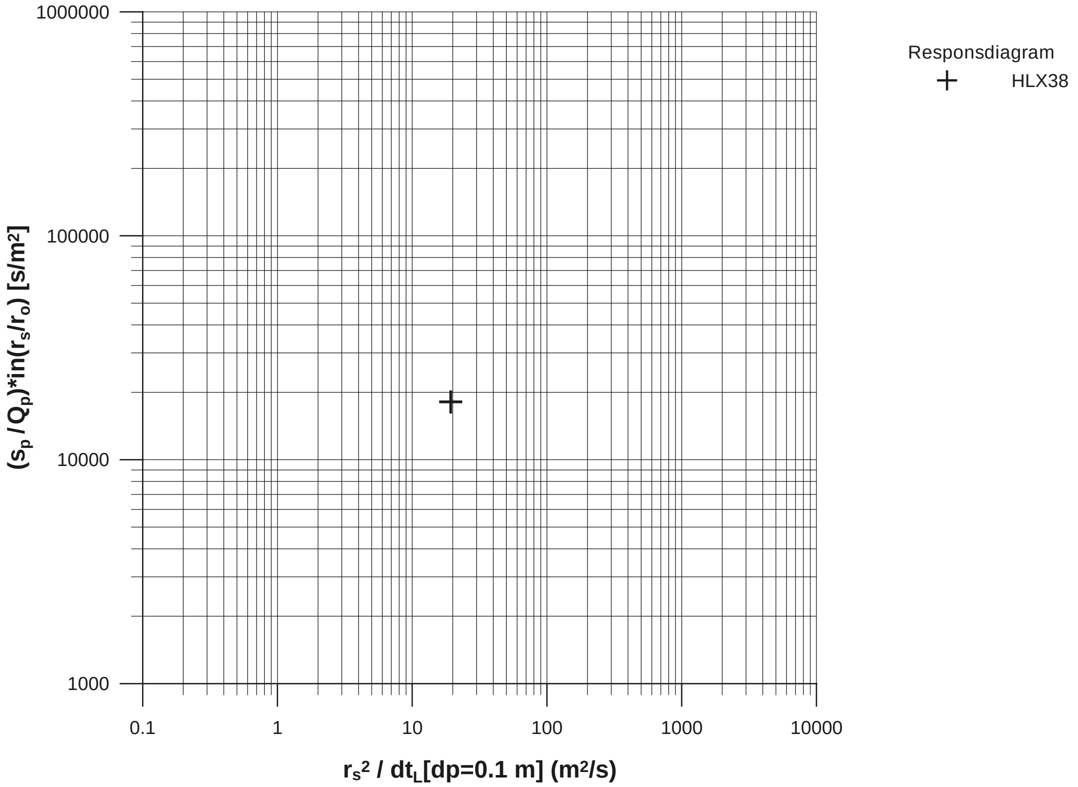

Figure 6-62. *Response diagram showing the responding observation section during the interference test in KLX14A.*

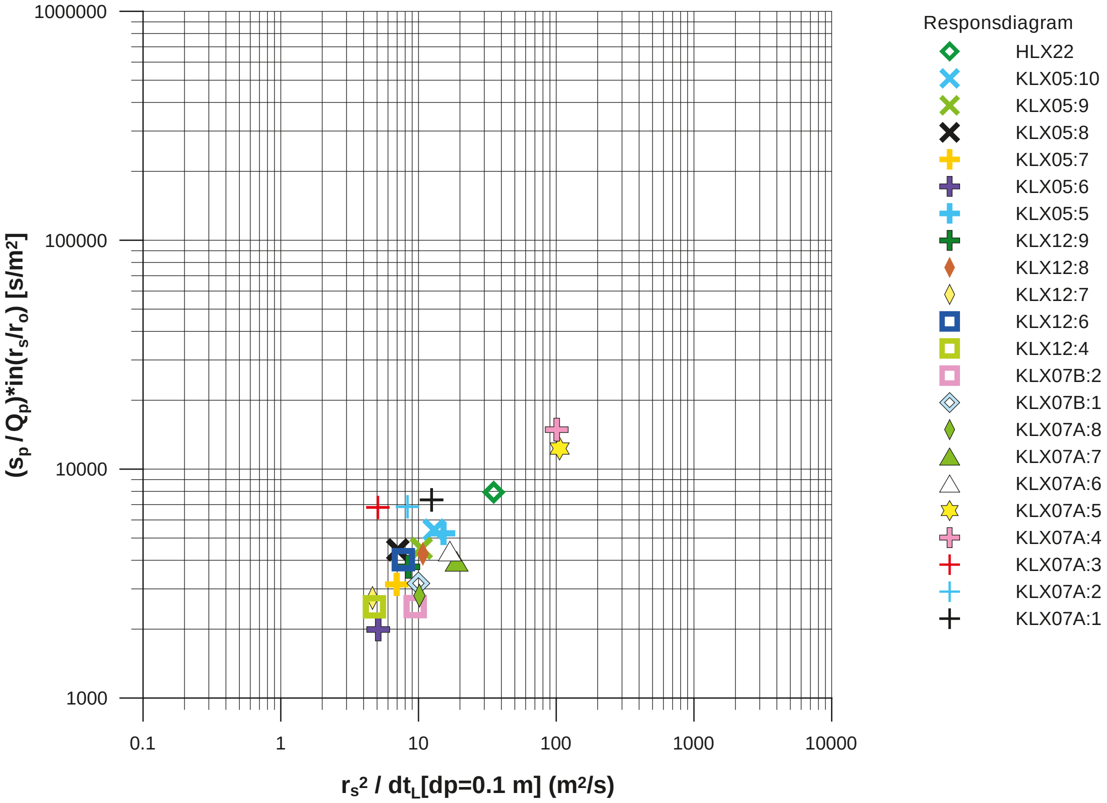

Figure 6-63. *Response diagram showing the responses in the responding observation sections during the interference test in KLX21B.*

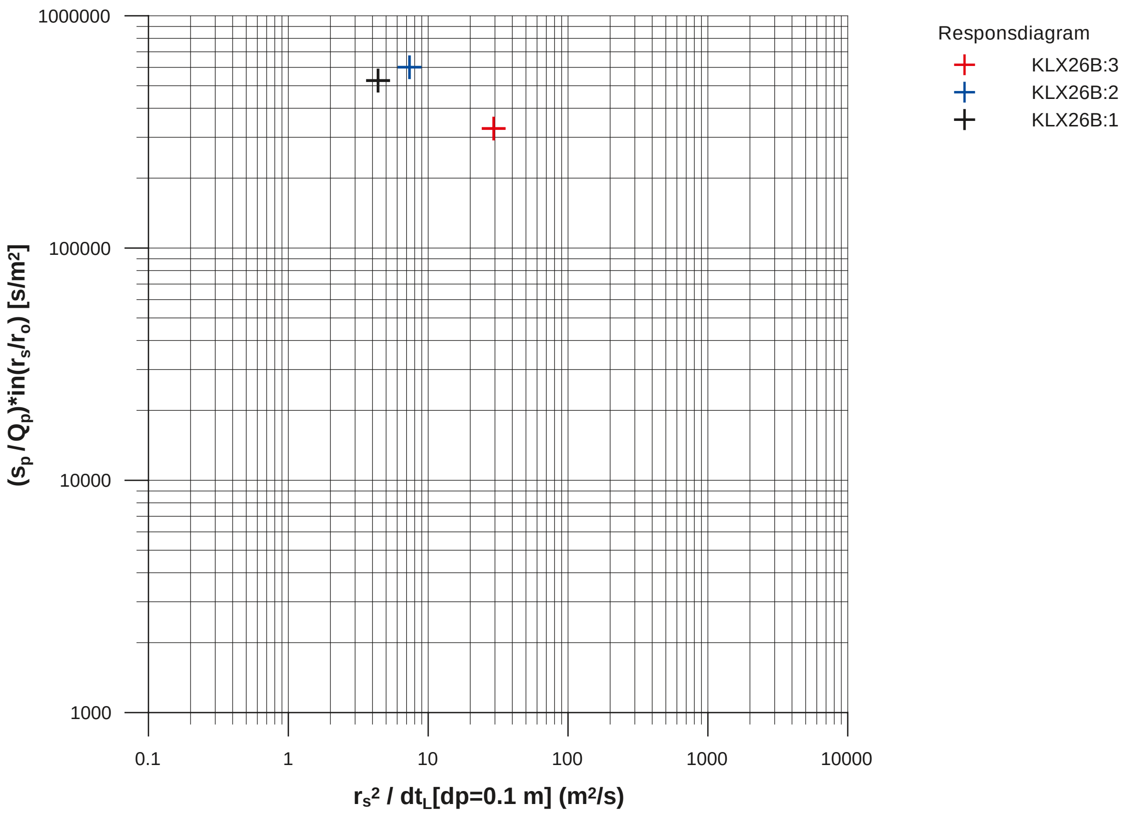

Figure 6-64. *Response diagram showing the responses in the responding observation sections during the interference test in KLX26A.*

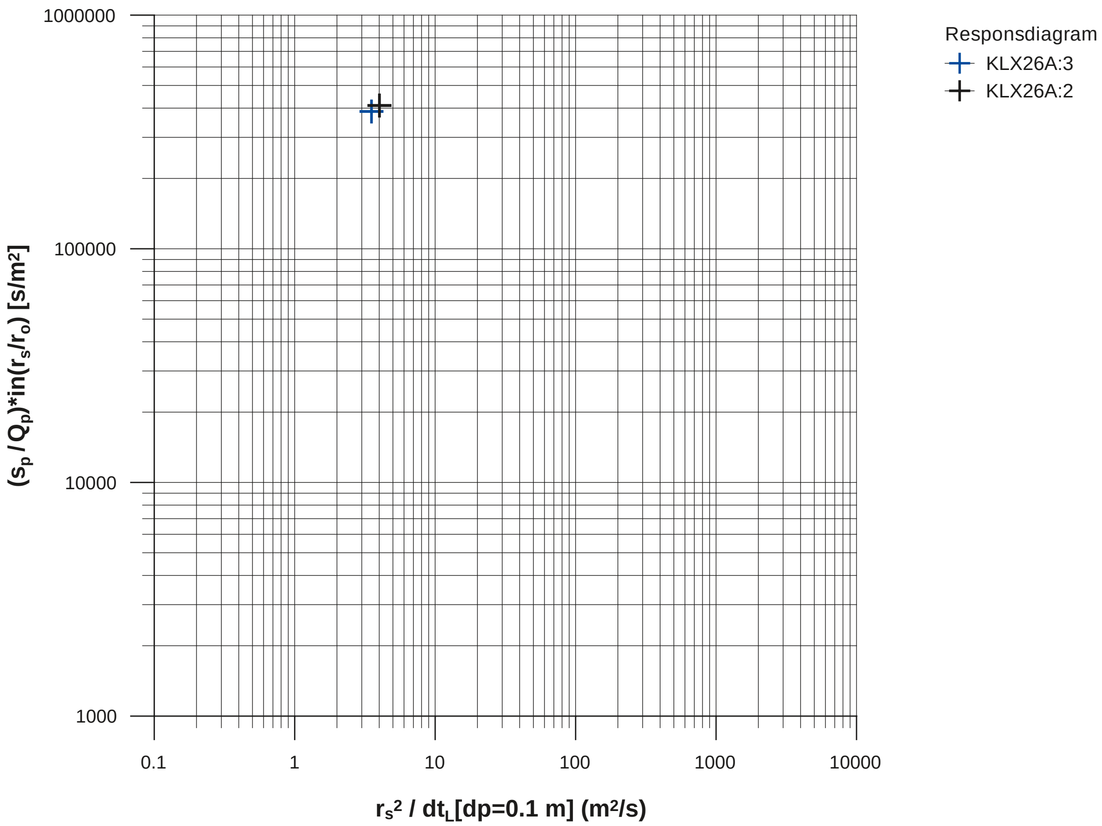

Figure 6-65. *Response diagram showing the responses in the responding observation sections during the interference test in KLX26B.*

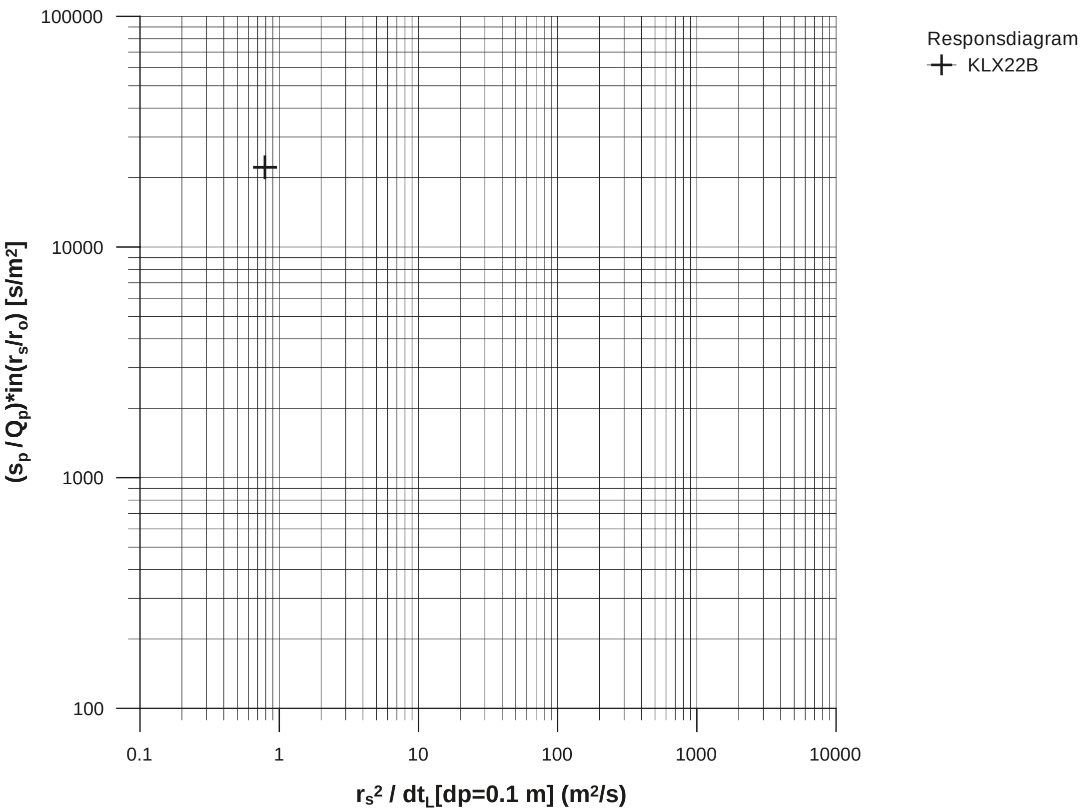

Figure 6-66. *Response diagram showing the responses in the responding observation sections during the interference test in KLX22A.*

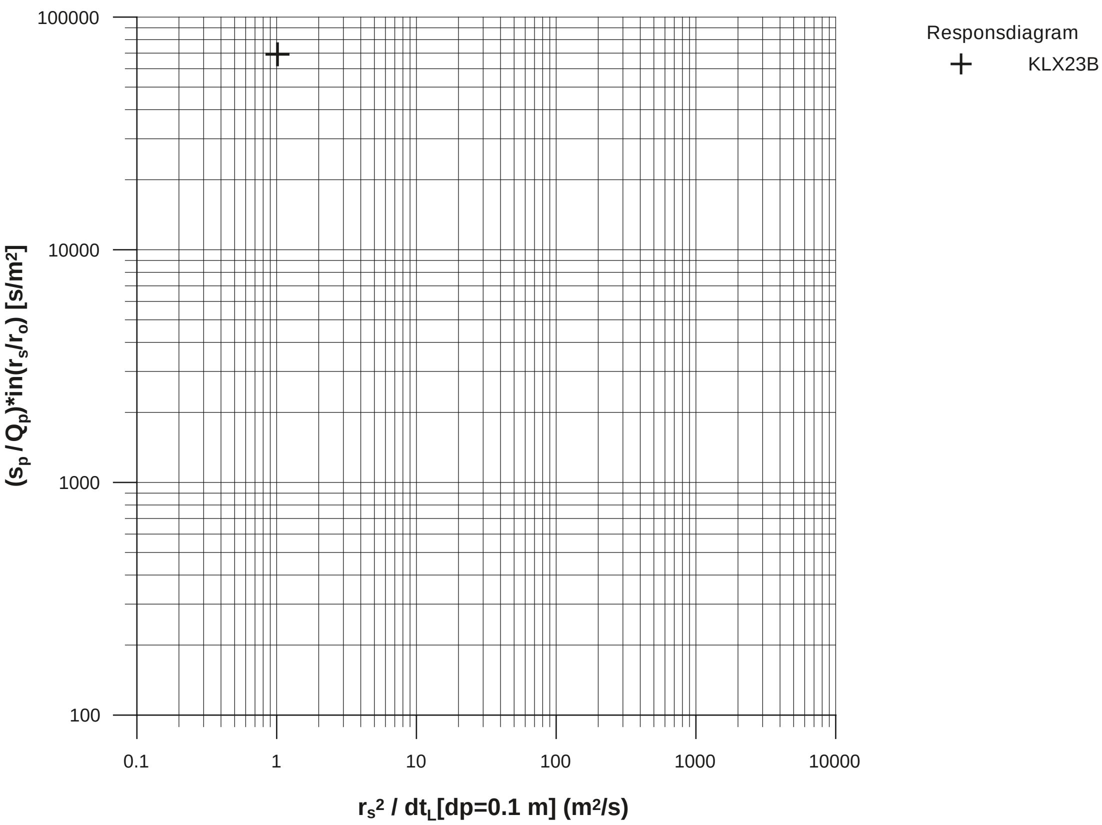

Figure 6-67. *Response diagram showing the responses in the responding observation sections during the interference test in KLX23A.*

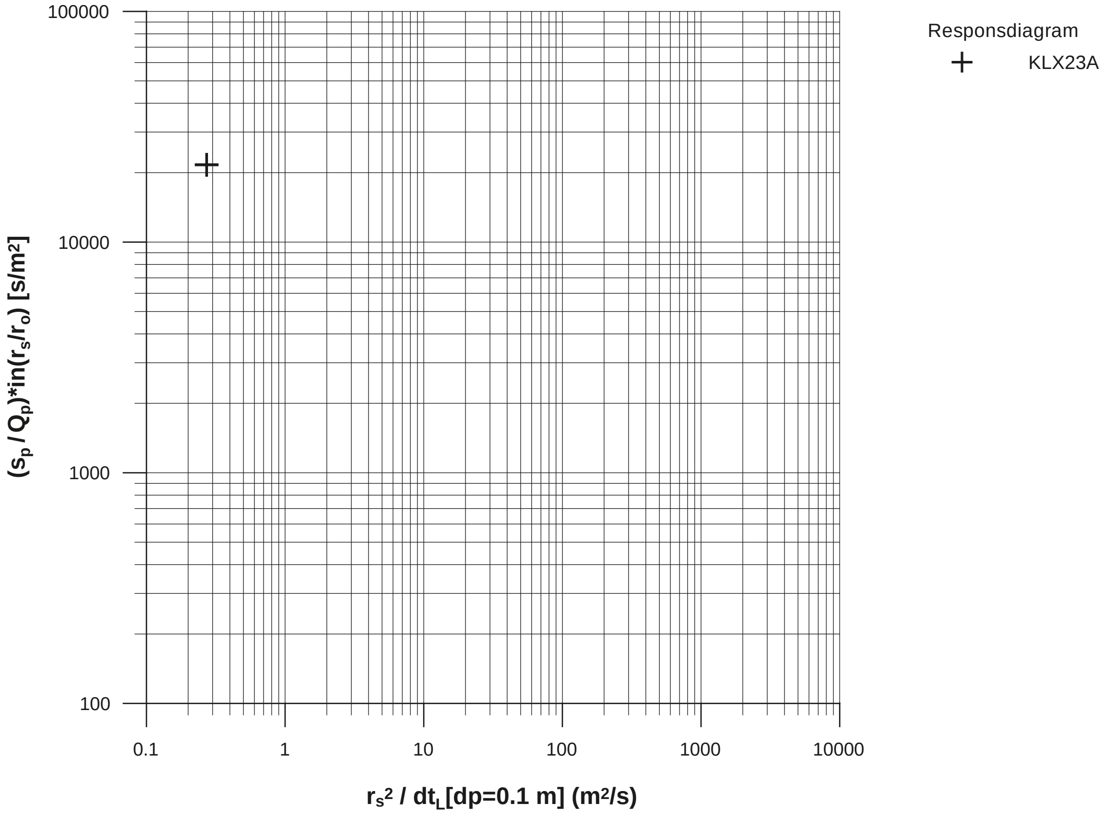

Figure 6-68. *Response diagram showing the responses in the responding observation sections during the interference test in KLX23B.*

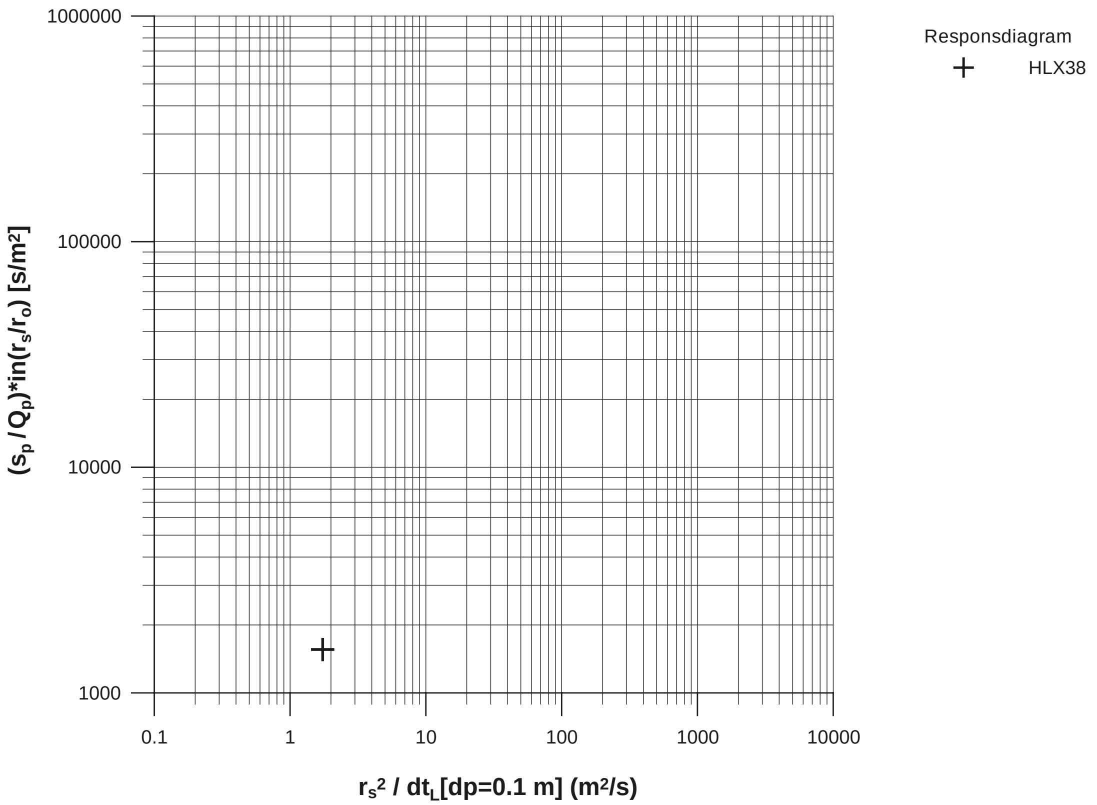

Figure 6-69. *Response diagram showing the responses in the responding observation sections during the interference test in KLX15A.*

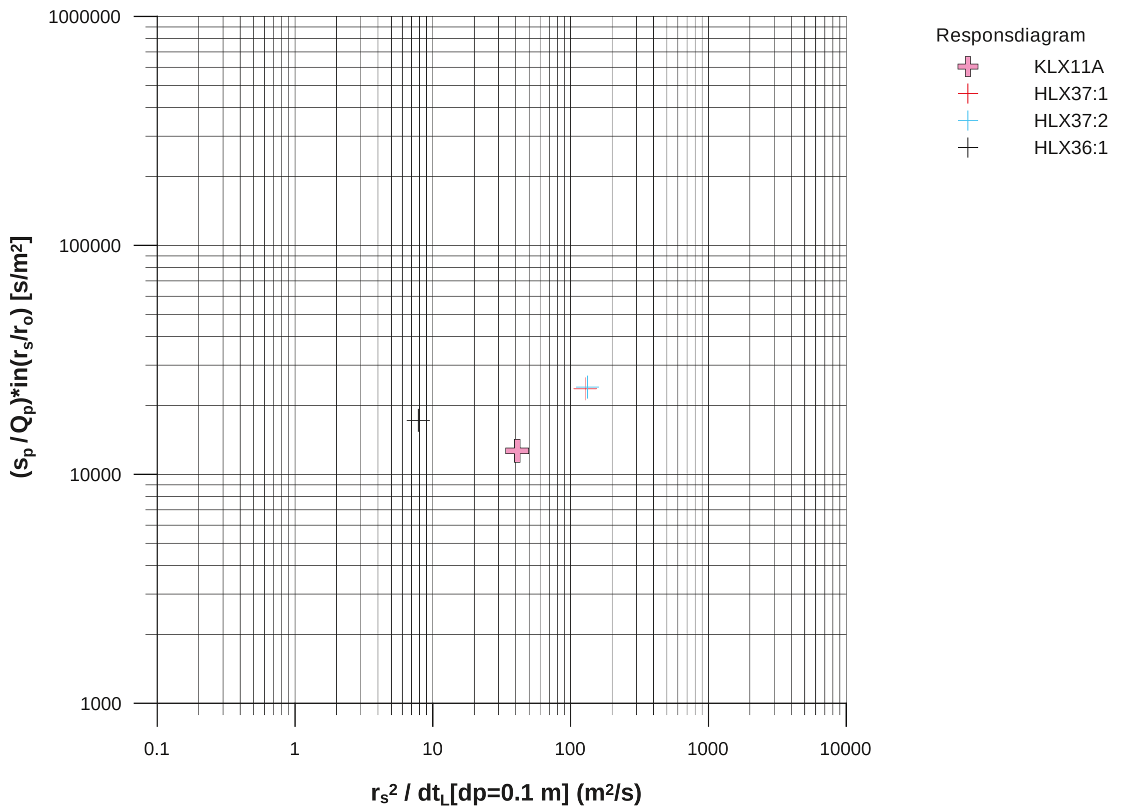

Figure 6-70. *Response diagram showing the responses in the responding observation sections during the interference test in KLX19A.*

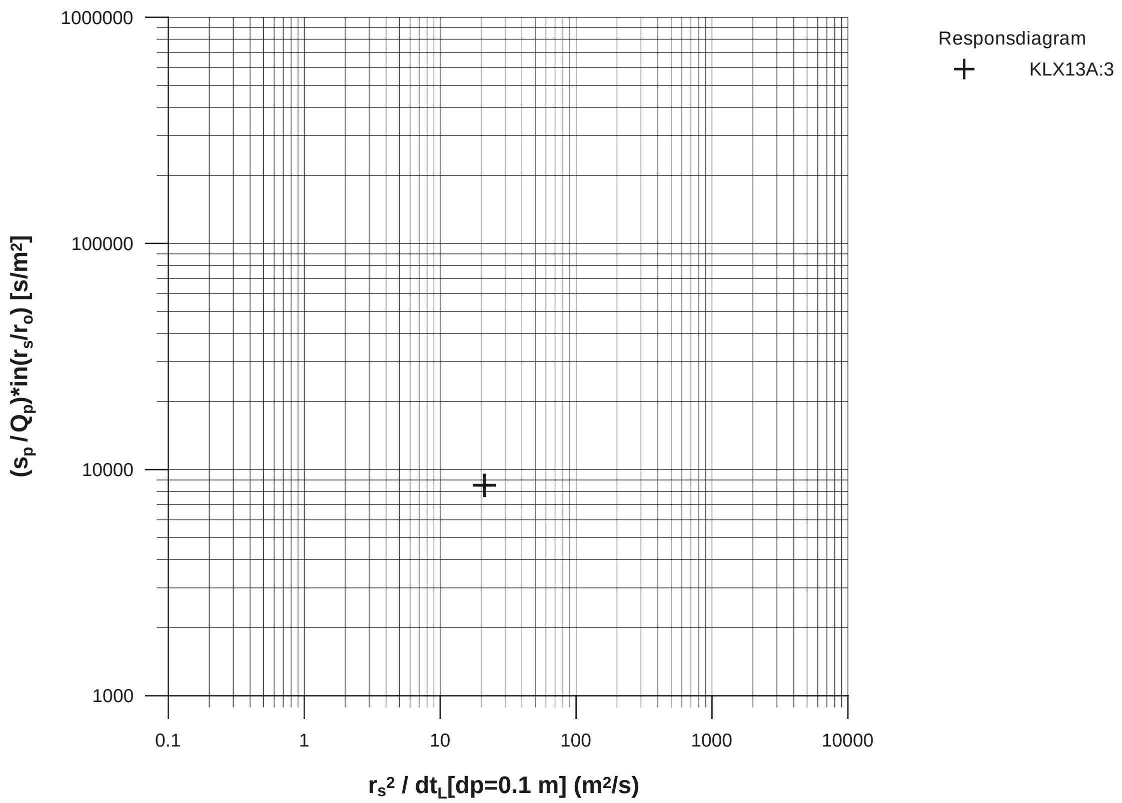

Figure 6-71. *Response diagram showing the responses in the responding observation sections during the interference test in KLX17A.*

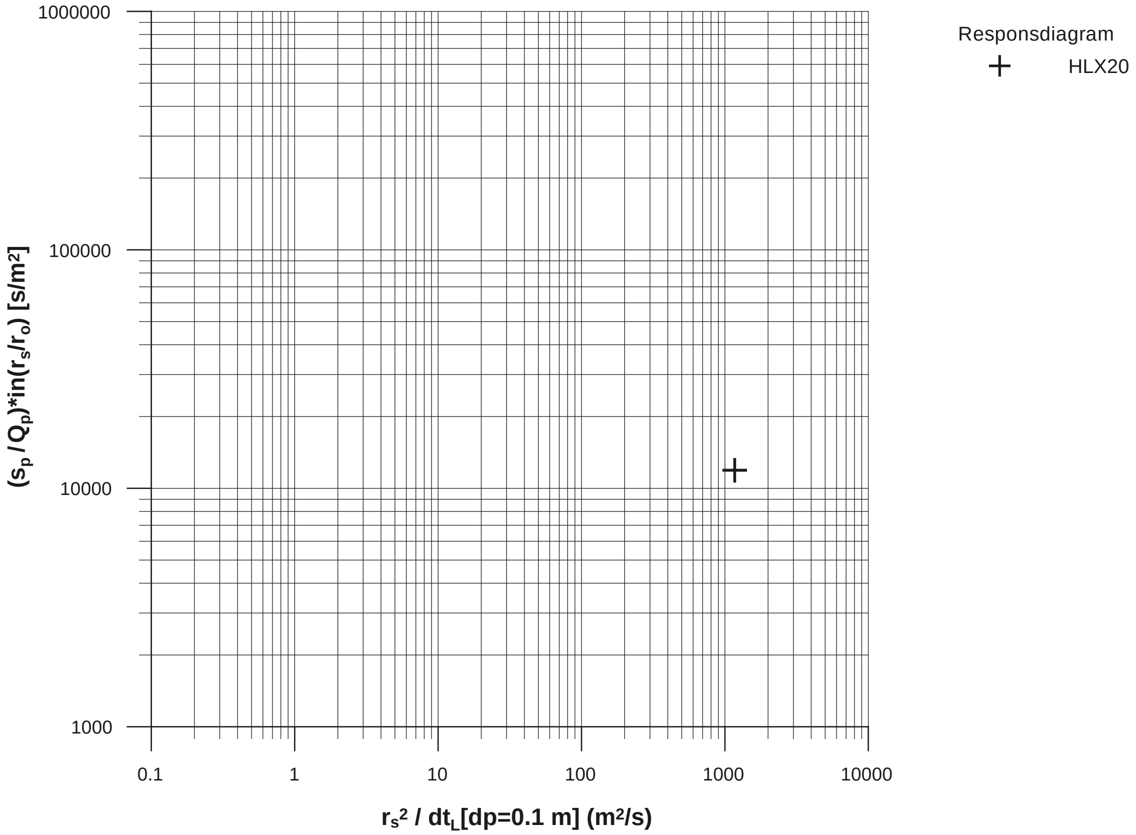

Figure 6-72. *Response diagram showing the responses in the responding observation sections during the interference test in KLX06.*

6.17 Estimation of the hydraulic diffusivity

The hydraulic diffusivity of observation sections can be estimated from the observed response time lag in the section according to Section 5.5.2. The time lag dt_L is here based on a drawdown s = 0.01 m in the observation section. The estimated time lags based on the drawdown in the observation sections are shown in Table 6-55 together with the estimated hydraulic diffusivity T/S of the sections. For comparison, the ratio of the estimated transmissivity and storativity To/So from the transient evaluation of the responses in these sections from the interference tests are also presented.

Table 6-55 shows that the estimated hydraulic diffusivities from the time lags in general are much higher compared to the ratio of To/So from the transient evaluation of the test sections.

Table 6-55. Estimated response lag times and hydraulic diffusivity for the selected observation sections from the interference tests.

Pumping borehole	Observation borehole	Section (m)	measured $dt_{L[s=0.01\ m]}$ (s)	r_s (m)	T/S (m^2/s)	T_o/S_o (m^2/s)
KLX14A	HLX38	15.00–199.50	600	192.6	2.56	5.15
KLX21B	KLX07A:1	781.00–844.73	3,000	449	3.13	1.31
KLX21B	KLX07A:2	753.00–780.00	2,400	447	3.73	0.80
KLX21B	KLX07A:3	612.00–752.00	3,600	455	2.77	0.73
KLX21B	KLX07A:4	457.00–611.00	1,200	504	8.45	19.35
KLX21B	KLX07A:5	333.00–456.00	1,440	585	9.76	21.54
KLX21B	KLX07A:6	204.00–332.00	6,000	675	4.04	4.91
KLX21B	KLX07A:7	104.00–203.00	3,600	768	7.90	4.90
KLX21B	KLX07A:8	11.80–103.00	20,400	855	2.51	2.15
KLX21B	KLX07B:1	95.00–200.00	24,000	830	2.10	2.39
KLX21B	KLX07B:2	9.60–94.00	36,000	875	1.73	1.88
KLX21B	KLX12:4	386.00–425.00	81,000	864	0.94	0.52
KLX21B	KLX12:6	160.00–290.00	27,000	863	2.08	1.07
KLX21B	KLX12:7	142.00–159.00	75,000	874	1.02	0.75
KLX21B	KLX12:8	104.00–141.00	12,000	880	3.99	2.19
KLX21B	KLX12:9	17.90–103.00	24,000	900	2.47	1.36
KLX21B	KLX05:5	361.00–500.00	18,000	964	3.51	2.33
KLX21B	KLX05:6	256.00–360.00	63,000	926	1.29	0.55
KLX21B	KLX05:7	241.00–255.00	60,000	913	1.30	0.95
KLX21B	KLX05:8	220.00–240.00	60,000	910	1.29	0.95
KLX21B	KLX05:9	128.00–219.00	39,000	904	1.74	1.50
KLX21B	KLX05:10	15.00–127.00	12,000	904	4.21	2.24
KLX21B	HLX22	9.00–163.20	3,000	581	5.24	11.11
KLX26A	KLX26B:1	47.00–50.40	15	17	0.52	0.52
KLX26A	KLX26B:2	21.00–46.00	3	21	3.39	1.12
KLX26A	KLX26B:3	2.30–20.00	9	42	5.03	6.16
KLX26B	KLX26A:2	22.00–47.00	25.8	19	0.44	0.24
KLX26B	KLX26A:3	2.60–21.00	12	13	0.41	0.70
KLX22A	KLX22B	2.00–100.25	60	55.5	1.54	0.18
KLX23A	KLX23B	2.30–50.30	540	37	0.11	1.90
KLX23B	KLX23A	2.30–100.20	180	37	0.28	0.15
KLX15A	HLX38	15.00–199.50	120,000	952	0.81	0.41
KLX19A	HLX36:1	50.00–199.80	6,000	728	4.93	1.06
KLX19A	HLX37:2	118.00–148.00	1,500	737	15.55	24.17
KLX19A	HLX37:1	149.00–199.80	1,440	710	14.93	22.69
KLX19A	KLX11A	12.00–992.30	12,000	701	2.67	3.40
KLX17A	KLX13A:3	11.80–339.00	6,000	552	4.37	4.30
KLX06	HLX20	9.00–202.20		246		27.50

6.18 Summary of the results of the interference test

A compilation of measured test data from the interference test is shown in Tables 6-56 and 6-57. In Tables 6-58 and 6-59 calculated hydraulic parameters for the pumping boreholes and the evaluated observation sections are presented.

Nomenclature used:

Q/s = specific flow for the pumping/injection borehole

T_M = steady state transmissivity from Moye´s equation

T_T = transmissivity from transient evaluation of single-hole test

T_o = transmissivity from transient evaluation of interference test

S_o = storativity from transient evaluation of interference test

T_o/S_o = hydraulic diffusivity (m^2/s)

K'/b' = leakage coefficient from transient evaluation of interference test

S* = assumed storativity by the estimation of the skin factor in single hole tests

C = wellbore storage coefficient

ξ = skin factor

The estimated transmissivity of the observation section may be more weighted towards the hydraulic properties close to the pumping borehole. In addition, the estimated transmissivity in the observation sections may be overestimated from the interference test due to poor hydraulic connection to the pumping borehole.

The results of the interference tests show a rather good agreement between the estimated hydraulic diffusivity of the sections based on the response time lags and from the results of the transient evaluation, respectively, also at long distances from the pumping borehole.

Table 6-56. Summary of test data from the pumping borehole during the interference tests.

Pumping borehole ID	Section (m)	Test Type[1)]	h_i (m)	h_p (m)	h_F (m)	Q_p (m^3/s)	Q_m (m^3/s)	V_p (m^3)
KLX14A	6.50–176.30	1B	5.95	0.84	5.67	5.23E-04	5.23E-04	130.54
KLX21B	11.90–858.80	1B	7.15	3.65	6.85	9.08E-04	9.08E-04	564.74
KLX26A	2.60–101.10	1B	11.51	6.51	0.00	1.75E-05	1.75E-05	2.66
KLX26B	2.30–50.40	1B	11.43	6.42	9.65	2.33E-05	2.33E-05	1.61
KLX22A	2.00–100.45	1B	13.63	3.59	13.06	1.45E-04	1.45E-04	35.81
KLX22B	2.00–100.25	1B	16.29	6.09	14.97	5.83E-05	5.83E-05	14.54
KLX23A	2.30–100.20	1B	11.14	0.78	10.29	1.11E-04	1.11E-04	18.94
KLX23B	2.30–50.30	1B	13.13	2.81	12.65	1.67E-05	1.67E-05	2.73
KLX16A	11.25–433.50	1B	8.58	3.62	7.65	4.68E-04	4.68E-04	236.80
KLX15A	11.65–1,000.43	1B	6.75	–0.31	5.03	4.94E-04	4.94E-04	387.51
KLX19A	98.80–800.07	1B	12.84	2.96	12.28	9.68E-04	9.68E-04	480.96
KLX18A	312.00–611.28	1A	300.79	286.18	–	7.70E-5	7.42E-5	17.99
KLX06	11.88–998.94	1B	12.9	6.1	–	1.25E-3	–	–

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 6-57. Summary of test data from the observation sections involved in the interference tests.

Pumping borehole ID	Borehole ID	Section (m)	Test Type[1)]	h_i (m.a.s.l.)	h_p (m.a.s.l.)	h_F (m.a.s.l.)
KLX14A	HLX38	15.00–199.50	2	5.56	3.66	5.69
KLX21B	KLX07A:1	781.00–844.73	2	5.83	4.74	5.58
KLX21B	KLX07A:2	753.00–780.00	2	5.50	4.48	5.26
KLX21B	KLX07A:3	612.00–752.00	2	5.25	4.24	5.00
KLX21B	KLX07A:4	457.00–611.00	2	7.94	5.77	7.85
KLX21B	KLX07A:5	333.00–456.00	2	8.22	6.47	8.02
KLX21B	KLX07A:6	204.00–332.00	2	9.78	9.17	9.25
KLX21B	KLX07A:7	104.00–203.00	2	10.05	9.51	8.86
KLX21B	KLX07A:8	11.80–103.00	2	10.82	10.44	10.34
KLX21B	KLX07B:1	95.00–200.00	2	10.33	9.90	9.70
KLX21B	KLX07B:2	9.60–94.00	2	10.74	10.40	10.20
KLX21B	KLX12:4	386.00–425.00	2	10.20	9.86	9.79
KLX21B	KLX12:6	160.00–290.00	2	10.18	9.64	9.71
KLX21B	KLX12:7	142.00–159.00	2	10.98	10.62	10.59
KLX21B	KLX12:8	104.00–141.00	2	10.63	10.06	10.22
KLX21B	KLX12:9	17.90–103.00	2	10.97	10.48	10.59
KLX21B	KLX05:5	361.00–500.00	2	10.50	9.80	10.08
KLX21B	KLX05:6	256.00–360.00	2	10.26	10.00	9.88
KLX21B	KLX05:7	241.00–255.00	2	10.27	9.85	9.82
KLX21B	KLX05:8	220.00–240.00	2	10.39	9.80	9.96
KLX21B	KLX05:9	128.00–219.00	2	10.40	9.80	9.96
KLX21B	KLX05:10	15.00–127.00	2	10.53	9.80	10.07
KLX21B	HLX22	9.00–163.20	2	7.12	5.99	6.98
KLX26A	KLX26B	47.00–50.40	2	11.06	7.81	11.17
KLX26A	KLX26B	21.00–46.00	2	11.13	7.68	11.20
KLX26A	KLX26B	2.30–20.00	2	11.84	10.31	11.34
KLX26B	KLX26A	22.00–47.00	2	10.90	7.65	10.92
KLX26B	KLX26A	2.60–21.00	2	11.54	8.02	11.49
KLX22A	KLX22B	2.00–100.25	2	15.36	14.77	15.42
KLX23A	KLX23B	2.30–50.30	2	15.13	13.00	15.21
KLX23B	KLX23A	2.30–100.20	2	16.20		
KLX15A	HLX38	15.00–199.50	2	5.73	5.61	5.66
KLX19A	HLX36:1	50.00–199.80	2		11.36	13.90
KLX19A	HLX37:2	118.00–148.00	2	12.94	9.42	13.54
KLX19A	HLX37:1	149.00–199.80	2	12.94	9.46	13.55
KLX19A	KLX11A	12.00–992.30	2		11.33	13.20
KLX17A	KLX13A:3	11.80–339.00	2	14.31	13.77	14.02
KLX06	HLX20	9.00–202.20	2	10.9	8.2	

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 6-58. Summary of calculated hydraulic parameters from the single-hole tests.

Pumping borehole ID	Section (m)	Test type	Q/s (m^2/s)	T_M (m^2/s)	T_T (m^2/s)	ξ (–)	C (m^3/Pa)	S* (–)
KLX14A	6.50–176.30	1B	1.02E-04	1.42E-04	5.50E-05	–7	3.2E-06	5.20E-06
KLX21B	11.90–858.80	1B	2.60E-04	4.30E-04	4.50E-04	–6	3.2E-06	1.50E-05
KLX26A	2.60–101.10	1B	3.50E-06	4.60E-06				
KLX26B	2.30–50.40	1B	4.70E-06	5.50E-06	5.50E-06	15.6	3.7E-07	1.60E-06
KLX22A	2.00–100.45	1B	1.40E-05	1.20E-05	3.30E-05	0.2	3.6E-07	4.00E-06
KLX22B	2.00–100.25	1B	5.72E-06	7.43E-06	3.40E-06	–6.2	4.0E-07	1.10E-06
KLX23A	2.30–100.20	1B	1.10E-05	1.40E-05	3.00E-05	6.7	5.7E-07	3.80E-06
KLX23B	2.30–50.30	1B	1.60E-06	1.90E-06	4.50E-06	10.3	3.6E-07	1.60E-06
KLX16A	11.25–433.50	1B	9.44E-05	1.45E-04	4.32E-05	–0.99	6.2E-07	4.60E-06
KLX15A	11.65–1,000.43	1B	7.01E-05	1.17E-04	4.10E-05	–7.4	4.1E-07	4.50E-06
KLX19A	98.80–800.07	1B	9.80E-05	1.60E-04	1.60E-04	3.8	3.7E-06	8.80E-06
KLX17A	12.00–701.10	1C	1.60E-04	2.60E-04				
KLX18A	312.00–611.28	1A	5.3E-6	7.8E-6	7.6E-6	0.5	3.3E-7	1.9E-6
KLX06	11.88–998.94	1B	1.84E-4	3.06E-4	3.0E-4	–6	2.51E-6	9E-6

[1)] 1A: Wireline test, 1B: Pumping test-submersible pump, 1C: Air lift pumping, 2: Interference test.

Table 6-59. Summary of calculated hydraulic parameters from the interference tests between pumping boreholes and observation boreholes.

Pumping borehole ID	Observation borehole ID	Section (m)	Test type	T_o (m^2/s)	S_o (–)	T_o/S_o (m^2/s)	K'/b' (s^{-1})
KLX14A	HLX38	15.00–199.50	2	6.70E-05	1.30E-05	5.15	7.77E-11
KLX21B	KLX07A:1	781.00–844.73	2	1.10E-04	8.40E-05	1.31	9.30E-11
KLX21B	KLX07A:2	753.00–780.00	2	8.80E-05	1.10E-04	0.80	1.58E-10
KLX21B	KLX07A:3	612.00–752.00	2	7.30E-05	1.00E-04	0.73	1.84E-10
KLX21B	KLX07A:4	457.00–611.00	2	1.20E-04	6.20E-06	19.35	1.49E-11
KLX21B	KLX07A:5	333.00–456.00	2	1.40E-04	6.50E-06	21.54	1.52E-11
KLX21B	KLX07A:6	204.00–332.00	2	2.70E-04	5.50E-05	4.91	3.57E-11
KLX21B	KLX07A:7	104.00–203.00	2	2.50E-04	5.10E-05	4.90	5.13E-11
KLX21B	KLX07A:8	11.80–103.00	2	1.40E-04	6.50E-05	2.15	1.74E-10
KLX21B	KLX07B:1	95.00–200.00	2	1.60E-04	6.70E-05	2.39	1.43E-10
KLX21B	KLX07B:2	9.60–94.00	2	1.20E-04	6.40E-05	1.88	2.06E-10
KLX21B	KLX12:4	386.00–425.00	2	1.50E-05	2.90E-05	0.52	1.57E-10
KLX21B	KLX12:6	160.00–290.00	2	4.80E-05	4.50E-05	1.07	1.38E-10
KLX21B	KLX12:7	142.00–159.00	2	6.30E-05	8.40E-05	0.75	1.99E-10
KLX21B	KLX12:8	104.00–141.00	2	1.40E-04	6.40E-05	2.19	6.72E-11
KLX21B	KLX12:9	17.90–103.00	2	7.50E-05	5.50E-05	1.36	1.46E-10
KLX21B	KLX05:5	361.00–500.00	2	7.00E-05	3.00E-05	2.33	8.51E-11
KLX21B	KLX05:6	256.00–360.00	2	1.20E-05	2.20E-05	0.55	1.42E-10
KLX21B	KLX05:7	241.00–255.00	2	4.00E-05	4.20E-05	0.95	1.63E-10
KLX21B	KLX05:8	220.00–240.00	2	4.00E-05	4.20E-05	0.95	1.62E-10
KLX21B	KLX05:9	128.00–219.00	2	6.30E-05	4.20E-05	1.50	1.16E-10
KLX21B	KLX05:10	15.00–127.00	2	7.60E-05	3.40E-05	2.24	8.91E-11
KLX21B	HLX22	9.00–163.20	2	2.00E-04	1.80E-05	11.11	3.06E-11
KLX26A	KLX26B:1	47.00–50.40	2	2.90E-06	5.60E-06	0.52	4.20E-11
KLX26A	KLX26B:2	21.00–46.00	2	2.80E-06	2.50E-06	1.12	2.60E-11
KLX26A	KLX26B:3	2.30–20.00	2	6.10E-06	9.90E-07	6.16	2.11E-11
KLX26B	KLX26A:2	22.00–47.00	2	2.00E-06	8.30E-06	0.24	2.76E-10
KLX26B	KLX26A:3	2.60–21.00	2	3.50E-06	6.00E-06	0.70	2.95E-21
KLX22A	KLX22B	2.00–100.25	2	5.20E-05	2.90E-04	0.18	5.06E-15
KLX23A	KLX23B	2.30–50.30	2	1.90E-05	1.00E-05	1.90	5.58E-14
KLX23B	KLX23A	2.30–100.20	2	1.30E-05	8.80E-05	0.15	5.44E-09
KLX15A	HLX38	15.00–199.50	2	7.70E-05	1.90E-04	0.41	3.23E-18
KLX19A	HLX36:1	50.00–199.80	2	1.80E-05	1.70E-05	1.06	3.40E-29
KLX19A	HLX37:1	149.00–199.80	2	5.90E-05	2.60E-06	22.69	1.09E-11
KLX19A	HLX37:2	118.00–148.00	2	5.80E-05	2.40E-06	24.17	1.05E-11
KLX19A	KLX11A	12.00–992.30	2	5.10E-05	1.50E-05	3.40	1.24E-10
KLX17A	KLX13A:3	11.80–339.00	2	4.30E-05	1.00E-05	4.30	9.37E-11
KLX06	HLX20	9.00–202.20	2	2.20E-04	8.00E-06	27.50	

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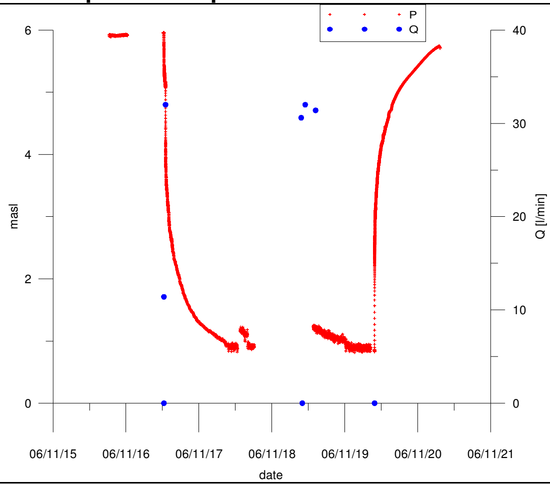
Appendix 1

Test summary sheets

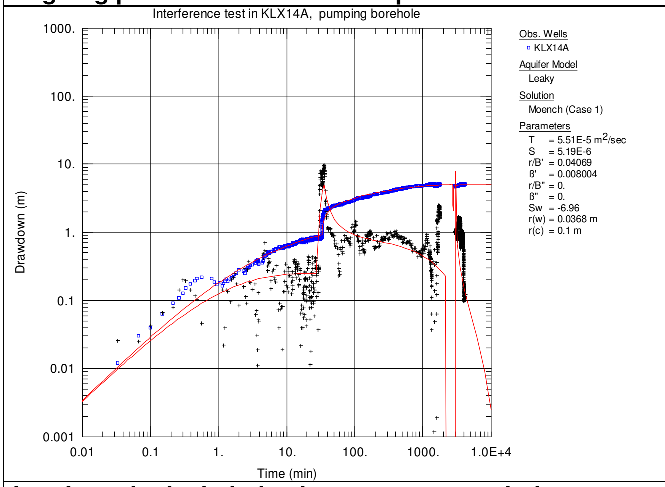
Test Summary Sheet – Pumping borehole KLX14A

Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX14A	Test start:	2006-11-16 12:29:02
Test section (m):	6.5-176.3	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

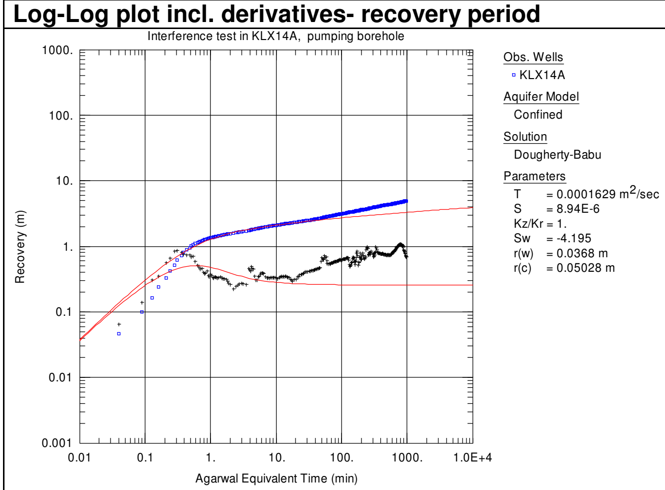
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	58.4		
p_p(kPa)	8.2	p_F (kPa)	55.6
Q_p (m^3/s)	$5.23 \cdot 10^{-4}$		
t_p (min)	4160	t_F (min)	1295
S^* (-)	$5.2 \cdot 10^{-6}$	S^* (-)	$8.9 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	-	r (m)	-
Results		**Results**	
Q/s (m^2/s)	$1.0 \cdot 10^{-4}$		
T_M (m^2/s)	$1.4 \cdot 10^{-4}$		
Flow regime:	WBS->PRF1->PRF2->PSS	Flow regime:	WBS->PRF1->PRF2
dt_1 (min)	50	dt_1 (min)	1
dt_2 (min)	600	dt_2 (min)	30
T (m^2/s)	$5.5 \cdot 10^{-5}$	T (m^2/s)	$1.6 \cdot 10^{-4}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$3.2 \cdot 10^{-6}$	C (m^3/Pa)	$8.1 \cdot 10^{-7}$
C_D (-)		C_D (-)	
ξ (-)	-7.0	ξ (-)	4.2
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	50	C (m^3/Pa)	$3.2 \cdot 10^{-6}$
dt_2 (min)	600	C_D (-)	
T_T (m^2/s)	$5.5 \cdot 10^{-5}$	ξ (-)	-7.0
S* (-)	$5.2 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

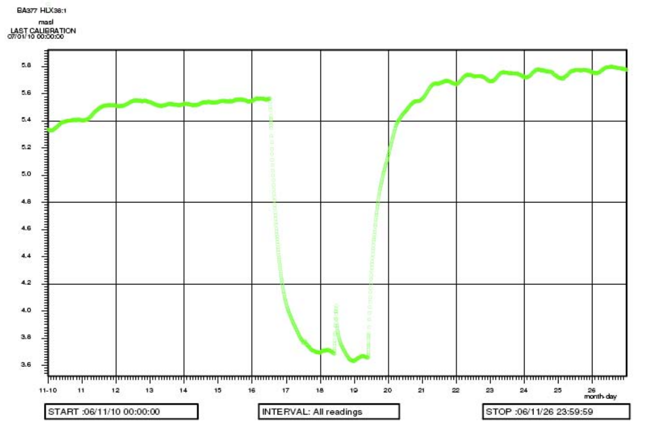
Comments:

Several flow rate changes occurred during the flow period. Only a few flow rate data are available. Pressure data are lacking between c. 1800-3000 min during the flow period. After initial WBS during the first c. 1 min of the flow period a period of approximate PRF was developed between c. 2-30 min. At c. 30 min the flow rate was increased c. 3 times. A second PRF developed between c. 50-600 min. A nearly pseudo-stationary pressure (PSS) was achieved after c. 1400 min. After initial WBS during the first c. 1 min a first PRF is developed between c. 1-30 min of equivalent time during the recovery period. A second PRF is indicated between c. 100-1000 min. Alternatively, an apparent no-flow boundary (NFB) may be assumed after c. 30 min. The representative parameters were selected from the flow period.

Test Summary Sheet – Observation borehole HLX38 (pumping borehole KLX14A)

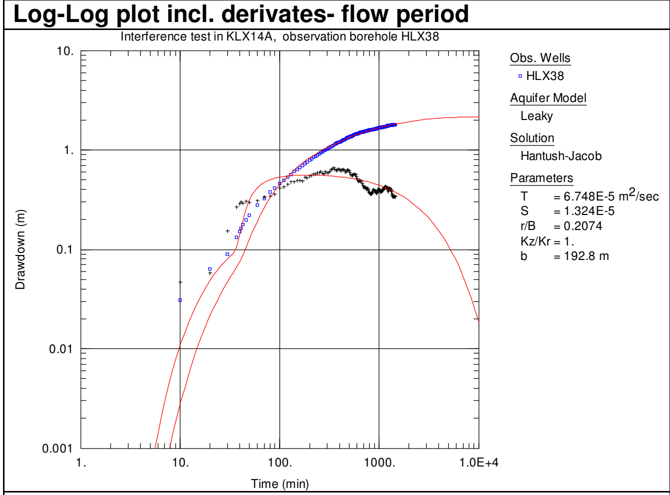
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	HLX38	Test start:	2006-11-16 12:29:02
Test section (m):	15.0-199.5	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.139	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

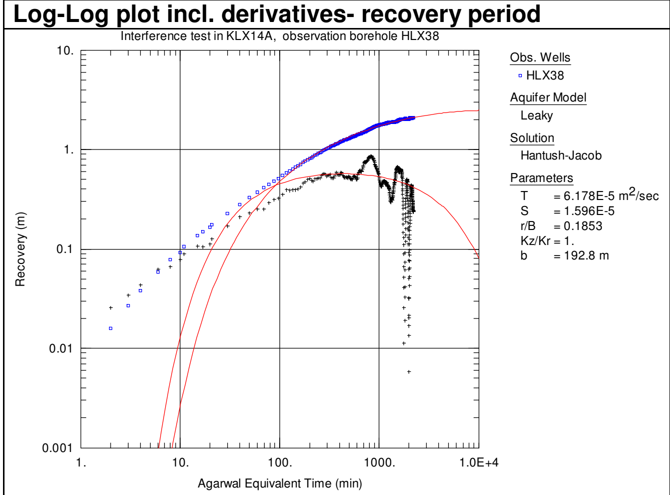


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	54.6		
p_p(kPa)	35.9	p_F (kPa)	55.8
Q_p (m³/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	192.6	r (m)	192.6
Results		**Results**	
Q/s (m²/s)			
T_M (m²/s)			
Flow regime:	PRF→PSF	Flow regime:	PRF→PSF
dt_1 (min)	200	dt_1 (min)	200
dt_2 (min)	600	dt_2 (min)	600
T (m²/s)	$6.7 \cdot 10^{-5}$	T (m²/s)	$6.2 \cdot 10^{-5}$
S (-)	$1.3 \cdot 10^{-5}$	S (-)	$1.6 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m³/Pa)		C (m³/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m²/s)		T_{GRF}(m²/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	200	C (m³/Pa)	
dt_2 (min)	600	C_D (-)	
T_T (m²/s)	$6.7 \cdot 10^{-5}$	ξ (-)	
S (-)	$1.3 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

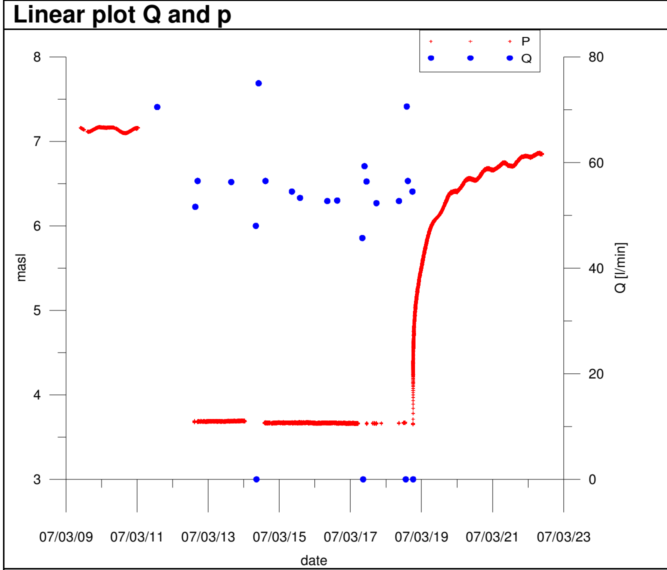
The flow period is dominated by PRF during c. 200-600 min, transitioning to PSF by the end. The recovery period also shows PRF during c. 200-600 min, transitioning to PSF by the end. The responses during the flow and recovery period respectively are consistent. Initial WBS is indicated during both periods in this long section.

The transient evaluation of the flow period is selected as representative for the test.

Test Summary Sheet – Pumping borehole KLX21B

Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX21B	Test start:	2007-03-11 13:37:00
Test section (m):	11.9- 858.8	Responsible for test execution:	SKB field crew
Section diameter, $2\cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

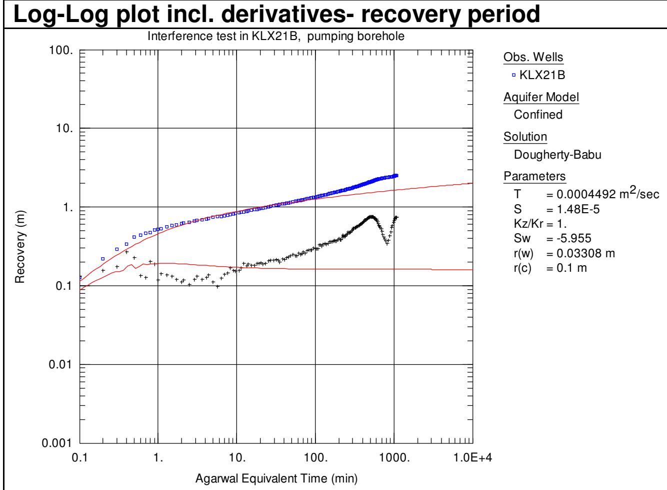


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	c. 70.2		
p_p(kPa)	35.8	p_F (kPa)	67.2
Q_p (m³/s)	$9.08\cdot10^{-4}$		
t_p (min)	10366	t_F (min)	5225
S^* (-)		S^* (-)	$1.5\cdot10^{-5}$
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.		Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m²/s)	$2.6\cdot10^{-4}$		
T_M (m²/s)	$4.3\cdot10^{-4}$		
Flow regime:		Flow regime:	WBS>PRF1 >PRF2?
dt_1 (min)		dt_1 (min)	1
dt_2 (min)		dt_2 (min)	50
T (m²/s)		T (m²/s)	$4.5\cdot10^{-4}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m³/Pa)		C (m³/Pa)	$3.2\cdot10^{-6}$
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	-6.0
T_{GRF}(m²/s)		T_{GRF}(m²/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period

No pressure data

Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	1	C (m³/Pa)	$3.2\cdot10^{-6}$
dt_2 (min)	50	C_D (-)	
T_T (m²/s)	$4.5\cdot10^{-4}$	ξ (-)	-6.0
S* (-)	$1.5\cdot10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

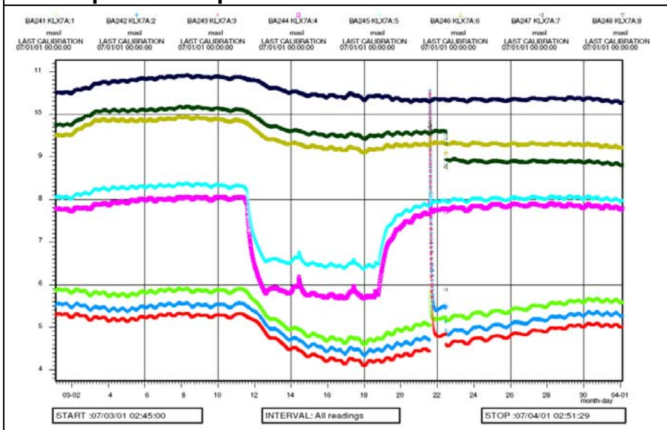
After initial WBS a first PRF is developed between c. 1-50 min of equivalent time. After a transition period a second PRF is weakly indicated between c. 300-1100 min. Alternatively, an apparent no-flow boundary (NFB) may be assumed after c. 50 min.

The first PRF is assumed to represent the hydraulic properties of the rock close to the borehole. The second PRF (or NFB) is considered as representative of the rock conditions at a certain distance from the borehole. The first PRF is selected as representative for the test.

Test Summary Sheet – Observation borehole KLX07A:1 (pumping borehole KLX21B)

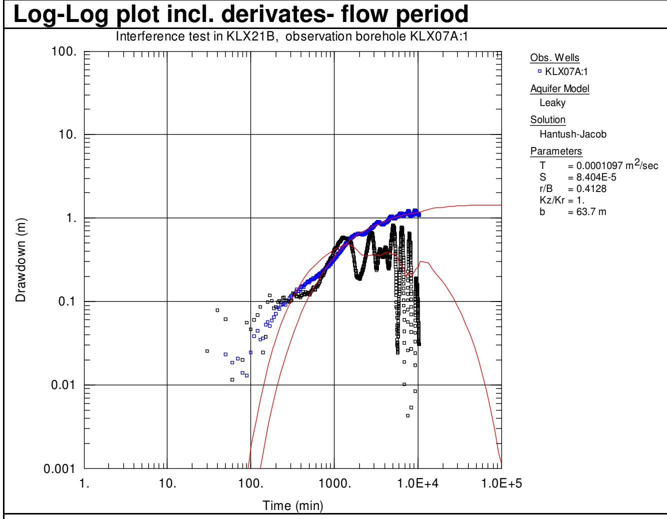
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07A:1	Test start:	2007-03-11 13:37:00
Test section (m):	781.0-844.7	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

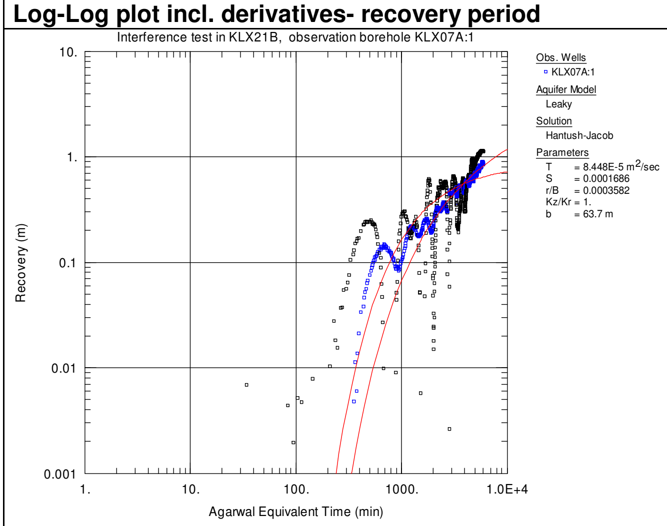


Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	57.2		
p_p(kPa)	46.5	p_F (kPa)	54.8
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	449	r (m)	449
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	Transition
dt_1 (min)	1000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$1.1 \cdot 10^{-4}$	T (m^2/s)	$8.4 \cdot 10^{-5}$
S (-)	$8.4 \cdot 10^{-5}$	S (-)	$1.7 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	1000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$1.1 \cdot 10^{-4}$	ξ (-)	
S (-)	$8.4 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

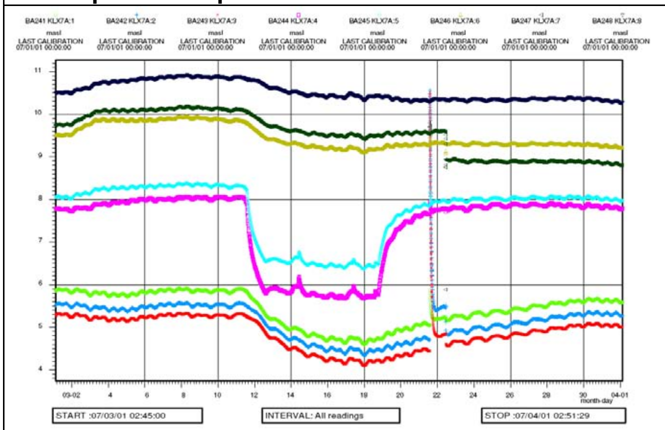
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

Test Summary Sheet – Observation borehole KLX07A:2 (pumping borehole KLX21B)

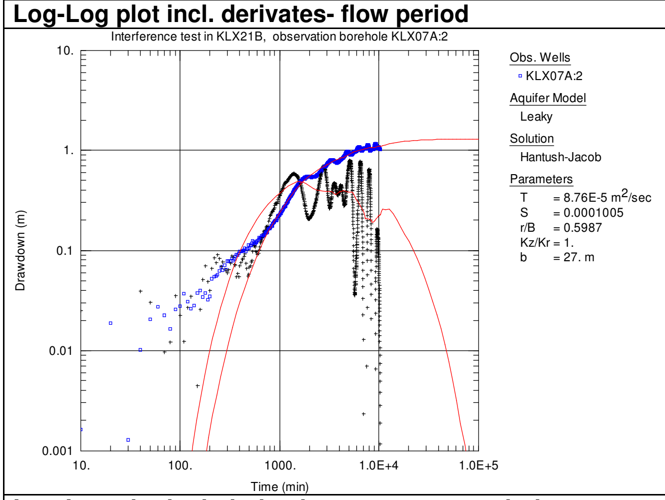
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07A:2	Test start:	2007-03-11 13:37:00
Test section (m):	753.0-780.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

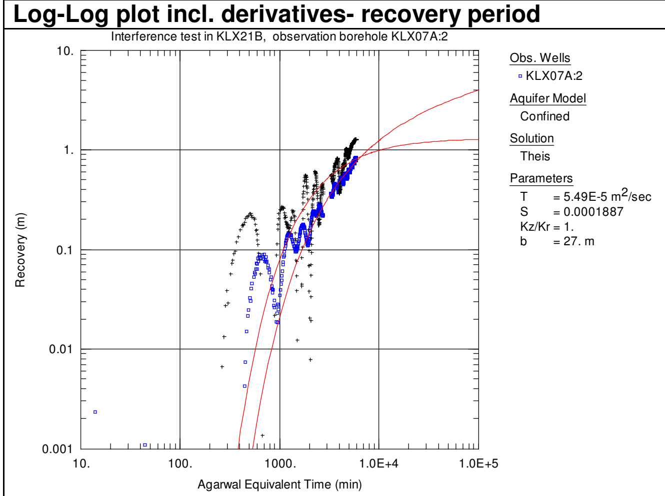


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	54.0		
p_p(kPa)	44.0	p_F (kPa)	51.7
Q_p (m³/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	447	r (m)	447
Results		**Results**	
Q/s (m²/s)			
T_M (m²/s)			
Flow regime:	PRF→PSF	Flow regime:	Transition
dt_1 (min)	1000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m²/s)	$8.8 \cdot 10^{-5}$	T (m²/s)	$5.5 \cdot 10^{-5}$
S (-)	$1.0 \cdot 10^{-4}$	S (-)	$1.8 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m³/Pa)		C (m³/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m²/s)		T_{GRF}(m²/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	1000	C (m³/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m²/s)	$8.8 \cdot 10^{-5}$	ξ (-)	
S (-)	$1.0 \cdot 10^{-4}$		
K_s (m/s)			
S_s (1/m)			

Comments:

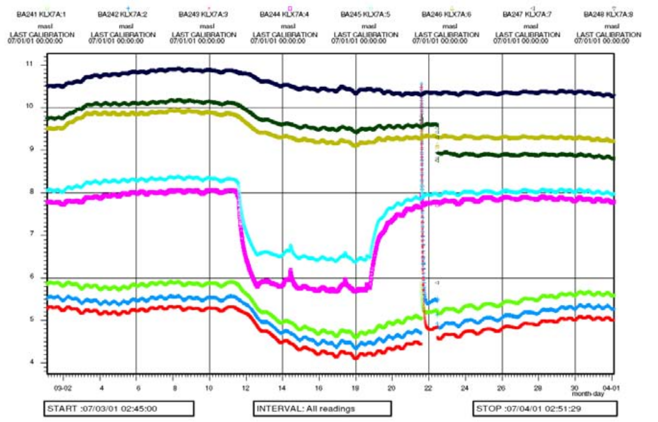
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

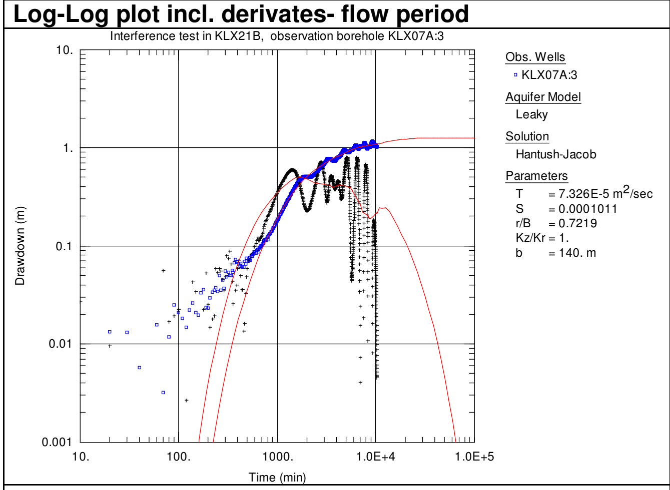
Test Summary Sheet – Observation borehole KLX07A:3 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07A:3	Test start:	2007-03-11 13:37:00
Test section (m):	612.0-752.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

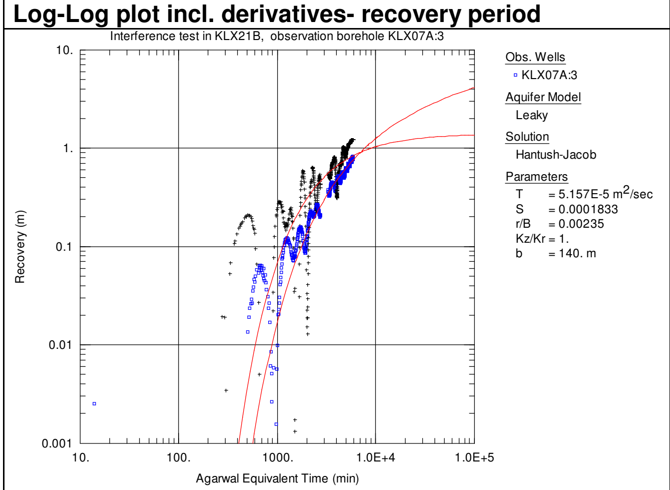
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	51.5		
p_p(kPa)	41.6	p_F (kPa)	49.1
Q_p (m^3/s)			
tp (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	455	r (m)	455
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	Transition
dt_1 (min)	1000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$7.3 \cdot 10^{-5}$	T (m^2/s)	$5.2 \cdot 10^{-5}$
S (-)	$1.0 \cdot 10^{-4}$	S (-)	$1.8 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	1000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$7.3 \cdot 10^{-5}$	ξ (-)	
S (-)	$1.0 \cdot 10^{-4}$		
K_s (m/s)			
S_s (1/m)			

Comments:

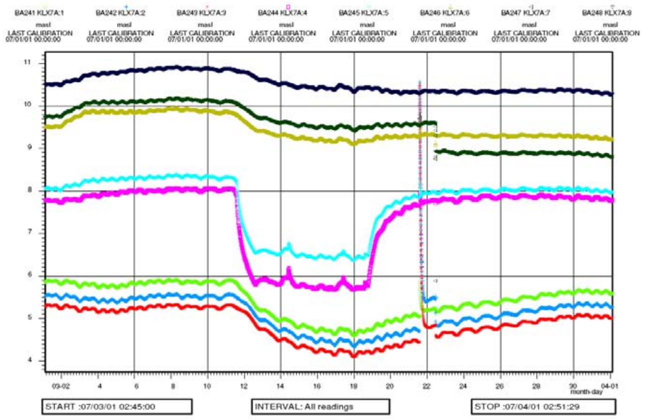
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

Test Summary Sheet – Observation borehole KLX07A:4 (pumping borehole KLX21B)

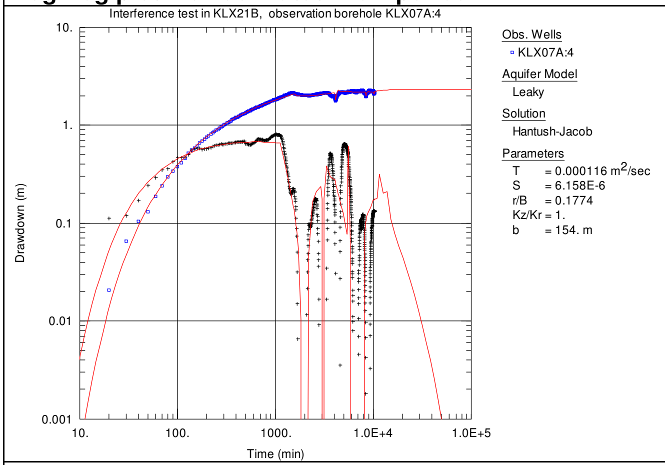
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07A:4	Test start:	2007-03-11 13:37:00
Test section (m):	457.0-611.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

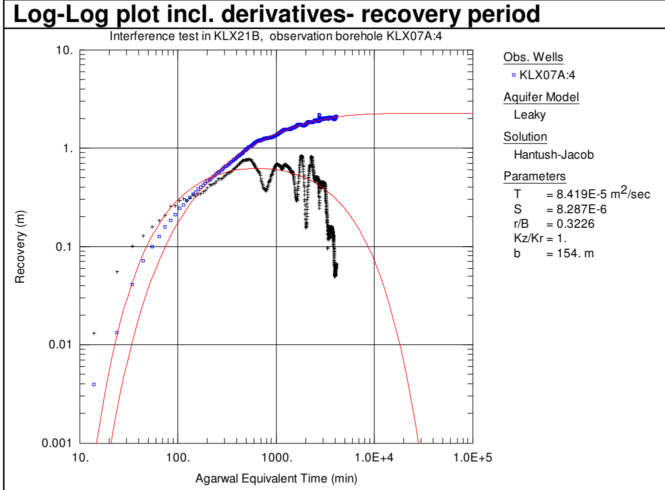


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	77.9		
p_p(kPa)	56.6	p_F (kPa)	77.0
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	504	r (m)	504
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	PRF→PSF
dt_1 (min)	200	dt_1 (min)	300
dt_2 (min)	1000	dt_2 (min)	1500
T (m^2/s)	$1.2 \cdot 10^{-4}$	T (m^2/s)	$8.4 \cdot 10^{-5}$
S (-)	$6.2 \cdot 10^{-6}$	S (-)	$8.3 \cdot 10^{-6}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	200	C (m^3/Pa)	
dt_2 (min)	1500	C_D (-)	
T_T (m^2/s)	$1.2 \cdot 10^{-4}$	ξ (-)	
S (-)	$6.2 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

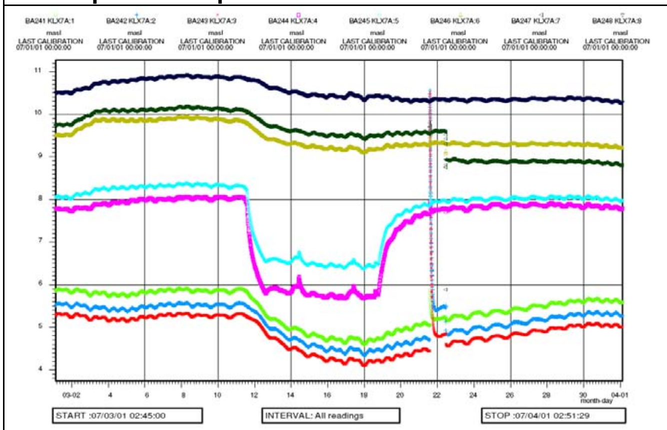
A distinct response occurred in this observation section. Both the flow and recovery period are dominated by PRF transitioning to PSF by the end.

The transient evaluation of the flow period is selected as representative for the test.

Test Summary Sheet – Observation borehole KLX07A:5 (pumping borehole KLX21B)

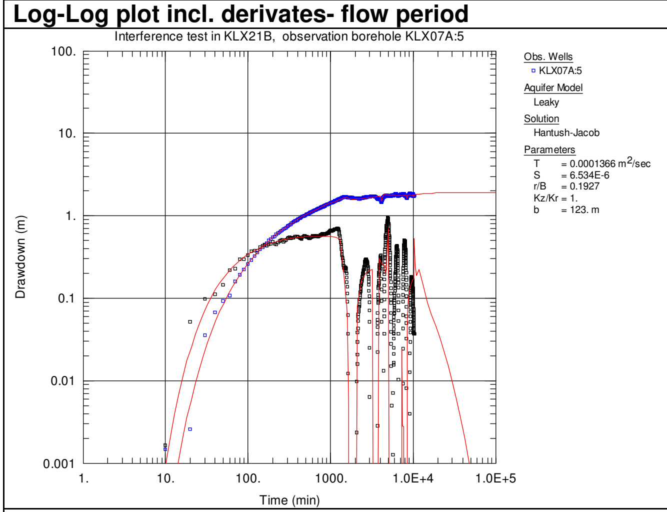
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07A:5	Test start:	2007-03-11 13:37:00
Test section (m):	333.0-456.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

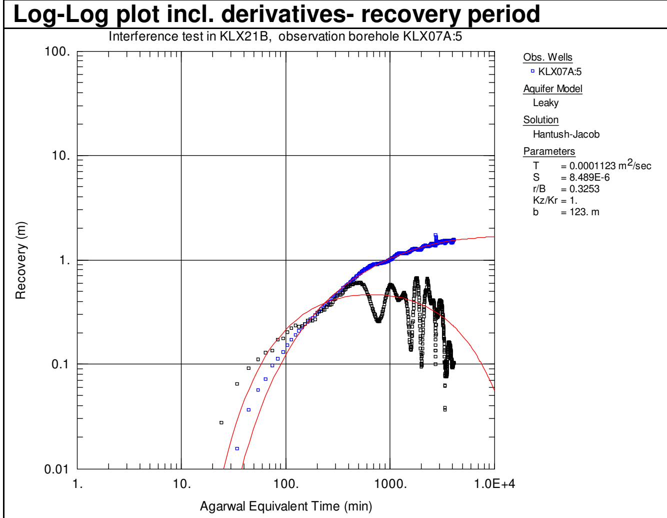


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	80.7		
p_p(kPa)	63.5	p_F (kPa)	78.7
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^{o}C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	585	r (m)	585
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	PRF→PSF
dt_1 (min)	400	dt_1 (min)	500
dt_2 (min)	1000	dt_2 (min)	1000
T (m^2/s)	$1.4 \cdot 10^{-4}$	T (m^2/s)	$1.1 \cdot 10^{-4}$
S (-)	$6.5 \cdot 10^{-6}$	S (-)	$8.5 \cdot 10^{-6}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	400	C (m^3/Pa)	
dt_2 (min)	1000	C_D (-)	
T_T (m^2/s)	$1.4 \cdot 10^{-4}$	ξ (-)	
S (-)	$6.5 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

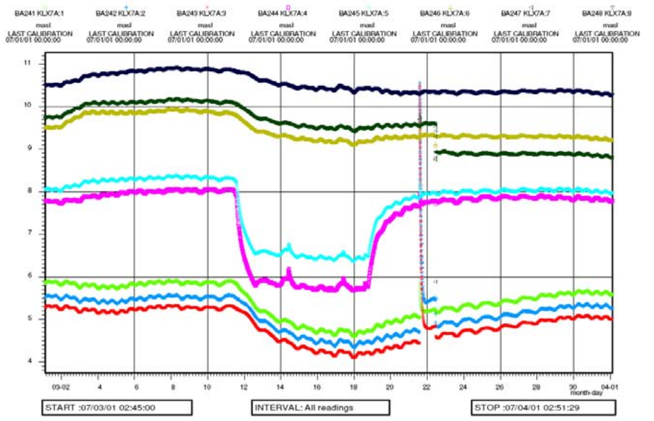
A distinct response occurred in this observation section. Both the flow and recovery period are dominated by PRF transitioning to PSF by the end.

The transient evaluation of the flow period is selected as representative for the test.

Test Summary Sheet – Observation borehole KLX07A:6 (pumping borehole KLX21B)

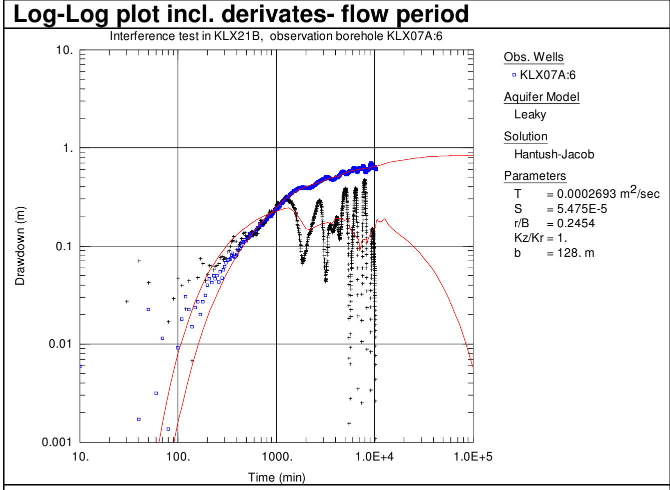
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07A:6	Test start:	2007-03-11 13:37:00
Test section (m):	204.0-332.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

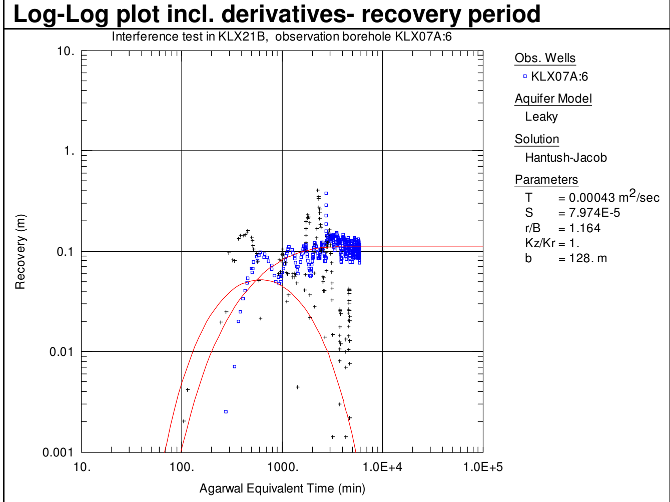


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	96.0		
p_p(kPa)	90.0	p_F (kPa)	90.8
Q_p (m^3/s)			
t_p(min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	675	r (m)	675
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	PSF
dt_1 (min)	1000	dt_1 (min)	
dt_2 (min)	6000	dt_2 (min)	
T (m^2/s)	$2.7 \cdot 10^{-4}$	T (m^2/s)	$4.3 \cdot 10^{-4}$
S (-)	$5.5 \cdot 10^{-5}$	S (-)	$8.0 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	1000	C (m^3/Pa)	
dt_2 (min)	6000	C_D (-)	
T_T (m^2/s)	$2.7 \cdot 10^{-4}$	ξ (-)	
S (-)	$5.5 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

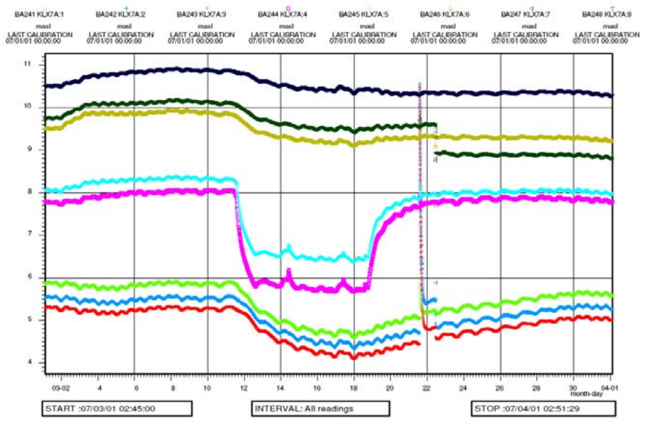
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PSF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

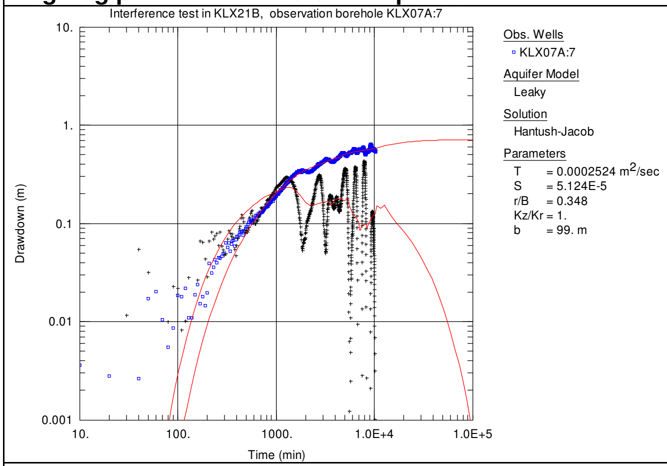
Test Summary Sheet – Observation borehole KLX07A:7 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07A:7	Test start:	2007-03-11 13:37:00
Test section (m):	104.0-203.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

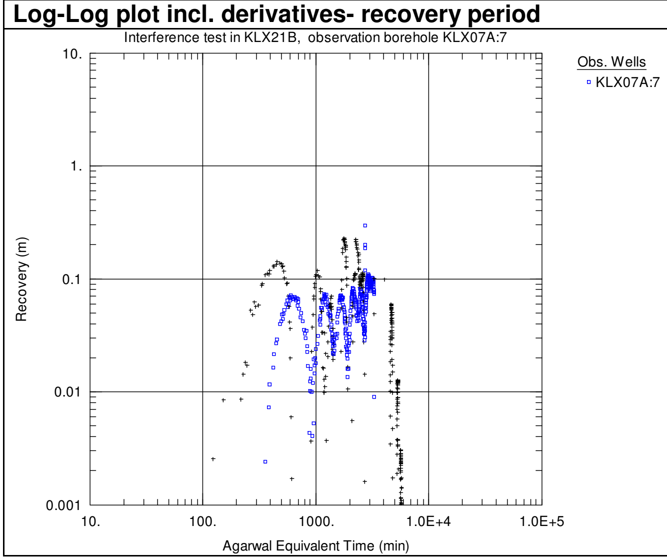
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	98.6		
p_p(kPa)	93.3	p_F (kPa)	86.9
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	768	r (m)	768
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	
dt_1 (min)	1000	dt_1 (min)	
dt_2 (min)	6000	dt_2 (min)	
T (m^2/s)	$2.5 \cdot 10^{-4}$	T (m^2/s)	
S (-)	$5.1 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	1000	C (m^3/Pa)	
dt_2 (min)	6000	C_D (-)	
T_T (m^2/s)	$2.5 \cdot 10^{-4}$	ξ (-)	
S (-)	$5.1 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

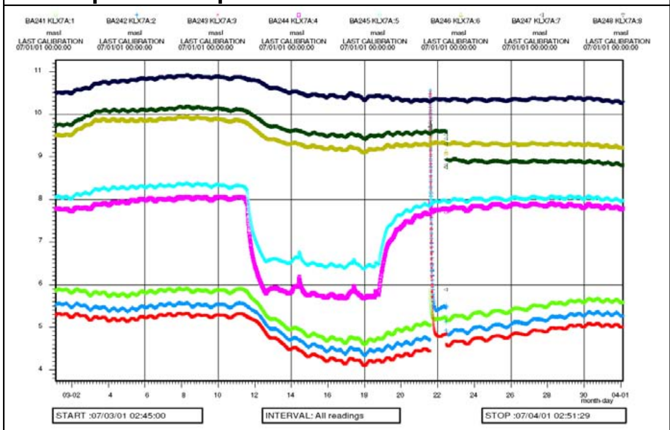
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to an instrumental failure.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

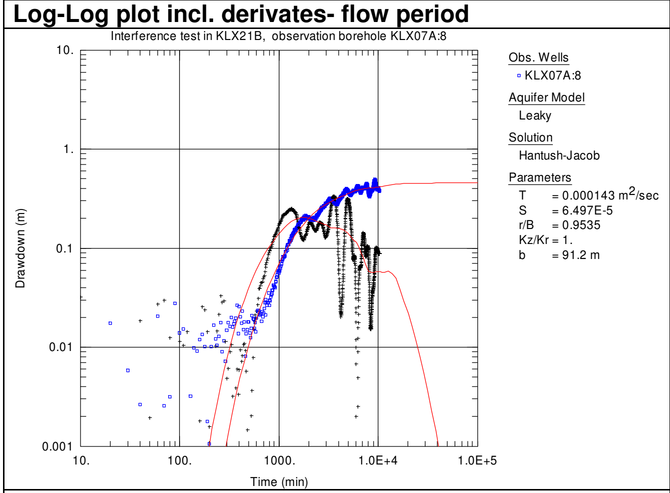
Test Summary Sheet – Observation borehole KLX07A:8 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07A:8	Test start:	2007-03-11 13:37:00
Test section (m):	11.8-103.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

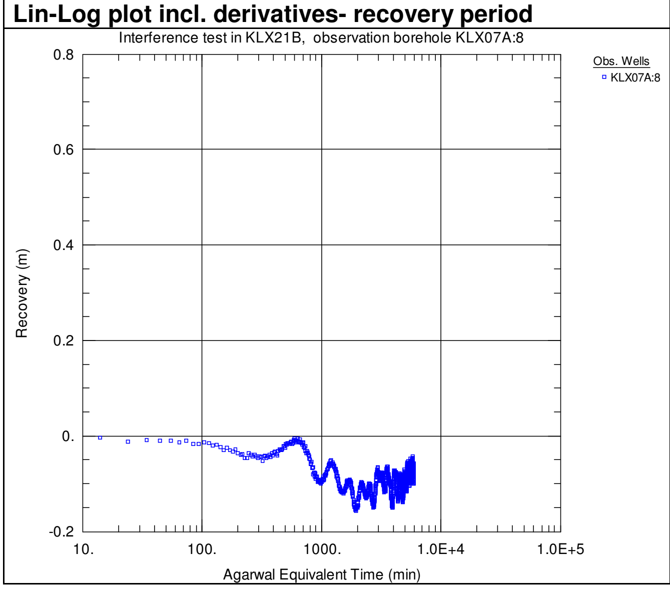
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Lin-Log plot incl. derivatives- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	106.2		
p_p(kPa)	102.5	p_F (kPa)	101.5
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^oC)			
Derivative fact.	0.3	Derivative fact.	0.2
r (m)	855	r (m)	855
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	
dt_1 (min)	1000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$1.4 \cdot 10^{-4}$	T (m^2/s)	
S (-)	$6.5 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	1000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$1.4 \cdot 10^{-4}$	ξ (-)	
S (-)	$6.5 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

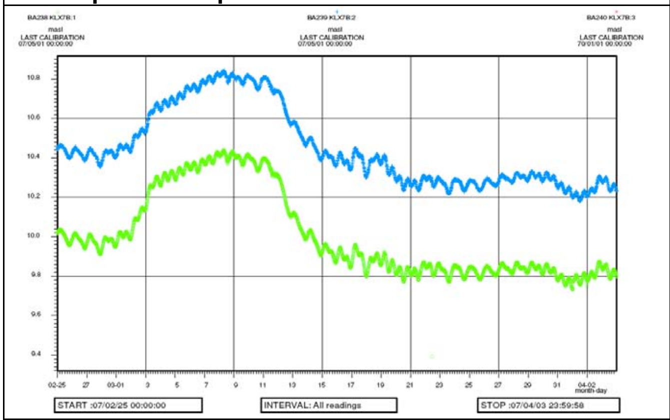
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

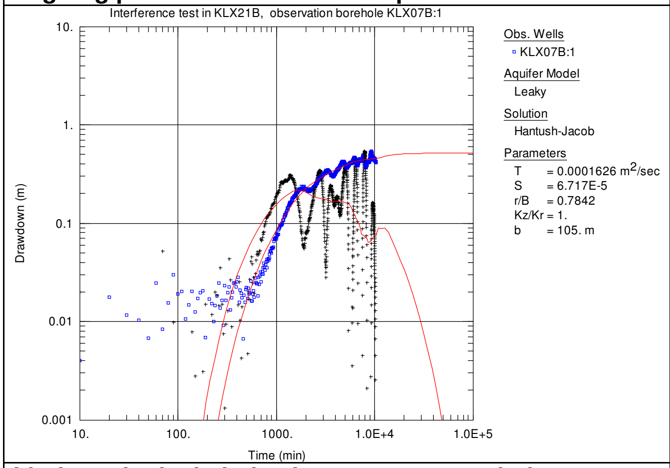
Test Summary Sheet – Observation borehole KLX07B:1 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07B:1	Test start:	2007-03-11 13:37:00
Test section (m):	95.0-200.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

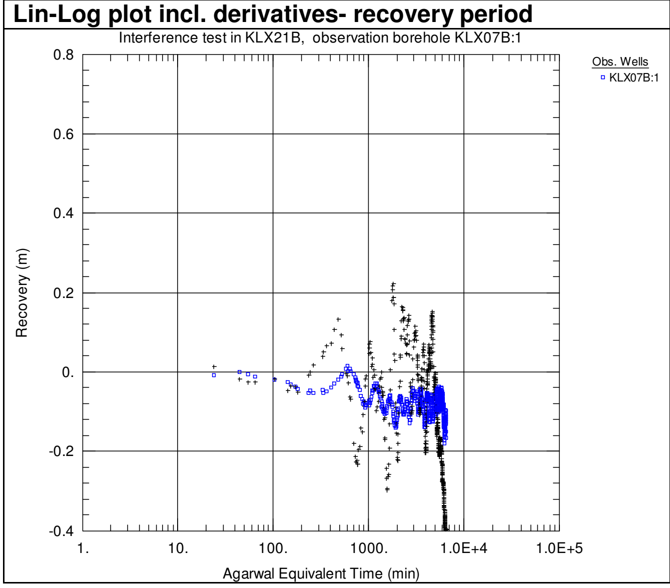
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Lin-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	101.4		
p_p (kPa)	97.2	p_F (kPa)	95.2
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	830	r (m)	830
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	
dt_1 (min)	1000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$1.6 \cdot 10^{-4}$	T (m^2/s)	
S (-)	$6.7 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	1000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$1.6 \cdot 10^{-4}$	ξ (-)	
S (-)	$6.7 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

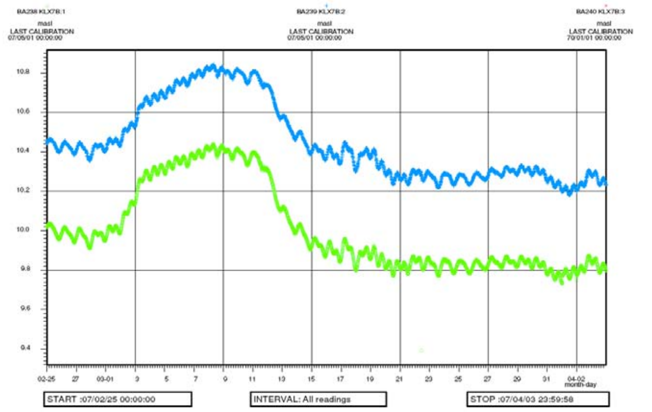
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

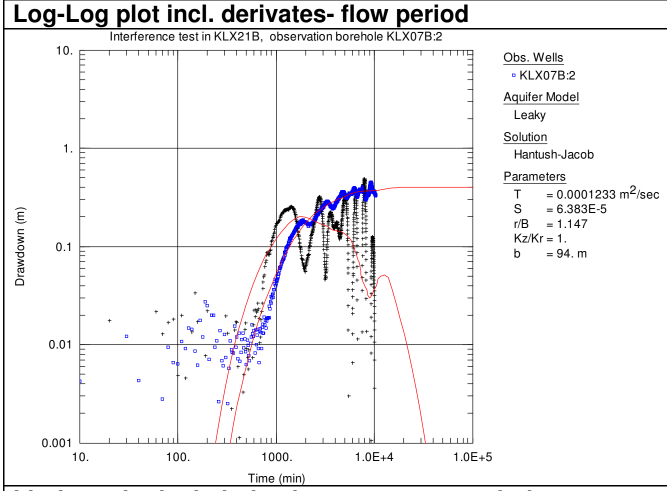
Test Summary Sheet – Observation borehole KLX07B:2 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX07B:2	Test start:	2007-03-11 13:37:00
Test section (m):	9.6-94.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

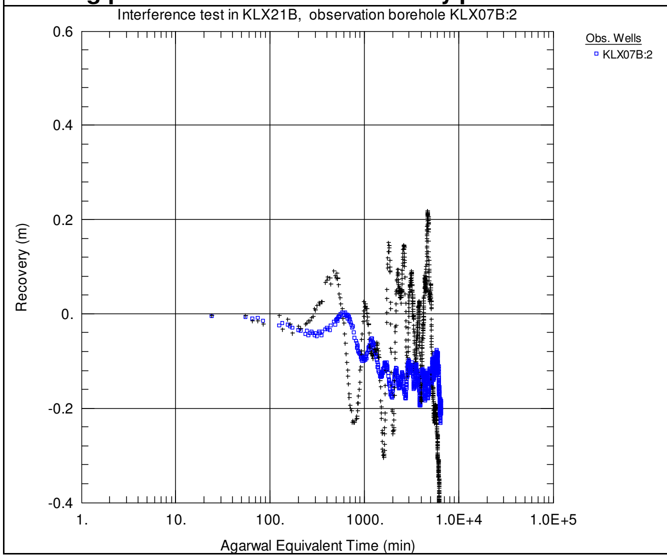
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Lin-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	105.4		
p_p (kPa)	102.1	p_F (kPa)	100.1
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	875	r (m)	875
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	
dt_1 (min)	1000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$1.2 \cdot 10^{-4}$	T (m^2/s)	
S (-)	$6.4 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	1000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$1.2 \cdot 10^{-4}$	ξ (-)	
S (-)	$6.4 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

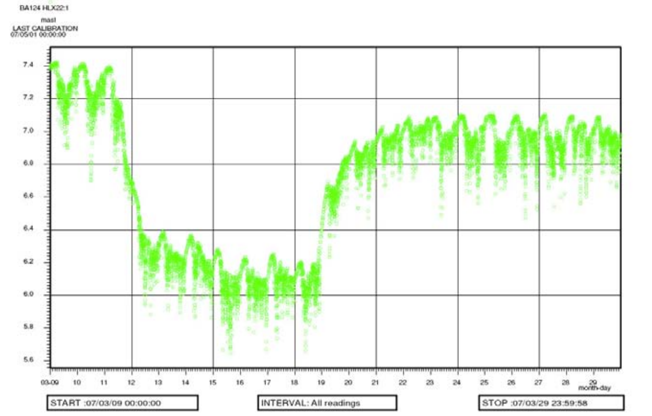
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

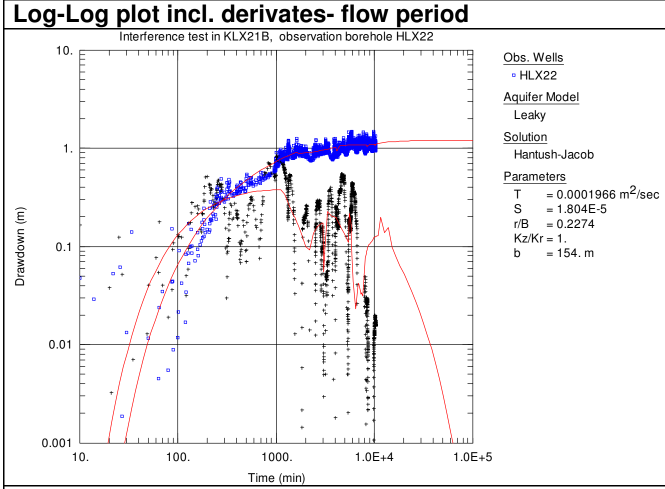
Test Summary Sheet – Observation borehole HLX22 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	HLX22	Test start:	2007-03-11 13:37:00
Test section (m):	9.0-163.2	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.138	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

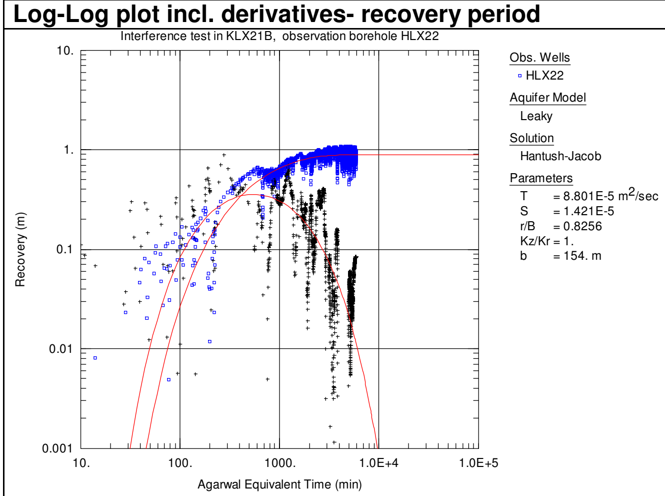
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	69.9		
p_p(kPa)	58.8	p_F (kPa)	68.5
Q_p (m³/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.3	Derivative fact.	0.3
r (m)	581	r (m)	581
Results		**Results**	
Q/s (m²/s)			
T_M (m²/s)			
Flow regime:	PRF→PSF	Flow regime:	PSF
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m²/s)	$2.0 \cdot 10^{-4}$	T (m²/s)	$8.8 \cdot 10^{-5}$
S (-)	$1.8 \cdot 10^{-5}$	S (-)	$1.4 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m³/Pa)		C (m³/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m²/s)		T_{GRF}(m²/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	2000	C (m³/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m²/s)	$2.0 \cdot 10^{-4}$	ξ (-)	
S (-)	$1.8 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

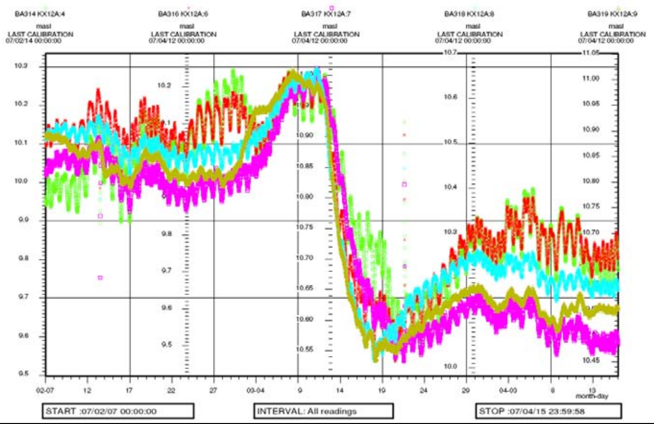
The flow period is dominated by PRF transitioning to PSF by the end. During the recovery period a transition to PSF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

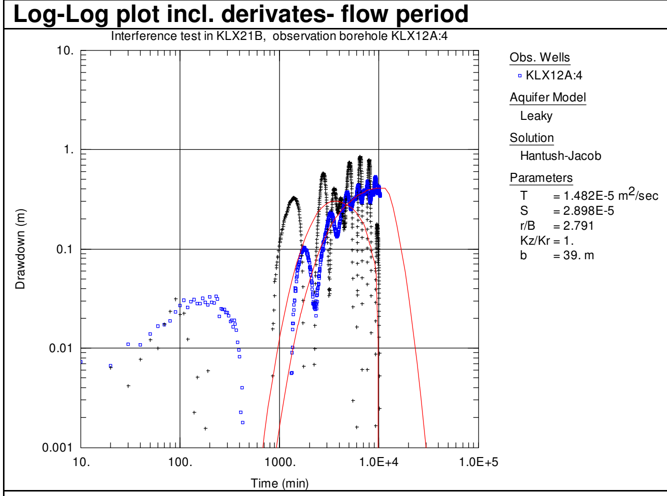
Test Summary Sheet – Observation borehole KLX12A:4 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX12A:4	Test start:	2007-03-11 13:37:00
Test section (m):	386.0-425.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

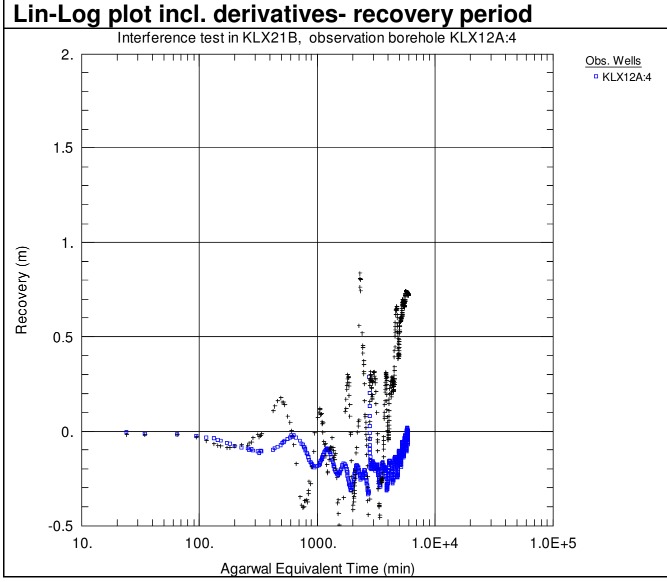
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Lin-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	100.1		
p_p (kPa)	96.8	p_F (kPa)	96.1
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (^oC)			
Derivative fact.	0.2	Derivative fact.	
r (m)	864	r (m)	864
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PSF	Flow regime:	
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$1.5 \cdot 10^{-5}$	T (m^2/s)	
S (-)	$2.9 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$1.5 \cdot 10^{-5}$	ξ (-)	
S (-)	$2.9 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

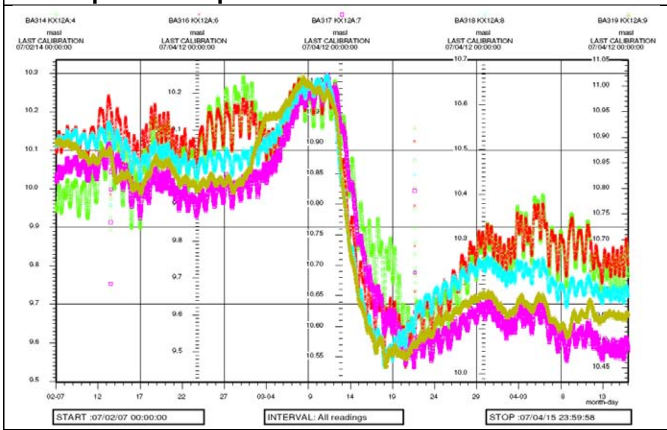
The flow period is dominated by a transition to PSF by the end. The responses during both the flow and recovery period are considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

Test Summary Sheet – Observation borehole KLX12A:6 (pumping borehole KLX21B)

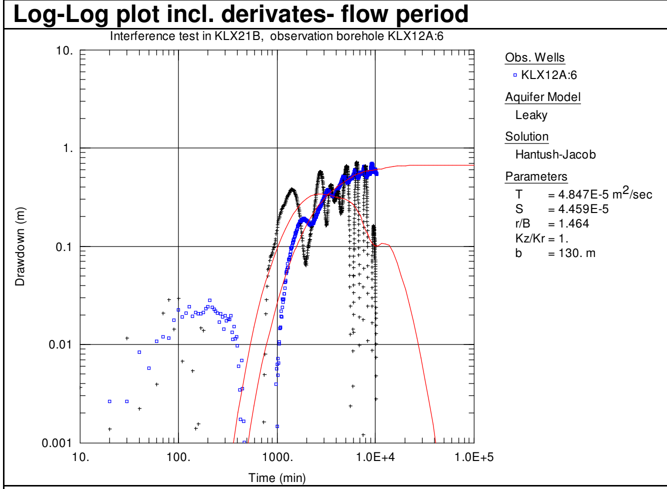
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX12A:6	Test start:	2007-03-11 13:37:00
Test section (m):	160.0-290.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

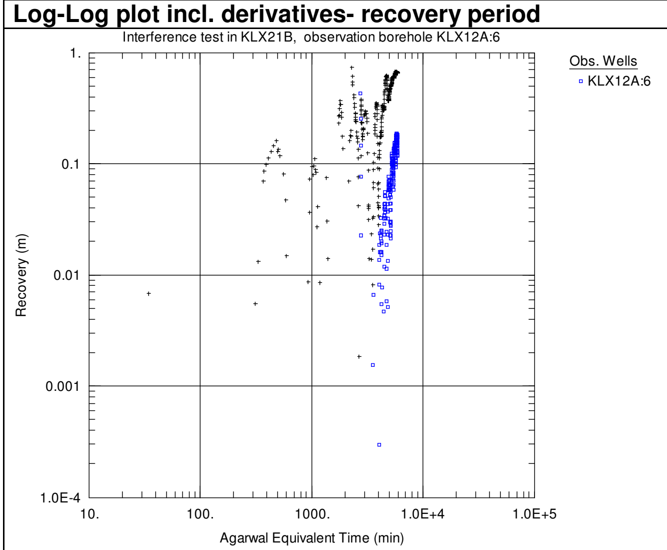


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	99.9		
p_p(kPa)	94.6	p_F (kPa)	95.3
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^oC)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	863	r (m)	863
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	4000	dt_2 (min)	
T (m^2/s)	$4.8 \cdot 10^{-5}$	T (m^2/s)	
S (-)	$4.5 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	4000	C_D (-)	
T_T (m^2/s)	$4.8 \cdot 10^{-5}$	ξ (-)	
S (-)	$4.5 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

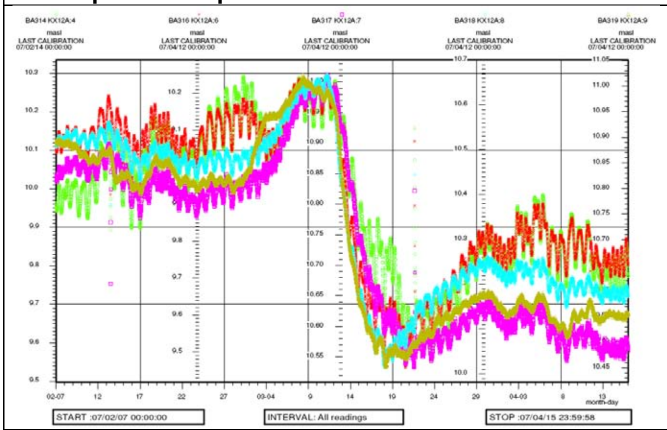
The flow period is dominated by a short PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

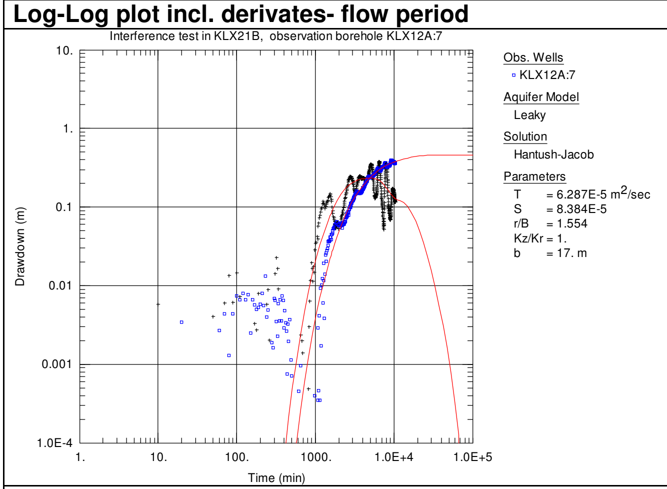
Test Summary Sheet – Observation borehole KLX12A:7 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX12A:7	Test start:	2007-03-11 13:37:00
Test section (m):	142.0-159.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

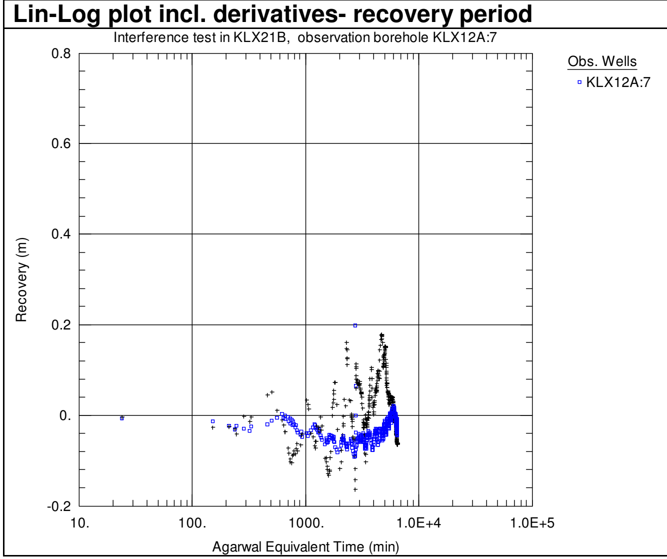
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Lin-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	107.8		
p_p(kPa)	104.2	p_F (kPa)	103.9
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^oC)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	874	r (m)	874
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	4000	dt_2 (min)	
T (m^2/s)	$6.3 \cdot 10^{-5}$	T (m^2/s)	
S (-)	$8.4 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	4000	C_D (-)	
T_T (m^2/s)	$6.3 \cdot 10^{-5}$	ξ (-)	
S (-)	$8.4 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

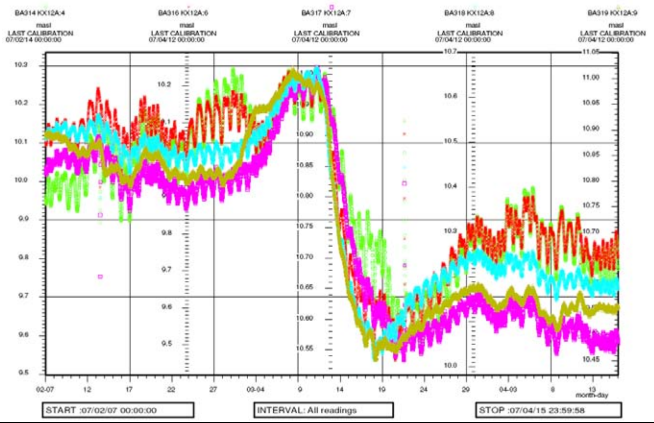
The flow period is dominated by a short PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

Test Summary Sheet – Observation borehole KLX12A:8 (pumping borehole KLX21B)

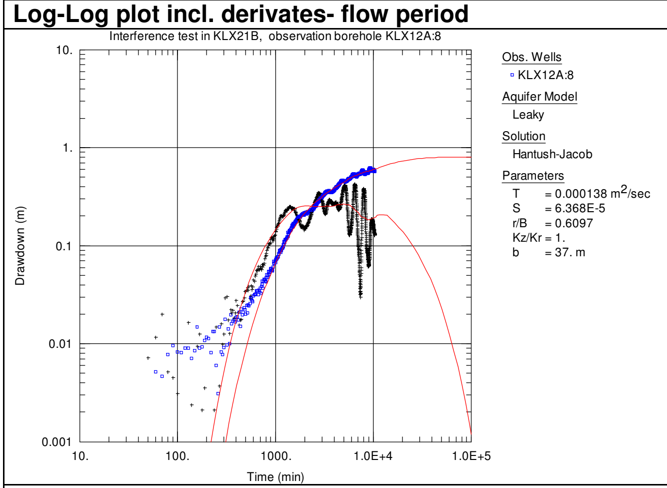
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX12A:8	Test start:	2007-03-11 13:37:00
Test section (m):	104.0-141.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

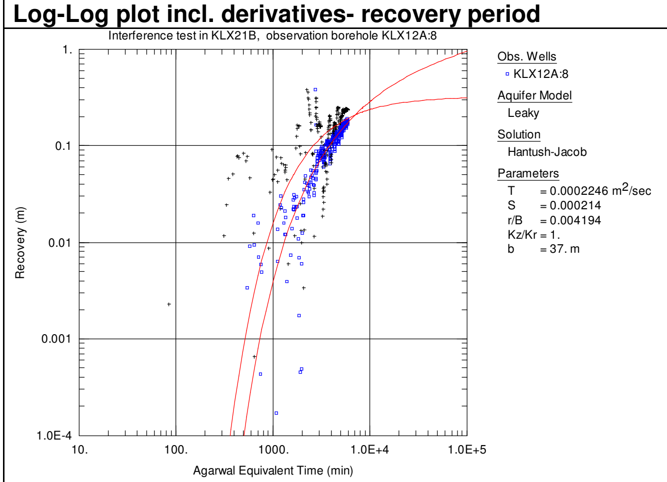


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	104.3		
p_p(kPa)	98.7	p_F (kPa)	100.3
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^oC)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	880	r (m)	880
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	Transition
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$1.4 \cdot 10^{-4}$	T (m^2/s)	$2.2 \cdot 10^{-4}$
S (-)	$6.4 \cdot 10^{-5}$	S (-)	$2.1 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$1.4 \cdot 10^{-4}$	ξ (-)	
S (-)	$6.4 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

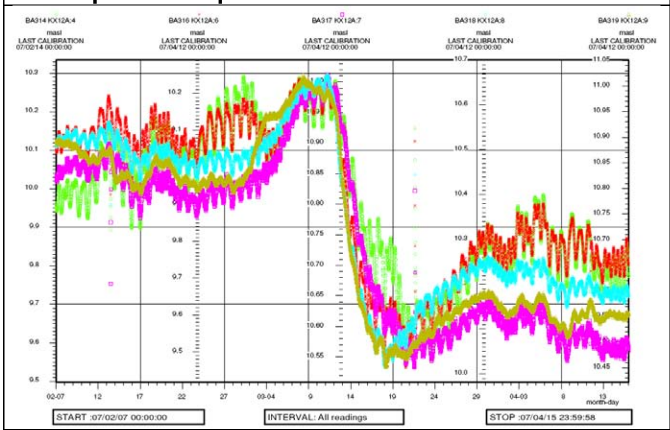
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

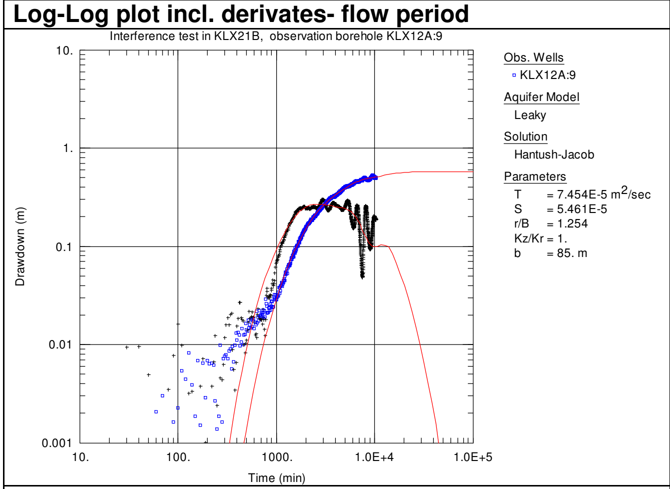
Test Summary Sheet – Observation borehole KLX12A:9 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX12A:9	Test start:	2007-03-11 13:37:00
Test section (m):	17.9-103.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

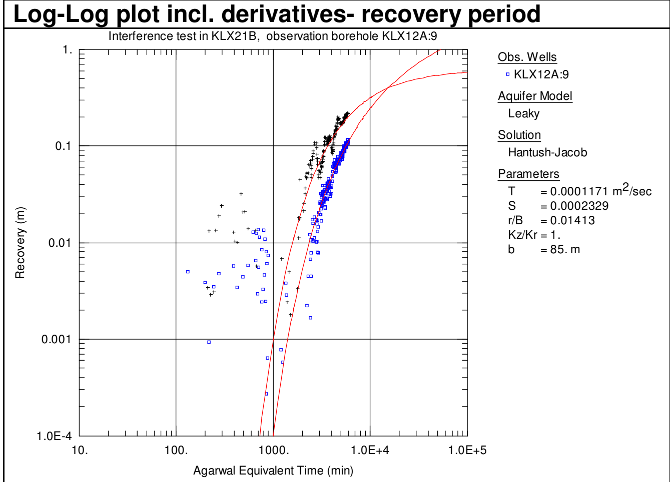
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	107.7		
p_p (kPa)	102.8	p_F (kPa)	103.9
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (^{o}C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	900	r (m)	900
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	Transition
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$7.5 \cdot 10^{-5}$	T (m^2/s)	$1.2 \cdot 10^{-4}$
S (-)	$5.5 \cdot 10^{-5}$	S (-)	$2.3 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$7.5 \cdot 10^{-5}$	ξ (-)	
S (-)	$5.5 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

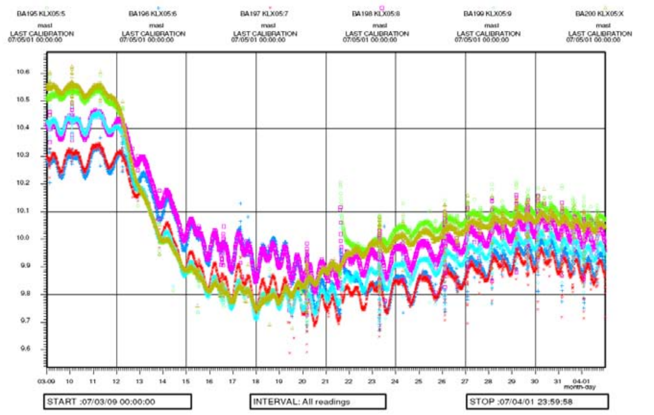
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

Test Summary Sheet – Observation borehole KLX05:5 (pumping borehole KLX21B)

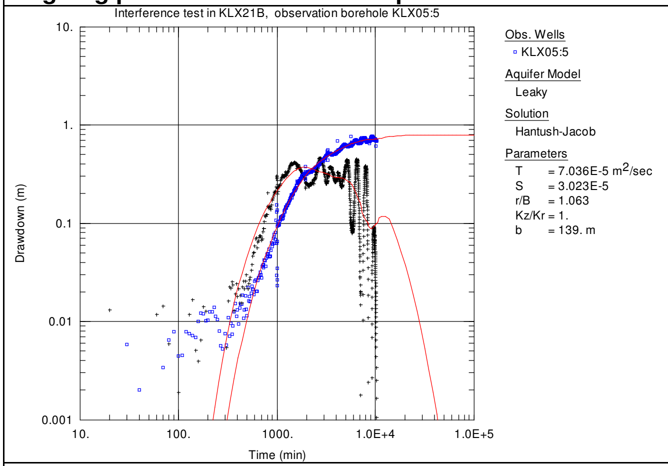
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX05:5	Test start:	2007-03-11 13:37:00
Test section (m):	361.0-500.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

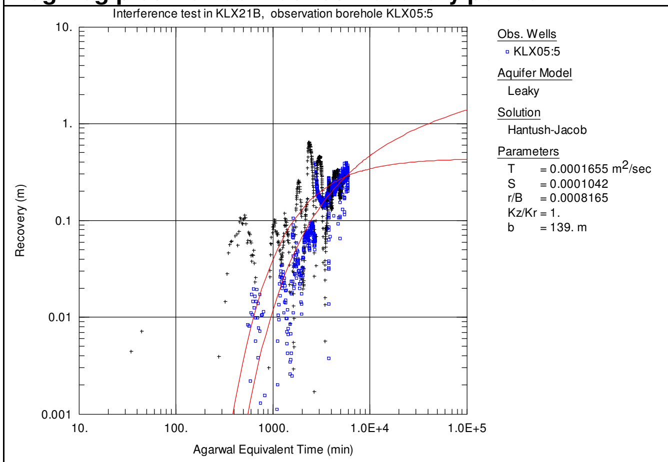


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	103.0		
p_p(kPa)	96.2	p_F (kPa)	98.9
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	964	r (m)	964
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	Transition
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$7.0 \cdot 10^{-5}$	T (m^2/s)	$1.7 \cdot 10^{-4}$
S (-)	$3.0 \cdot 10^{-5}$	S (-)	$1.0 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$7.0 \cdot 10^{-5}$	ξ (-)	
S (-)	$3.0 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

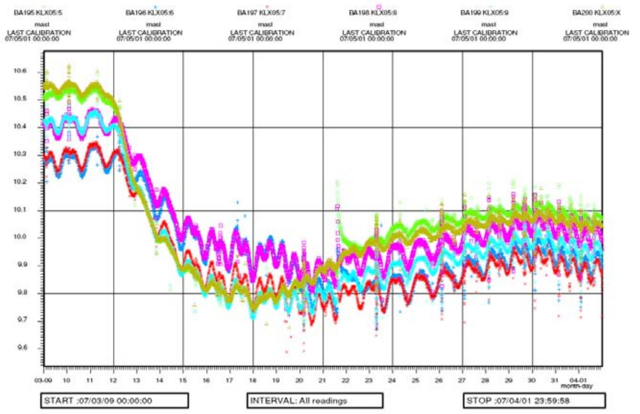
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

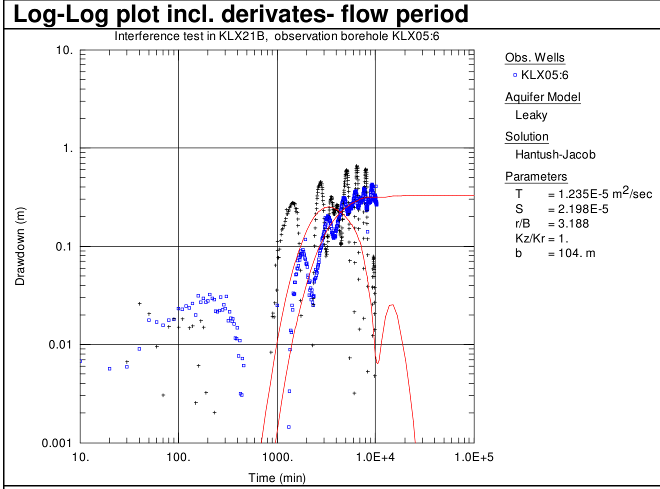
Test Summary Sheet – Observation borehole KLX05:6 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX05:6	Test start:	2007-03-11 13:37:00
Test section (m):	256.0-360.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

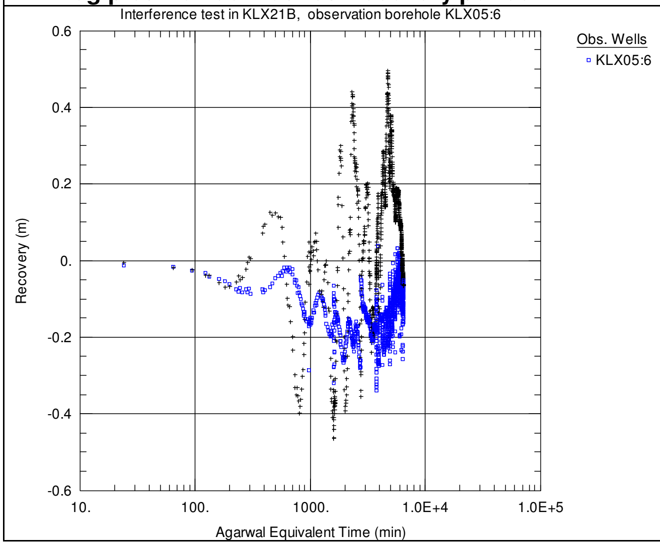
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Lin-Log plot incl. derivatives- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	100.7		
p_p (kPa)	98.1	p_F (kPa)	97.0
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	926	r (m)	926
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PSF	Flow regime:	
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$1.2 \cdot 10^{-5}$	T (m^2/s)	
S (-)	$2.2 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$1.2 \cdot 10^{-5}$	ξ (-)	
S (-)	$2.2 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

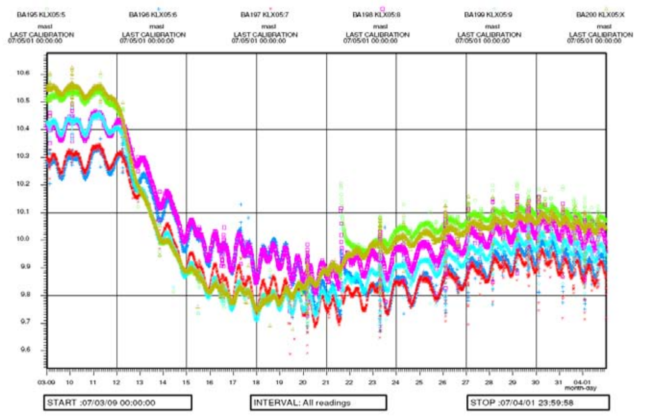
The flow period is dominated by a transition to PSF by the end. The responses during both the flow and recovery period are considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

Test Summary Sheet – Observation borehole KLX05:7 (pumping borehole KLX21B)

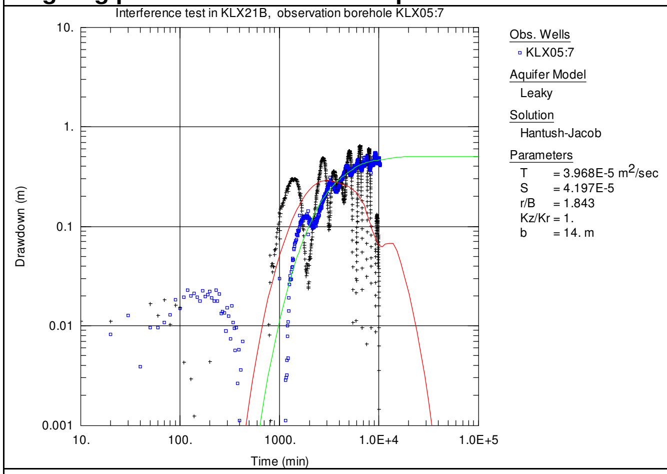
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX05:7	Test start:	2007-03-11 13:37:00
Test section (m):	241.0-255.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

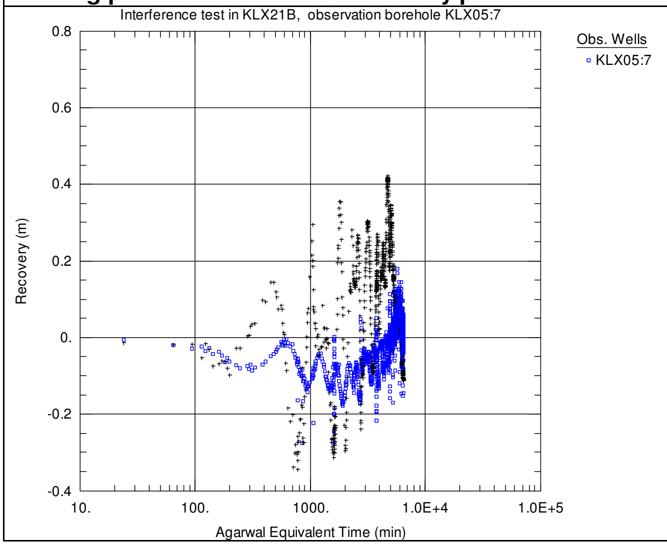


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	100.8		
p_p(kPa)	96.7	p_F (kPa)	96.4
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	913	r (m)	913
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	4000	dt_2 (min)	
T (m^2/s)	$4.0 \cdot 10^{-5}$	T (m^2/s)	
S (-)	$4.2 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Lin-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	4000	C_D (-)	
T_T (m^2/s)	$4.0 \cdot 10^{-5}$	ξ (-)	
S (-)	$4.2 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

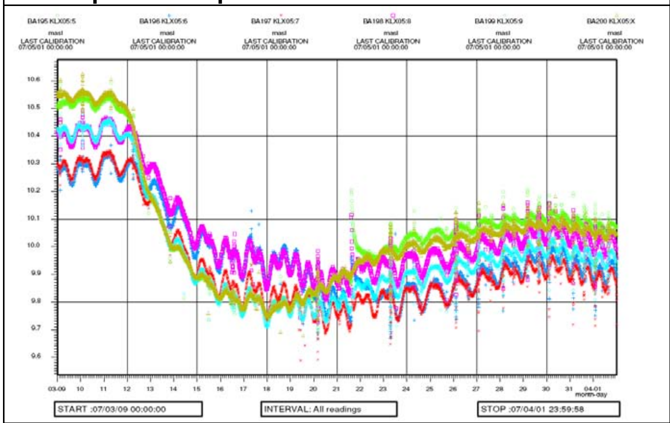
The flow period is dominated by a short PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

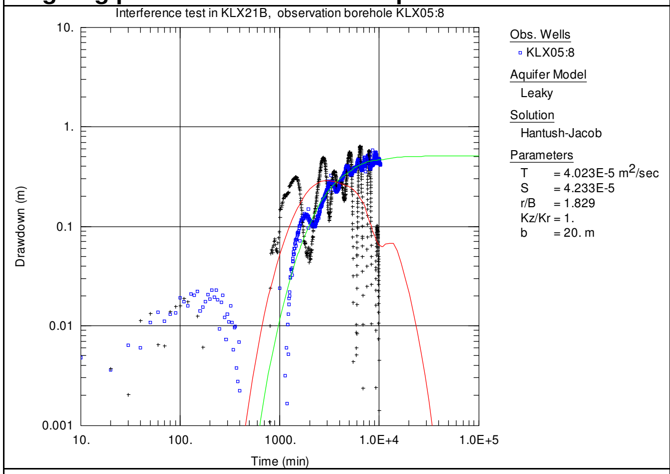
Test Summary Sheet – Observation borehole KLX05:8 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX05:8	Test start:	2007-03-11 13:37:00
Test section (m):	220.0-240.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

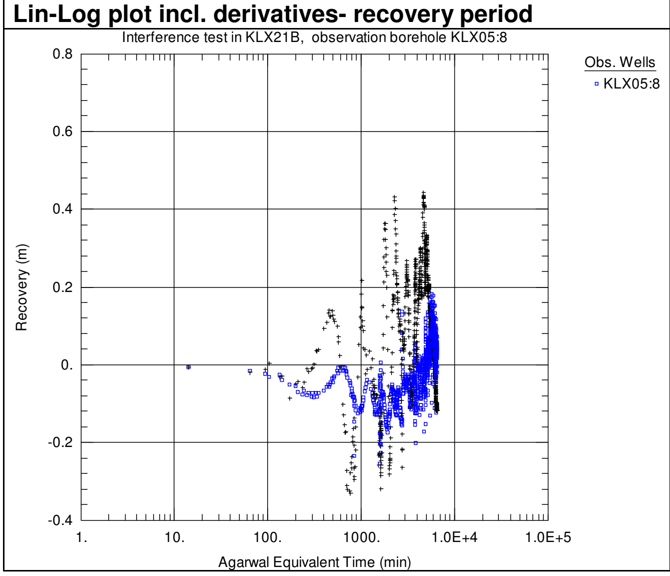
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Lin-Log plot incl. derivates- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	102.0		
p_p(kPa)	96,2	p_F (kPa)	97.7
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^oC)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	910	r (m)	910
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	4000	dt_2 (min)	
T (m^2/s)	$4.0 \cdot 10^{-5}$	T (m^2/s)	
S (-)	$4.2 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	4000	C_D (-)	
T_T (m^2/s)	$4.0 \cdot 10^{-5}$	ξ (-)	
S (-)	$4.2 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

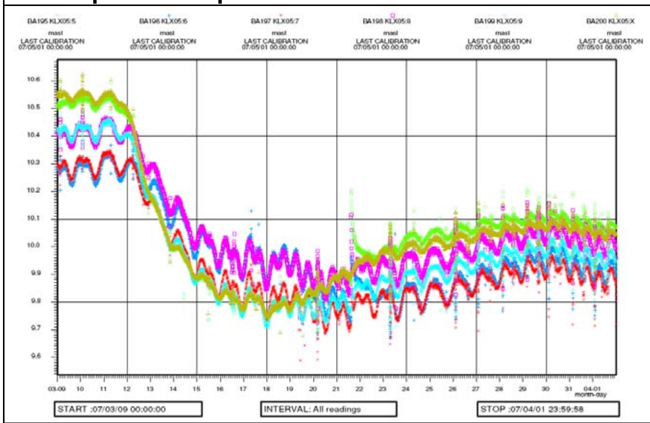
The flow period is dominated by a short PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects.

The transient evaluation of the flow period is selected as representative for the test. No unambiguous transient evaluation could be made on the recovery period.

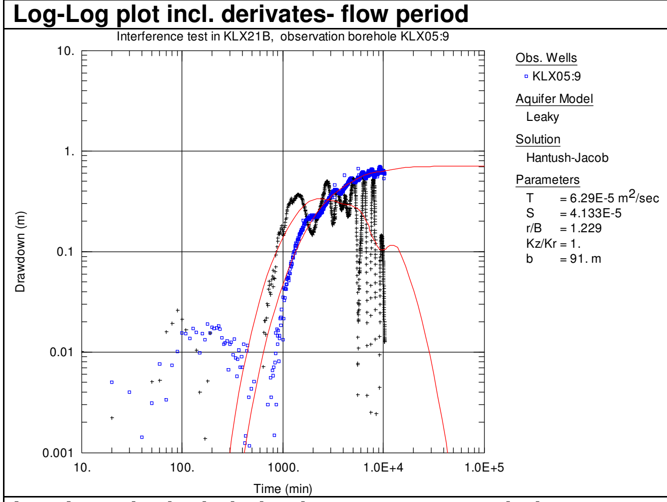
Test Summary Sheet – Observation borehole KLX05:9 (pumping borehole KLX21B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX05:9	Test start:	2007-03-11 13:37:00
Test section (m):	128.0-219.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

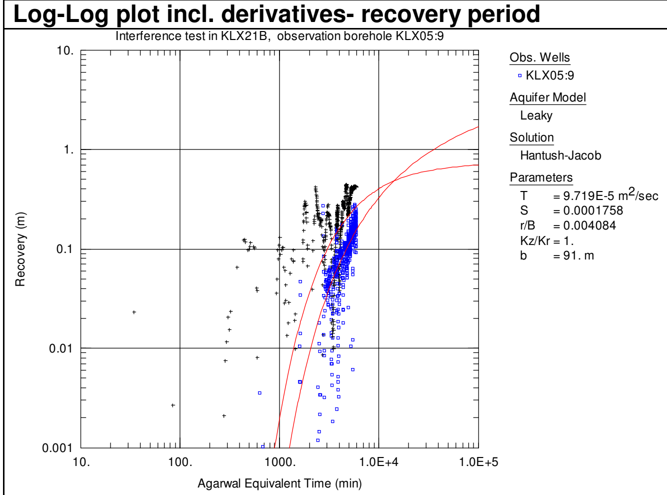
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	102.1		
p_p(kPa)	96.2	p_F (kPa)	97.7
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	904	r (m)	904
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	Transition
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$6.3 \cdot 10^{-5}$	T (m^2/s)	$9.7 \cdot 10^{-5}$
S (-)	$4.2 \cdot 10^{-5}$	S (-)	$1.7 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.			
dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$6.3 \cdot 10^{-5}$	ξ (-)	
S (-)	$4.2 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

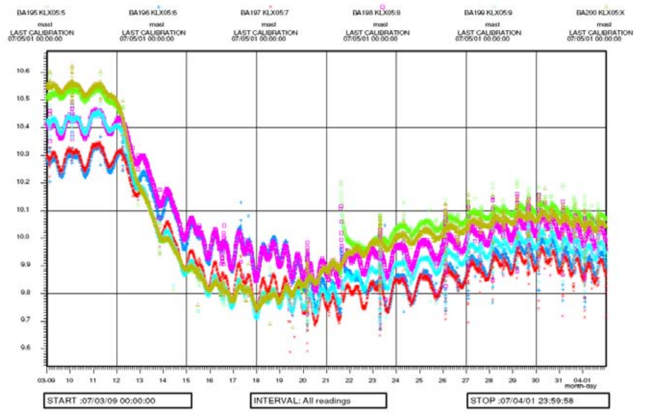
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

Test Summary Sheet – Observation borehole KLX05:10 (pumping borehole KLX21B)

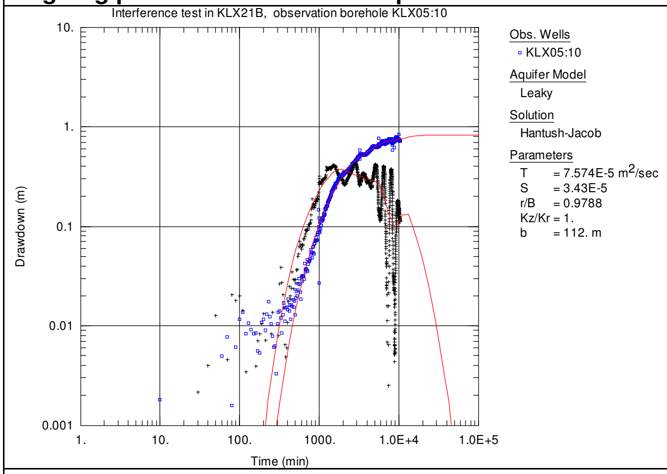
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX05:10	Test start:	2007-03-11 13:37:00
Test section (m):	15.0-127.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

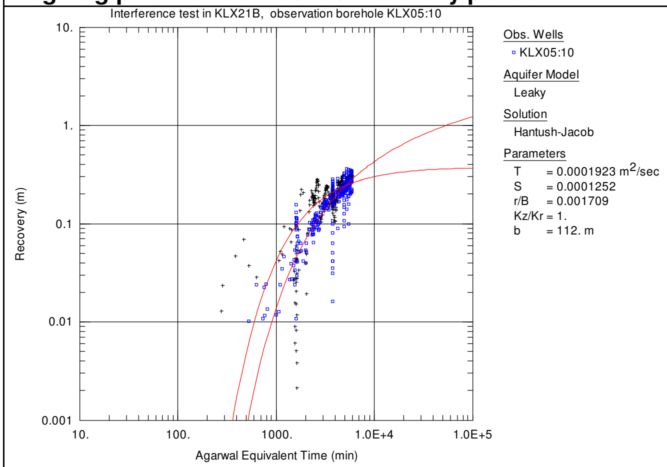


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	103.3		
p_p(kPa)	96.2	p_F (kPa)	98.8
Q_p (m^3/s)			
tp (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	904	r (m)	904
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF→PSF	Flow regime:	Transition
dt_1 (min)	2000	dt_1 (min)	
dt_2 (min)	5000	dt_2 (min)	
T (m^2/s)	$7.6 \cdot 10^{-5}$	T (m^2/s)	$1.9 \cdot 10^{-4}$
S (-)	$3.4 \cdot 10^{-5}$	S (-)	$1.3 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	2000	C (m^3/Pa)	
dt_2 (min)	5000	C_D (-)	
T_T (m^2/s)	$7.6 \cdot 10^{-5}$	ξ (-)	
S (-)	$3.4 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

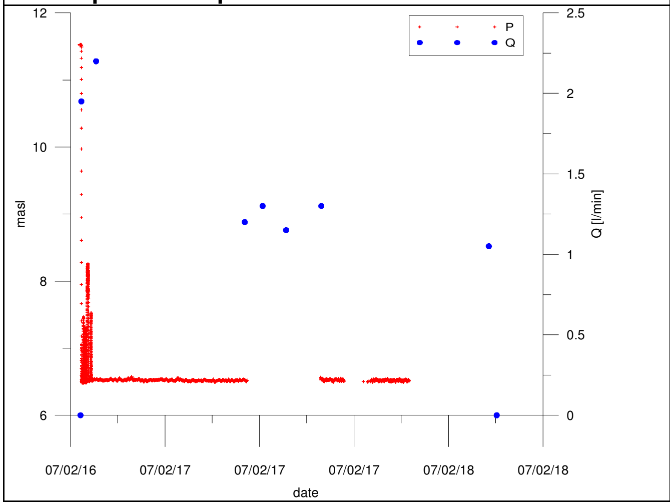
The flow period is dominated by PRF transitioning to PSF by the end. The recovery period is considered as very uncertain due to precipitation and tidal effects. A transition to a possible PRF is indicated.

The transient evaluation of the flow period is selected as representative for the test. The transient evaluation of the recovery period is uncertain.

Test Summary Sheet – Pumping borehole KLX26A

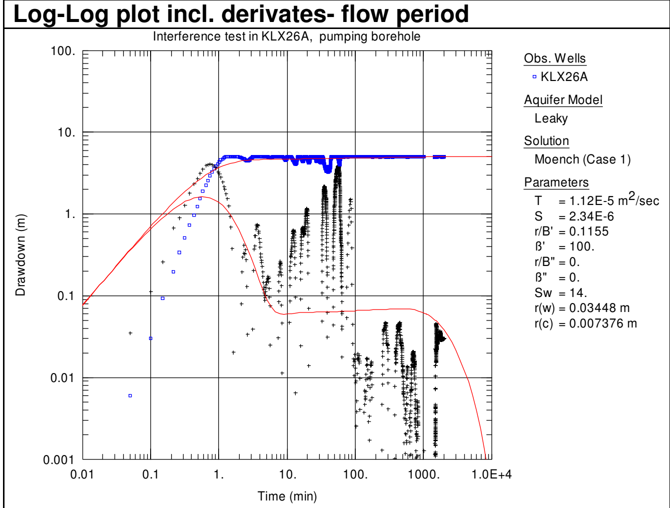
Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX26A	Test start:	2007-02-16 15:30:00
Test section (m):	2.6-101.1	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	113.0		
p_p(kPa)	63.9 (t=1998 min)	p_F (kPa)	
Q_p (m^3/s)	$1.75 \cdot 10^{-5}$		
t_p (min)	2532	t_F (min)	
S^* (-)	$2.3 \cdot 10^{-6}$	S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.4	Derivative fact.	
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$3.5 \cdot 10^{-6}$		
T_M (m^2/s)	$4.6 \cdot 10^{-6}$		
Flow regime:	WBS->PSS	Flow regime:	
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$(1.1 \cdot 10^{-5})$	T (m^2/s)	
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)	(14)	ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



No unambiguous transient evaluation possible - Example

Log-Log plot incl. derivatives- recovery period

No data available

Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$(1.1 \cdot 10^{-5})$	ξ (-)	
S* (-)	$2.3 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

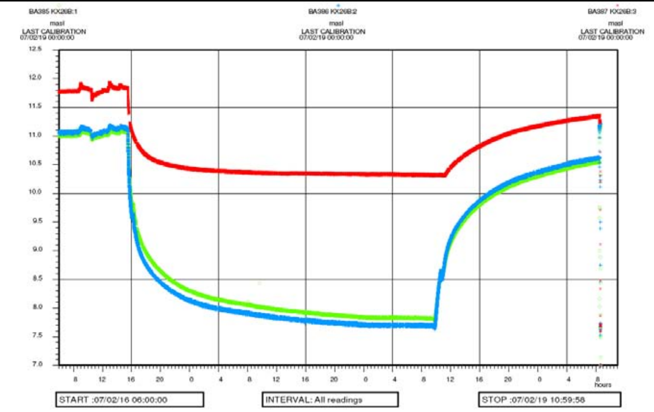
Comments:

Uncertain flow rate history during the flow period. A constant flow rate was assumed by the transient evaluation of the flow period. Pressure data are lacking between c. 2000 min to stop of pumping at 2532 min. After initial effects of WBS a distinct transition to a pseudo-steady state occurred. No unambiguous transient evaluation could be made on the flow period. An example of a possible transient evaluation is shown.
No data are available from the recovery period. The steady-state transmissivity T_M is selected as representative.

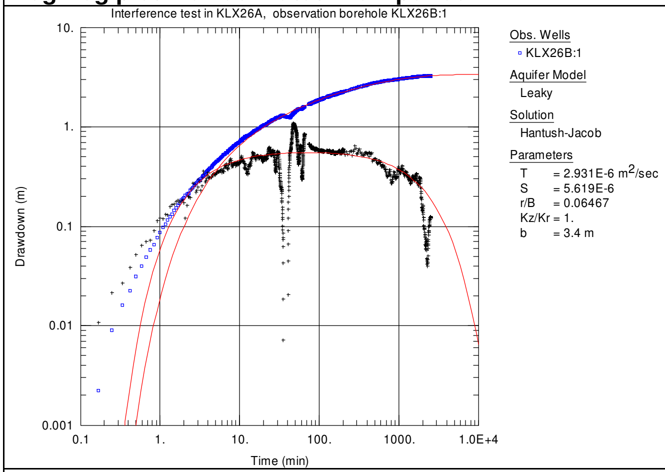
Test Summary Sheet – Observation borehole KLX26B:1 (pumping borehole KLX26A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX26A:1	Test start:	2007-02-16 15:30:00
Test section (m):	47.0-50.4	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

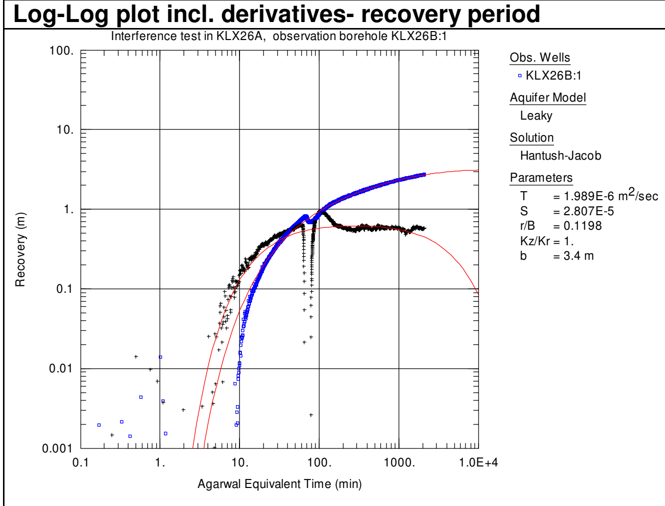
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	108.5		
p_p (kPa)	76.6	p_F (kPa)	103.4
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (^oC)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	17	r (m)	17
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF->PSF	Flow regime:	PRF
dt_1 (min)	50	dt_1 (min)	200
dt_2 (min)	400	dt_2 (min)	2000
T (m^2/s)	$2.9 \cdot 10^{-6}$	T (m^2/s)	$2.0 \cdot 10^{-6}$
S (-)	$5.6 \cdot 10^{-6}$	S (-)	$2.8 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	50	C (m^3/Pa)	
dt_2 (min)	400	C_D (-)	
T_T (m^2/s)	$2.9 \cdot 10^{-6}$	ξ (-)	
S (-)	$5.6 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

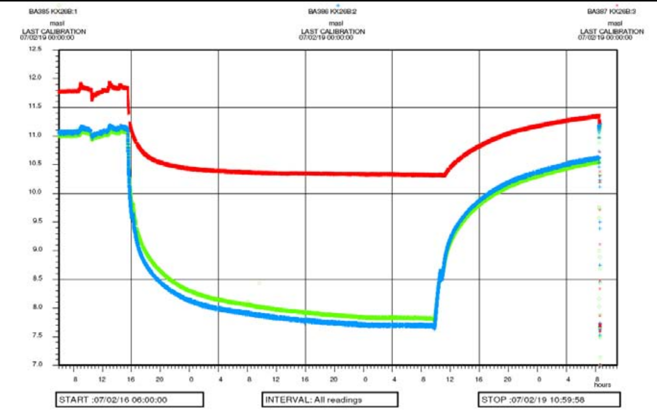
During the flow period, pseudo-radial flow is dominating between c. 50-400 min transitioning to pseudo-spherical (leaky) flow by the end. The recovery period is dominated by pseudo-radial flow between c. 200-2000 min.

The agreement of the estimated transmissivities from the flow and recovery period respectively is good. The parameter values from the flow period are selected as the most representative.

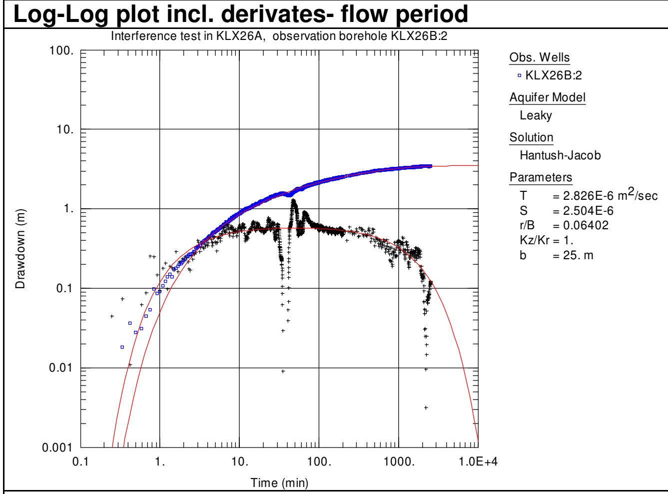
Test Summary Sheet – Observation borehole KLX26B:2 (pumping borehole KLX26A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX26B:2	Test start:	2007-02-16 15:30:00
Test section (m):	21.0-46.0	Responsible for test execution:	SKB field crew
Section diameter, 2·r_w (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

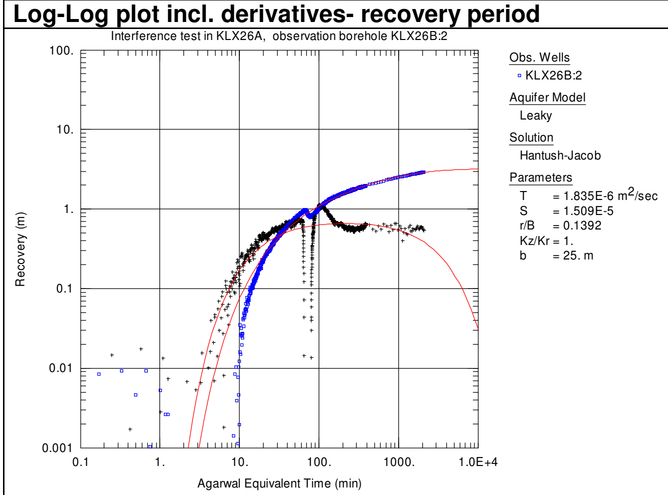
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	109.2		
p_p(kPa)	75.4	p_F (kPa)	104.2
Q_p (m^3/s)			
tp (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^oC)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	21	r (m)	21
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF->PSF	Flow regime:	PRF
dt_1 (min)	20	dt_1 (min)	200
dt_2 (min)	200	dt_2 (min)	2000
T (m^2/s)	$2.8 \cdot 10^{-6}$	T (m^2/s)	$1.8 \cdot 10^{-6}$
S (-)	$2.5 \cdot 10^{-6}$	S (-)	$1.5 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	20	C (m^3/Pa)	
dt_2 (min)	200	C_D (-)	
T_T (m^2/s)	$2.8 \cdot 10^{-6}$	ξ (-)	
S (-)	$2.5 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

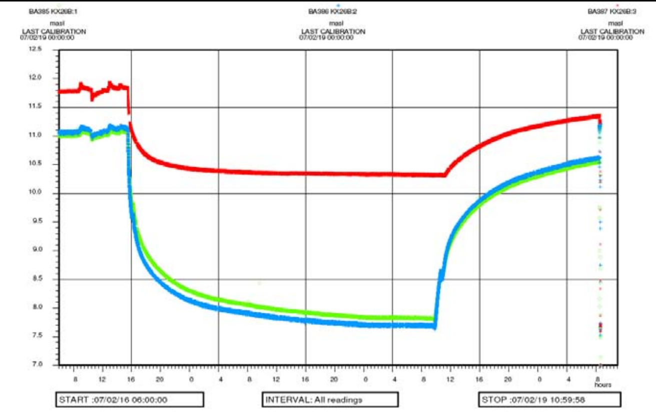
During the flow period, pseudo-radial flow is dominating between c. 20-200 min transitioning to pseudo-spherical (leaky) flow by the end. The recovery period is dominated by pseudo-radial flow between c. 200-2000 min.

The agreement of the estimated transmissivities from the flow and recovery period respectively is good. The parameter values from the flow period are selected as the most representative.

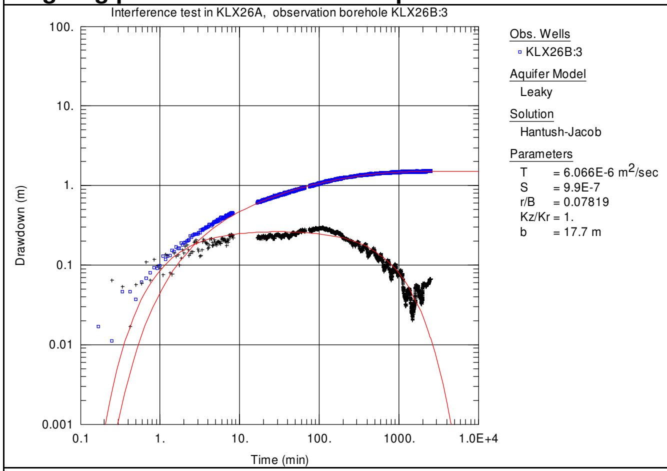
Test Summary Sheet – Observation borehole KLX26B:3 (pumping borehole KLX26A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX26B:3	Test start:	2007-02-16 15:30:00
Test section (m):	2.3-20.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

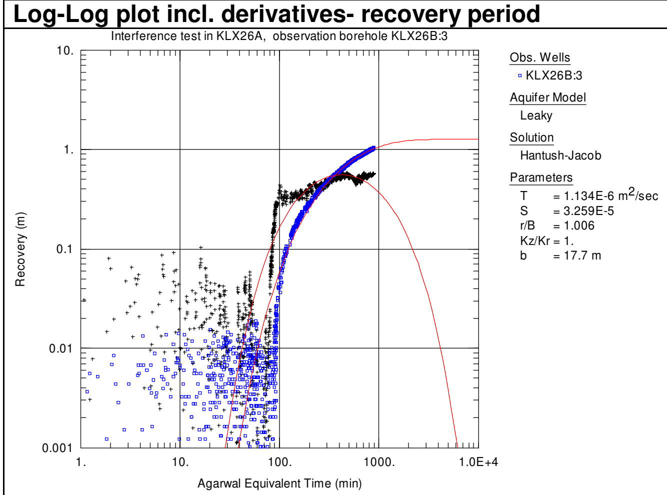
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	116.2		
p_p(kPa)	101.2	p_F (kPa)	111.3
Q_p (m^3/s)			
tp (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.1
r (m)	42	r (m)	42
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF->PSF	Flow regime:	PRF
dt_1 (min)	20	dt_1 (min)	500
dt_2 (min)	100	dt_2 (min)	2000
T (m^2/s)	$6.1 \cdot 10^{-6}$	T (m^2/s)	$1.3 \cdot 10^{-6}$
S (-)	$9.9 \cdot 10^{-7}$	S (-)	$3.3 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	20	C (m^3/Pa)	
dt_2 (min)	100	C_D (-)	
T_T (m^2/s)	$6.1 \cdot 10^{-6}$	ξ (-)	
S (-)	$9.9 \cdot 10^{-7}$		
K_s (m/s)			
S_s (1/m)			

Comments:

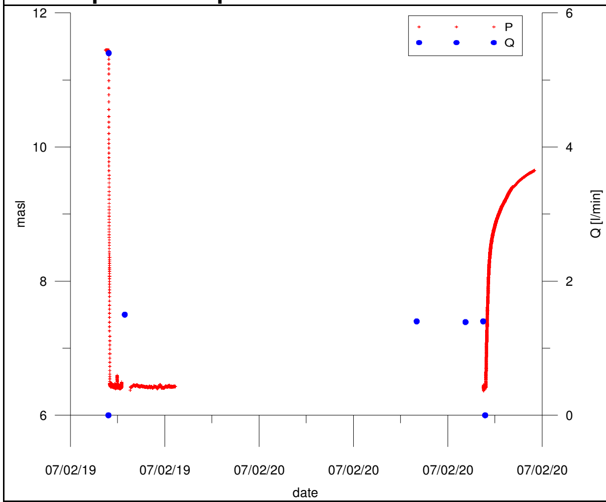
During the flow period, pseudo-radial flow is dominating between c. 20-100 min transitioning to pseudo-spherical (leaky) flow by the end. The recovery period is dominated by pseudo-radial flow between c. 500-2000 min.

The estimated parameter values from the flow period are selected as the most representative.

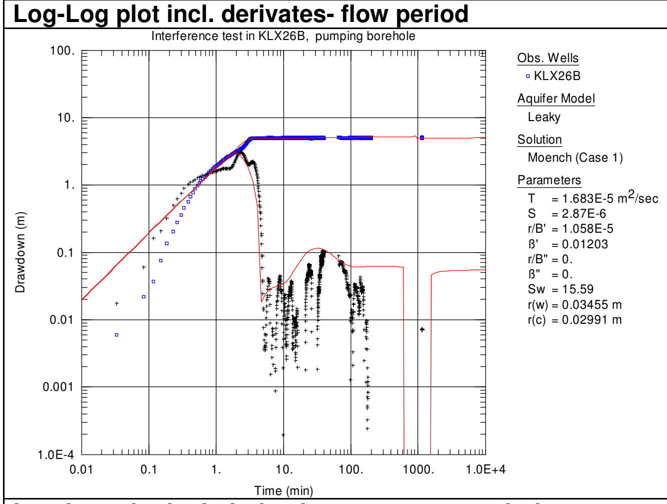
Test Summary Sheet – Pumping borehole KLX26B

Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX26B	Test start:	2007-02-19 16:21:00
Test section (m):	2.3-50.4	Responsible for test execution:	SKB field crew
Section diameter, $2\cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

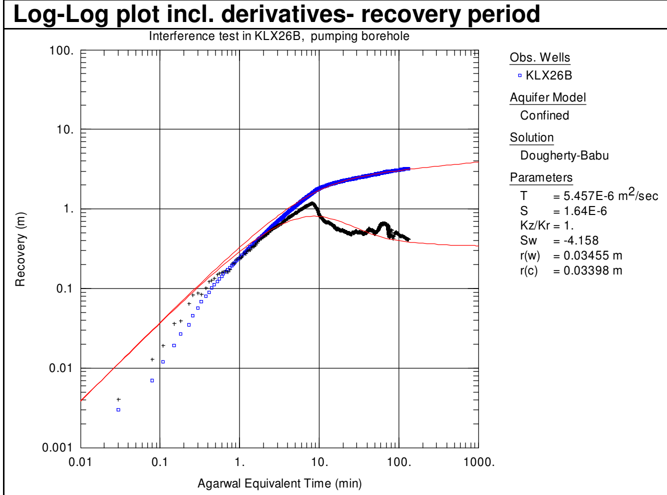
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	112.2		
p_p(kPa)	63.0	p_F (kPa)	94.7
Q_p (m^3/s)	$2.33\cdot10^{-5}$		
t_p (min)	1150	t_F (min)	149
S^* (-)	$2.9\cdot10^{-6}$	S^* (-)	$1.6\cdot10^{-6}$
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.4	Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$4.7\cdot10^{-6}$		
T_M (m^2/s)	$5.5\cdot10^{-6}$		
Flow regime:	WBS->PSS	Flow regime:	WBS->(PRF)
dt_1 (min)		dt_1 (min)	20
dt_2 (min)		dt_2 (min)	150
T (m^2/s)	$1.7\cdot10^{-5}$	T (m^2/s)	$5.5\cdot10^{-6}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$2.9\cdot10^{-7}$	C (m^3/Pa)	$3.7\cdot10^{-6}$
C_D (-)		C_D (-)	
ξ (-)	15.6	ξ (-)	-4.2
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	20	C (m^3/Pa)	$3.7\cdot10^{-6}$
dt_2 (min)	150	C_D (-)	
T_T (m^2/s)	$5.5\cdot10^{-6}$	ξ (-)	-4.2
S* (-)	$1.6\cdot10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

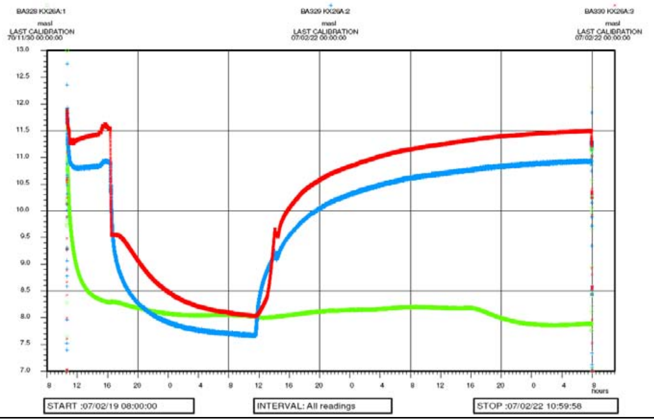
An extra data point (t=3 min, Q=1.5 L/min) was inserted in the flow rate data file to accommodate with the observed drawdown curve. The flow rate varied during the flow period and is uncertain. Pressure data are lacking between c. 40-60 min and c. 200-1100 min. After initial WBS during the first c. 3 min a distinct transition to a pseudo-stationary pressure (PSS) occurred during the flow period.

The pressure recovery was not entirely consistent with the drawdown response. After initial effects of WBS during the first c 5 min a transition towards a pseudo-radial flow regime occurred by the end. The transient evaluation from the recovery period was selected as representative for KLX26B.

Test Summary Sheet – Observation borehole KLX26A:2 (pumping borehole KLX26B)

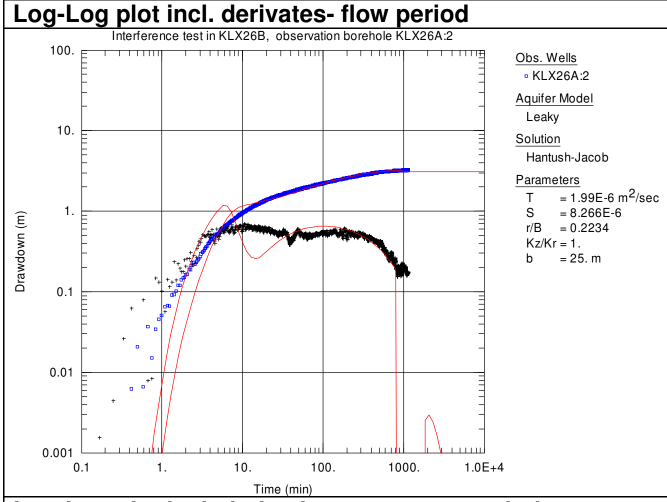
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX26A:2	Test start:	2007-02-19 16:21:00
Test section (m):	22.0-47.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

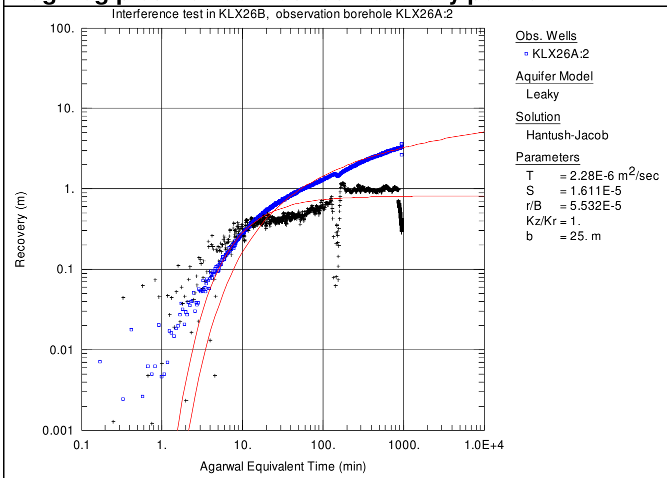


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	107.0		
p_p (kPa)	75.1	p_F (kPa)	107.2
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (^oC)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	19	r (m)	19
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF->PSF	Flow regime:	PRF
dt_1 (min)	10	dt_1 (min)	150
dt_2 (min)	300	dt_2 (min)	800
T (m^2/s)	$2.0 \cdot 10^{-6}$	T (m^2/s)	$2.3 \cdot 10^{-6}$
S (-)	$8.3 \cdot 10^{-6}$	S (-)	$1.6 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	10	C (m^3/Pa)	
dt_2 (min)	300	C_D (-)	
T_T (m^2/s)	$2.0 \cdot 10^{-6}$	ξ (-)	
S (-)	$8.3 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

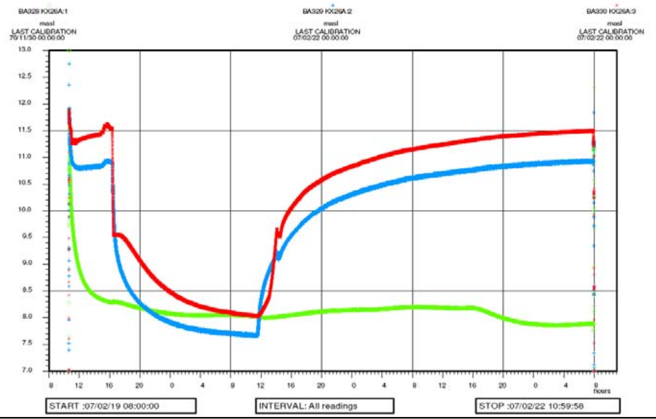
The transient evaluation is based on variable flow rate during the flow period. A pseudo-radial flow regime developed after c. 10 min to the end of the flow period. By the end a pseudo-spherical flow regime was developed.
After a transition period a pseudo-radial flow regime developed after c. 150 min to the end of the recovery period.

Consistent results of evaluated parameter values are obtained from the flow and recovery period respectively. The parameter values estimated from the flow period are selected as the most representative for the test section.

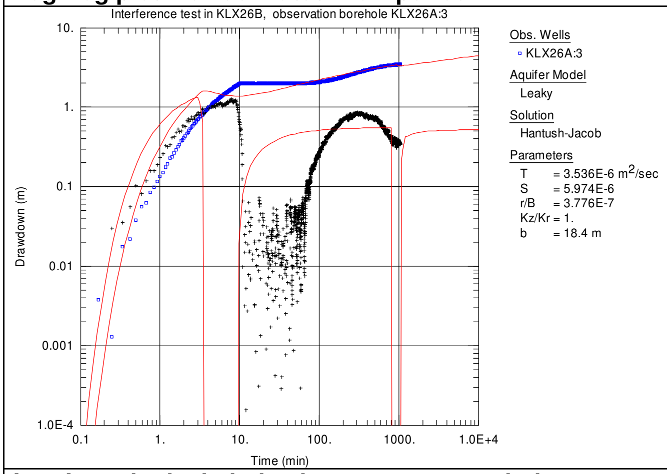
Test Summary Sheet – Observation borehole KLX26A:3 (pumping borehole KLX26B)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX26A:3	Test start:	2007-02-19 16:21:00
Test section (m):	2.6-21.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

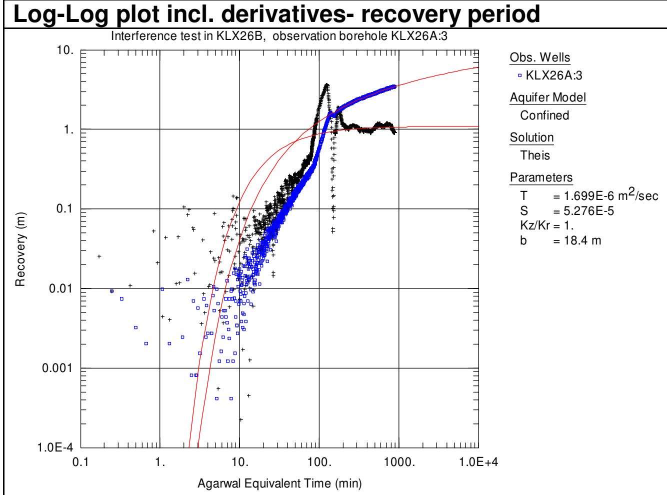
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	113.2		
p_p (kPa)	78.7	p_F (kPa)	112.8
Q_p (m^3/s)			
tp (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (^{o}C)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	13	r (m)	13
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	(PRF->PSF)	Flow regime:	PRF
dt_1 (min)	(200)	dt_1 (min)	200
dt_2 (min)	(400)	dt_2 (min)	800
T (m^2/s)	$3.5 \cdot 10^{-6}$	T (m^2/s)	$1.7 \cdot 10^{-6}$
S (-)	$6.0 \cdot 10^{-6}$	S (-)	$5.3 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	(200)	C (m^3/Pa)	
dt_2 (min)	(400)	C_D (-)	
T_T (m^2/s)	$3.5 \cdot 10^{-6}$	ξ (-)	
S (-)	$6.0 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

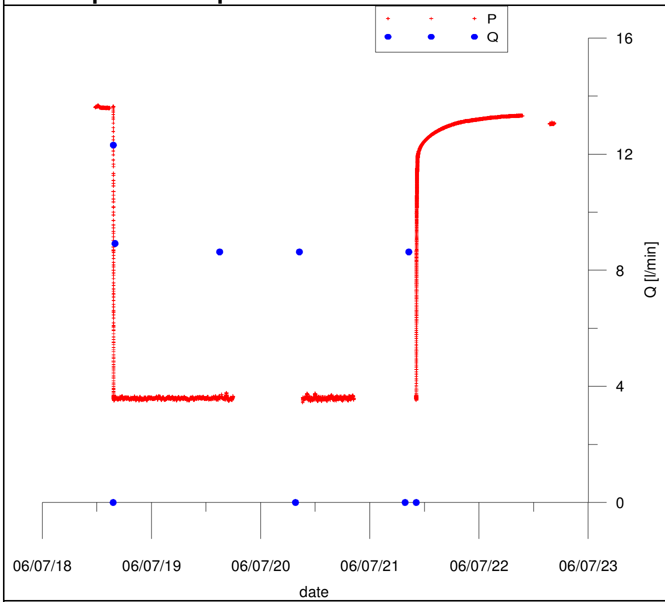
The responses during both the flow and recovery period are distorted and thus uncertain. The transient evaluations of both periods should thus be regarded as approximate. The transient evaluation is based on variable flow rate during the flow period.

An apparent pseudo-radial flow regime is indicated between c. 200-400 min during the flow period. During the recovery period a pseudo-radial flow regime is indicated between c. 200-800 min. The parameter values estimated from the flow period are selected as the most representative.

Test Summary Sheet – Pumping borehole KLX22A

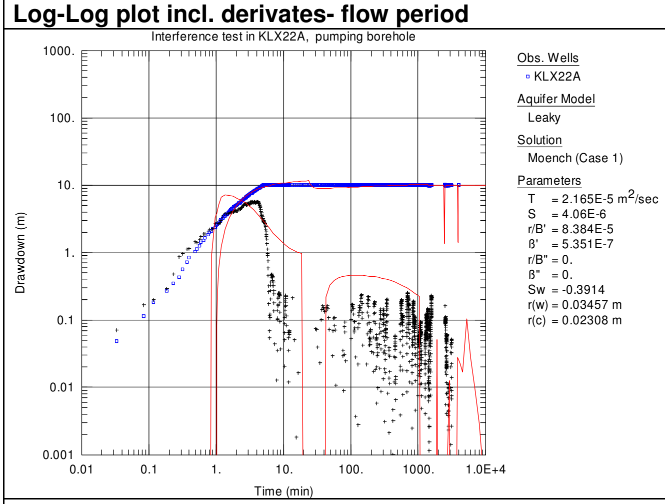
Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX22A	Test start:	2006-07-18 15:37:00
Test section (m):	2.0-100.45	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigsson

Linear plot Q and p

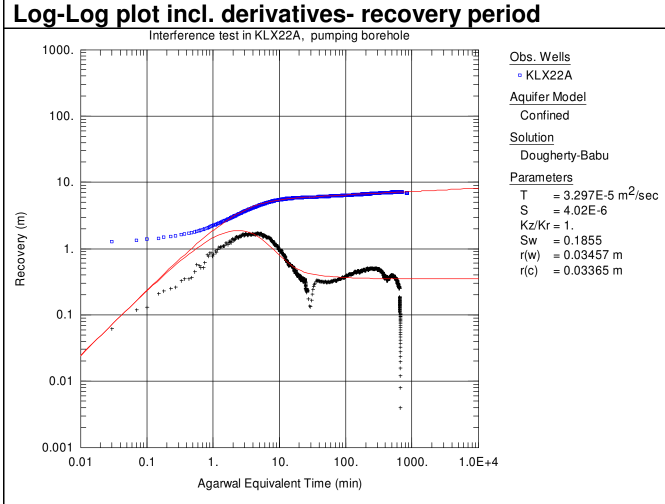


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)	133.6		
p_i (kPa)	133.7		
p_p(kPa)	35.26	p_F (kPa)	128.17
Q_p (m^3/s)	1.45^{-4}		
t_p (min)	3996	t_F (min)	2981
S^* (-)	$4.1 \cdot 10^{-6}$	S^* (-)	$4.0 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$1.4 \cdot 10^{-5}$		
T_M (m^2/s)	$1.2 \cdot 10^{-5}$		
Flow regime:	WBS->PSS	Flow regime:	WBS->(PRF)
dt_1 (min)		dt_1 (min)	20
dt_2 (min)		dt_2 (min)	600
T (m^2/s)	$2.2 \cdot 10^{-5}$	T (m^2/s)	$3.3 \cdot 10^{-5}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$1.7 \cdot 10^{-7}$	C (m^3/Pa)	$3.6 \cdot 10^{-7}$
C_D (-)		C_D (-)	
ξ (-)	-0.4	ξ (-)	0.2
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	20	C (m^3/Pa)	$3.6 \cdot 10^{-7}$
dt_2 (min)	600	C_D (-)	
T_T (m^2/s)	$3.3 \cdot 10^{-5}$	ξ (-)	0.2
S* (-)	$4.0 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

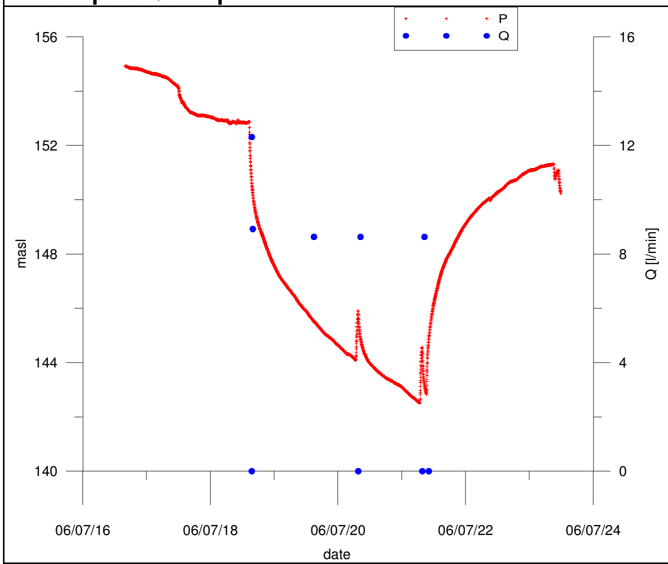
Uncertain flow rate history during the flow period. The transient evaluation is based on varying flow rate. During the flow period initial wellbore storage effects are followed by a distinct transition to a pseudo-steady state after c. 5 min. During the recovery period initial wellbore storage effects are followed by a transition to approximate pseudo-radial flow regime between c. 20-600 min.

The parameter values from the recovery period are selected as the most representative.

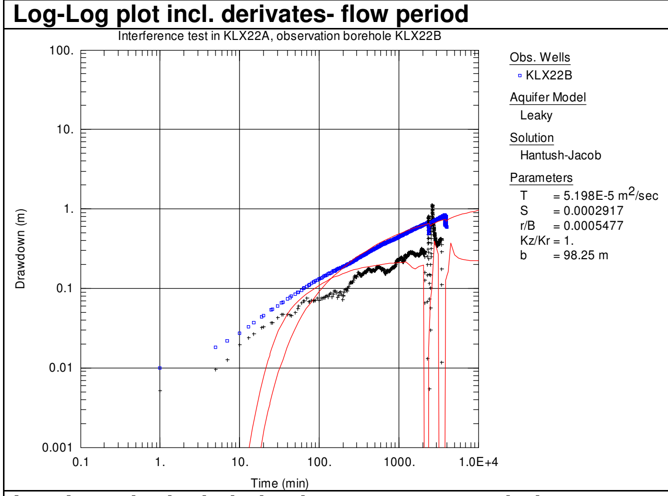
Test Summary Sheet – Observation borehole KLX22B (pumping borehole KLX22A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX22B	Test start:	2006-07-18 15:36:00
Test section (m):	2.0-100.25	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Johan Harrström

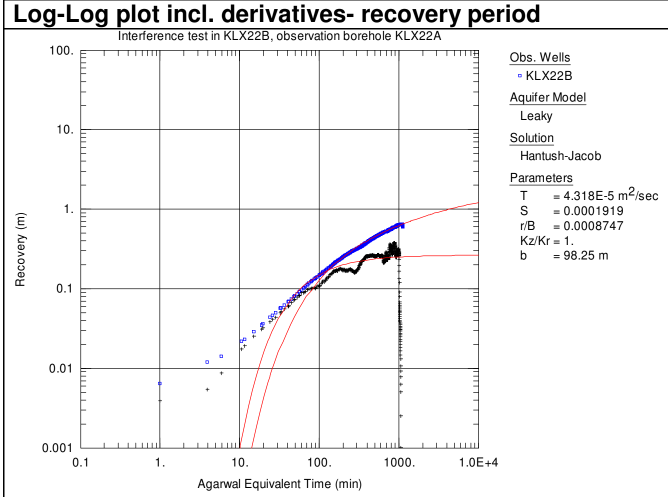
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	150.7		
p_p(kPa)	144.9	p_F (kPa)	151.3
Q_p (m³/s)			
t_p (min)	3996	t_F (min)	2981
S^* (-)		S^* (-)	
EC_w (mS/m)			
$Temp_w$(gr C			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	498	r (m)	498
Results		**Results**	
Q/s (m²/s)			
T_M (m²/s)			
Flow regime:	(PRF)	Flow regime:	(PRF)
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m²/s)	$5.2 \cdot 10^{-5}$	T (m²/s)	$4.3 \cdot 10^{-5}$
S (-)	$2.9 \cdot 10^{-4}$	S (-)	$1.9 \cdot 10^{-4}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m³/Pa)		C (m³/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m²/s)		T_{GRF}(m²/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.			
dt_1 (min)		C (m³/Pa)	
dt_2 (min)		C_D (-)	
T_T (m²/s)	$5.2 \cdot 10^{-5}$	ξ (-)	
S (-)	$2.9 \cdot 10^{-4}$		
K_s (m/s)			
S_s (1/m)			

Comments:

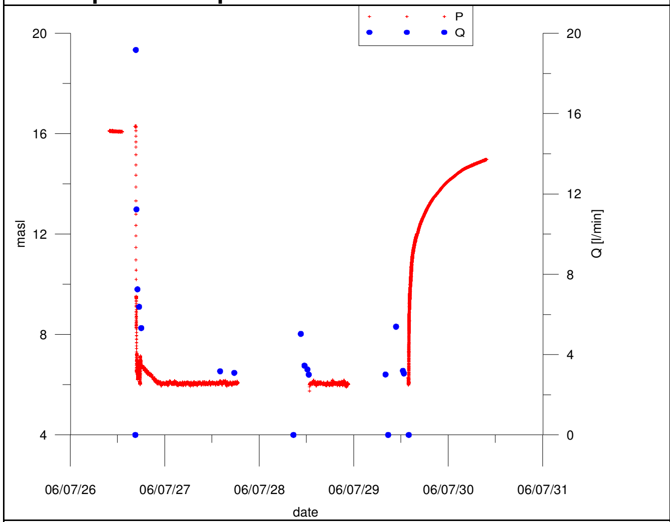
The transient evaluation is based on varying flow rate. During both the flow and recovery period a transition towards a possible pseudo-radial flow regime occurred.

The agreement of the estimated transmissivities from the flow and recovery period respectively is good. The parameter values from the flow period are selected as the most representative.

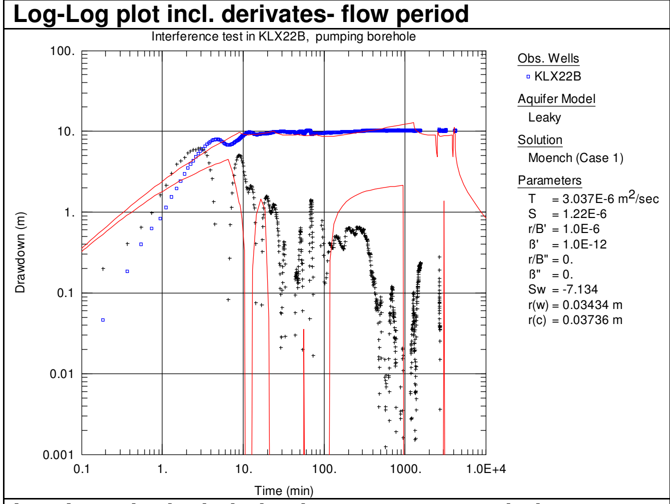
Test Summary Sheet – Pumping borehole KLX22B

Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX22B	Test start:	2006-07-26 16:41:00
Test section (m):	2.0-100.25	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

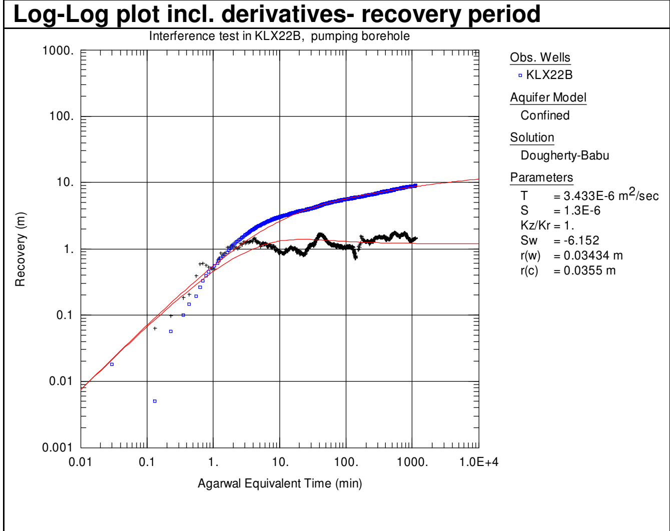
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	159.9		
p_p (kPa)	59.8	p_F (kPa)	149.6
Q_p (m^3/s)	$5.83 \cdot 10^{-5}$		
t_p (min)	4158	t_F (min)	1184
S^* (-)	$1.2 \cdot 10^{-6}$	S^* (-)	$1.1 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w (°C)			
Derivative fact.	0.3	Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$5.7 \cdot 10^{-6}$		
T_M (m^2/s)	$7.4 \cdot 10^{-6}$		
Flow regime:	WBS->PSS	Flow regime:	WBS->PRF
dt_1 (min)		dt_1 (min)	400
dt_2 (min)		dt_2 (min)	1000
T (m^2/s)	$3.0 \cdot 10^{-6}$	T (m^2/s)	$3.4 \cdot 10^{-6}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$4.5 \cdot 10^{-7}$	C (m^3/Pa)	$4.0 \cdot 10^{-7}$
C_D (-)		C_D (-)	
ξ (-)	-7.1	ξ (-)	-6.2
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	400	C (m^3/Pa)	$4.0 \cdot 10^{-7}$
dt_2 (min)	1000	C_D (-)	
T_T (m^2/s)	$3.4 \cdot 10^{-6}$	ξ (-)	-6.2
S^* (-)	$1.1 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

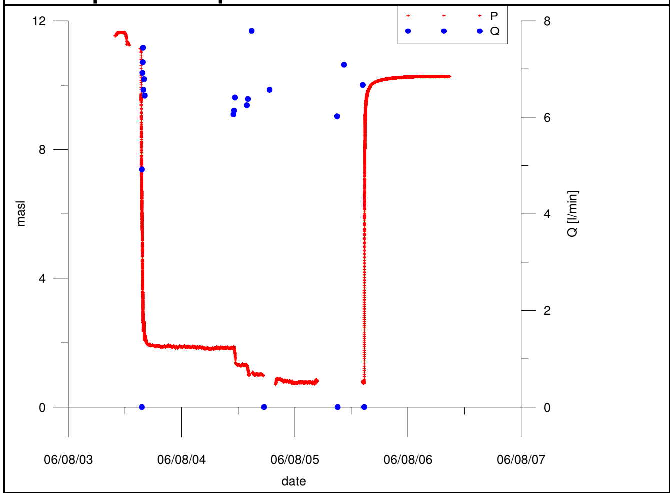
The reported flow rate is very uncertain by the end of the flow period. The transient evaluation is based on variable rate. During the flow period, initial wellbore storage effects are transitioning to a near pseudo-steady state after c. 10 minutes. During the recovery period initial wellbore storage effects are transitioning to pseudo-radial flow by the end.

The agreement in estimated parameter values is good between the flow and recovery period. The parameter values from the recovery period are selected as the most representative.

Test Summary Sheet – Pumping borehole KLX23A

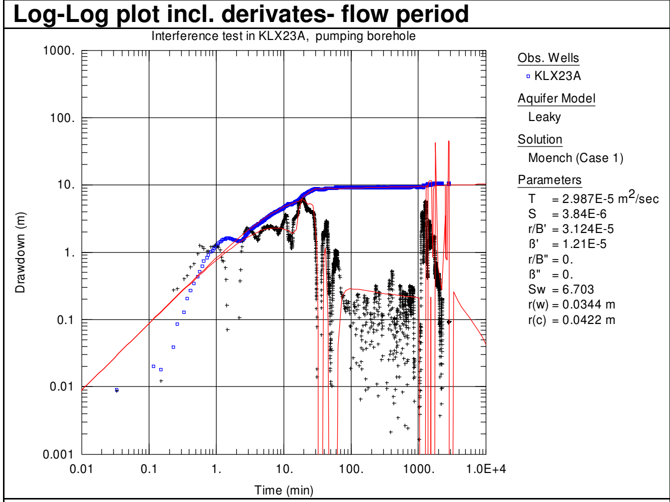
Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX23A	Test start:	2006-08-03 15:25:02
Test section (m):	2.3-100.2	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

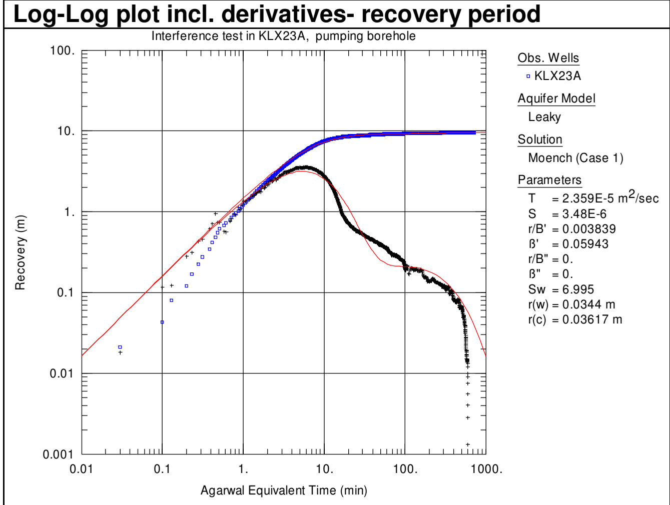


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	109.3		
p_p(kPa)	7.7	p_F (kPa)	101.0
Q_p (m^3/s)	$1.1 \cdot 10^{-4}$		
t_p (min)	2839	t_F (min)	1089
S^* (-)	$3.8 \cdot 10^{-6}$	S^* (-)	$3.5 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$1.1 \cdot 10^{-5}$		
T_M (m^2/s)	$1.4 \cdot 10^{-5}$		
Flow regime:	WBS->PSF	Flow regime:	WBS->PSF
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$3.0 \cdot 10^{-5}$	T (m^2/s)	$2.4 \cdot 10^{-5}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$5.7 \cdot 10^{-7}$	C (m^3/Pa)	$4.2 \cdot 10^{-7}$
C_D (-)		C_D (-)	
ξ (-)	6.7	ξ (-)	7.0
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	$5.7 \cdot 10^{-7}$
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$3.0 \cdot 10^{-5}$	ξ (-)	6.7
S* (-)	$3.8 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

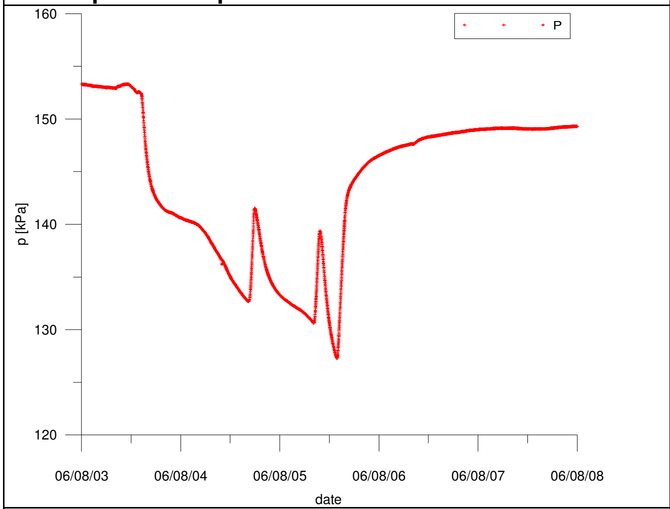
The flow rate varied during the flow period. The transient evaluation is based on varying flow rate. During both the flow and recovery period, initial wellbore storage effects are followed by a transition to pseudo-spherical (leaky) flow after c. 20 minutes. In the middle of the flow period the drawdown increased due to increasing flow rate.

The agreement in evaluated parameter values between the flow and recovery period is good. The parameter values from the flow period are selected as the most representative.

Test Summary Sheet – Observation borehole KLX23B (pumping borehole KLX23A)

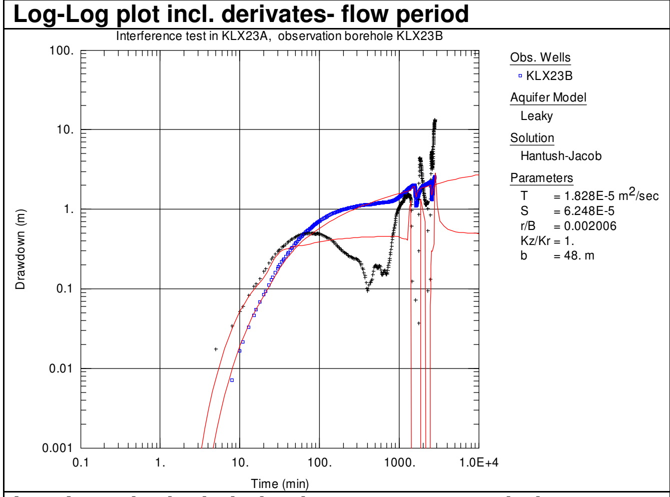
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX23B	Test start:	2006-08-03 15:25:02
Test section (m):	2.3-50.3	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

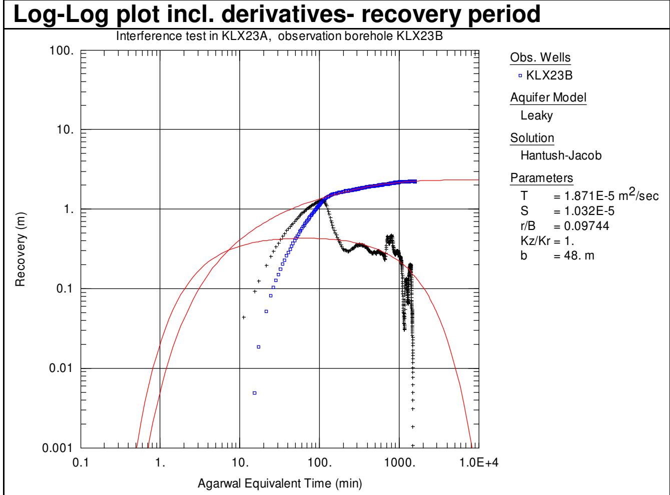


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	152.4		
p_p(kPa)	127.6	p_F (kPa)	149.3
Q_p (m^3/s)			
tp (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
$Temp_w$(gr C			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	37	r (m)	37
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	(PRF)	Flow regime:	PRF->PSF
dt_1 (min)		dt_1 (min)	200
dt_2 (min)		dt_2 (min)	800
T (m^2/s)	$1.8 \cdot 10^{-5}$	T (m^2/s)	$1.9 \cdot 10^{-5}$
S (-)	$6.2 \cdot 10^{-5}$	S (-)	$1.0 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	200	C (m^3/Pa)	
dt_2 (min)	800	C_D (-)	
T_T (m^2/s)	$1.9 \cdot 10^{-5}$	ξ (-)	
S (-)	$1.0 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

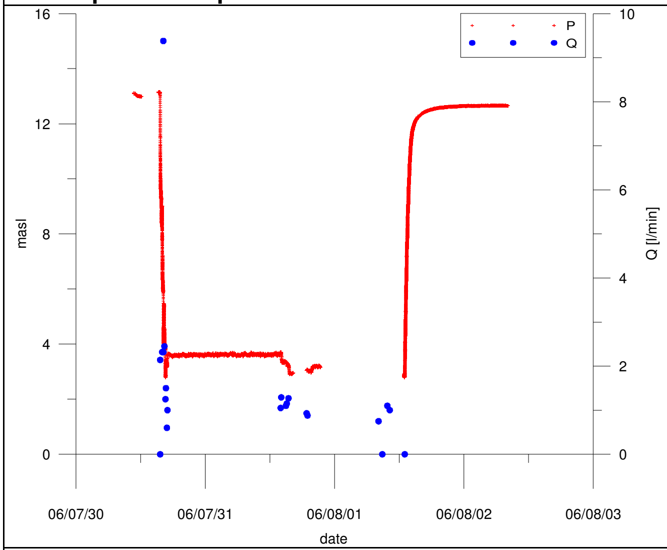
The transient evaluation is based on varying flow rate. During the flow period an apparent pseudo-radial flow regime is indicated although large variations in the flow rate occurred by the end. The recovery period indicates a pseudo-radial flow regime between c. 200-800 min. By the end a slight leakage flow occurs.

The parameter values from the recovery period are selected as the most representative in this case due to the variations in the flow rate during the flow period.

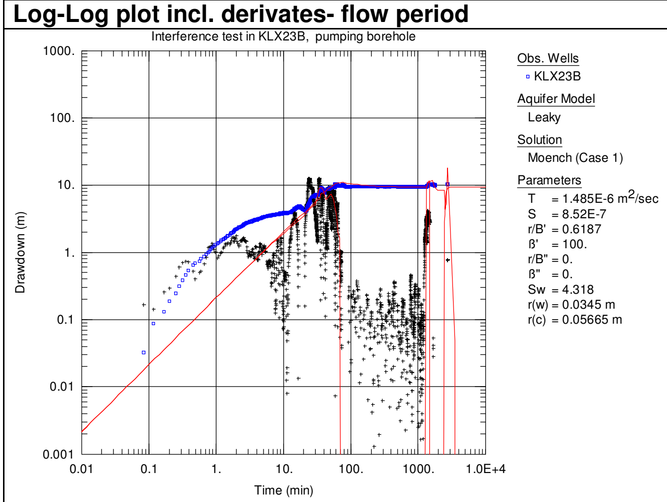
Test Summary Sheet – Pumping borehole KLX23B

Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX23B	Test start:	2006-07-30 15:38:02
Test section (m):	2.3-50.3	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

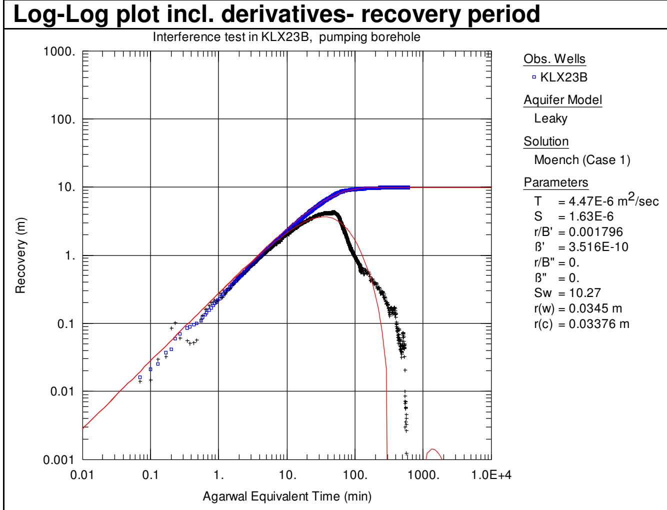


Log-Log plot incl. derivates- flow period



Example – No unambiguous transient evaluation is possible

Log-Log plot incl. derivatives- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	128.9		
p_p(kPa)	27.6	p_F (kPa)	124.1
Q_p (m^3/s)	$1.7 \cdot 10^{-5}$		
t_p (min)	2724	t_F (min)	1148
S^* (-)	$(8.5 \cdot 10^{-7})$	S^* (-)	$1.6 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$1.6 \cdot 10^{-6}$		
T_M (m^2/s)	$1.9 \cdot 10^{-6}$		
Flow regime:	WBS->PSS	Flow regime:	WBS->PSF
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$(1.5 \cdot 10^{-6})$	T (m^2/s)	$4.5 \cdot 10^{-6}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$(1.0 \cdot 10^{-6})$	C (m^3/Pa)	$3.6 \cdot 10^{-7}$
C_D (-)		C_D (-)	
ξ (-)	(4.3)	ξ (-)	10.3
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	$3.6 \cdot 10^{-7}$
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$4.5 \cdot 10^{-6}$	ξ (-)	10.3
S^* (-)	$1.6 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

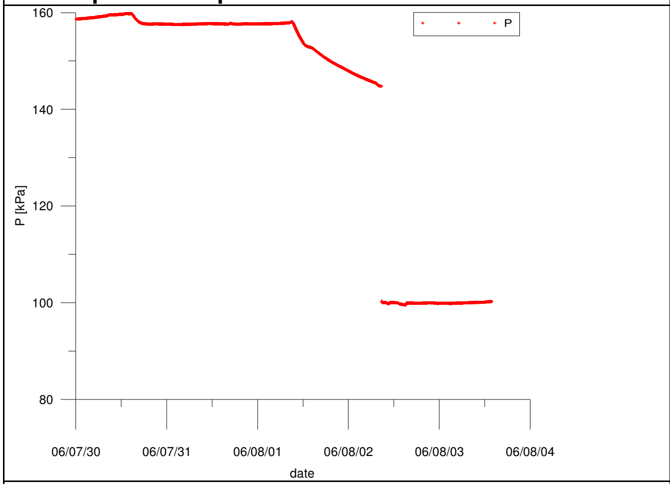
The flow rate varied during the flow period. The transient evaluation is based on varying flow rate. During both the flow and recovery period, initial wellbore storage effects are followed by a transition to nearly pseudo-state flow by the end. No unambiguous transient evaluation during the flow period.

The parameter values from the recovery period are selected as the most representative.

Test Summary Sheet – Observation borehole KLX23A (pumping borehole KLX23B)

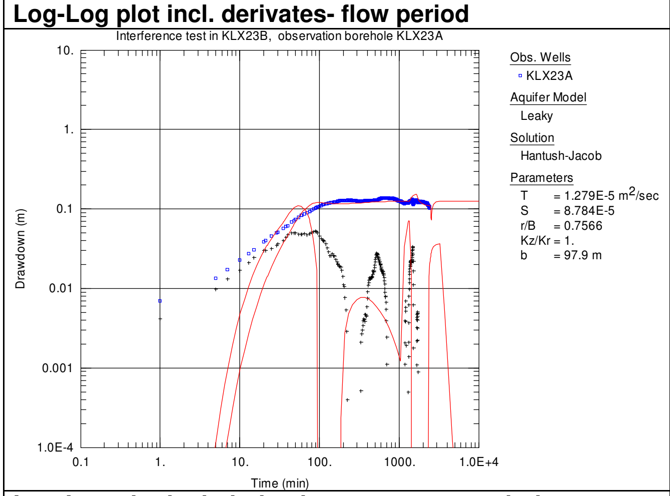
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX23A	Test start:	2006-07-30 15:38:05
Test section (m):	2.3-100.2	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	158.9		
p_p(kPa)		p_F (kPa)	
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^{o}C)			
Derivative fact.	0.2	Derivative fact.	
r (m)	37	r (m)	37
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	(PSF)	Flow regime:	
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$1.3 \cdot 10^{-5}$	T (m^2/s)	
S (-)	$8.8 \cdot 10^{-5}$	S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period

No representative data available from the recovery period.

Selected representative parameters.			
dt_1 (min)		C (m^3/Pa)	
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$1.3 \cdot 10^{-5}$	ξ (-)	
S (-)	$8.8 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

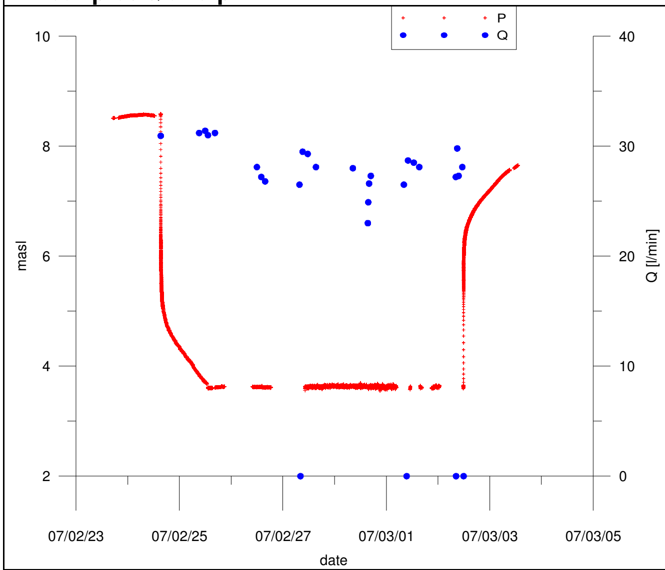
Only a small drawdown response was observed in this section. The transient evaluation is based on varying flow rate. An apparent pseudo-spherical (leaky) flow regime is indicated during the flow period. No representative data from the recovery period are available.

Transient evaluation from the flow period was considered as the most representative.

Test Summary Sheet – Pumping borehole KLX16A

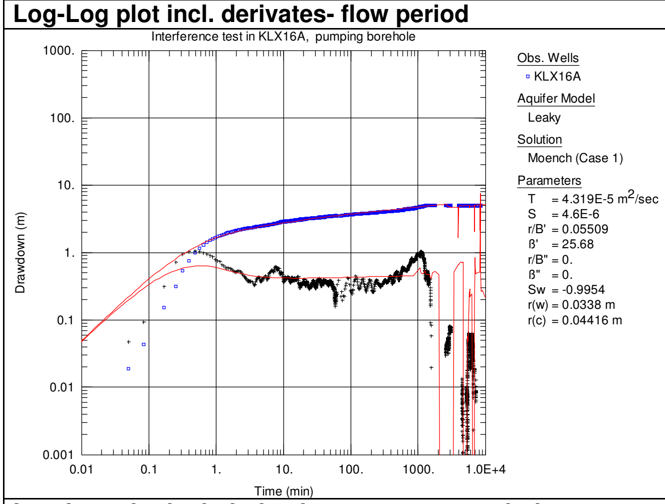
Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX16A	Test start:	2007-02-24 15:20
Test section (m):	11.25-433,5	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

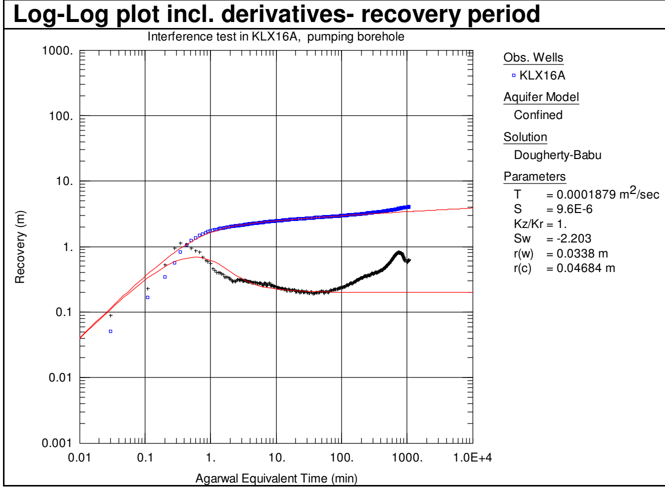


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	84.18		
p_p(kPa)	35.53	p_F (kPa)	75.10
Q_p (m^3/s)	$4.68 \cdot 10^{-4}$		
t_p (min)	8433	t_F (min)	1515
S^* (-)	$4.6 \cdot 10^{-6}$	S^* (-)	$9.6 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w (°C)			
Derivative fact.	0.2	Derivative fact.	0.1
r (m)	-	r (m)	-
Results		**Results**	
Q/s (m^2/s)	$9.4 \cdot 10^{-5}$		
T_M (m^2/s)	$1.5 \cdot 10^{-4}$		
Flow regime:	WBS->PRF->PSS	Flow regime:	WBS->PRF->NFB
dt_1 (min)	5	dt_1 (min)	10
dt_2 (min)	300	dt_2 (min)	80
T (m^2/s)	$4.3 \cdot 10^{-5}$	T (m^2/s)	$1.88 \cdot 10^{-4}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$6.2 \cdot 10^{-7}$	C (m^3/Pa)	$7.025 \cdot 10^{-7}$
C_D (-)		C_D (-)	
ξ (-)	-1.0	ξ (-)	-2.203
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	5	C (m^3/Pa)	$6.2 \cdot 10^{-7}$
dt_2 (min)	300	C_D (-)	
T_T (m^2/s)	$4.3 \cdot 10^{-5}$	ξ (-)	-1.0
S* (-)	$4.6 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

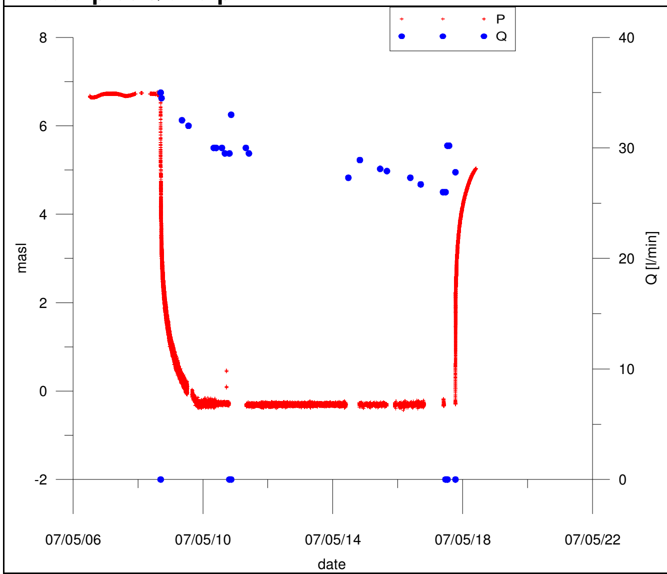
Comments:

Several changes of flow rate occurred during the flow period. After initial WBS during the first c. 0.5 min a period of approximate PRF was developed between c. 5-300 min. A nearly pseudo-stationary pressure (PSS) was achieved after c. 1400 min. After initial WBS during the first c. 0.5 min a first PRF is developed between c. 10-80 min of equivalent time during the recovery period. A second PRF is weakly indicated between c. 500-1100 min. Alternatively, an apparent no-flow boundary (NFB) may be assumed after c. 100 min. The representative parameters were selected from the flow period.

Test Summary Sheet – Pumping borehole KLX15A

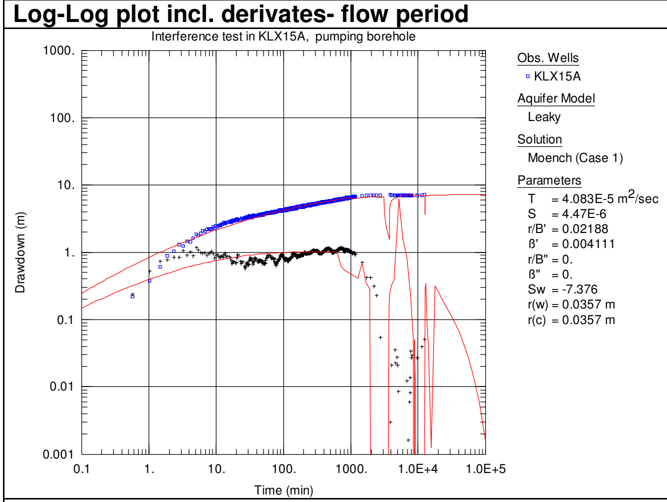
Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX15A	Test start:	2007-05-08 16:47:00
Test section (m):	11.7-1000.4	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

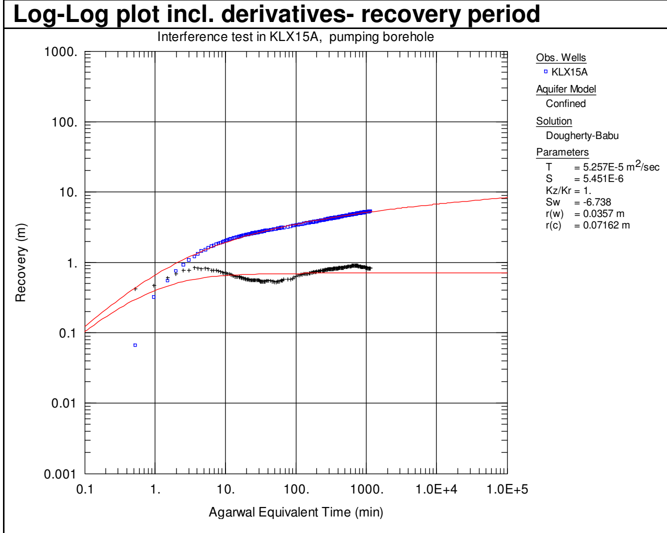


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	66.2		
p_p(kPa)	-3.0	p_F (kPa)	49.4
Q_p (m^3/s)	$4.9 \cdot 10^{-4}$		
t_p (min)	13074	t_F (min)	907
S^* (-)	$4.5 \cdot 10^{-6}$	S^* (-)	$5.5 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.4	Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$7.0 \cdot 10^{-5}$		
T_M (m^2/s)	$1.2 \cdot 10^{-4}$		
Flow regime:	WBS->PRF ->PSS	Flow regime:	WBS->PRF
dt_1 (min)	300	dt1 (min)	c. 50
dt_2 (min)	1000	dt2 (min)	c. 1000
T (m^2/s)	$4.1 \cdot 10^{-5}$	T (m2/s)	$5.3 \cdot 10^{-5}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$4.1 \cdot 10^{-7}$	C (m^3/Pa)	$1.6 \cdot 10^{-6}$
C_D (-)		C_D (-)	
ξ (-)	-7.4	ξ (-)	-6.7
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	300	C (m^3/Pa)	$4.1 \cdot 10^{-7}$
dt_2 (min)	1000	C_D (-)	
T_T (m^2/s)	$4.1 \cdot 10^{-5}$	ξ (-)	-7.4
S* (-)	$4.5 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

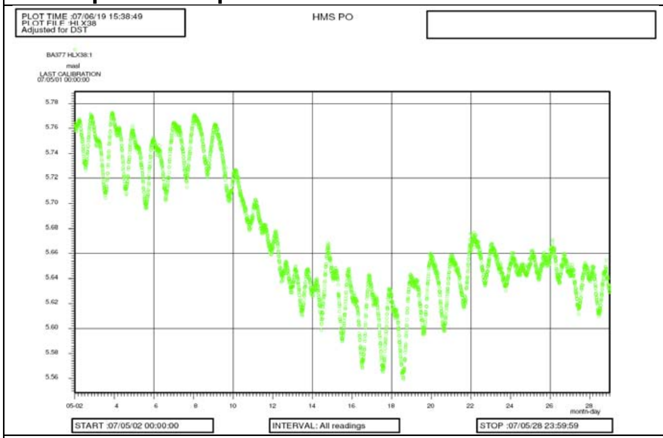
During both the flow and recovery period, wellbore storage effects are followed by dominating pseudo-radial flow. By the end of the flow period an almost pseudo-steady state occurred. During the recovery period an approximate pseudo-radial flow regime occurred.

The test was evaluated as a variable flow rate test. The agreement in evaluated parameter values between the flow and recovery period is good. The parameter values from the flow period are selected as the most representative.

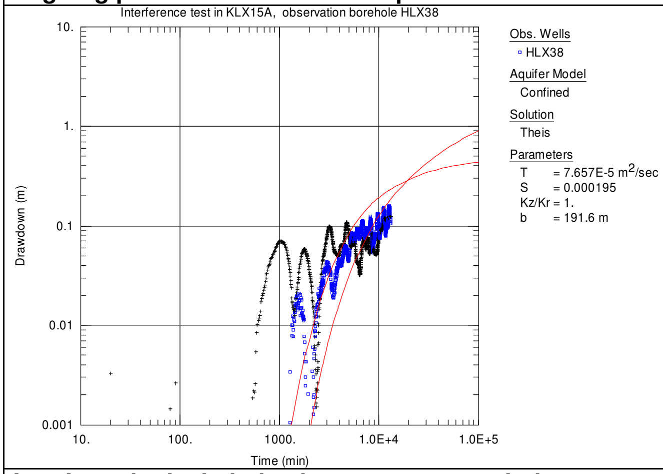
Test Summary Sheet – Observation borehole HLX38 (pumping borehole KLX15A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	HLX38	Test start:	2007-05-08 16:47:00
Test section (m):	15.0-199.5	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.139	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

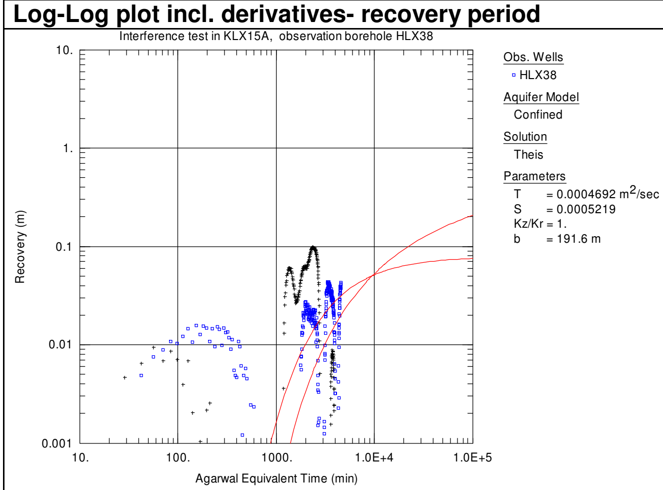
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	56.2		
p_p(kPa)	55.1	p_F (kPa)	55.5
Q_p (m^3/s)			
tp (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.4	Derivative fact.	0.4
r (m)	192.6	r (m)	192.6
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	Transition	Flow regime:	Transition
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$7.7 \cdot 10^{-5}$	T (m^2/s)	($4.7 \cdot 10^{-4}$)
S (-)	$1.9 \cdot 10^{-4}$	S (-)	($5.2 \cdot 10^{-4}$)
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$7.7 \cdot 10^{-5}$	ξ (-)	
S (-)	$1.9 \cdot 10^{-4}$		
K_s (m/s)			
S_s (1/m)			

Comments:

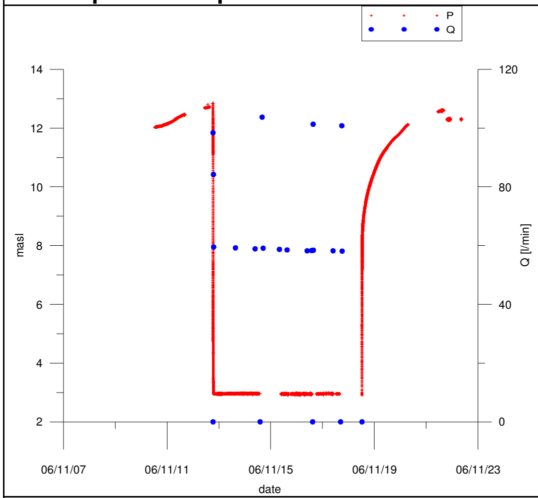
Only a very small response is deduced during the flow period in this section. The response during the recovery period is regarded as very uncertain and affected by tidal effects.

The transient evaluations during both the flow and recovery period are thus considered as very uncertain. The parameter values estimated from the flow period are selected as the most representative.

Test Summary Sheet – Pumping borehole KLX19A

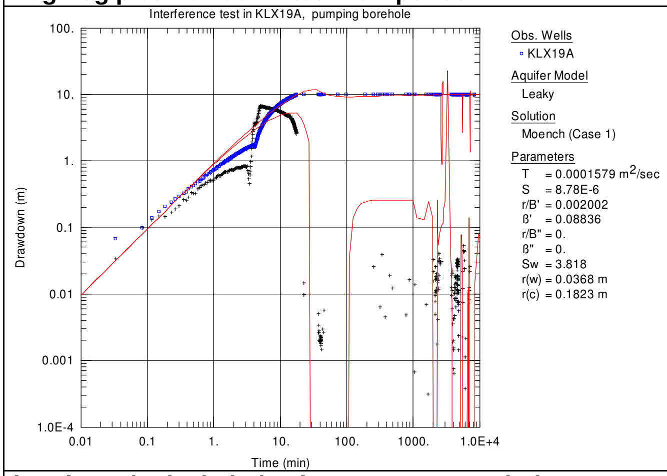
Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX19A	Test start:	2006-11-12 18:35:04
Test section (m):	98.8-800.1	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

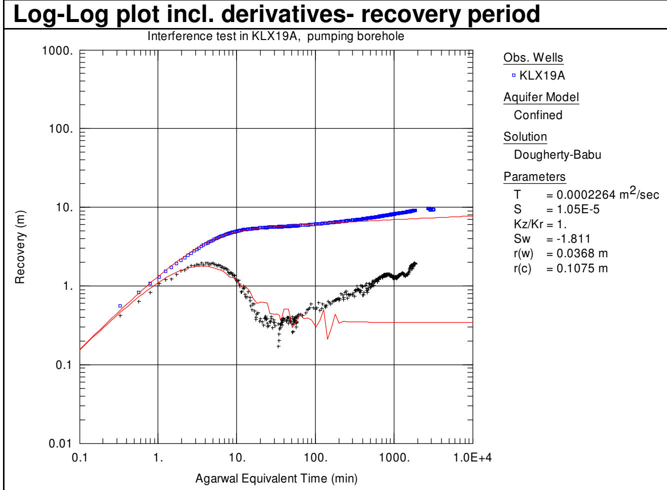


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	126.0		
p_p(kPa)	29.0	p_F (kPa)	120.5
Q_p (m^3/s)	$9.68 \cdot 10^{-4}$		
t_p (min)	8281	t_F (min)	5522
S^* (-)	$8.8 \cdot 10^{-6}$	S^* (-)	$1.0 \cdot 10^{-5}$
EC_w (mS/m)			
Te_w(^oC)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$9.8 \cdot 10^{-5}$		
T_M (m^2/s)	$1.5 \cdot 10^{-4}$		
Flow regime:	WBS->PSS	Flow regime:	WBS->PRF ->NFB
dt_1 (min)		dt_1 (min)	20
dt_2 (min)		dt_2 (min)	60
T (m^2/s)	$1.6 \cdot 10^{-4}$	T (m^2/s)	$2.3 \cdot 10^{-4}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$(1.1 \cdot 10^{-5})$	C (m^3/Pa)	$3.7 \cdot 10^{-6}$
C_D (-)		C_D (-)	
ξ (-)	3.8	ξ (-)	-1.8
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	$3.7 \cdot 10^{-6}$
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$1.6 \cdot 10^{-4}$	ξ (-)	3.8
S* (-)	$8.8 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

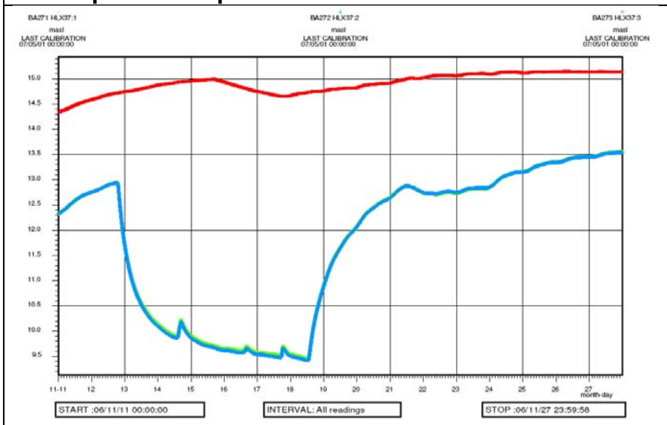
The flow rate curve is uncertain with several changes of flow rate. During the flow period initial effects of WBS occurred. The drawdown curve was distorted by an increase of flow rate after c. 5 min. After c. 20 min a pseudo-steady state pressure (PSS) was achieved throughout the flow period. The recovery was not consistent with the response during the flow period. After initial WBS a short period of PRF occurred. After c. 60 min an apparent no-flow boundary (NFB) was indicated.

The estimated parameter values from the flow period are selected as representative for the test.

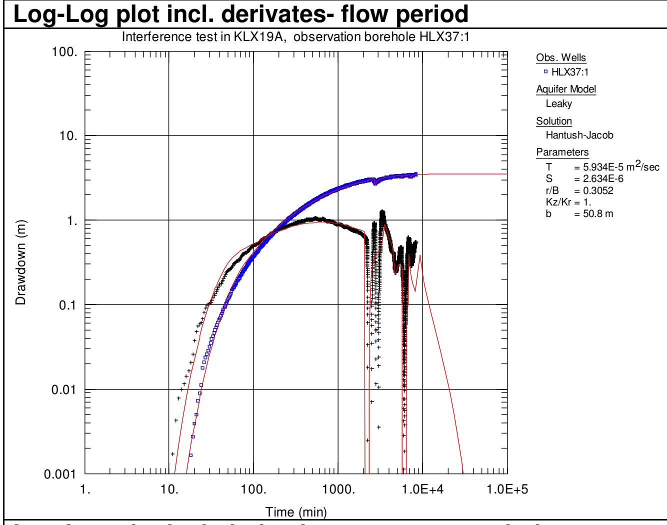
Test Summary Sheet – Observation borehole HLX37:1 (pumping borehole KLX19A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	HLX37:1	Test start:	2006-11-12 18:35:04
Test section (m):	149.0-199.8	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.139	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

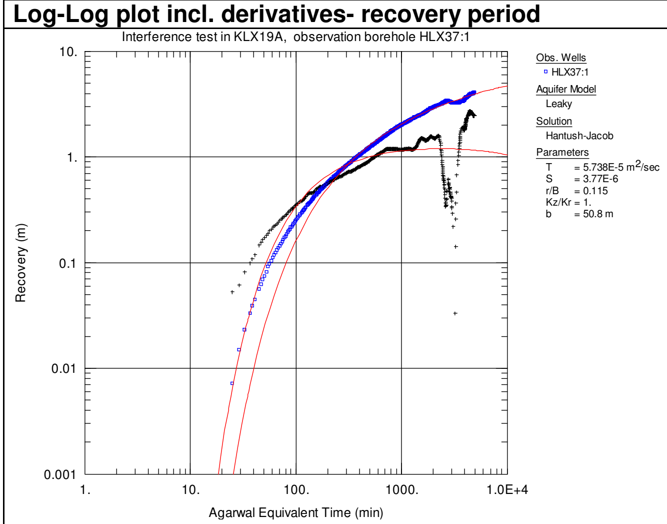
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		**Recovery period**	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	127.0		
p_p(kPa)	92.8	p_F (kPa)	133.0
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(^{o}C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	710	r (m)	710
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF->PSF	Flow regime:	PRF
dt_1 (min)	300	dt_1 (min)	700
dt_2 (min)	1000	dt_2 (min)	1500
T (m^2/s)	$5.9 \cdot 10^{-5}$	T (m^2/s)	$5.7 \cdot 10^{-5}$
S (-)	$2.6 \cdot 10^{-6}$	S (-)	$3.8 \cdot 10^{-6}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.			
dt_1 (min)	300	C (m^3/Pa)	
dt_2 (min)	1000	C_D (-)	
T_T (m^2/s)	$5.9 \cdot 10^{-5}$	ξ (-)	
S (-)	$2.6 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

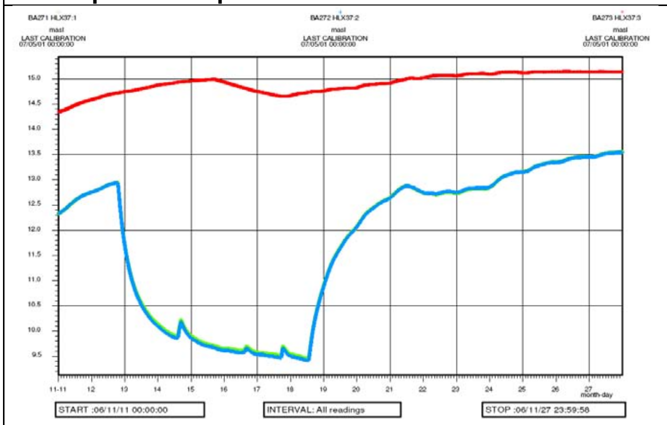
Distinct responses were obtained during the flow and recovery period. The flow period is dominated by nearly pseudo-radial flow transitioning to pseudo-spherical (leaky) flow. During the recovery period a transition to pseudo-radial flow occurred.

Consistent results of evaluated parameter values are obtained from the flow and recovery period respectively. The parameter values estimated from the flow period are selected as the most representative for the test section.

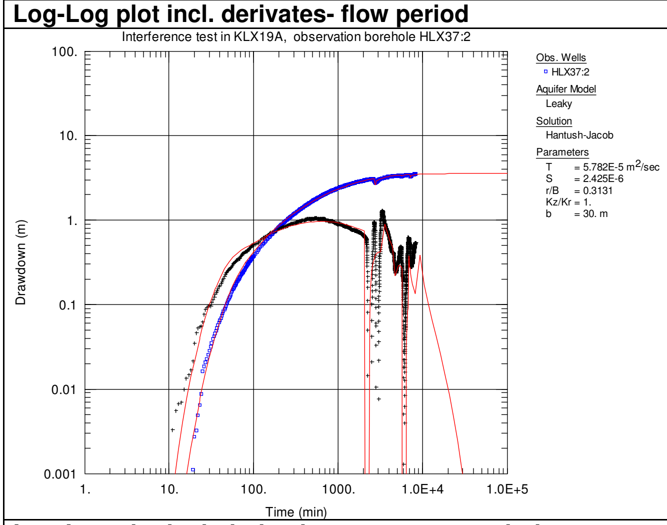
Test Summary Sheet – Observation borehole HLX37:2 (pumping borehole KLX19A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	HLX37:2	Test start:	2006-11-12 18:35:04
Test section (m):	118.0-148.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.139	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

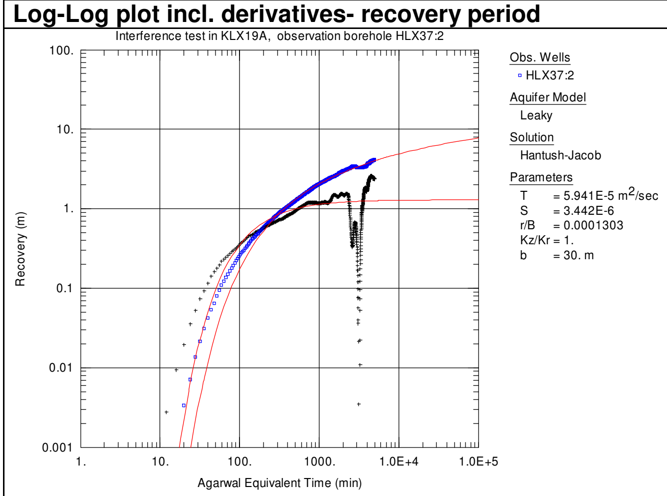
Linear plot Q and p



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	127.0		
p_p(kPa)	92.4	p_F (kPa)	132.9
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	737	r (m)	737
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF->PSF	Flow regime:	PRF
dt_1 (min)	300	dt_1 (min)	700
dt_2 (min)	1000	dt_2 (min)	1500
T (m^2/s)	$5.8 \cdot 10^{-5}$	T (m^2/s)	$5.9 \cdot 10^{-5}$
S (-)	$2.4 \cdot 10^{-6}$	S (-)	$3.4 \cdot 10^{-6}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	300	C (m^3/Pa)	
dt_2 (min)	1000	C_D (-)	
T_T (m^2/s)	$5.8 \cdot 10^{-5}$	ξ (-)	
S (-)	$2.4 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

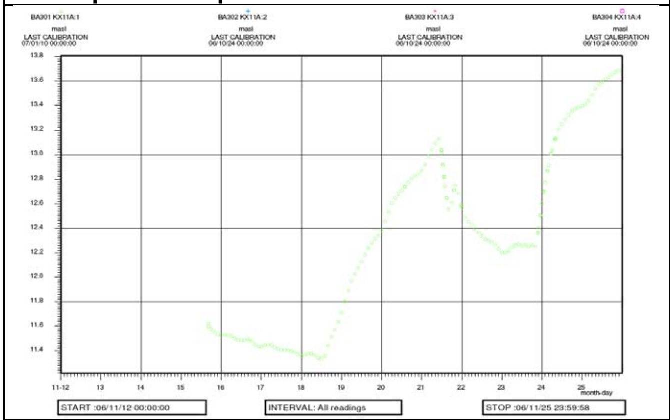
Distinct responses were obtained during the flow and recovery period. The flow period is dominated by nearly pseudo-radial flow transitioning to pseudo-spherical (leaky) flow. During the recovery period a transition to pseudo-radial flow occurred.

Consistent results of evaluated parameter values are obtained from the flow and recovery period respectively. The parameter values estimated from the flow period are selected as the most representative for the test section.

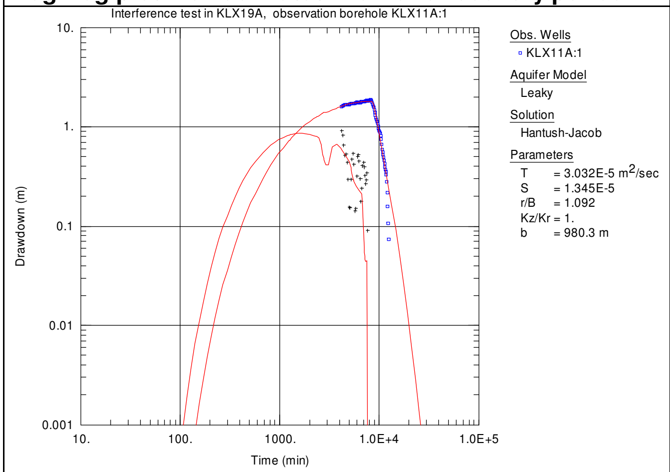
Test Summary Sheet – Observation borehole KLX11A (pumping borehole KLX19A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX11A:1	Test start:	2006-11-12 18:35:04
Test section (m):	12.0-992.3	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

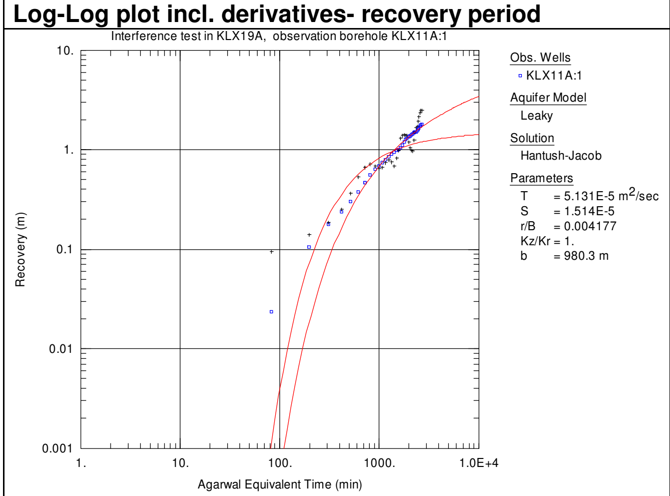


Log-Log plot incl. derivates- flow and recovery period



Limited pressure data available during flow period

Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)			
p_p (kPa)	111.2	p_F (kPa)	129.5
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (°C)			
Derivative fact.		Derivative fact.	0.1
r (m)		r (m)	701
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:		Flow regime:	Transition
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)		T (m^2/s)	$5.1 \cdot 10^{-5}$
S (-)		S (-)	$1.5 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$5.1 \cdot 10^{-5}$	ξ (-)	
S (-)	$1.5 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

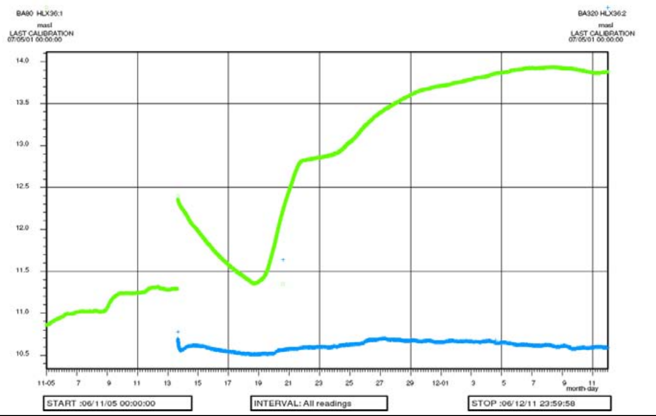
Only limited pressure data are available from the flow period. Thus, no individual transient evaluation can be made from the flow period. A combined evaluation with data from the flow and recovery period was made. Sparse data were available from the recovery period. The latter period indicates a transition period towards possible pseudo-radial flow.

The parameter values estimated from the recovery period are selected as representative.

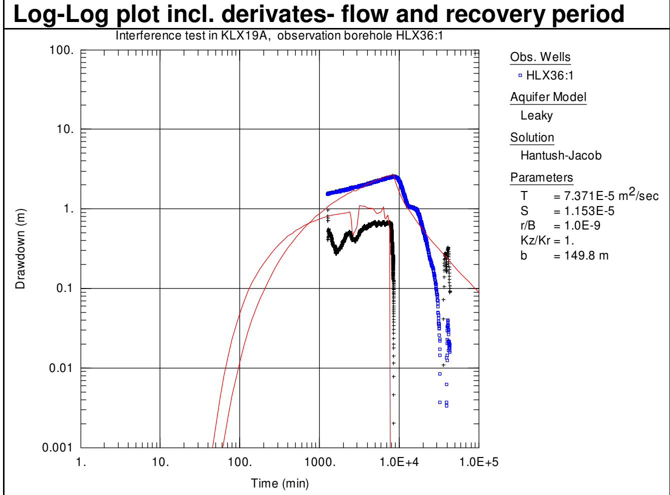
Test Summary Sheet – Observation borehole HLX36:1 (pumping borehole KLX19A)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	HLX36:1	Test start:	2006-11-12 18:35:04
Test section (m):	50.0-199.8	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.140	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

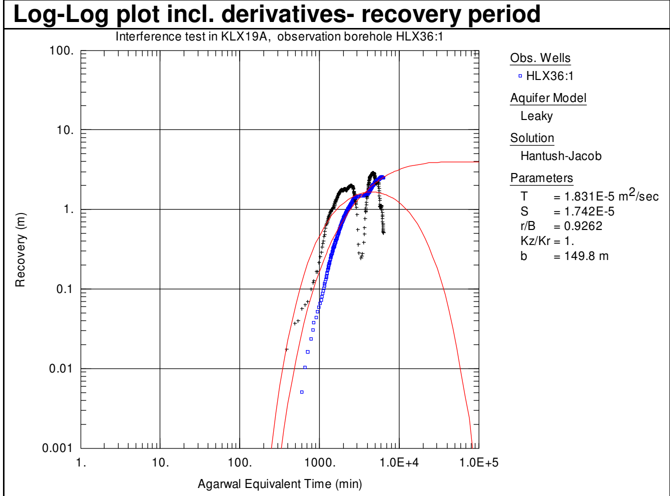


Log-Log plot incl. derivates- flow and recovery period



Limited pressure data available during flow period

Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)			
p_p(kPa)	111.5	p_F (kPa)	136.4
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	728	r (m)	728
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF	Flow regime:	Transition
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$7.4 \cdot 10^{-5}$	T (m^2/s)	$1.8 \cdot 10^{-5}$
S (-)	$1.2 \cdot 10^{-5}$	S (-)	$1.7 \cdot 10^{-5}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$1.8 \cdot 10^{-5}$	ξ (-)	
S (-)	$1.7 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

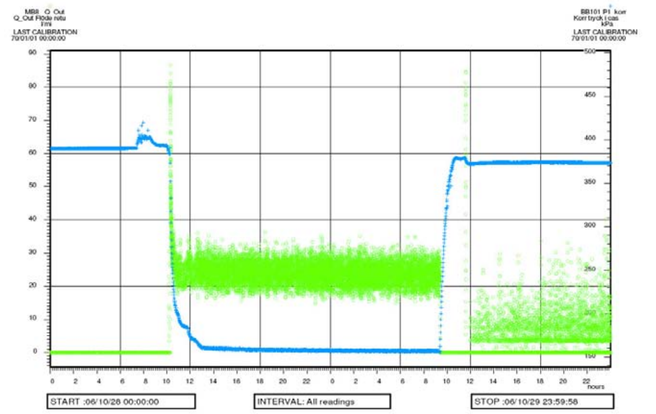
Only limited pressure data are available from the flow period. Thus, no individual transient evaluation can be made from the flow period. A combined evaluation with data from the flow and recovery period was made. The latter period indicates a transition period towards possible pseudo-radial flow.

The parameter values estimated from the recovery period are selected as representative.

Test Summary Sheet – Pumping borehole KLX17A

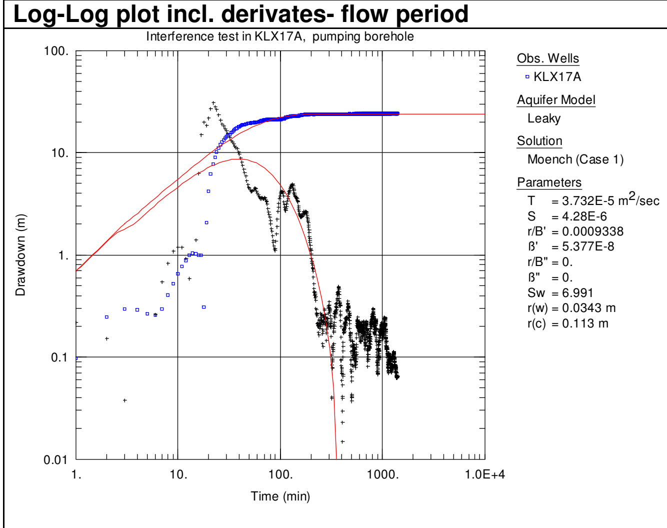
Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX17A	Test start:	2006-10-28 09:58:00
Test section (m):	12.0-701.1	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p



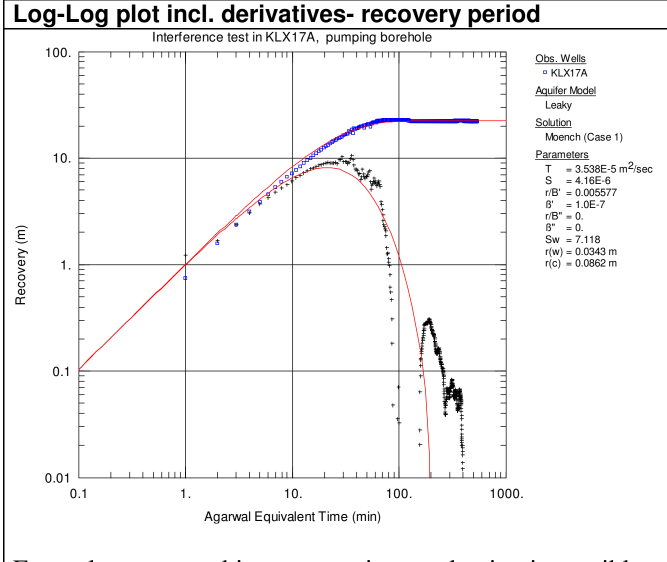
Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	393.5		
p_p (kPa)	157.5	p_F (kPa)	373.4
Q_p (m³/s)	$4.0 \cdot 10^{-4}$		
t_p (min)	1404	t_F (min)	877
S^* (-)	$4.3 \cdot 10^{-6}$	S^* (-)	$4.2 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w (°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)		r (m)	
Results		**Results**	
Q/s (m²/s)	$1.6 \cdot 10^{-4}$		
T_M (m²/s)	$2.6 \cdot 10^{-4}$		
Flow regime:	WBS->PSS	Flow regime:	WBS->PSS
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m²/s)	$(3.7 \cdot 10^{-5})$	T (m²/s)	$(3.5 \cdot 10^{-5})$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m³/Pa)	$(4.1 \cdot 10^{-6})$	C (m³/Pa)	$(2.4 \cdot 10^{-6})$
C_D (-)		C_D (-)	
ξ (-)	(7.0)	ξ (-)	(7.1)
T_{GRF} (m²/s)		T_{GRF} (m²/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Example - no unambiguous transient evaluation is possible

Log-Log plot incl. derivatives- recovery period



Example - no unambiguous transient evaluation is possible

Selected representative parameters.

dt_1 (min)		C (m³/Pa)	$(2.4 \cdot 10^{-6})$
dt_2 (min)		C_D (-)	
T_T (m²/s)	$(3.7 \cdot 10^{-5})$	ξ (-)	(7.0)
S* (-)	$(4.3 \cdot 10^{-6})$		
K_s (m/s)			
S_s (1/m)			

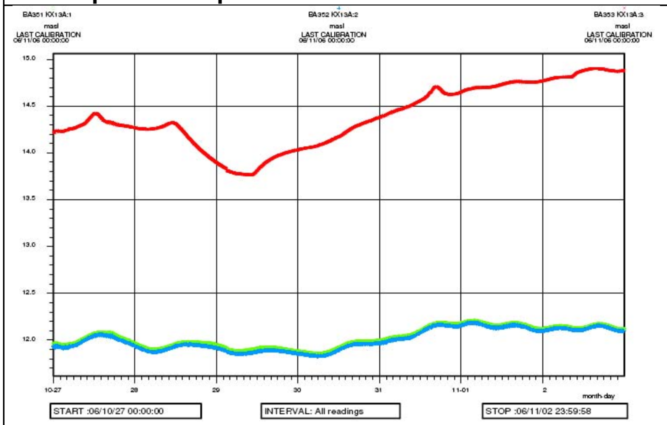
Comments:

Uncertain flow rate in the beginning of the flow period. A rather constant flow rate was maintained during the rest of the period. Both the flow and recovery period exhibit effects of initial WBS rapidly transitioning to a pseudo-steady state by the end. No unambiguous transient evaluation could be made on either the flow or recovery period. Examples of possible transient evaluations are shown.

Test Summary Sheet – Observation borehole KLX13A:3 (pumping borehole KLX17A)

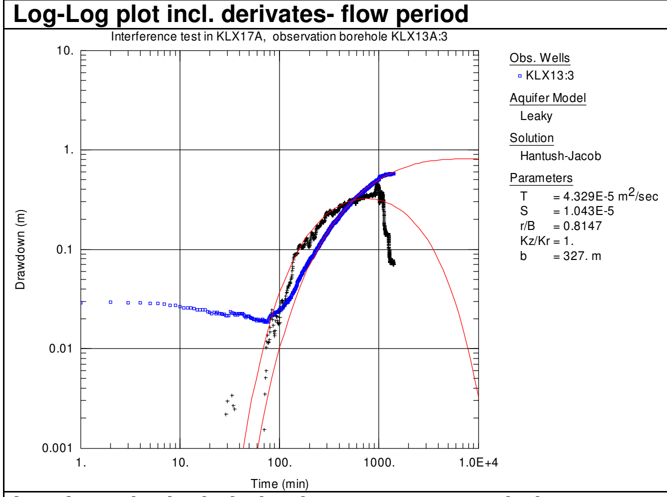
Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX13A:3	Test start:	2006-10-28 09:58:00
Test section (m):	11.8-339.0	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

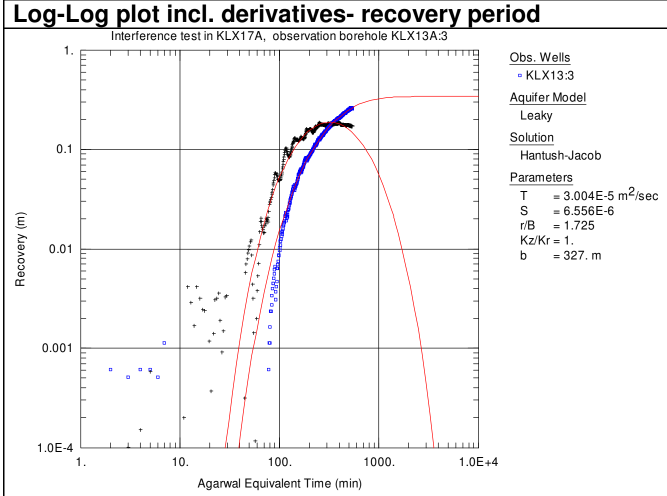


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	140.4		
p_p(kPa)	135.1	p_F (kPa)	137.6
Q_p (m^3/s)			
t_p (min)		t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.2
r (m)	552	r (m)	552
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	PRF ->PSF	Flow regime:	PRF ->PSF
dt_1 (min)	600	dt_1 (min)	300
dt_2 (min)	1000	dt_2 (min)	600
T (m^2/s)	$4.3 \cdot 10^{-5}$	T (m^2/s)	$3.0 \cdot 10^{-5}$
S (-)	$1.0 \cdot 10^{-5}$	S (-)	$6.6 \cdot 10^{-6}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	600	C (m^3/Pa)	
dt_2 (min)	1000	C_D (-)	
T_T (m^2/s)	$4.3 \cdot 10^{-5}$	ξ (-)	
S (-)	$1.0 \cdot 10^{-5}$		
K_s (m/s)			
S_s (1/m)			

Comments:

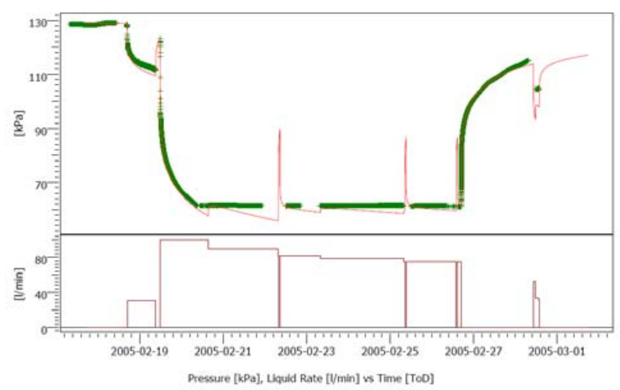
Rather distinct responses were obtained during the flow and recovery period. Both the flow and recovery period is dominated by nearly pseudo-radial flow transitioning to pseudo-spherical (leaky) flow by the end.

Rather consistent results of evaluated parameter values are obtained from the flow and recovery period respectively. The parameter values estimated from the flow period are selected as the most representative for the test section.

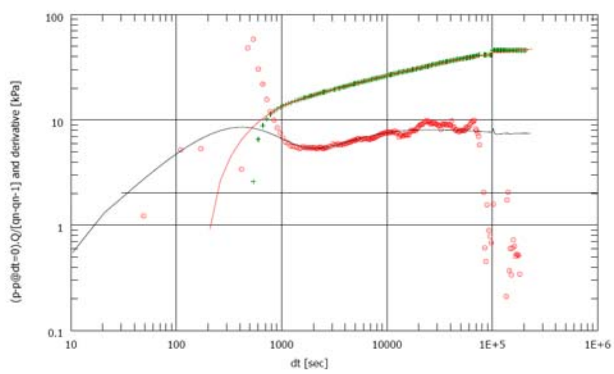
Test Summary Sheet – Pumping borehole KLX06

Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX06	Test start:	2005-02-18 16:52:00
Test section (m):	11.88 – 994.94	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	SKB Mansueto Morosini

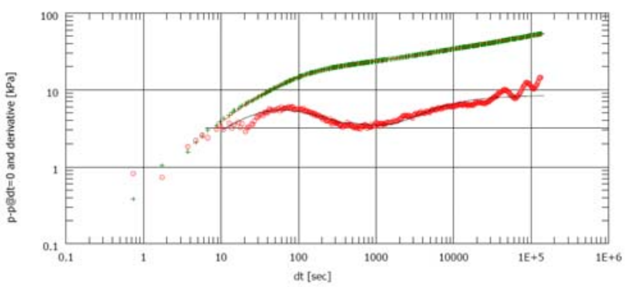
Linear plot of pressure



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
h_0 (masl)			
h_i (masl)	12.9		
h_p (masl)	6.1	h_F (masl)	
Q_p (m^3/s)	$1.25 \cdot 10^{-3}$		
t_p (min)	14215	t_F (min)	
S^* (-)	$8.0 \cdot 10^{-6}$	S^* (-)	
EC_w (mS/m)			
Te_w (°C)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$1.8 \cdot 10^{-4}$		
T_M (m^2/s)	$3.1 \cdot 10^{-4}$		
Flow regime:	**Radial composite**	Flow regime:	**WBS-IARF-tight faults**
dt_1 (min)		dt_1 (min)	5
dt_2 (min)		dt_2 (min)	18
T (m^2/s)		T (m^2/s)	$3.04 \cdot 10^{-4}$
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	$2.5 \cdot 10^{-6}$
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	-6.2
T_{GRF} (m^2/s)		T_{GRF} (m^2/s)	
S_{GRF} (-)		S_{GRF} (-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)	400	C (m^3/Pa)	
dt_2 (min)	1000	C_D (-)	
T_T (m^2/s)	$2.3 \cdot 10^{-4}$	ξ (-)	-6.2
S (-)			
K_s (m/s)			
S_s (1/m)			

Comments:

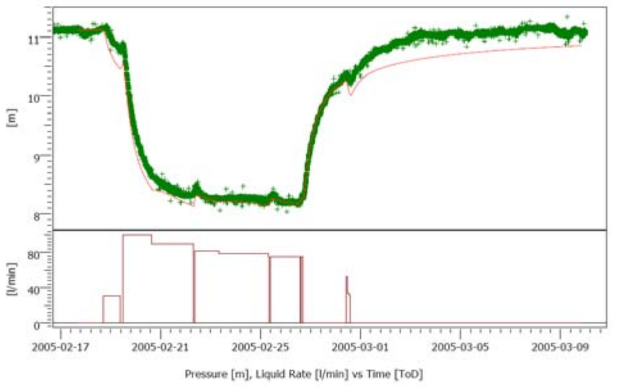
Transient parameter evaluation is only done for the recovery phase only due to initial disturbances at drawdown phase. The initial WBS of recovery period was followed by a radial flow regime from 5min to 18 min after pumpstop after. The radial flow period is followed by a period where flow is restricted by two intersecting impermeable boundaries with an angle of about 130 degrees. Other geometries were modelled ; radial composite and parallel faults, but the chosen geometry of intersecting "faults" provided the best match with measured data.

The parameter values estimated from the recovery period are selected as the most representative. Selected representative transmissivity value is $3.1 \cdot 10^{-4}$ m^2/s utilising a storativity of $8 \cdot 10^{-6}$ derived from the HLX20 observation borehole. A skin of -6 was obtained.

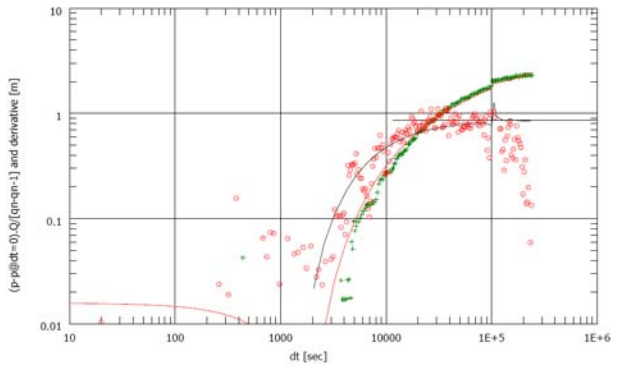
Test Summary Sheet – Observation borehole HLX20 (pumping borehole KLX06)

Project:	PLU	Test type:	2
Area:	Oskarshamn	Test no:	1
Borehole ID:	HLX20	Test start:	2005-02-18 16:52:00
Test section (m):	9.0-202.2	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.138	Responsible for test evaluation:	SKB Mansueto Morosini

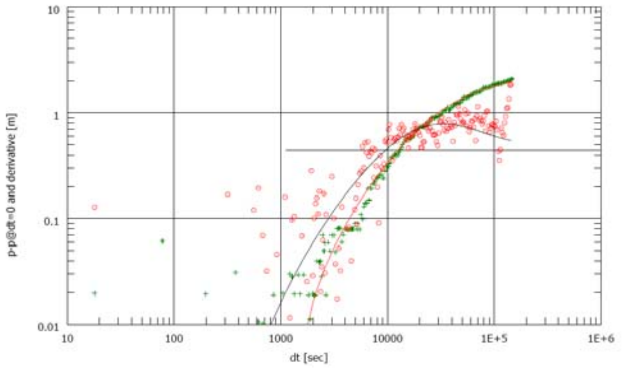
Linear plot of pressure



Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Flow period		Recovery period	
Indata		**Indata**	
h_0 (masl)			
h_i (masl)	10.89		
h_p (masl)	8.25	h_F (masl)	11.05
Q_p (m^3/s)			
t_p (min)	6839	t_F (min)	
S^* (-)		S^* (-)	
EC_w (mS/m)			
Te_w (^oC)			
Derivative fact.	0.1	Derivative fact.	0.1
r (m)	246.5	r (m)	246.5
Results		**Results**	
Q/s (m^2/s)			
T_M (m^2/s)			
Flow regime:	IARF	Flow regime:	IARF
dt_1 (min)		dt_1 (min)	
dt_2 (min)		dt_2 (min)	
T (m^2/s)	$1.2 \cdot 10^{-4}$	T (m^2/s)	$2.2 \cdot 10^{-4}$
S (-)	$4.7 \cdot 10^{-5}$	S (-)	$8.0 \cdot 10^{-6}$
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)		C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)		ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Selected representative parameters.

dt_1 (min)		C (m^3/Pa)	
dt_2 (min)		C_D (-)	
T_T (m^2/s)	$2.2 \cdot 10^{-4}$	ξ (-)	0
S (-)	$8.0 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

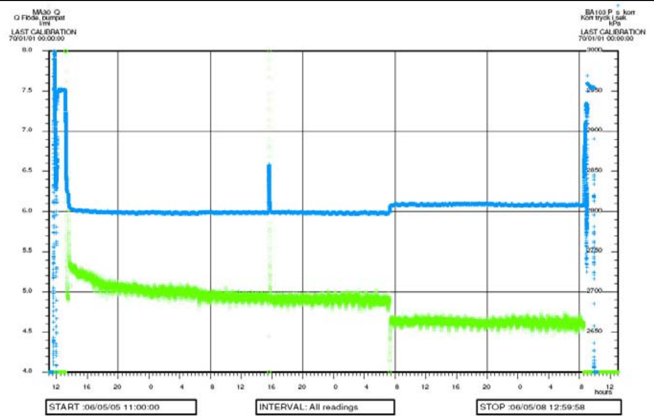
Comments:

Both drawdown and recovery phase were evaluated where both were best fitted to a homogeneous infinite acting aquifer with radial flow. Similar T-values were obtained of $1 \cdot 10^{-4}$ m^2/s for the drawdown and $2 \cdot 10^{-4}$ m^2/s for the recovery. The parameter values estimated from the recovery period are selected as the most representative since they provide slightly better match to the measured data when simulating the complete test history.

Test Summary Sheet – Pumping borehole KLX18A

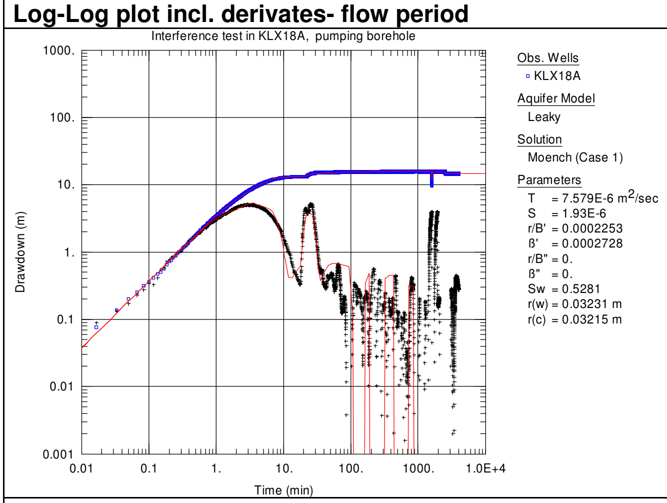
Project:	PLU	Test type:	1B
Area:	Oskarshamn	Test no:	1
Borehole ID:	KLX18A	Test start:	2006-05-05 13:09:58
Test section (m):	312.00-611.28	Responsible for test execution:	SKB field crew
Section diameter, $2 \cdot r_w$ (m):	0.076	Responsible for test evaluation:	GEOSIGMA AB Jan-Erik Ludvigson

Linear plot Q and p

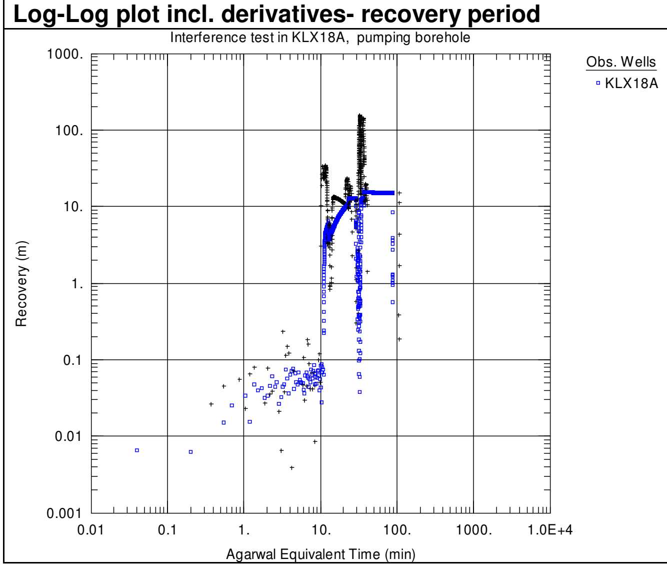


Flow period		Recovery period	
Indata		**Indata**	
p_0 (kPa)			
p_i (kPa)	2951.8		
p_p(kPa)	2808.4	p_F (kPa)	
Q_p (m^3/s)	$7.70 \cdot 10^{-5}$		
t_p (min)	4044.63	t_F (min)	
S^* (-)	$1.9 \cdot 10^{-6}$	S^* (-)	$3.3 \cdot 10^{-6}$
EC_w (mS/m)			
Te_w(°C)			
Derivative fact.	0.2	Derivative fact.	0.1
r (m)		r (m)	
Results		**Results**	
Q/s (m^2/s)	$5.3 \cdot 10^{-6}$		
T_M (m^2/s)	$7.8 \cdot 10^{-6}$		
Flow regime:	WBS->PRF->PSF	Flow regime:	
dt_1 (min)	100	dt_1 (min)	
dt_2 (min)	300	dt_2 (min)	
T (m^2/s)	$7.6 \cdot 10^{-6}$	T (m^2/s)	
S (-)		S (-)	
K_s (m/s)		K_s (m/s)	
S_s (1/m)		S_s (1/m)	
C (m^3/Pa)	$3.3 \cdot 10^{-7}$	C (m^3/Pa)	
C_D (-)		C_D (-)	
ξ (-)	0.5	ξ (-)	
T_{GRF}(m^2/s)		T_{GRF}(m^2/s)	
S_{GRF}(-)		S_{GRF}(-)	
D_{GRF} (-)		D_{GRF} (-)	

Log-Log plot incl. derivates- flow period



Log-Log plot incl. derivatives- recovery period



Selected representative parameters.

dt_1 (min)	100	C (m^3/Pa)	$3.3 \cdot 10^{-7}$
dt_2 (min)	300	C_D (-)	
T_T (m^2/s)	$7.6 \cdot 10^{-6}$	ξ (-)	0.5
S* (-)	$1.9 \cdot 10^{-6}$		
K_s (m/s)			
S_s (1/m)			

Comments:

During the flow period initial wellbore storage effects are followed by a short period of pseudo-radial flow transitioning to pseudo-spherical flow by the end. No representative response was obtained during the recovery period. Transient evaluation from the flow period was based on variable flow rate. No transient evaluation could be made from the recovery period.

The parameter values from the flow period are selected as the most representative for the test.

Appendix 2

Test diagrams

Nomenclature for AQTESOLV:

T = transmissivity (m^2/s)
S = storativity (-)
K_Z/K_r = ratio of hydraulic conductivities in the vertical and radial direction (set to 1)
Sw = skin factor
r(w) = borehole radius (m)
r(c) = effective casing radius (m)
r/B = leakage coefficient (s^{-1})
b = thickness of formation (m)

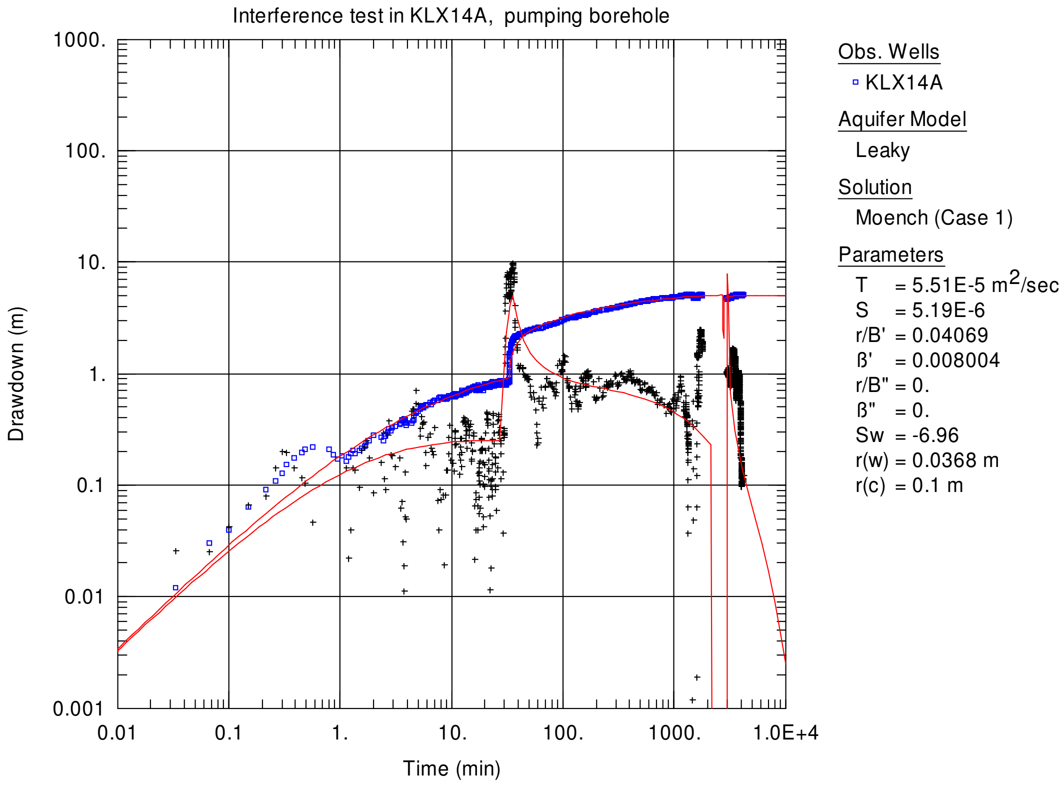


***Figure 1-1.** Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX14A.*

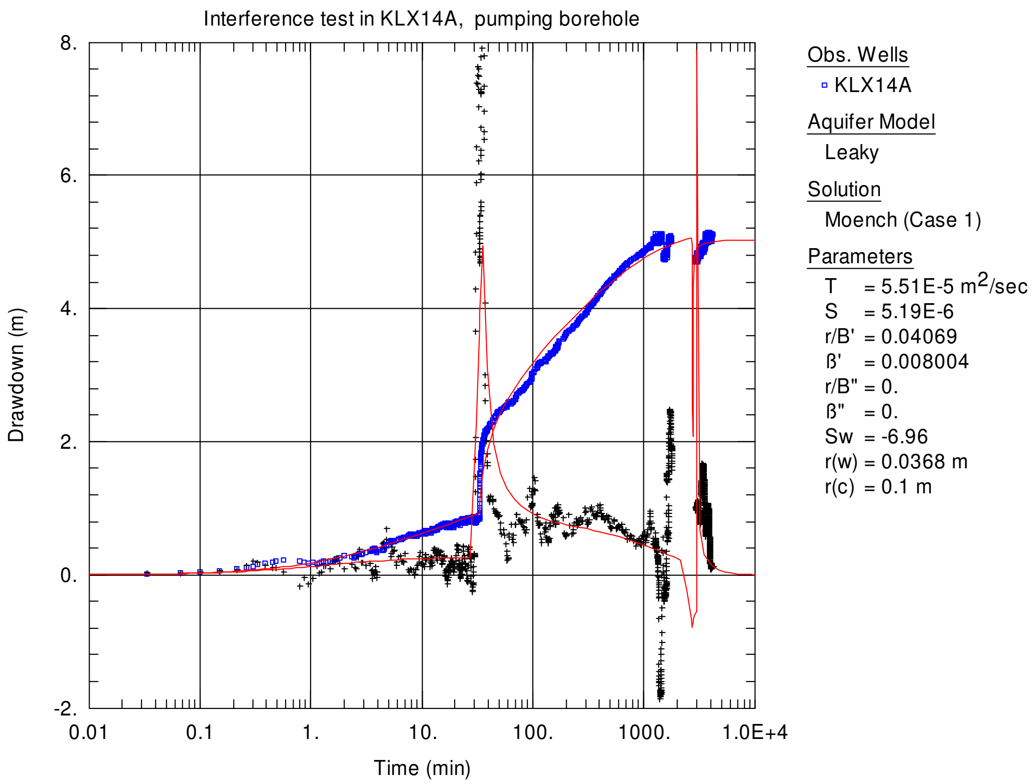


***Figure 1-2.** Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX14A.*

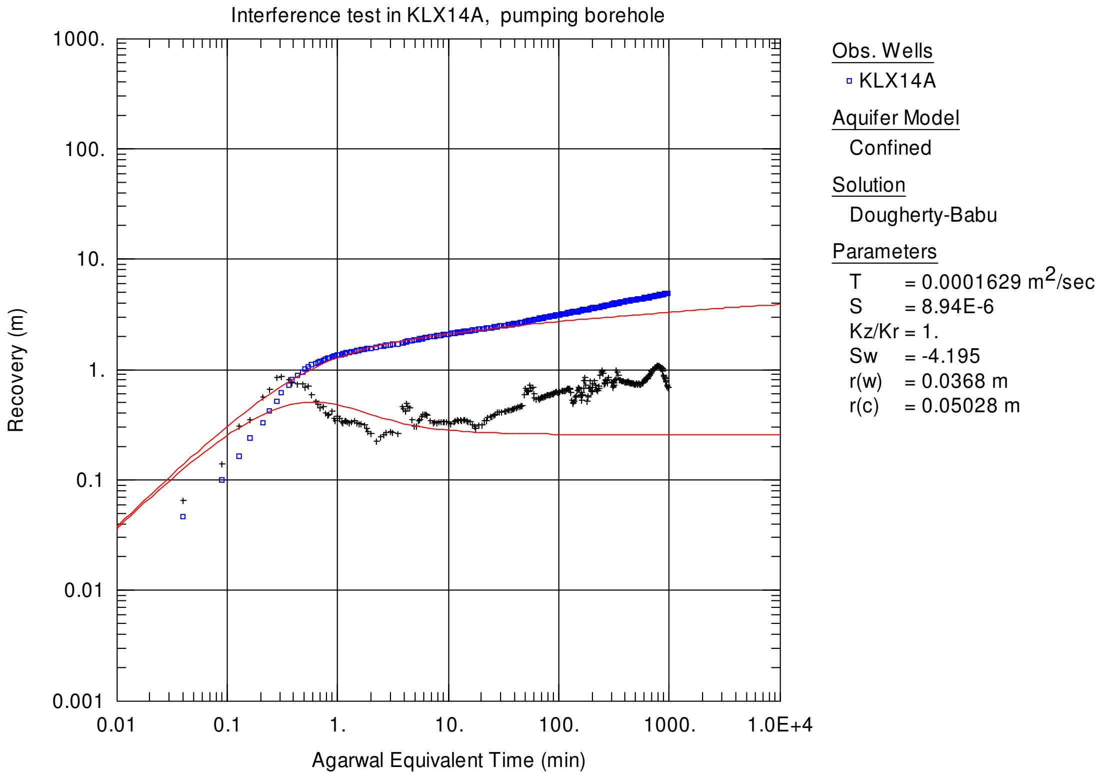


Figure 1-3. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX14A. The evaluation is based on the early-time recovery response.*

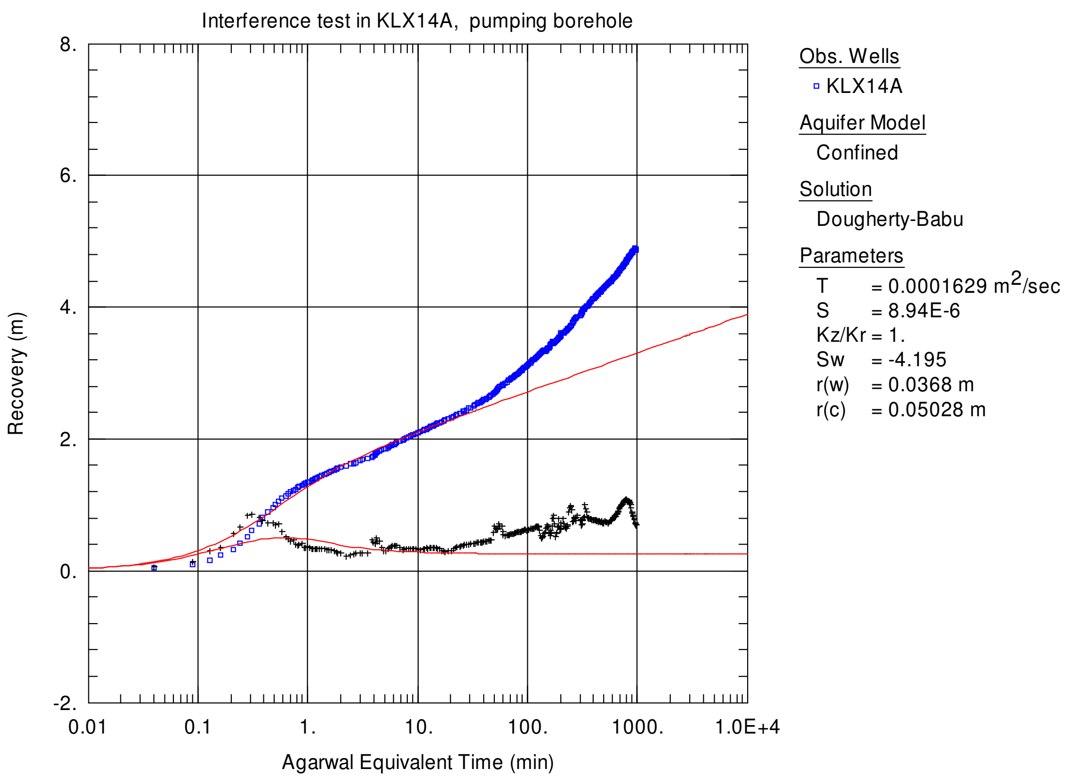


Figure 1-4. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX14A. The evaluation is based on the early-time recovery response.*

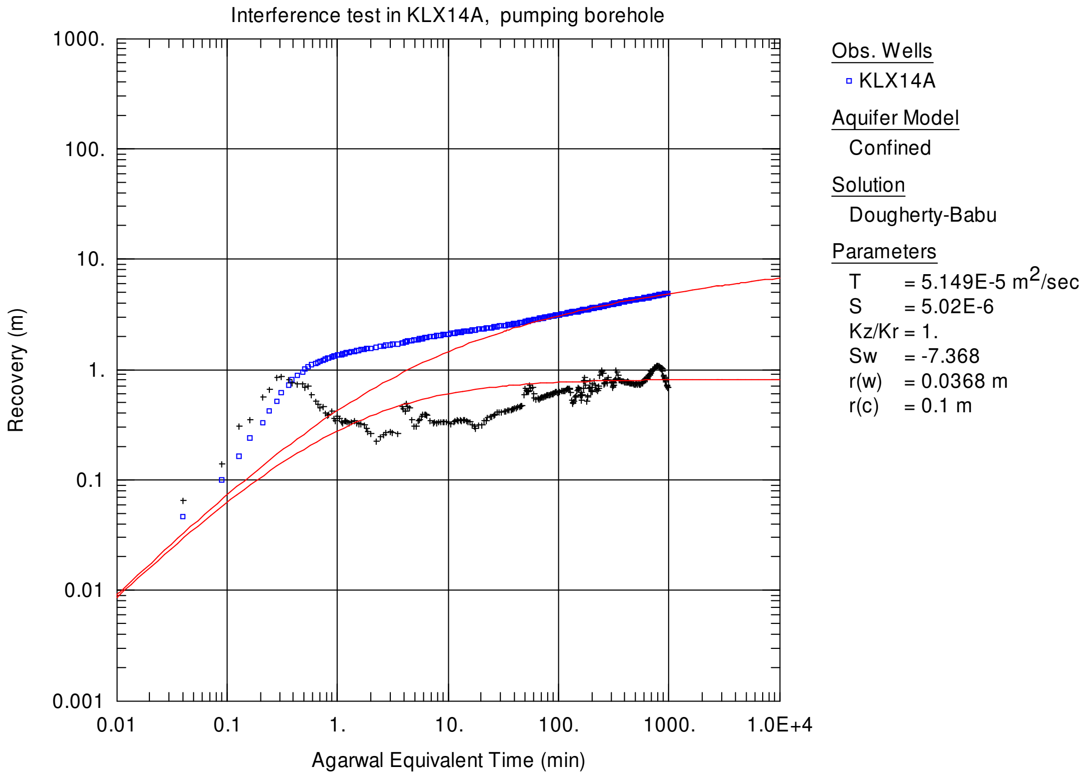


Figure 1-5. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX14A. The evaluation is based on the late-time recovery response.*

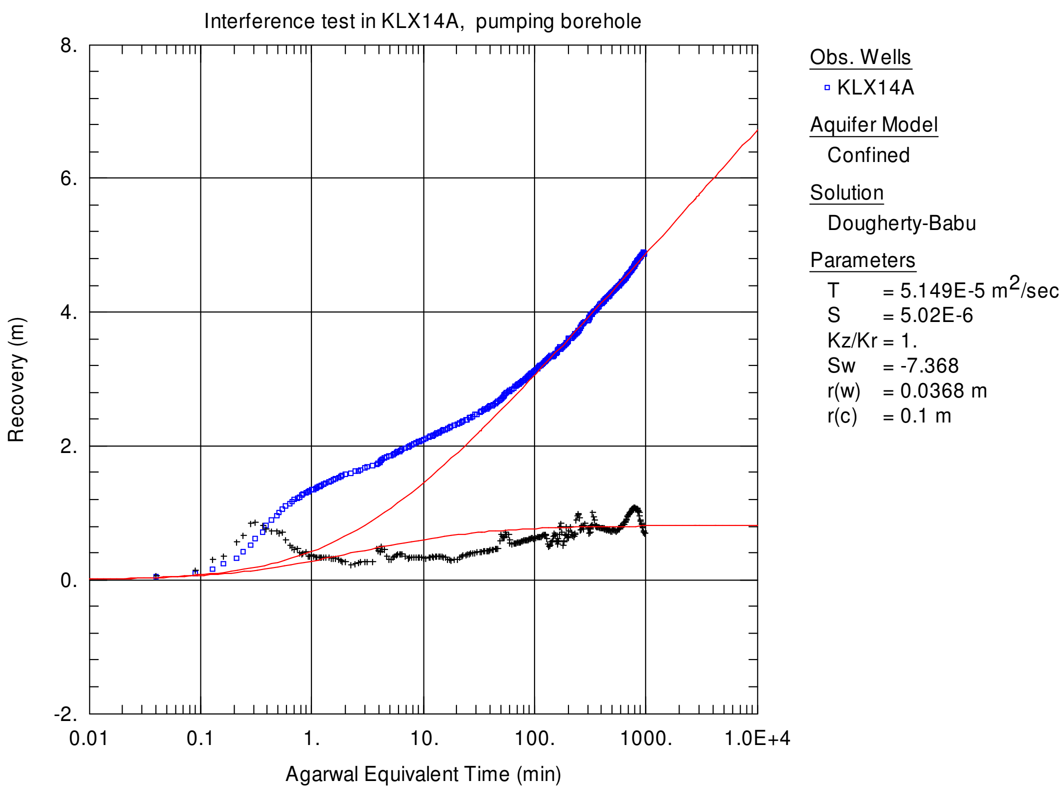


Figure 1-6. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX14A. The evaluation is based on the late-time recovery response.*

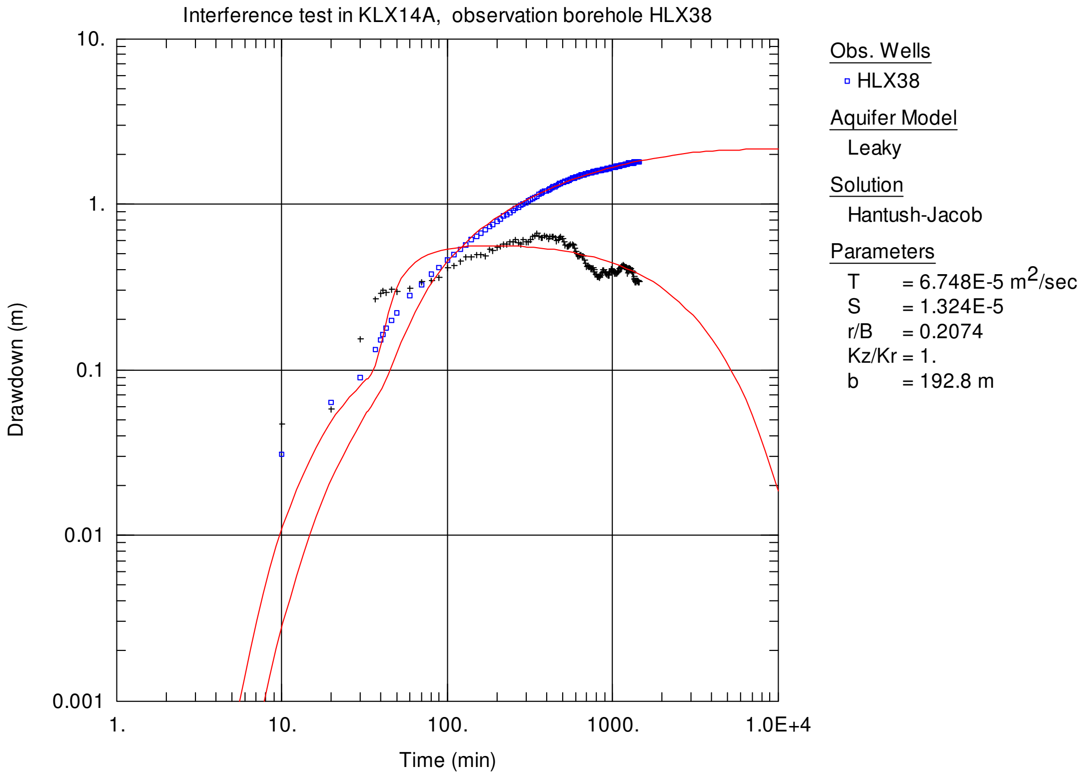


Figure 1-7. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX38 during pumping in borehole KLX14A.*

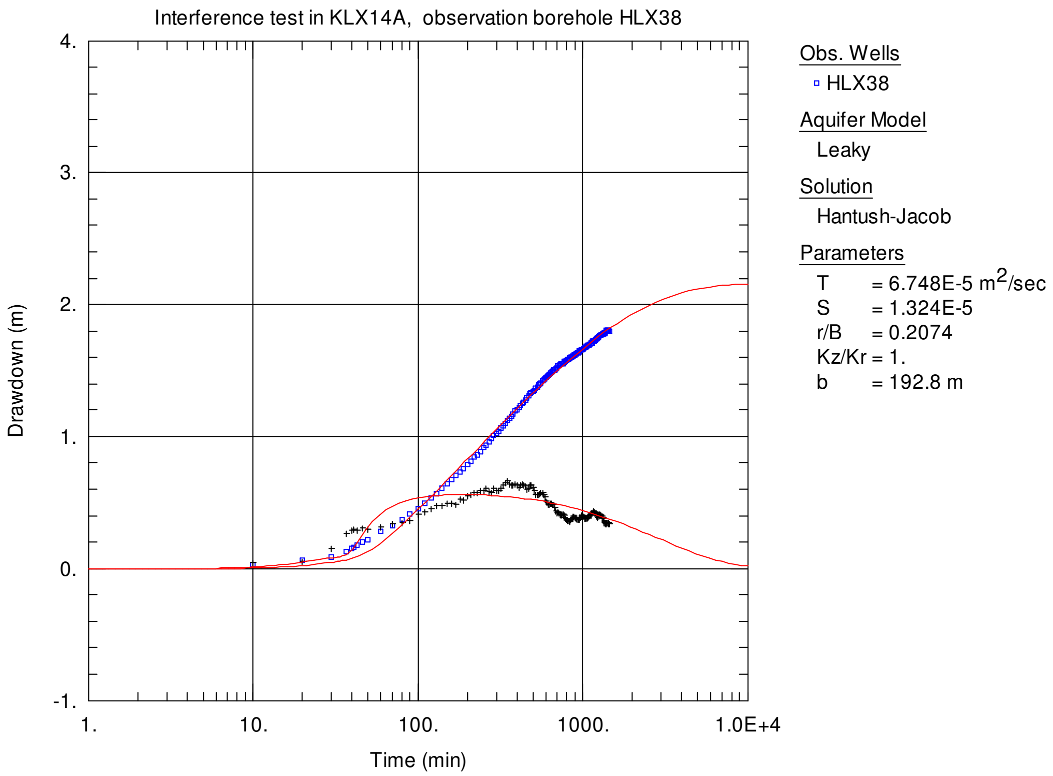


Figure 1-8. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX38 during pumping in borehole KLX14A.*

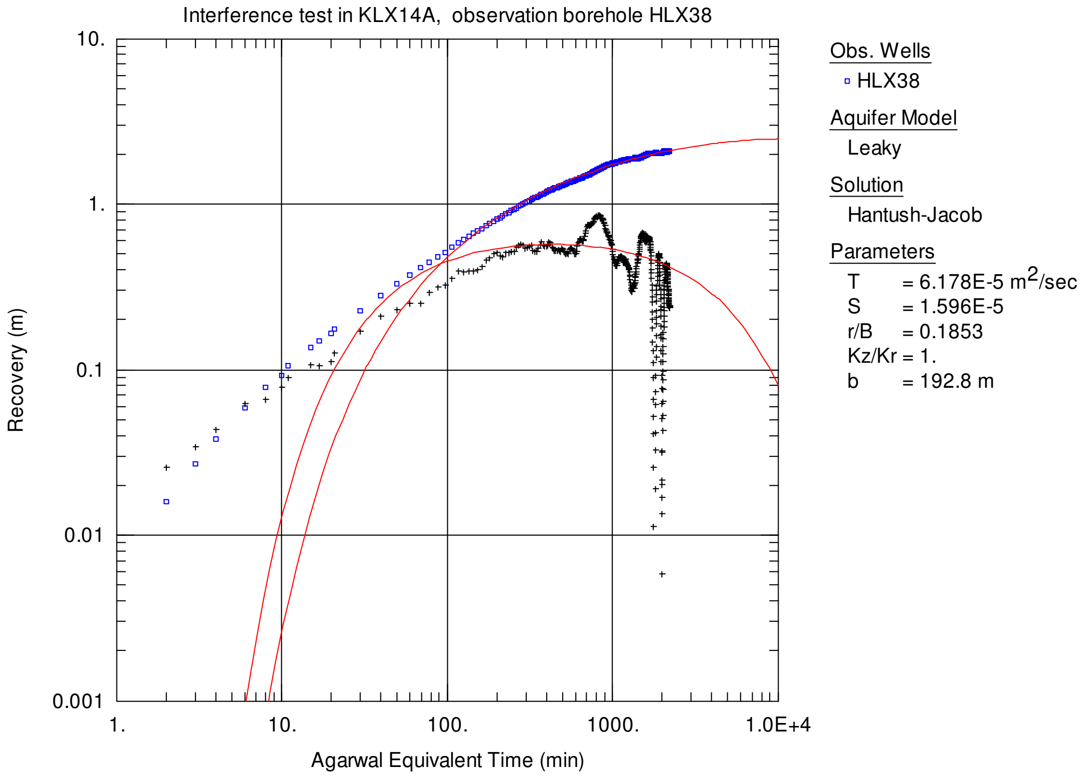


Figure 1-9. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX38 during pumping in borehole KLX14A.*

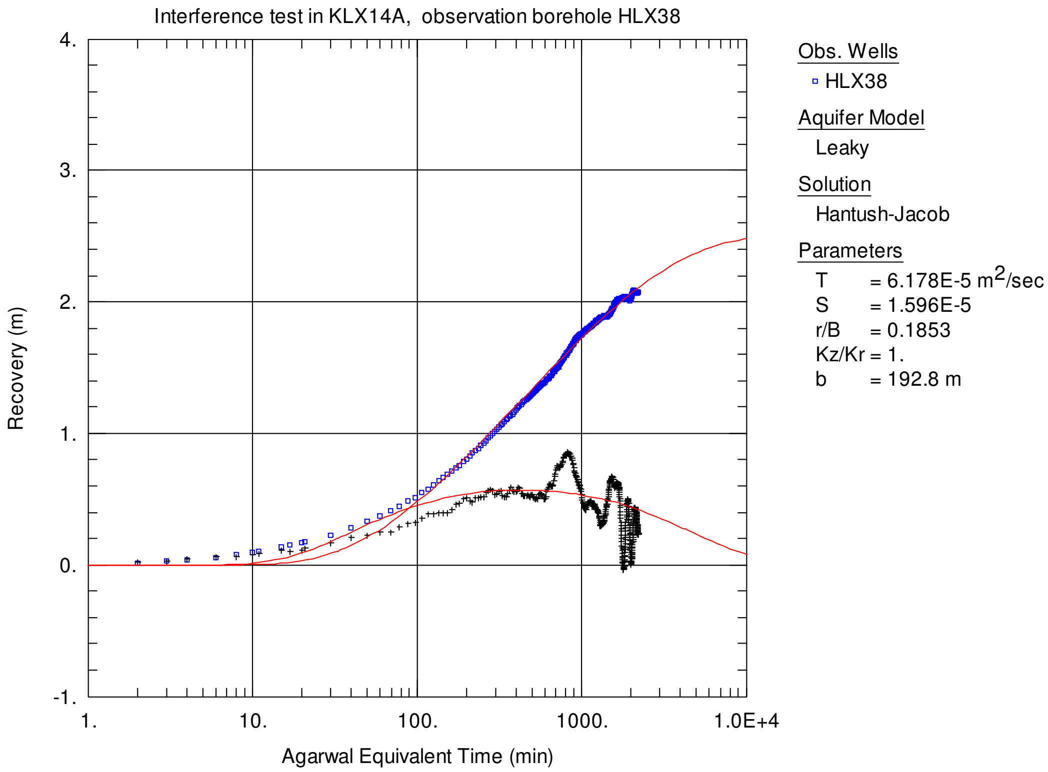


Figure 1-10. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX38 during pumping in borehole KLX14A.*

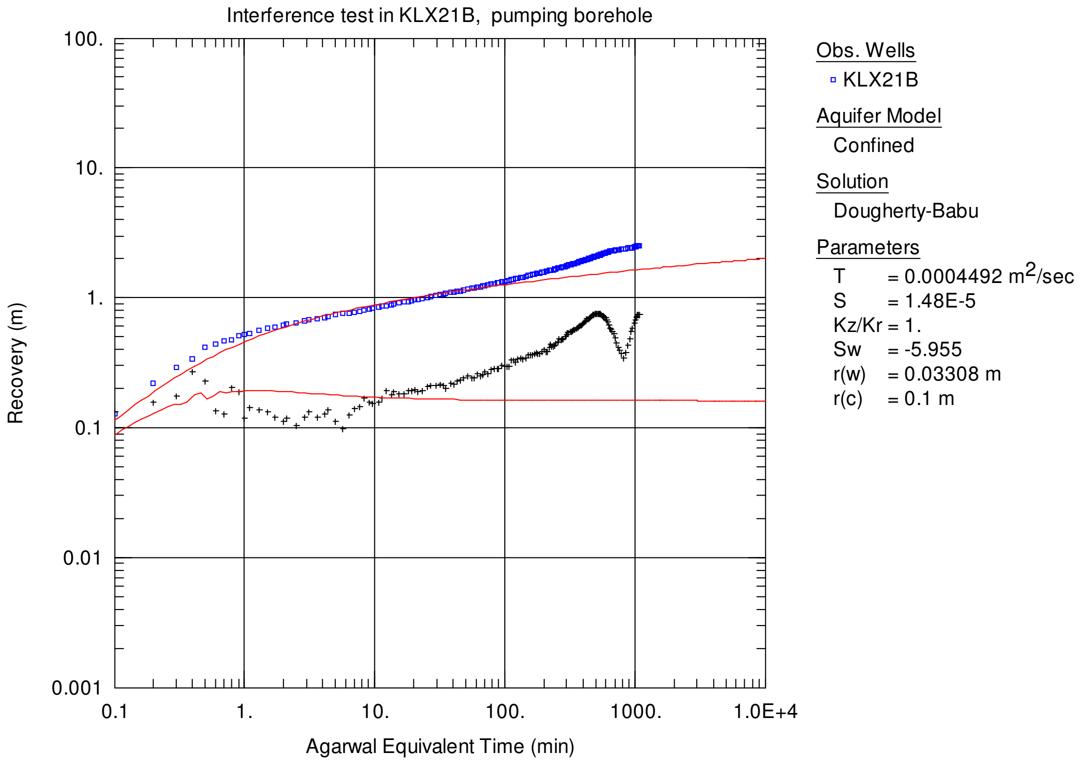


Figure 1-11. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX21B.*

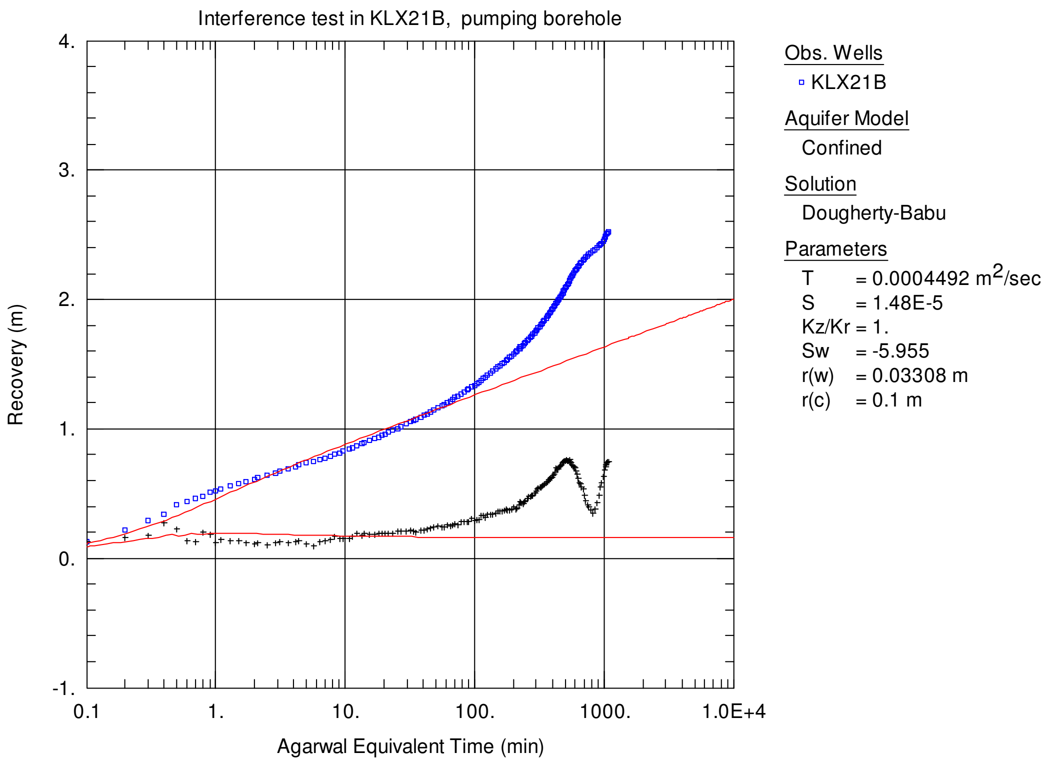


Figure 1-12. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX21B.*

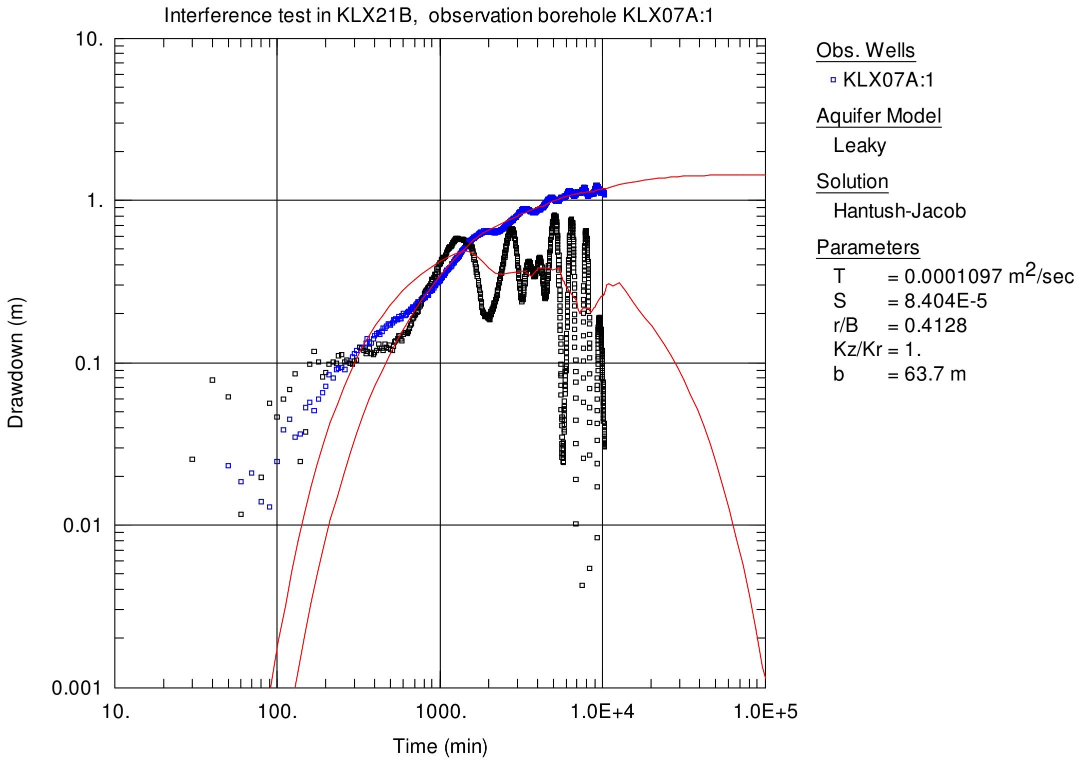


Figure 1-13. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:1 during pumping in borehole KLX21B.*

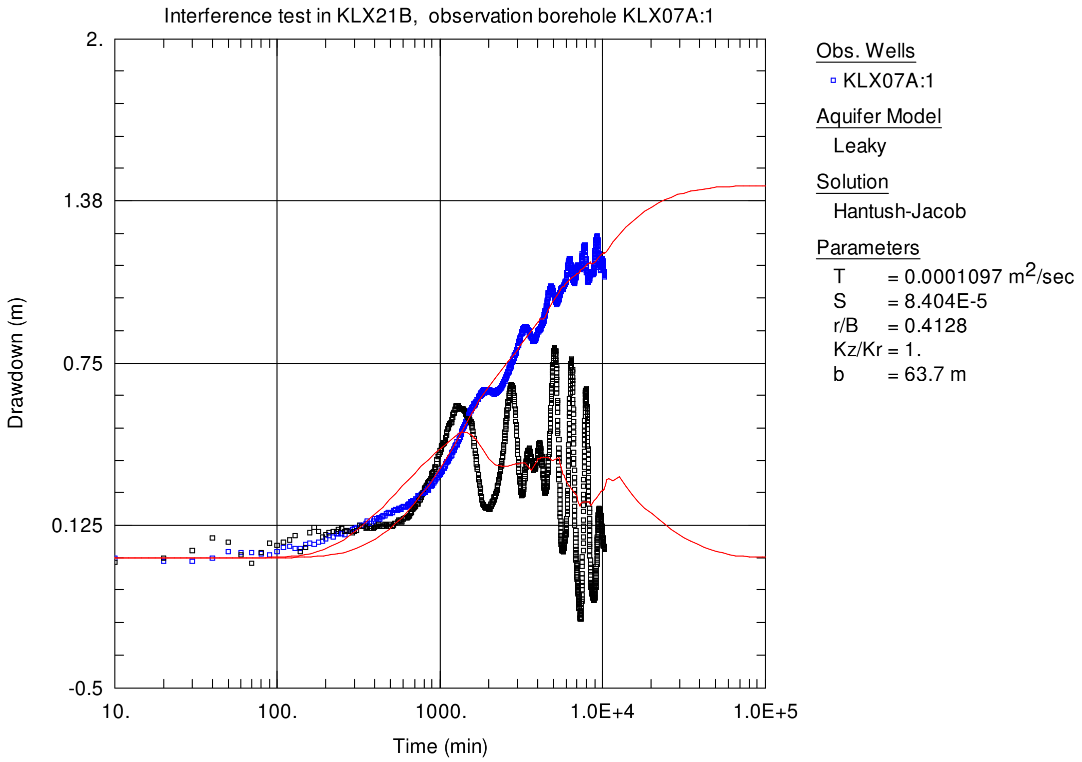


Figure 1-14. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:1 during pumping in borehole KLX21B.*

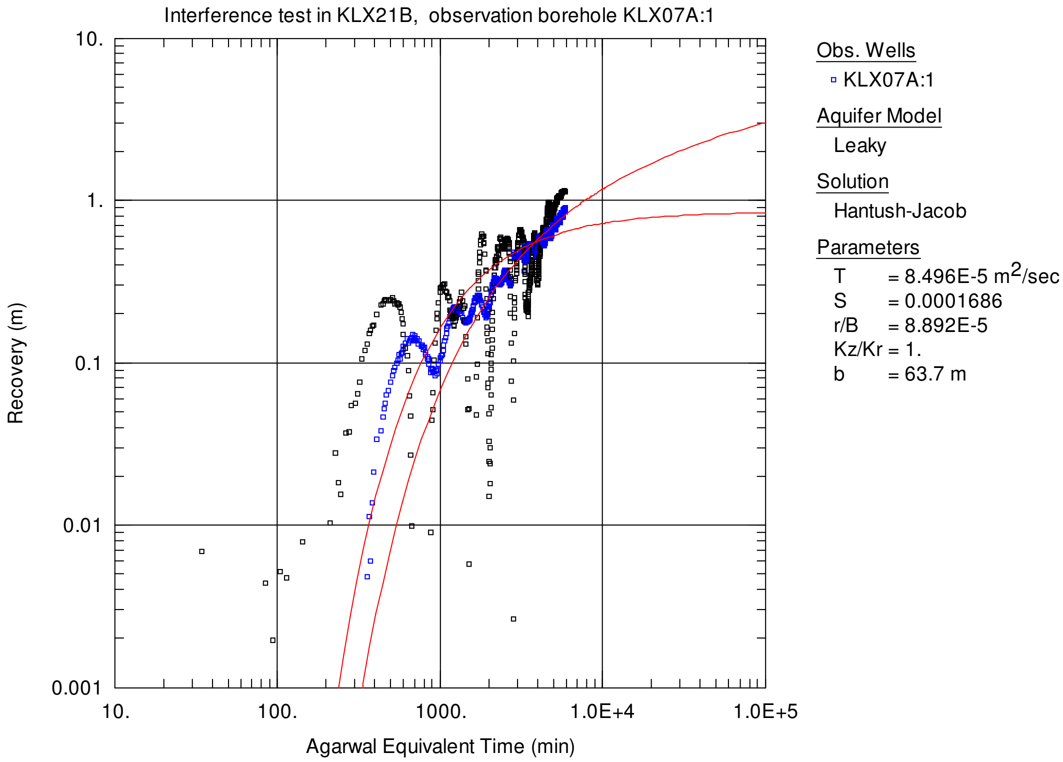


Figure 1-15. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:1 during pumping in borehole KLX21B.*

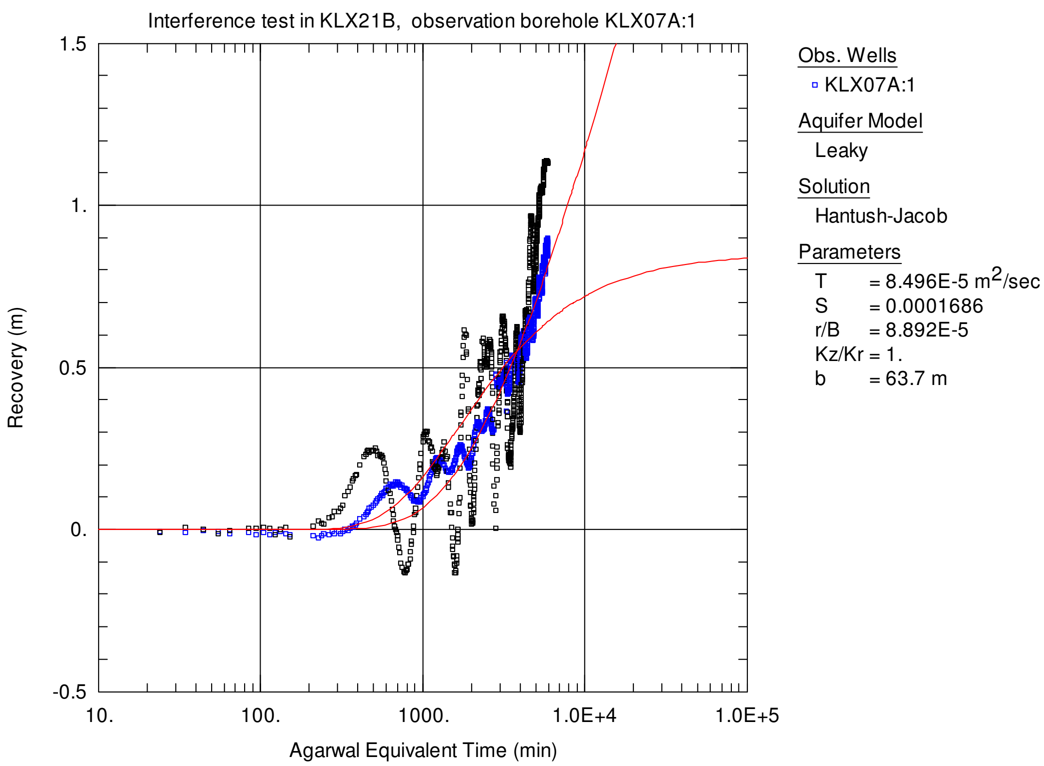


Figure 1-16. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:1 during pumping in borehole KLX21B.*

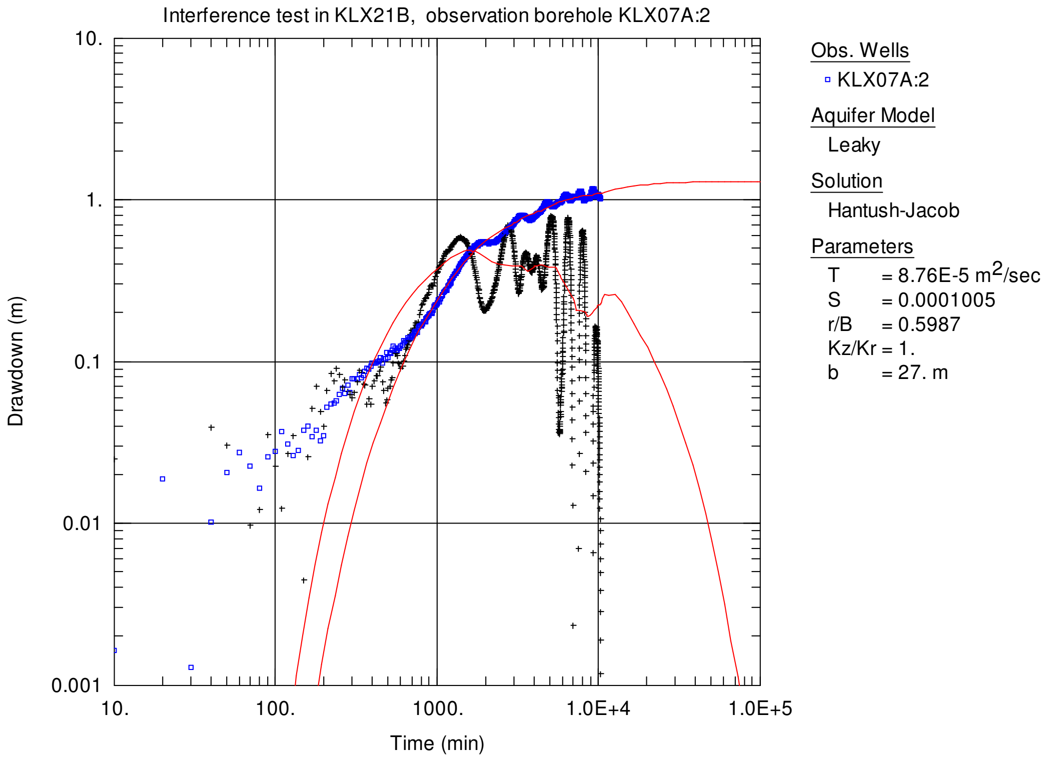


***Figure 1-17.** Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:2 during pumping in borehole KLX21B.*

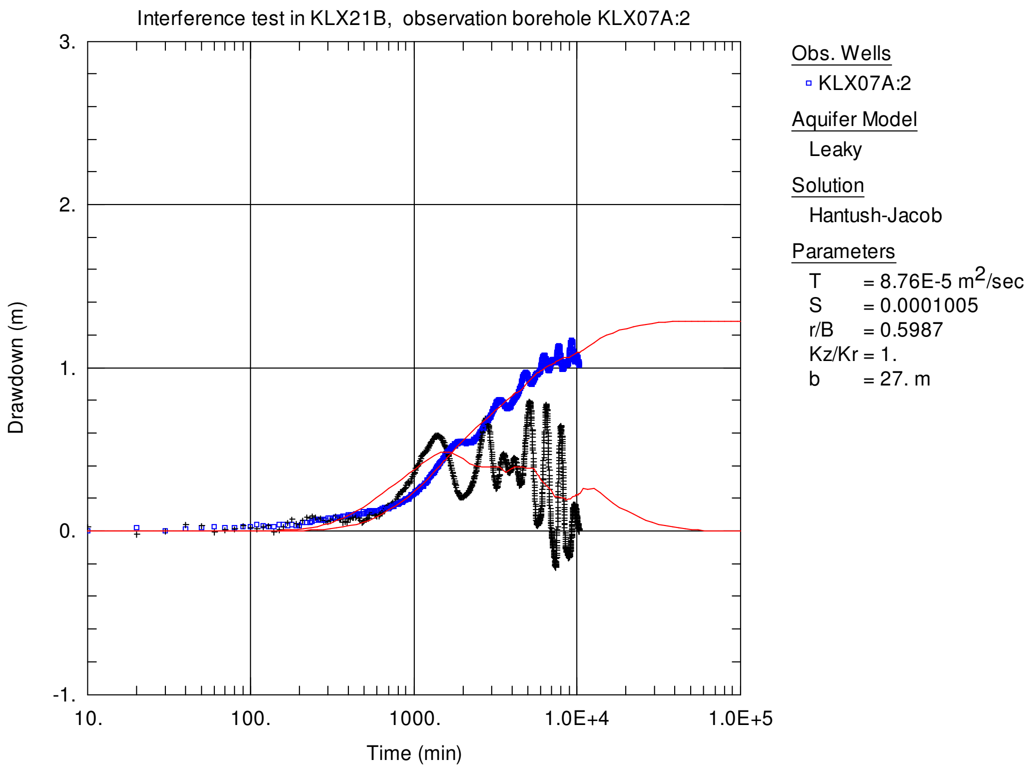


***Figure 1-18.** Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:2 during pumping in borehole KLX21B.*

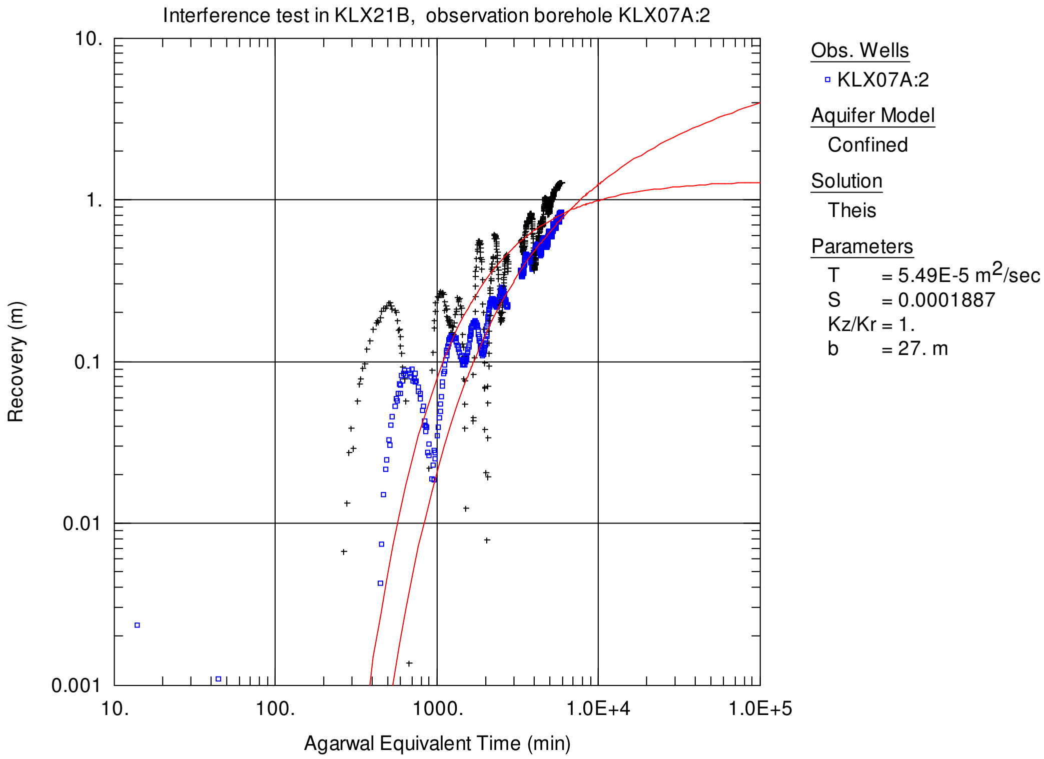


Figure 1-19. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:2 during pumping in borehole KLX21B.*

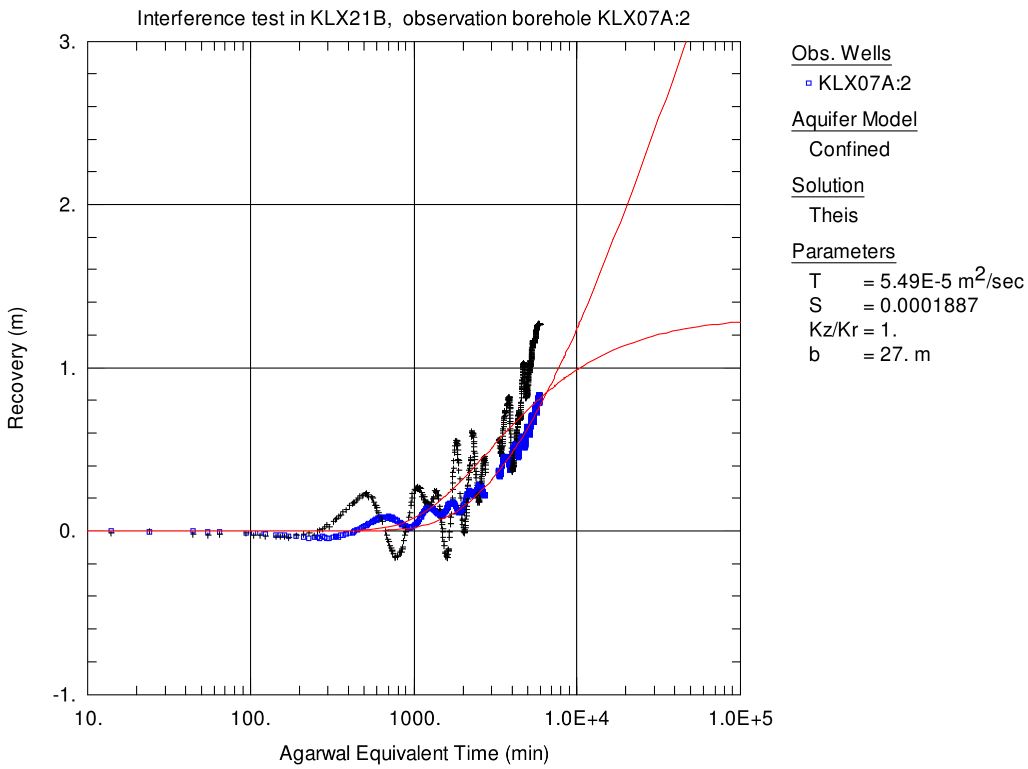


Figure 1-20. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:2 during pumping in borehole KLX21B.*

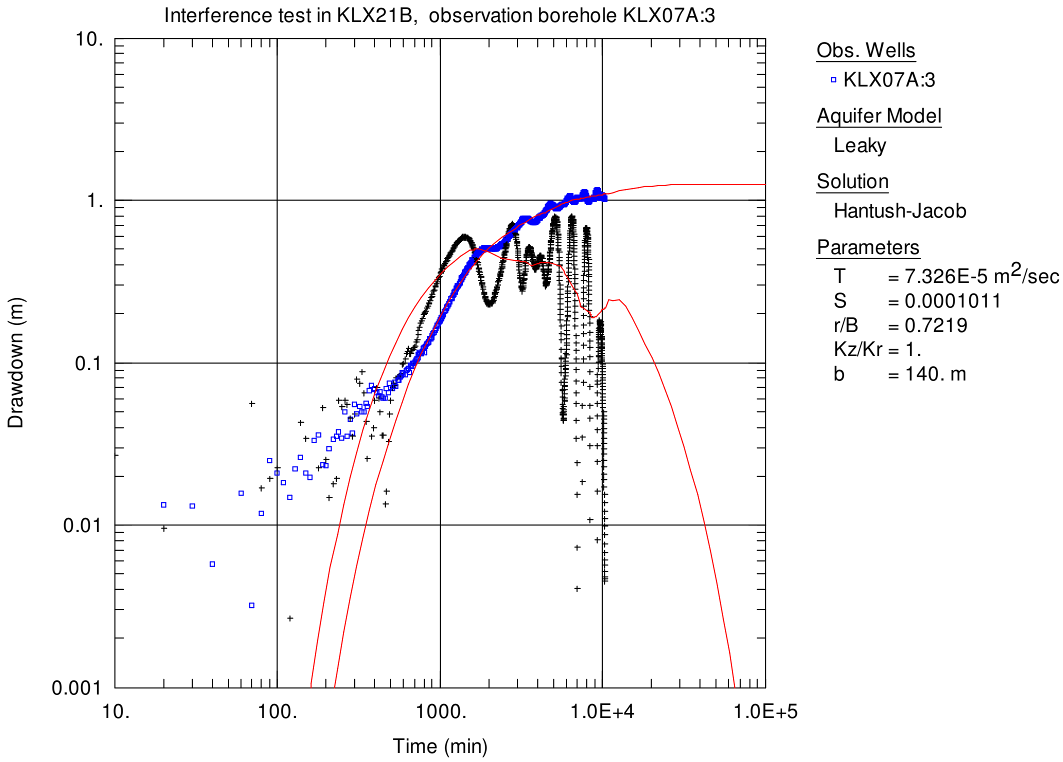


***Figure 1-21.** Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:3 during pumping in borehole KLX21B.*

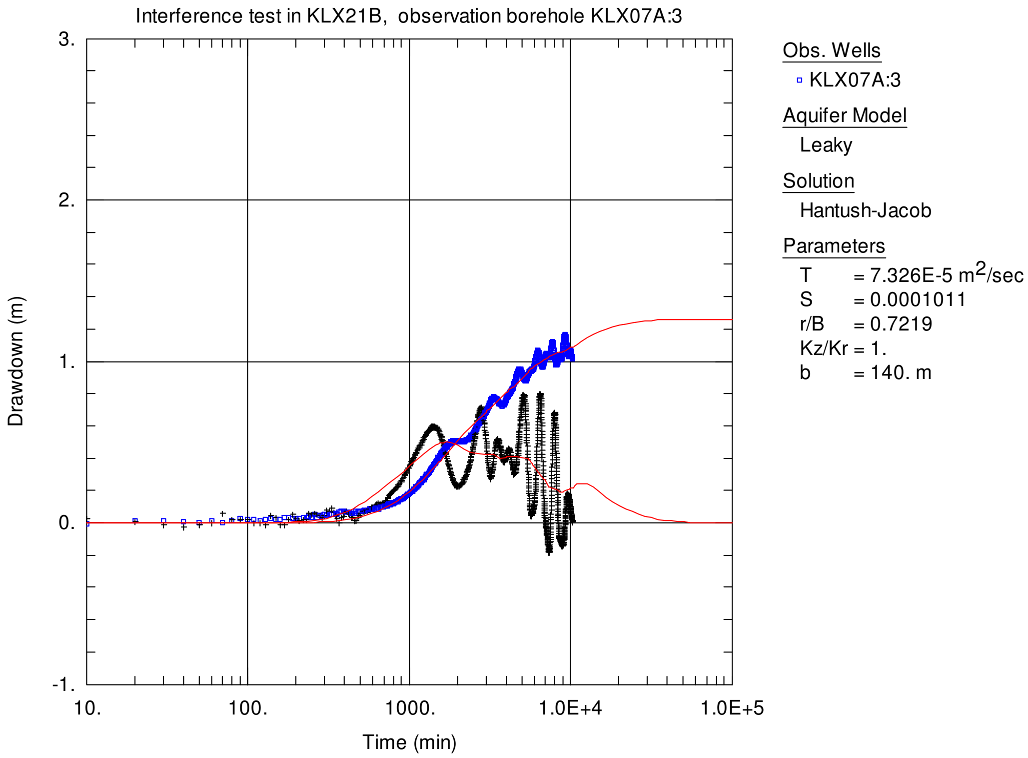


***Figure 1-22.** Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:3 during pumping in borehole KLX21B.*

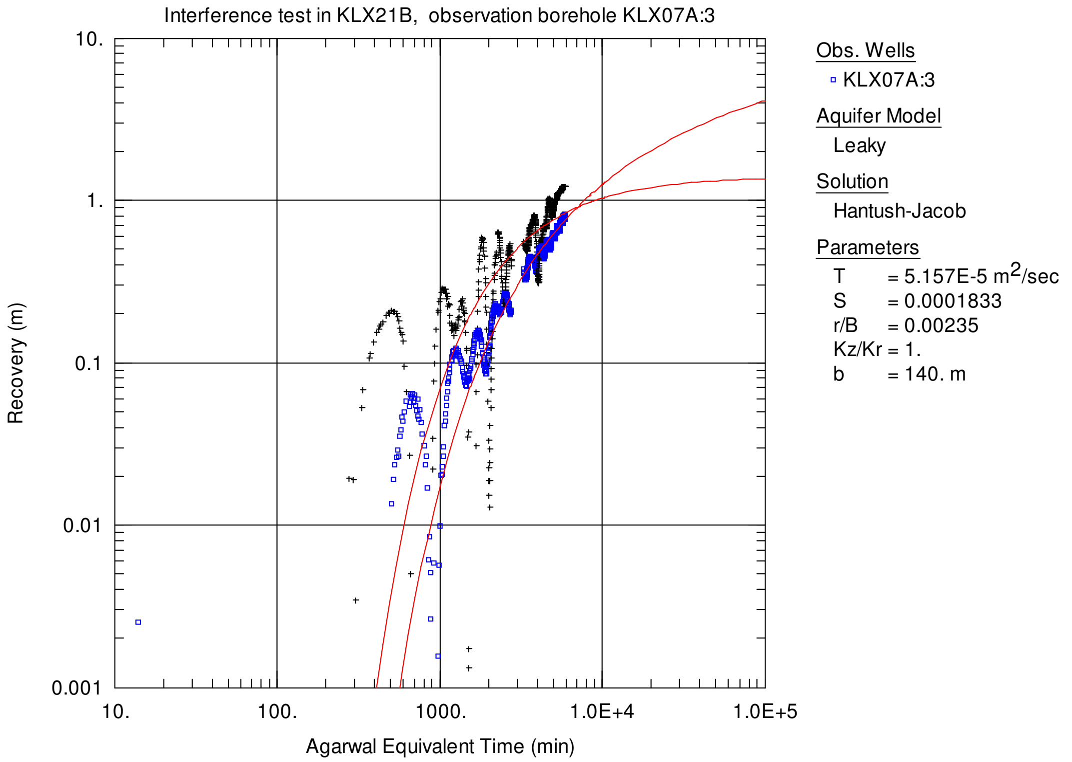


Figure 1-23. Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:3 during pumping in borehole KLX21B.

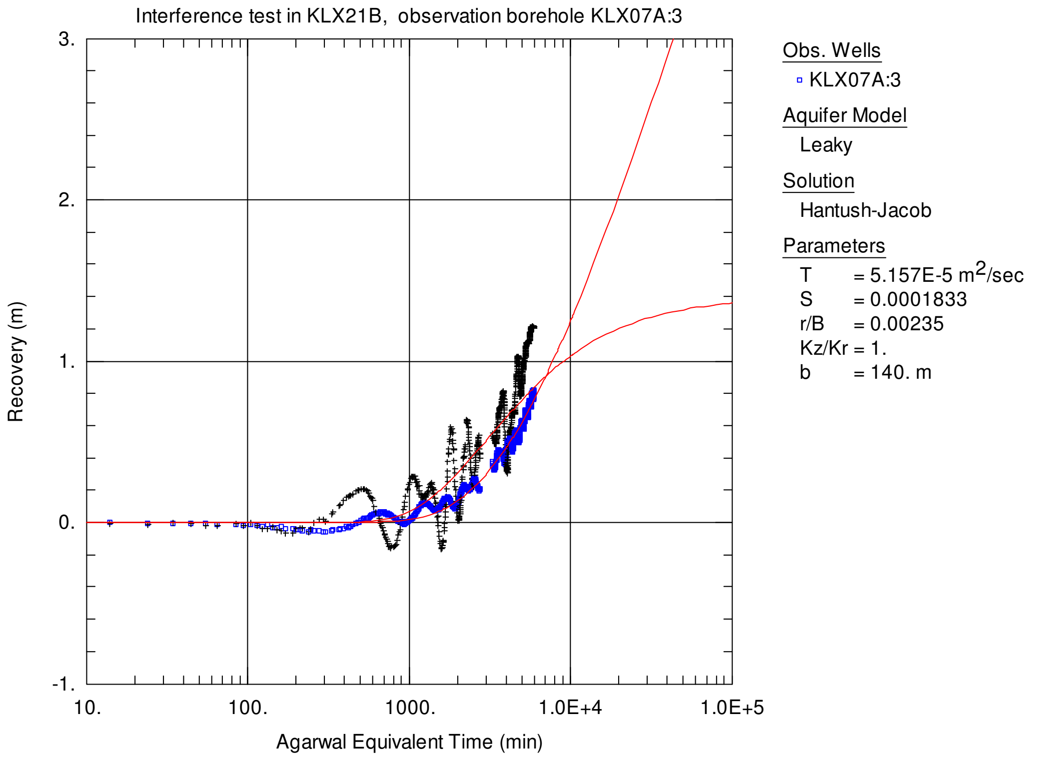


Figure 1-24. Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:3 during pumping in borehole KLX21B.

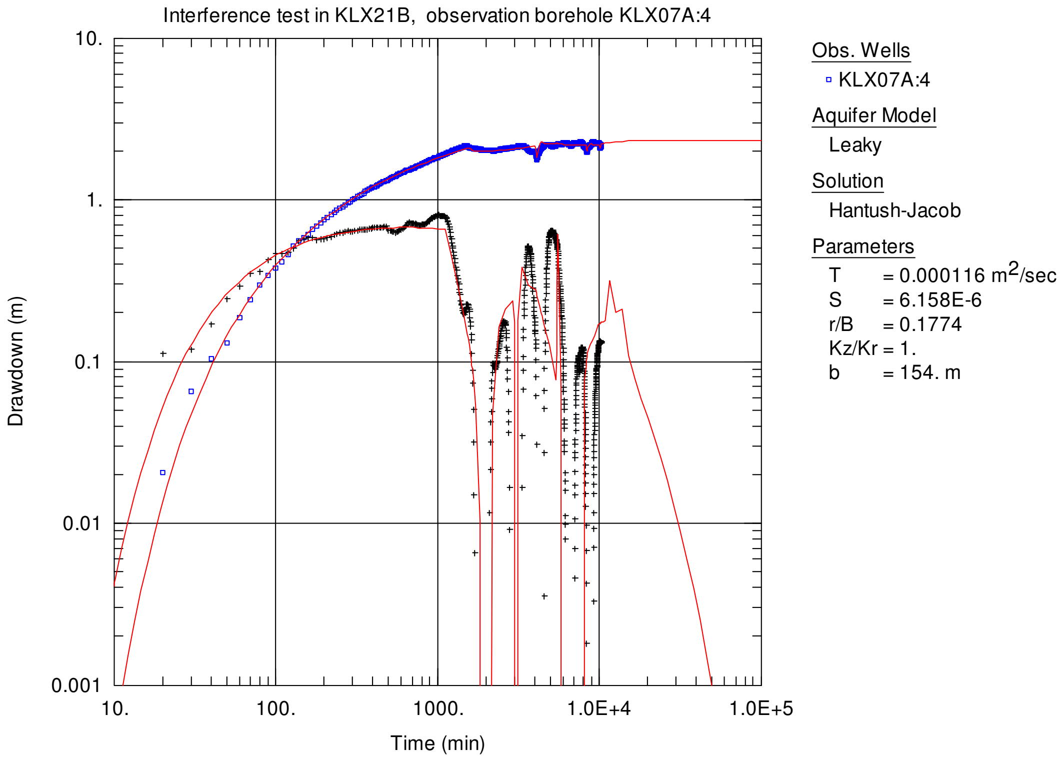


Figure 1-25. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:4 during pumping in borehole KLX21B.*

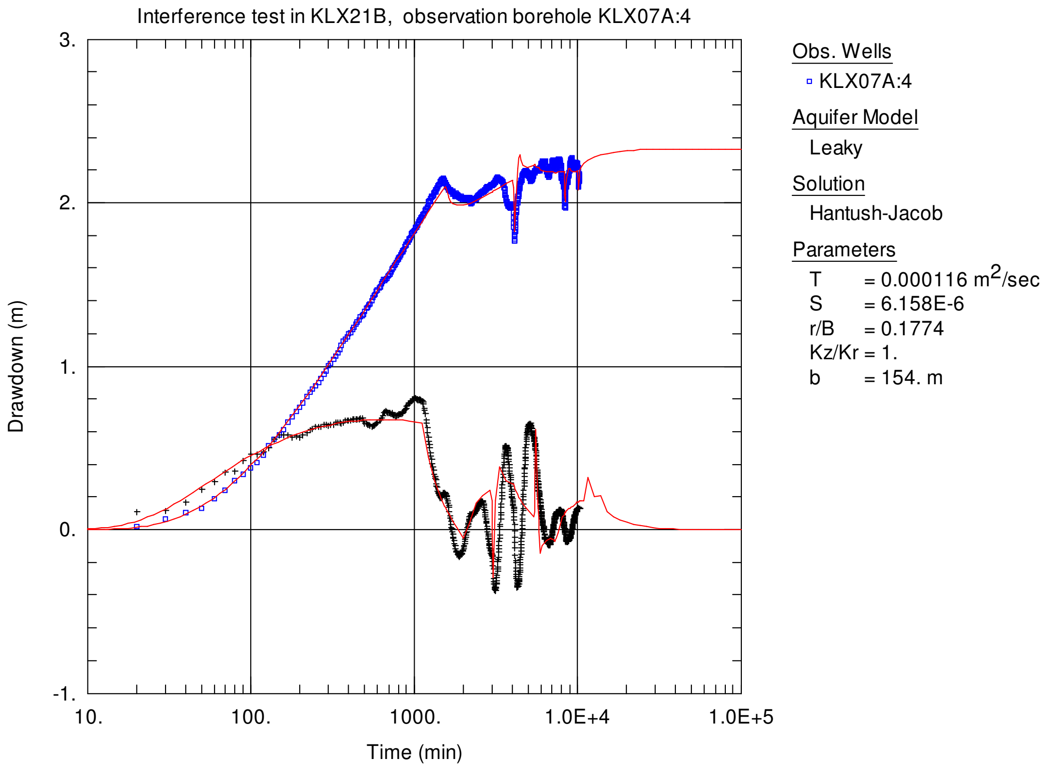


Figure 1-26. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:4 during pumping in borehole KLX21B.*

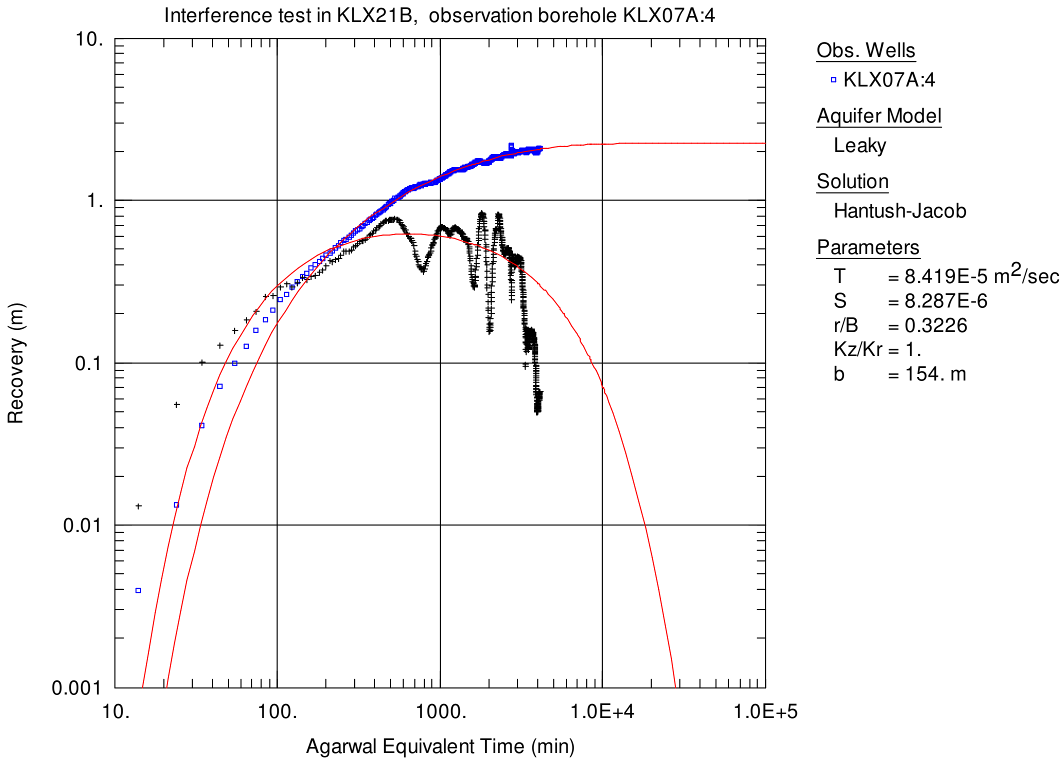


Figure 1-27. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:4 during pumping in borehole KLX21B.*

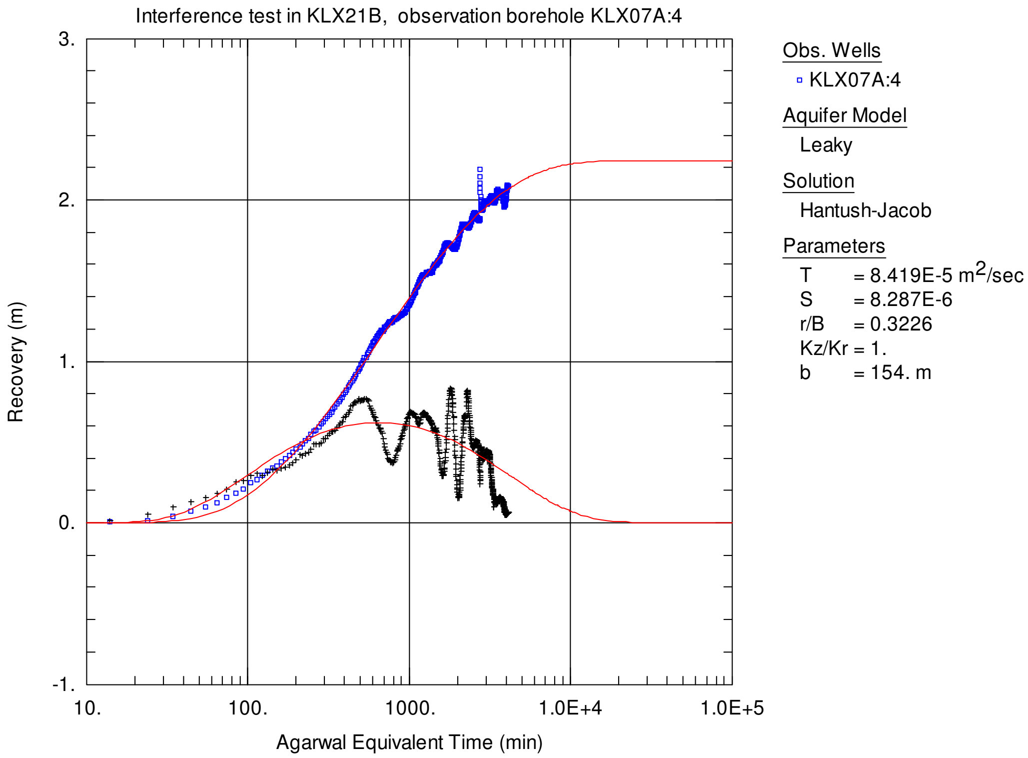


Figure 1-28. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:4 during pumping in borehole KLX21B.*

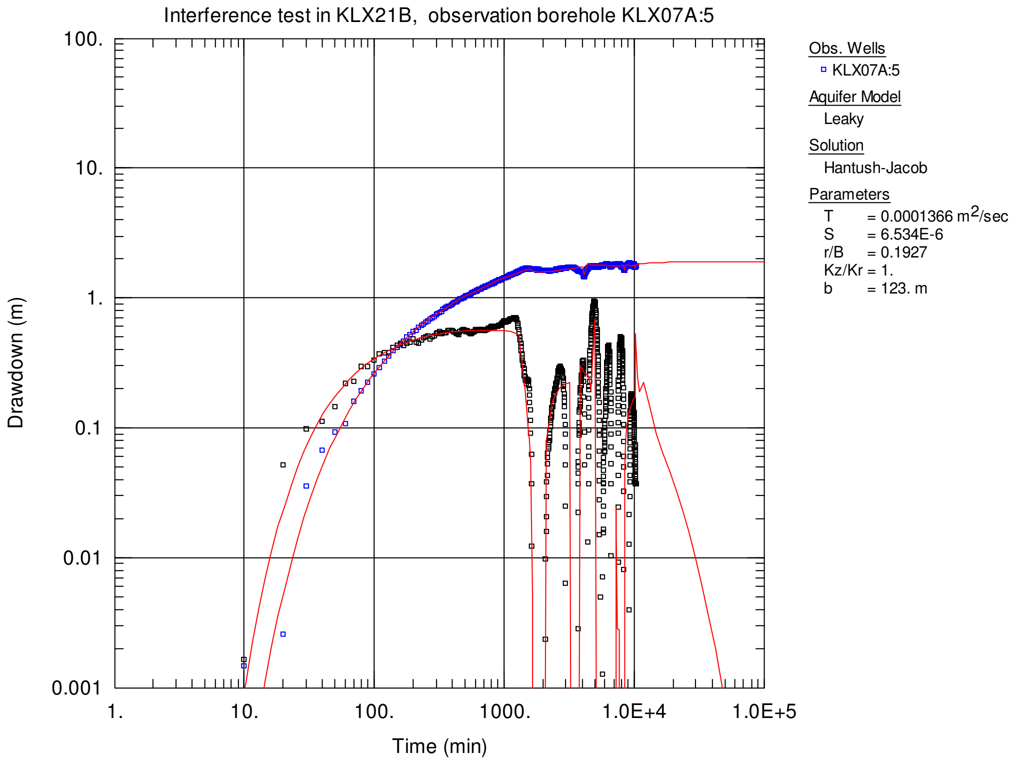


Figure 1-29. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:5 during pumping in borehole KLX21B.*

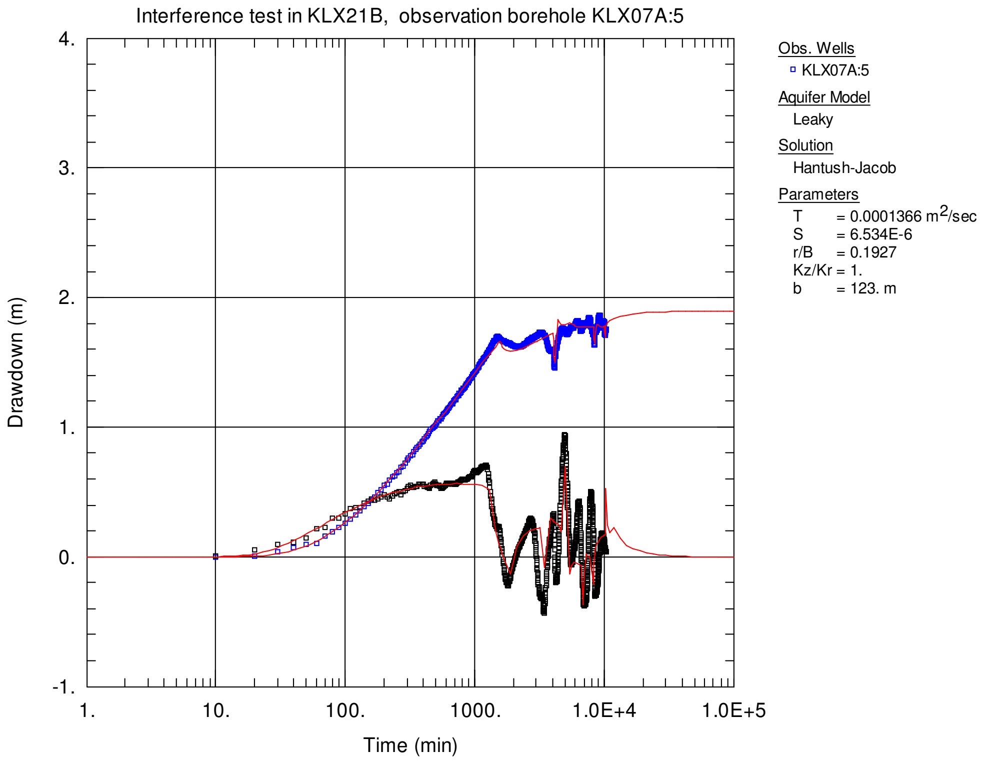


Figure 1-30. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:5 during pumping in borehole KLX21B.*

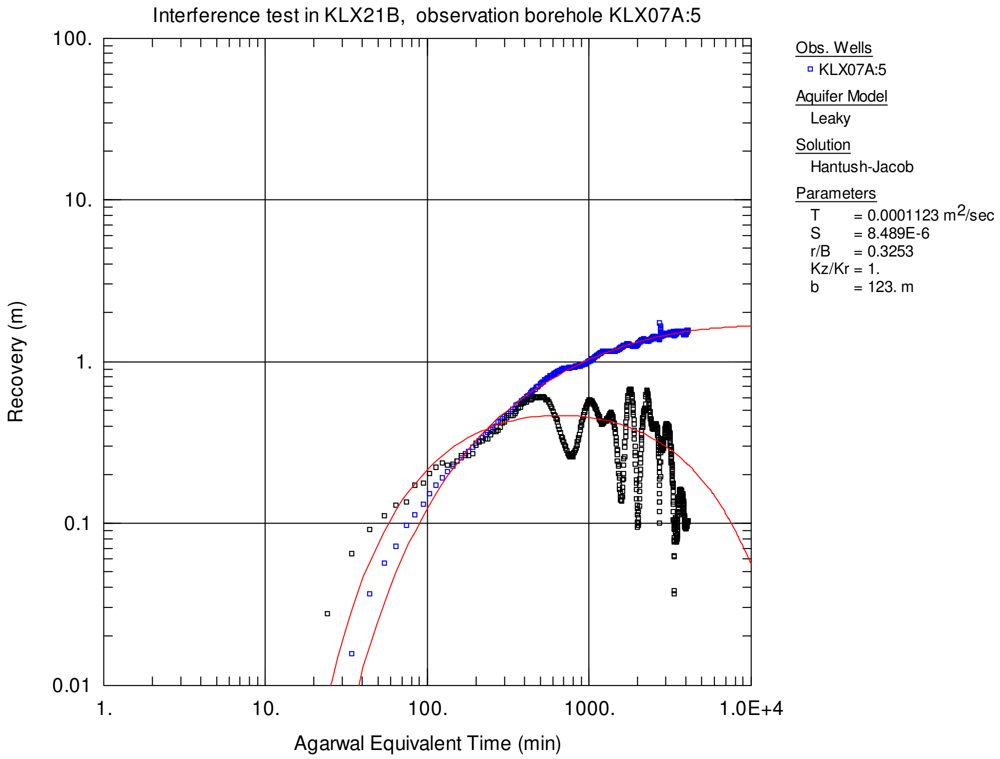


Figure 1-31. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:5 during pumping in borehole KLX21B.*

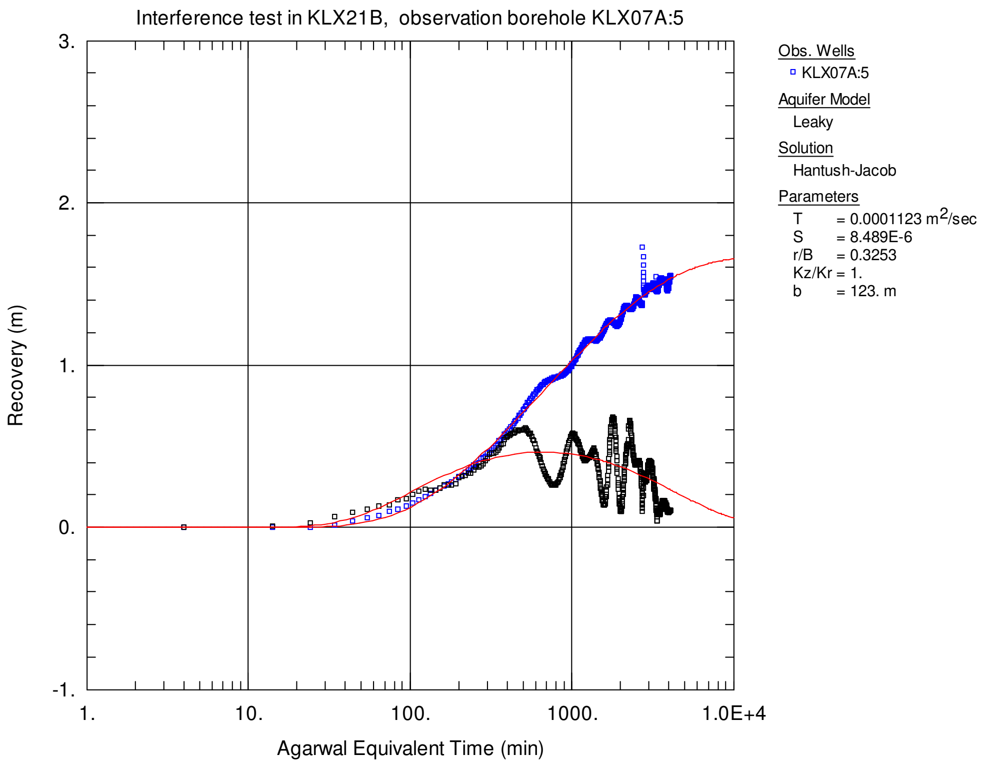


Figure 1-32. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:5 during pumping in borehole KLX21B.*

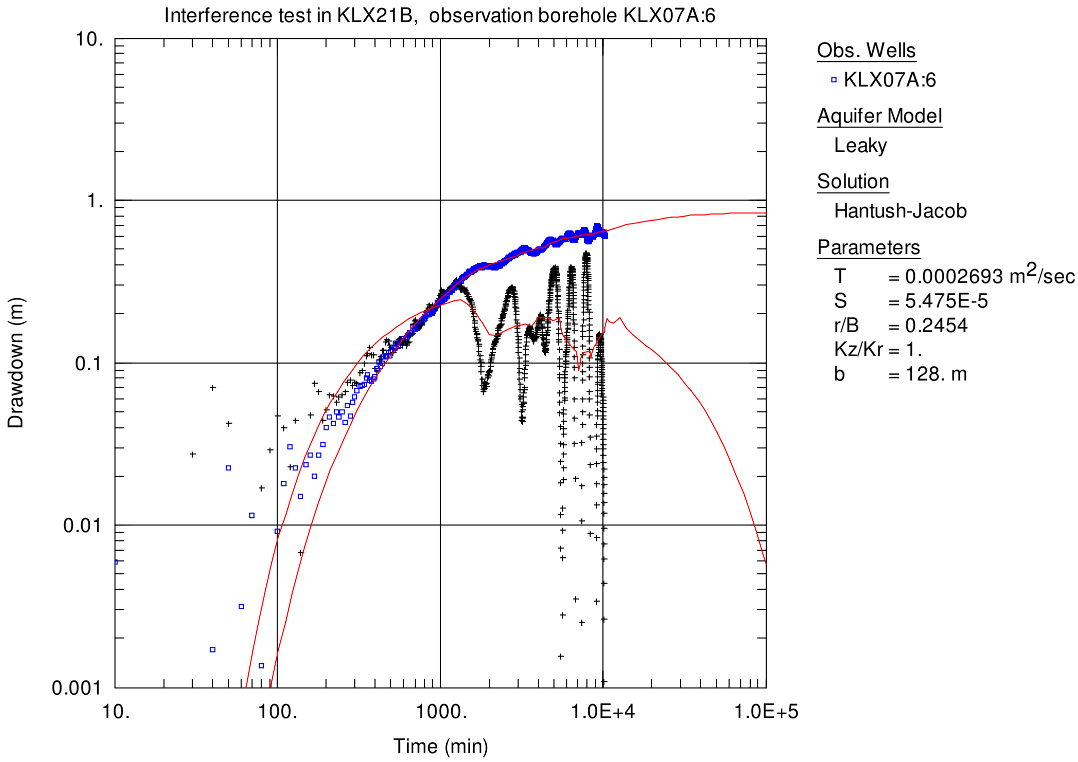


Figure 1-33. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:6 during pumping in borehole KLX21B.*

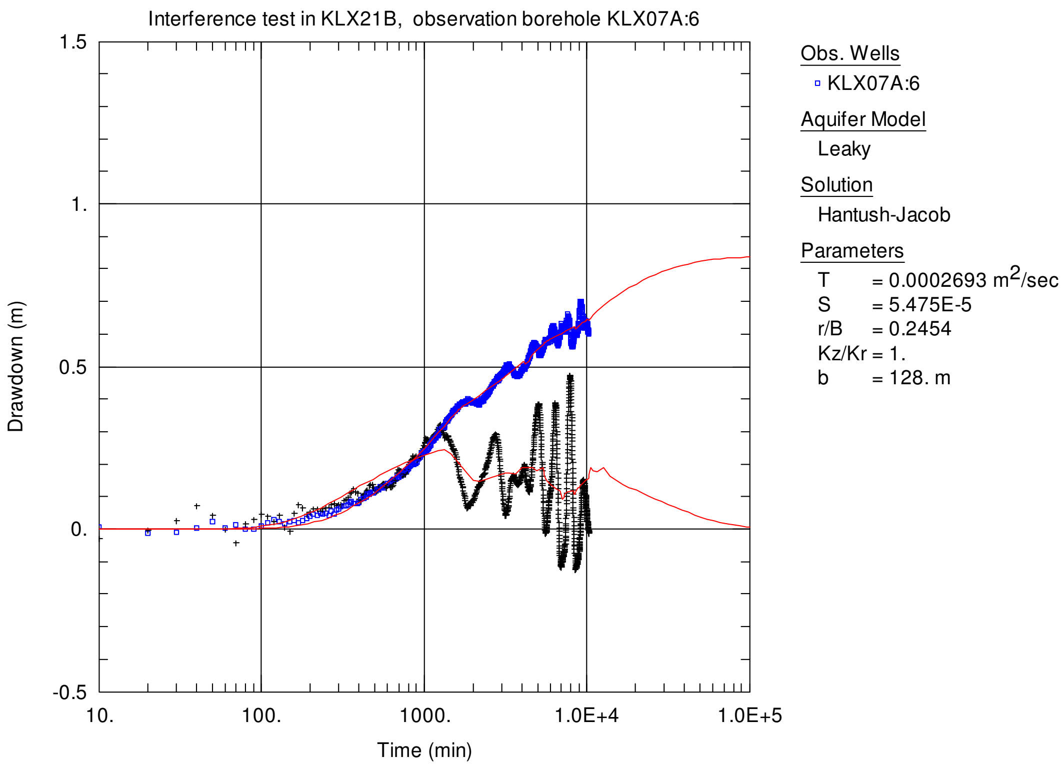


Figure 1-34. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:6 during pumping in borehole KLX21B.*

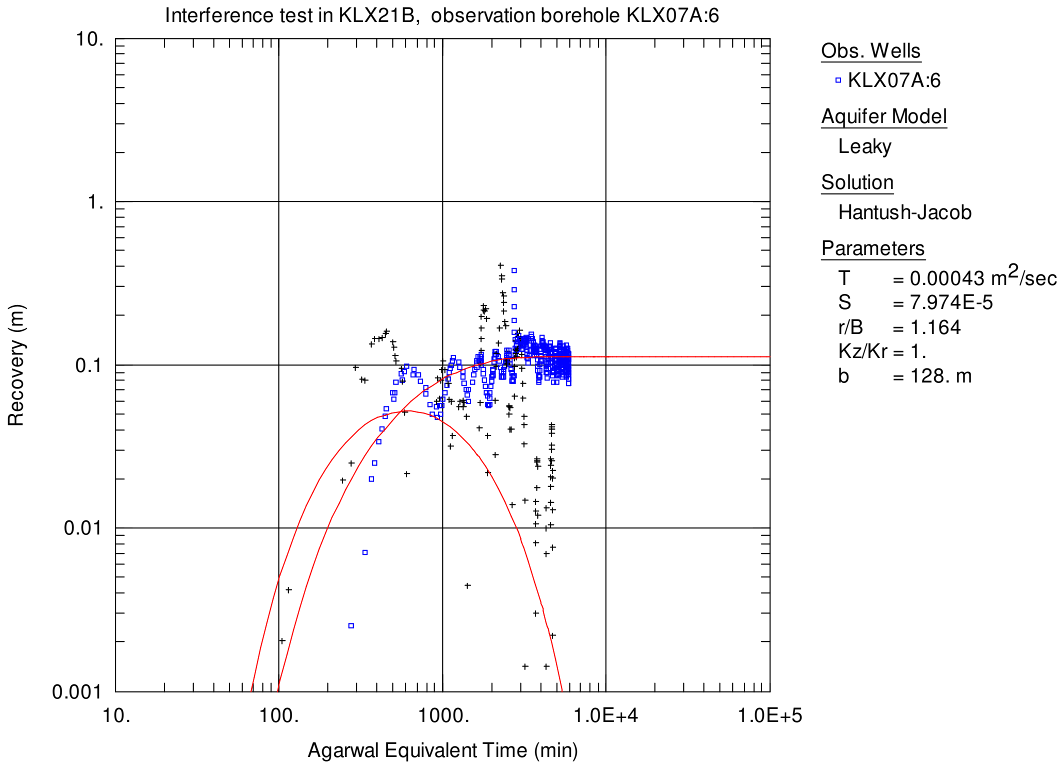


Figure 1-35. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:6 during pumping in borehole KLX21B.*

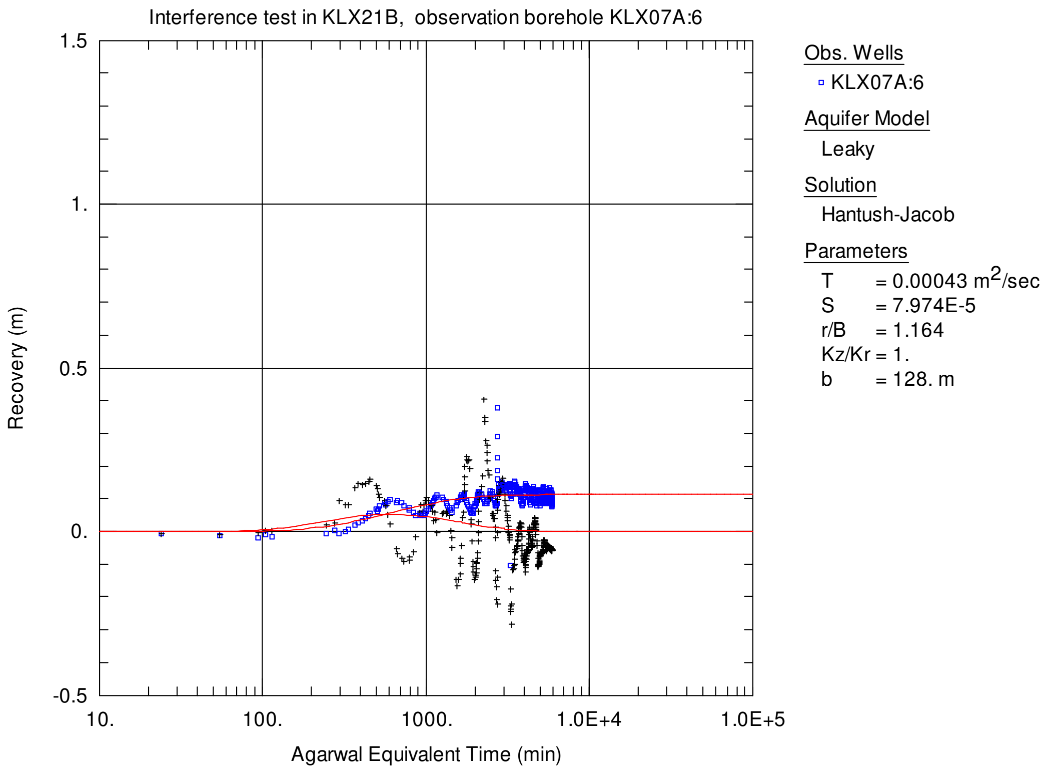


Figure 1-36. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:6 during pumping in borehole KLX21B.*

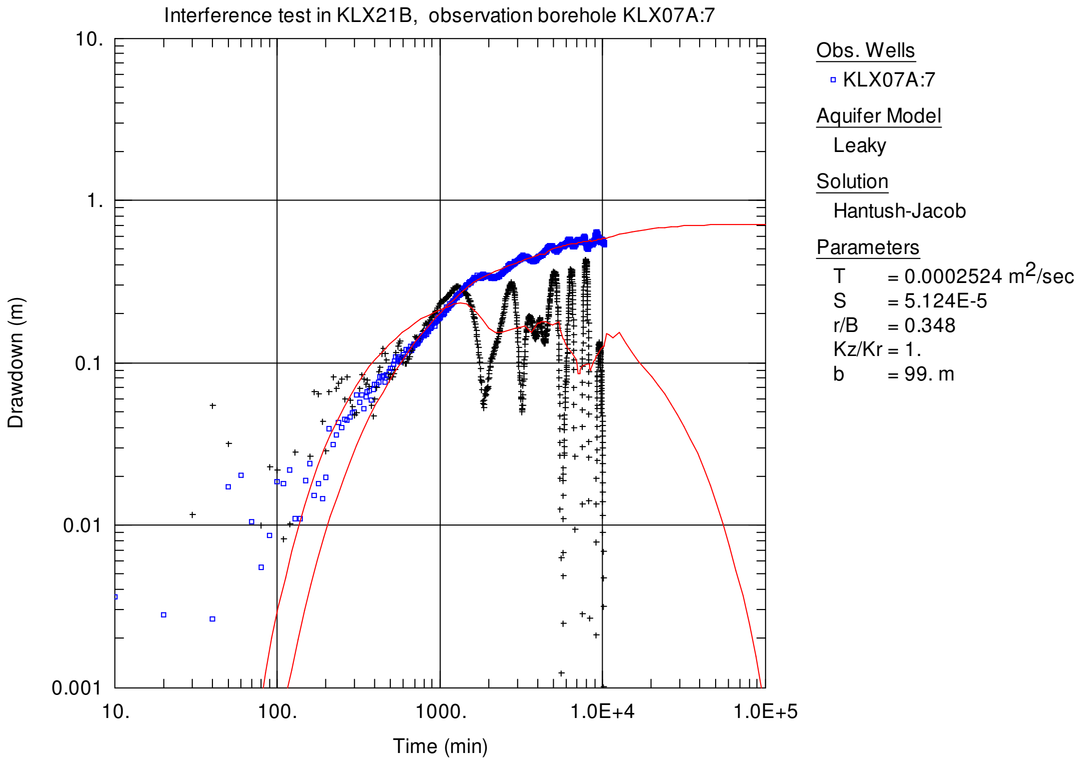


Figure 1-37. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:7 during pumping in borehole KLX21B.*

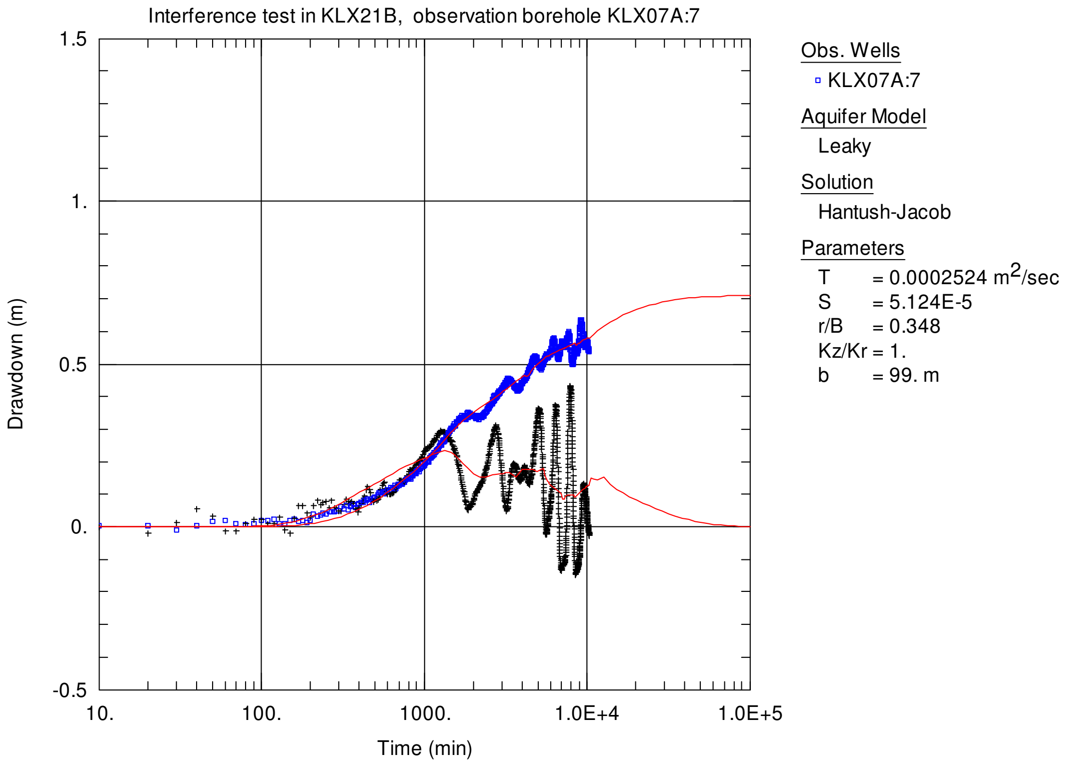


Figure 1-38. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:7 during pumping in borehole KLX21B.*

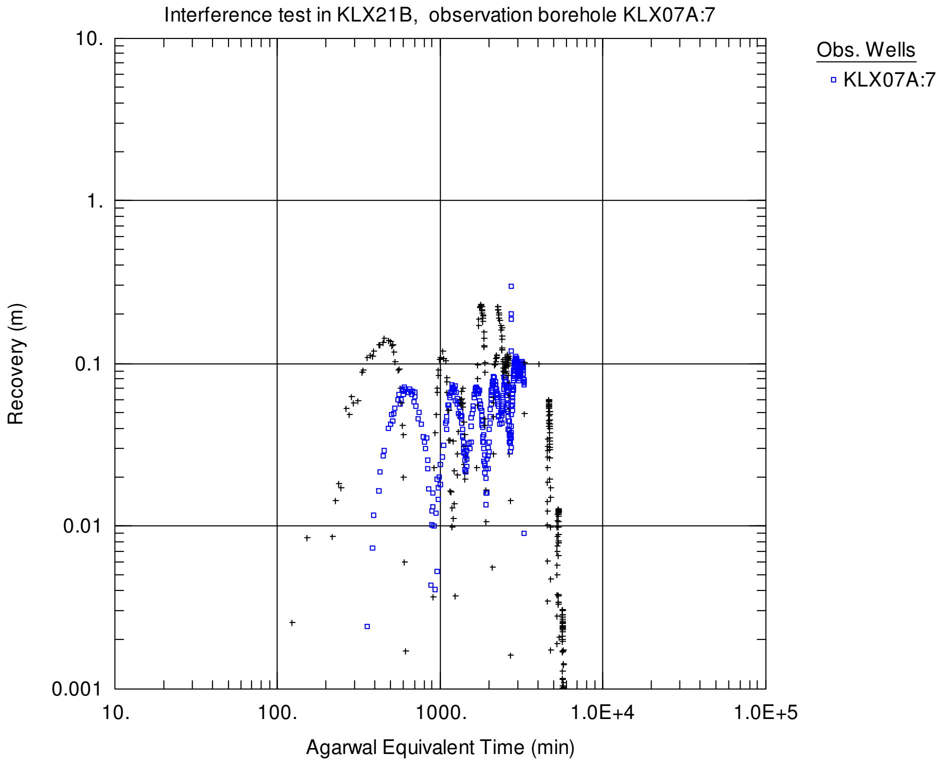


Figure 1-39. *. Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:7 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

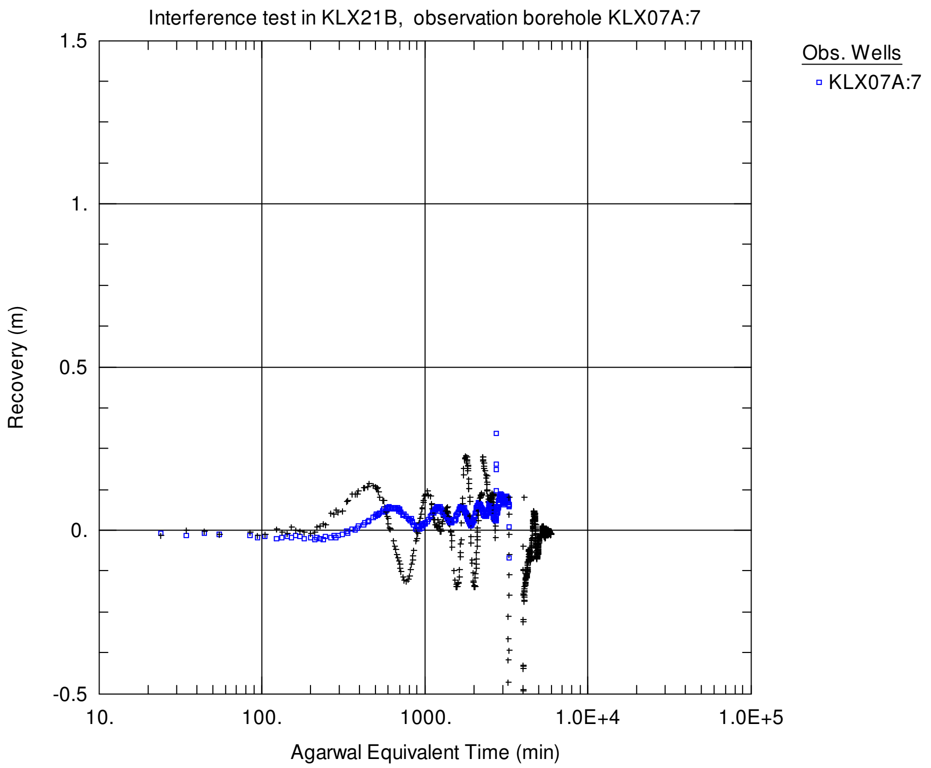


Figure 1-40. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:7 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

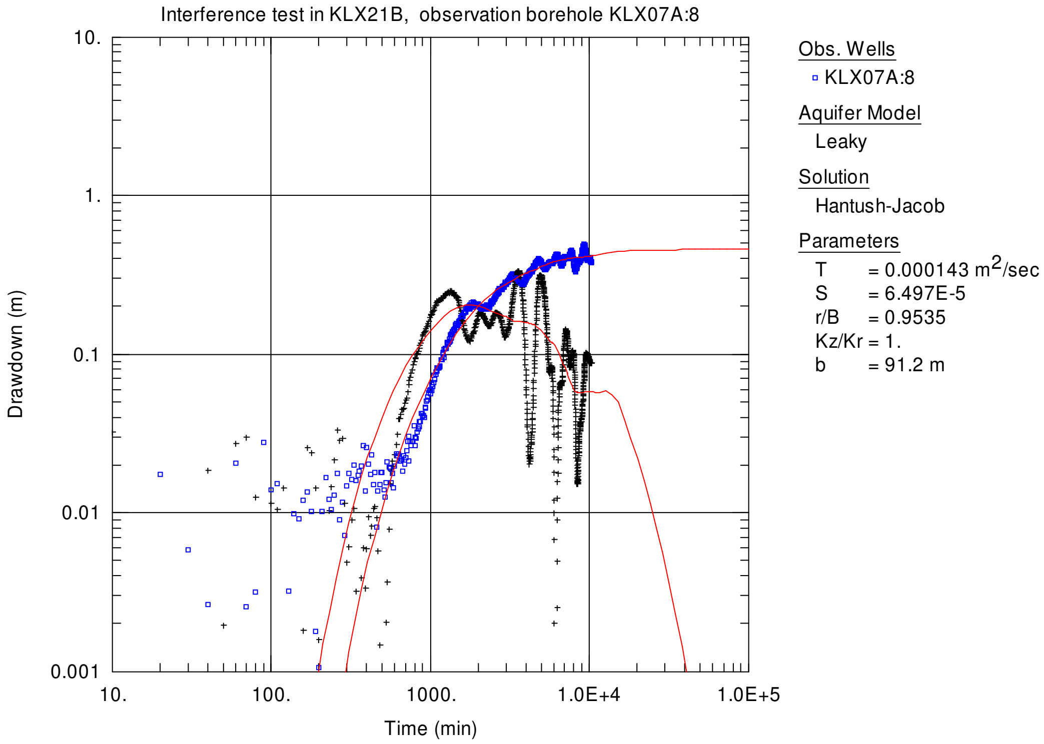


Figure 1-41. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:8 during pumping in borehole KLX21B.*

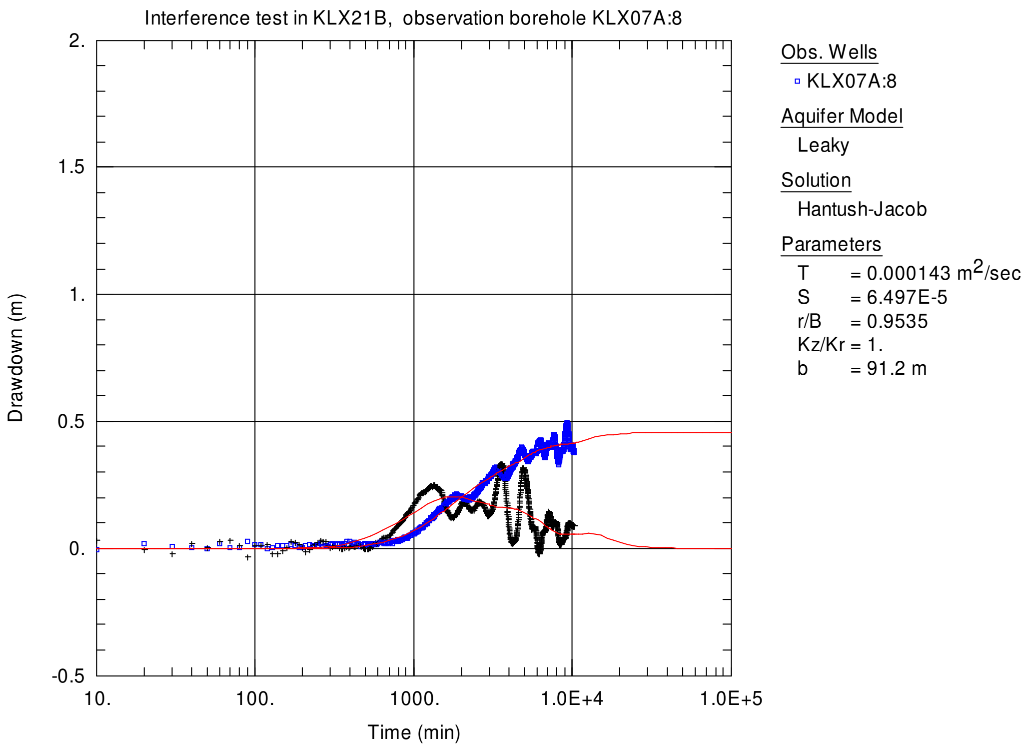


Figure 1-42. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07A:8 during pumping in borehole KLX21B.*

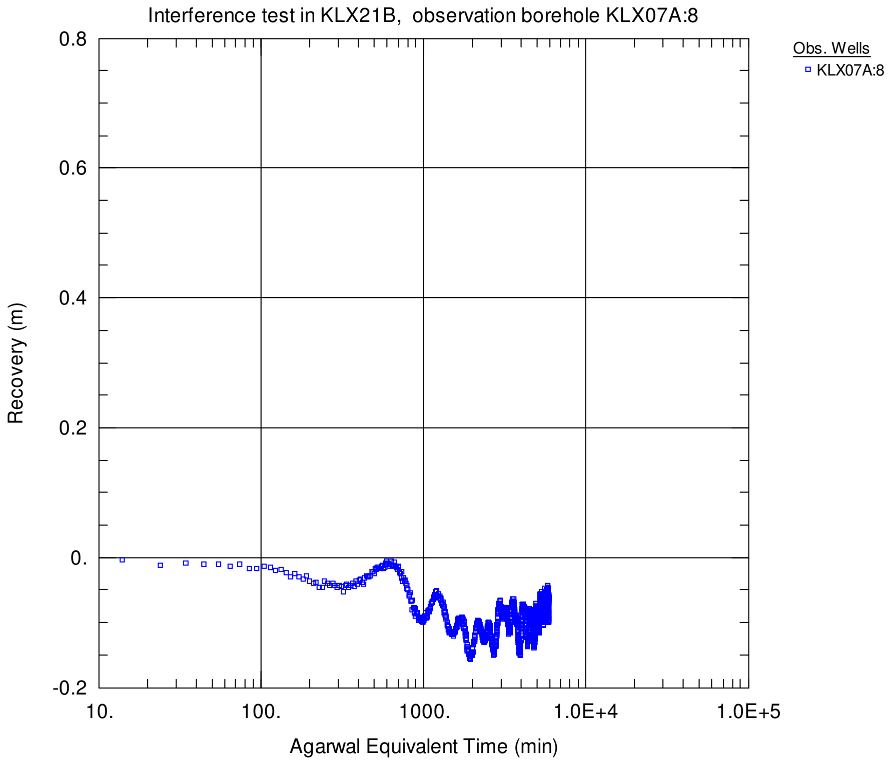


Figure 1-43. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07A:8 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

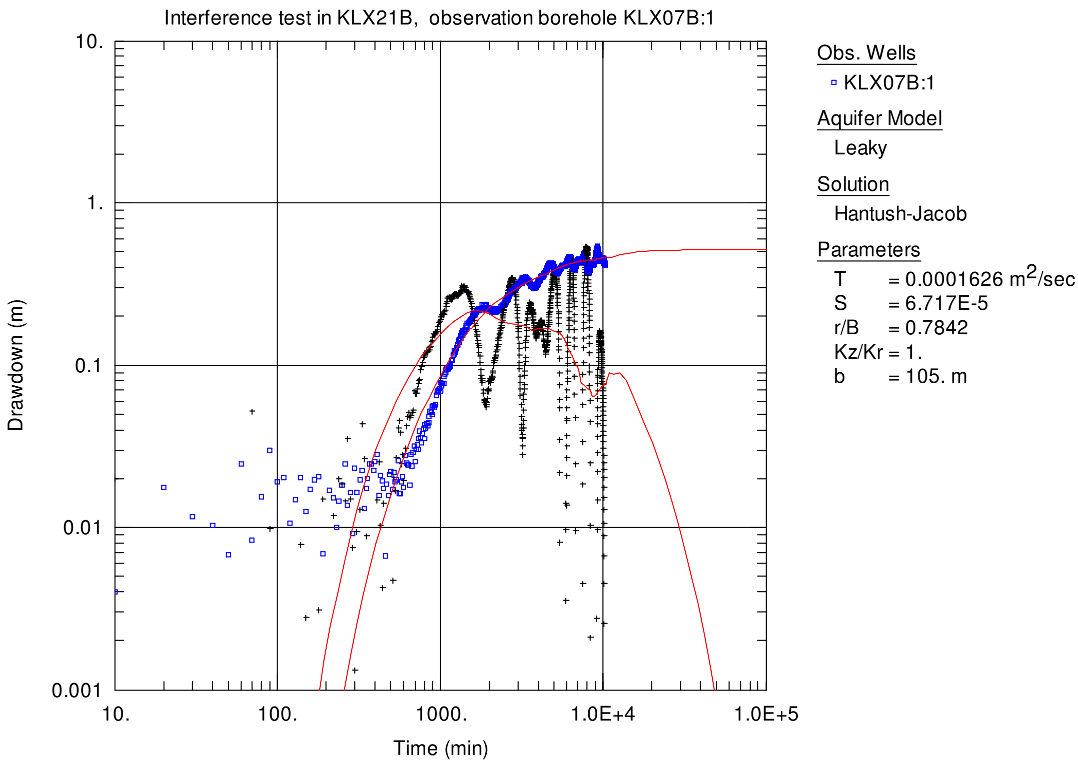


Figure 1-44. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07B:1 during pumping in borehole KLX21B.*

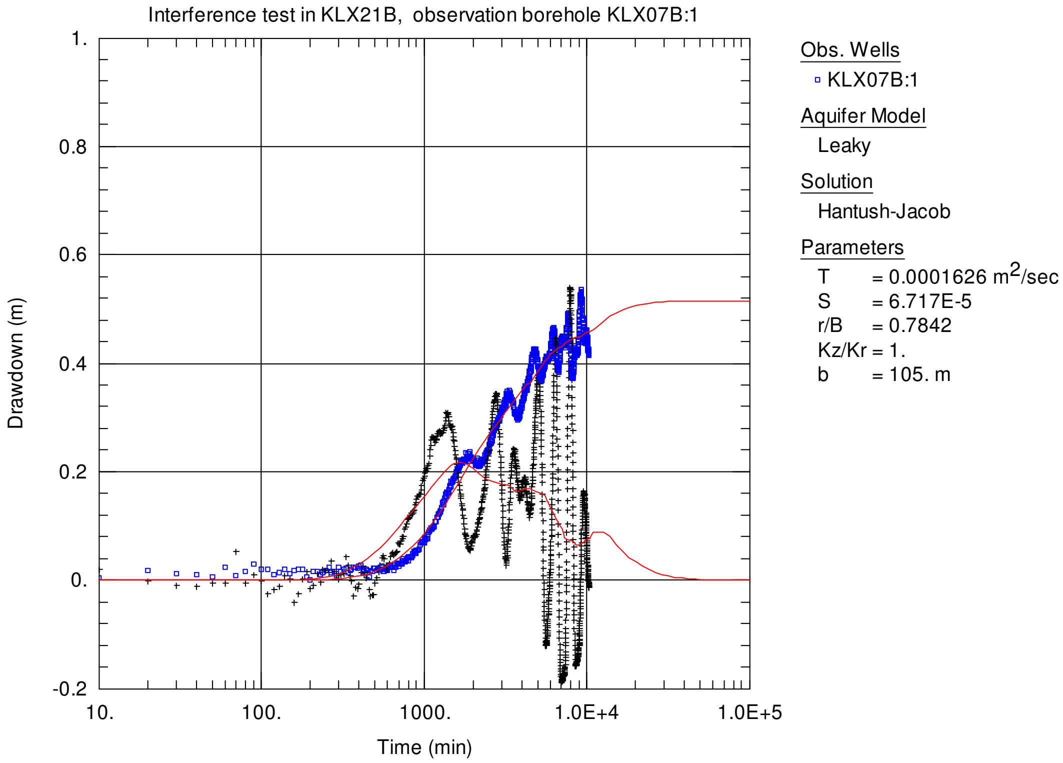


Figure 1-45. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07B:1 during pumping in borehole KLX21B.*

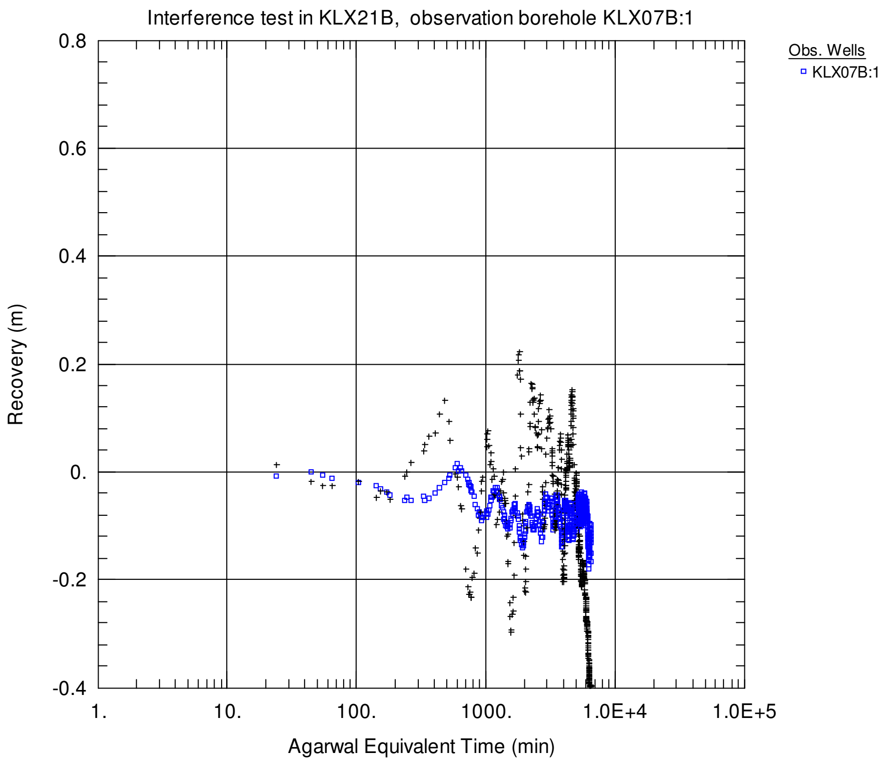


Figure 1-46. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07B:1 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

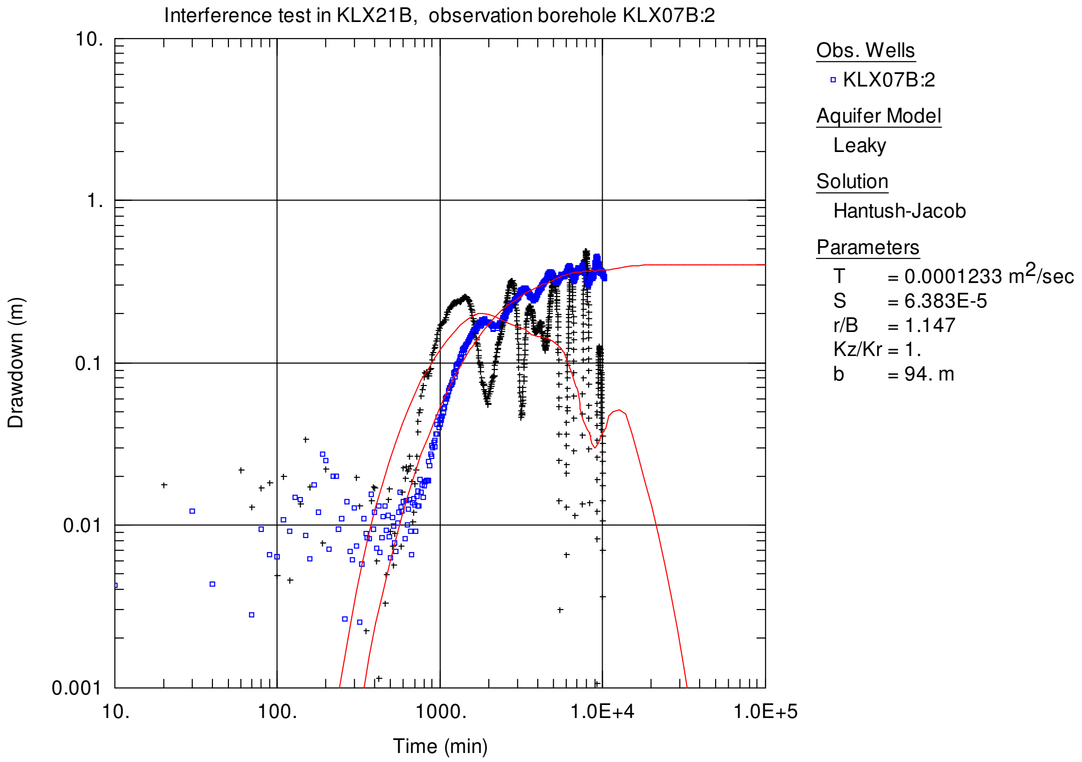


Figure 1-47. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07B:2 during pumping in borehole KLX21B.*

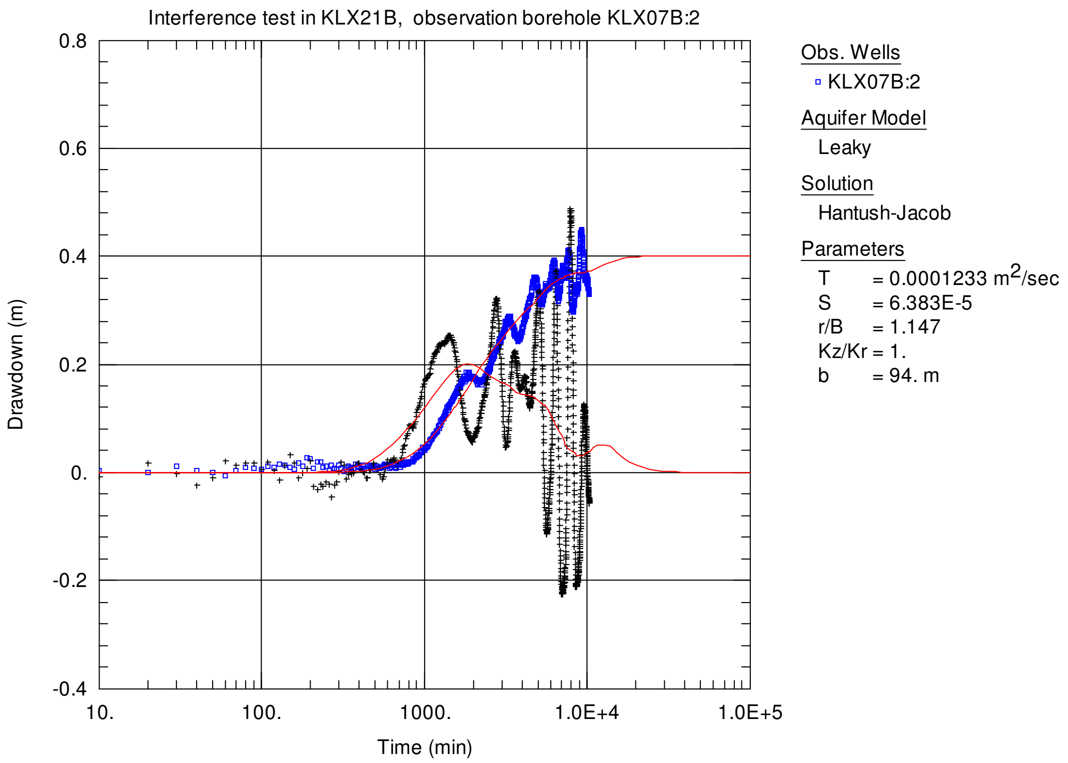


Figure 1-48. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX07B:2 during pumping in borehole KLX21B.*

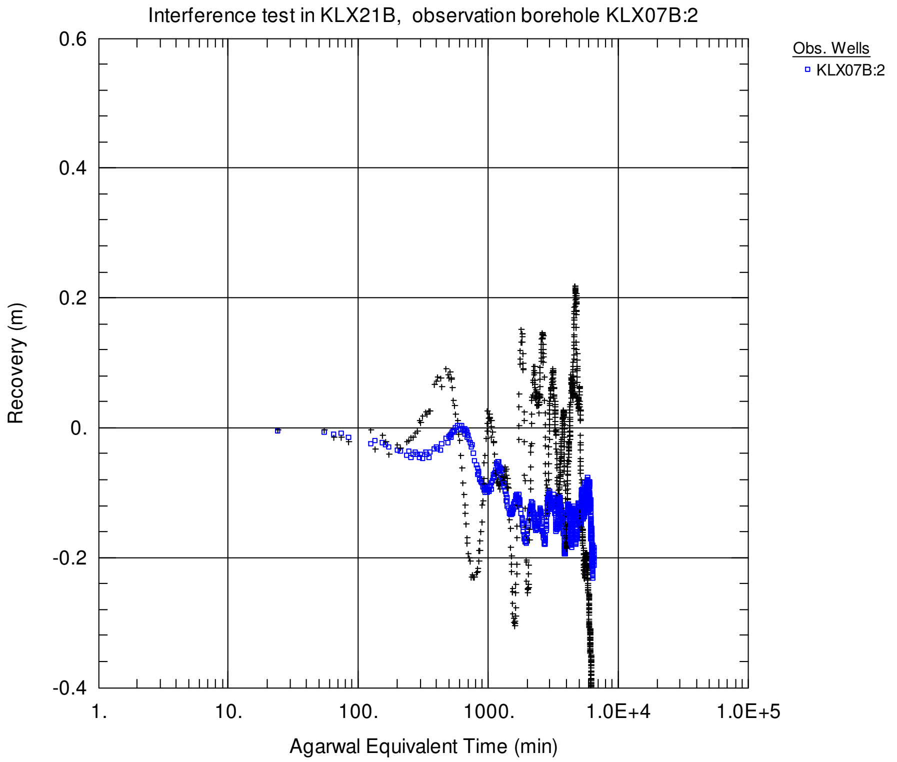


Figure 1-49. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX07B:2 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

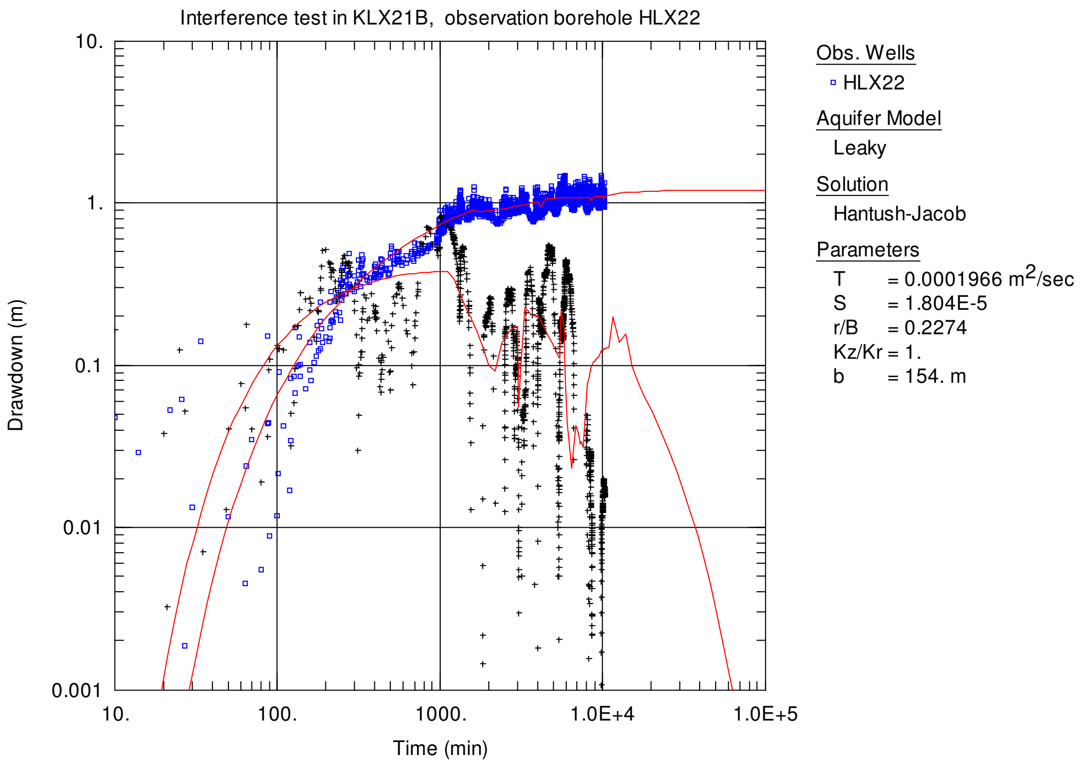


Figure 1-50. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX22 during pumping in borehole KLX21B.*

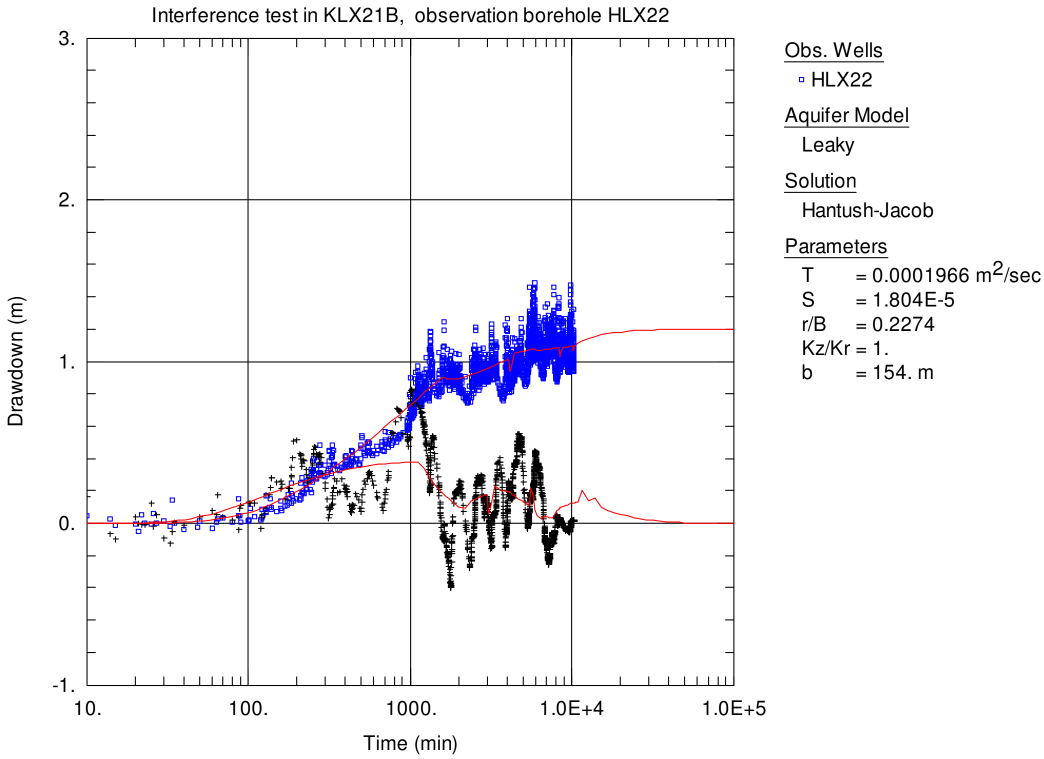


Figure 1-51. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX22 during pumping in borehole KLX21B.*

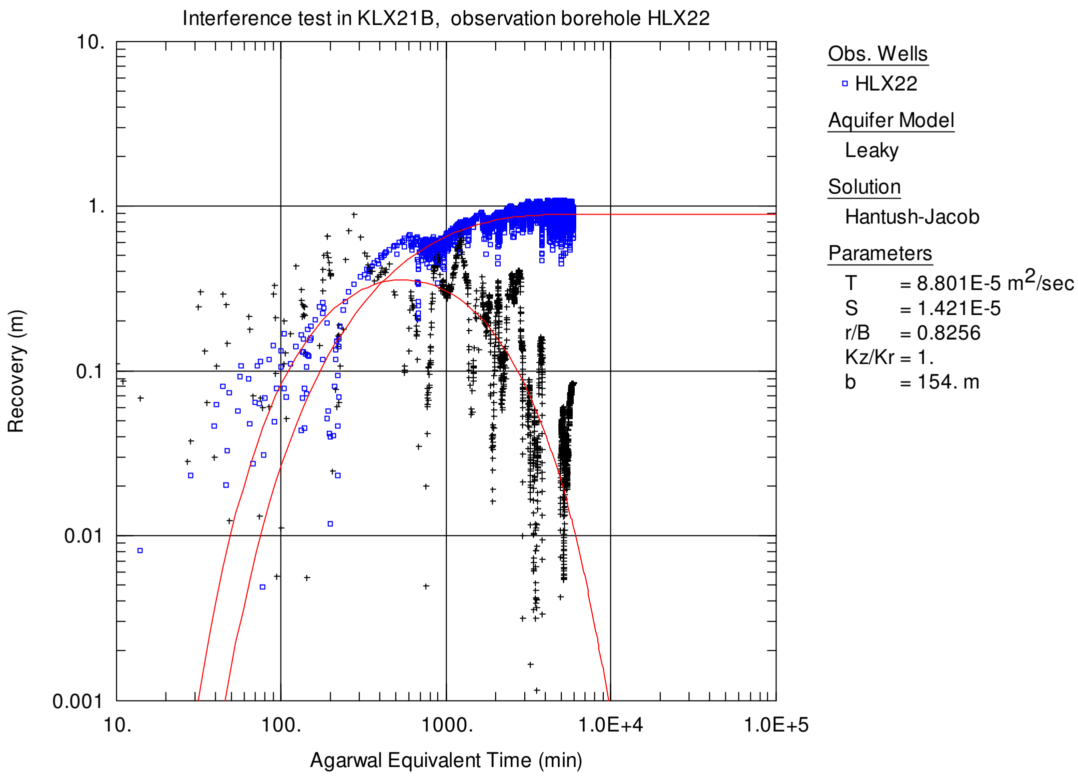


Figure 1-52. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX22 during pumping in borehole KLX21B.*

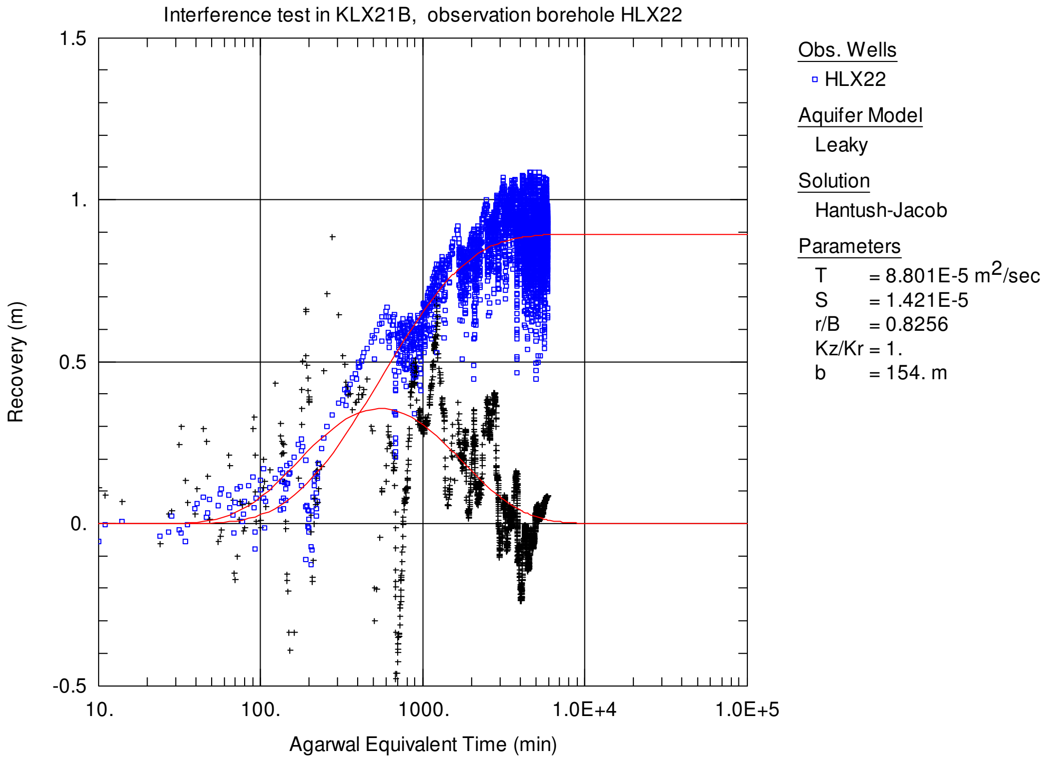


Figure 1-53. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX22 during pumping in borehole KLX21B.*

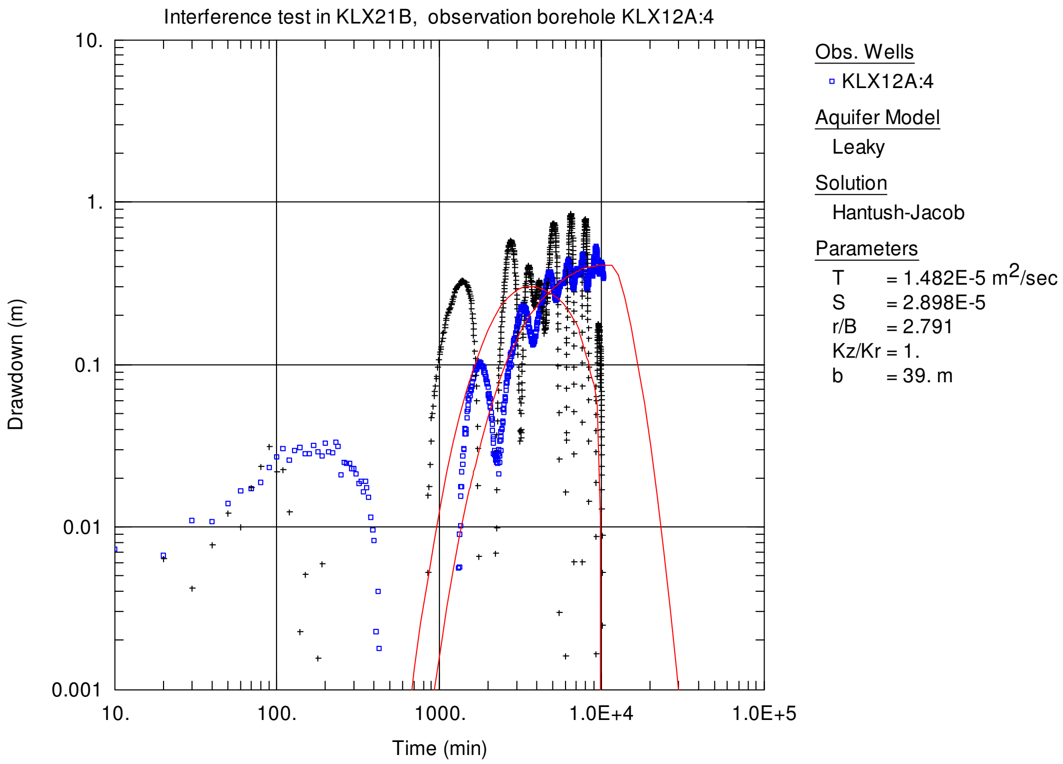


Figure 1-54. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:4 during pumping in borehole KLX21B.*

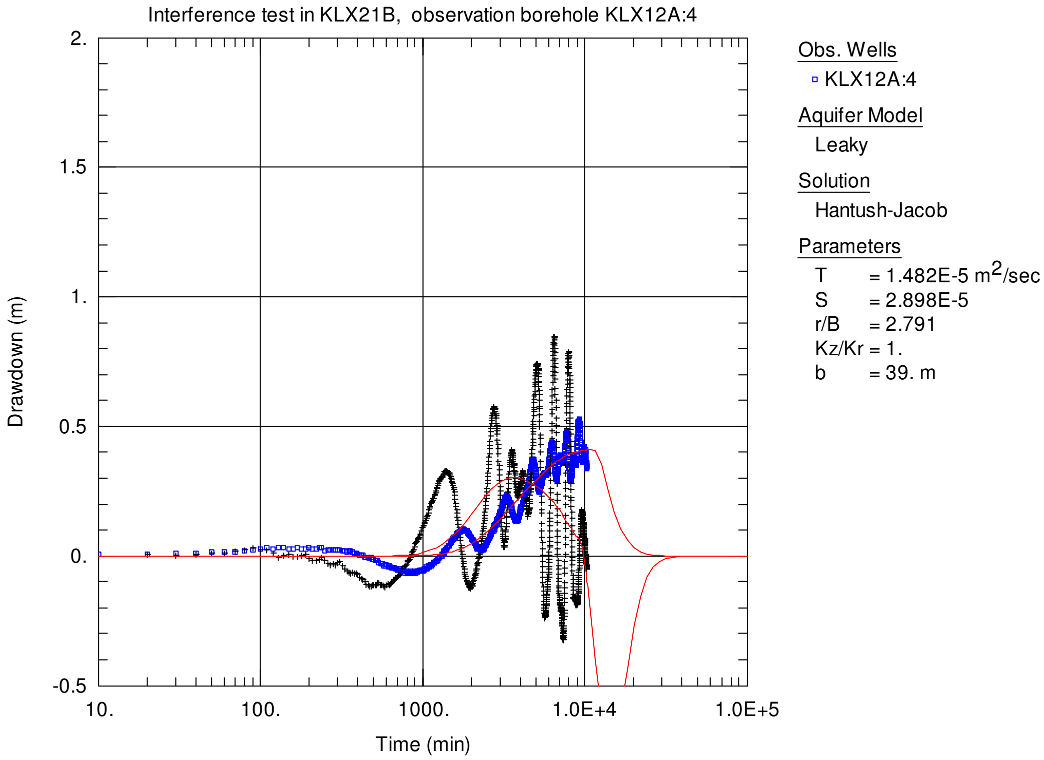


Figure 1-55. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:4 during pumping in borehole KLX21B.*

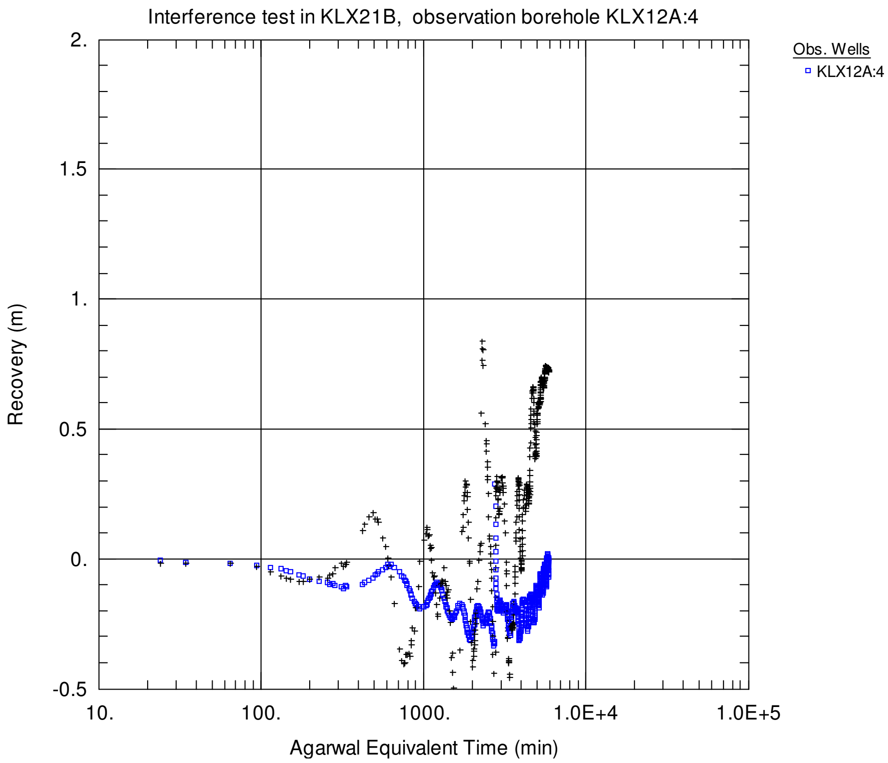


Figure 1-56. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX12A:4 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

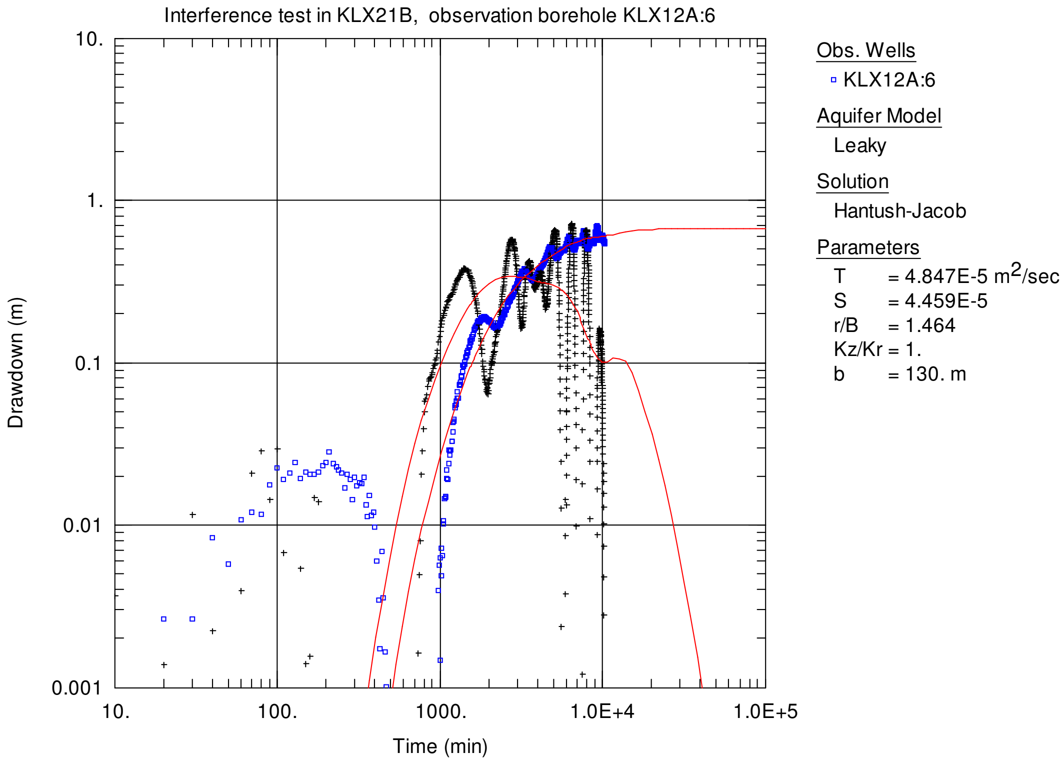


Figure 1-57. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:6 during pumping in borehole KLX21B.*

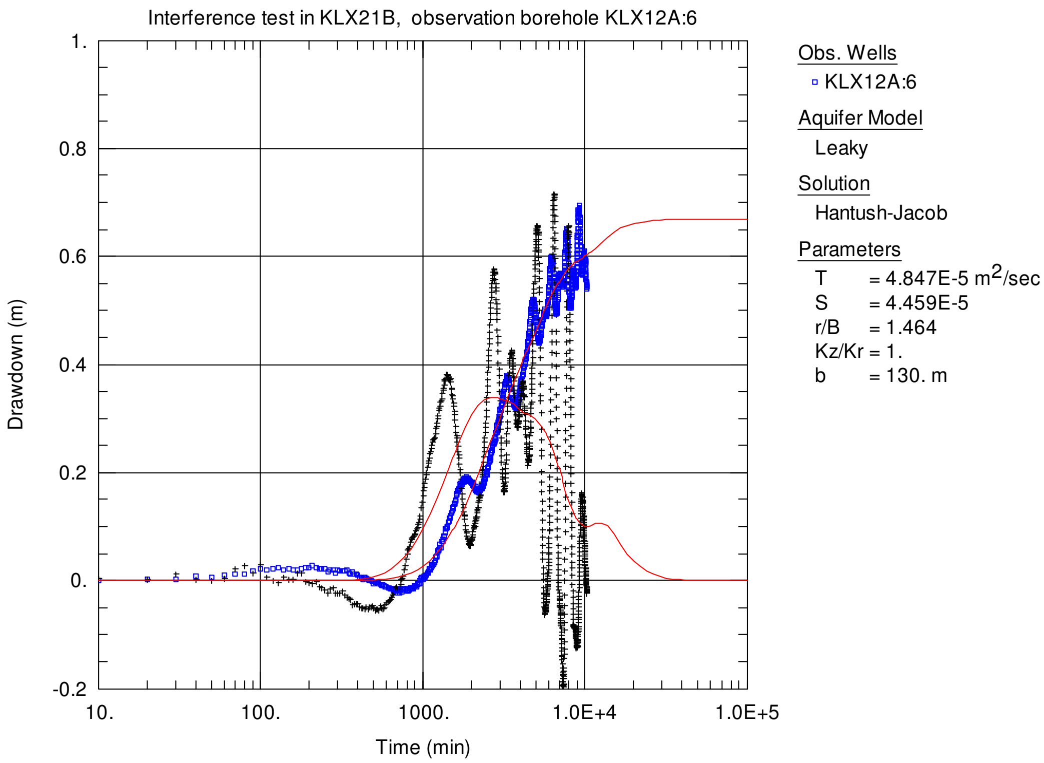


Figure 1-58. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:6 during pumping in borehole KLX21B.*

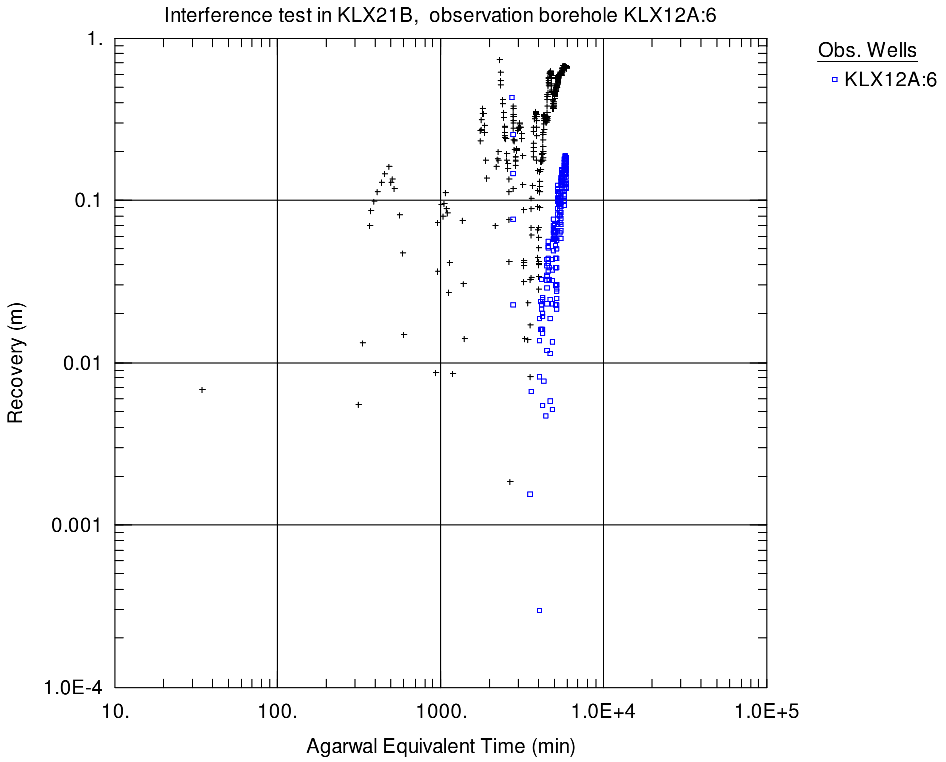


Figure 1-59. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX12A:6 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

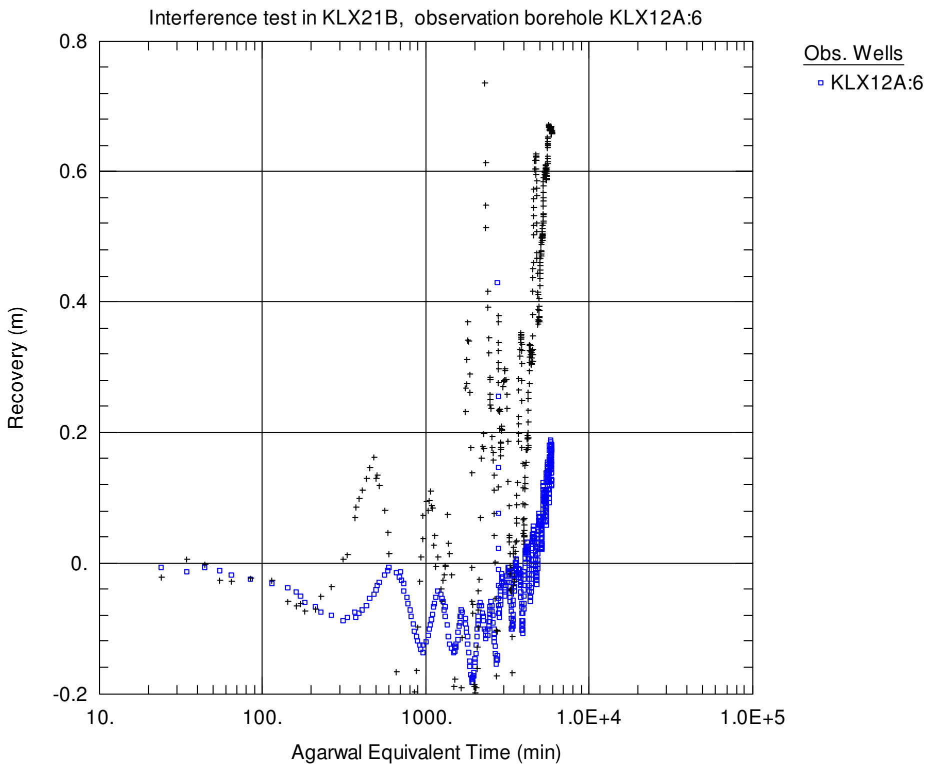


Figure 1-60. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX12A:6 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

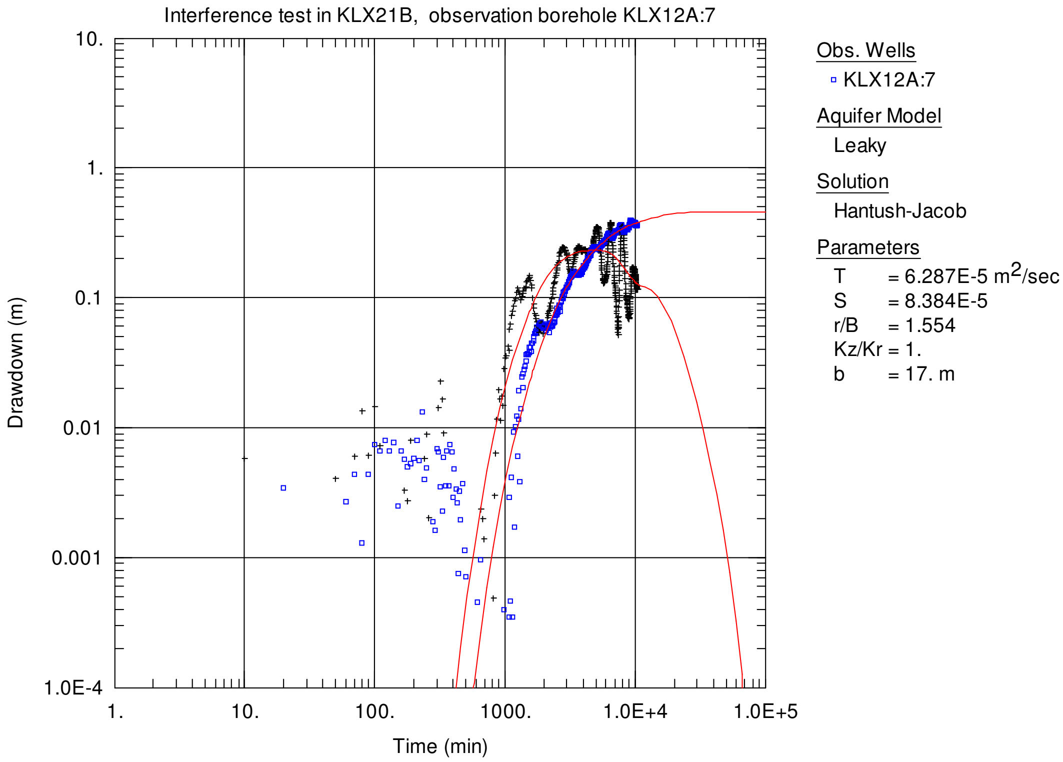


Figure 1-61. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:7 during pumping in borehole KLX21B.*

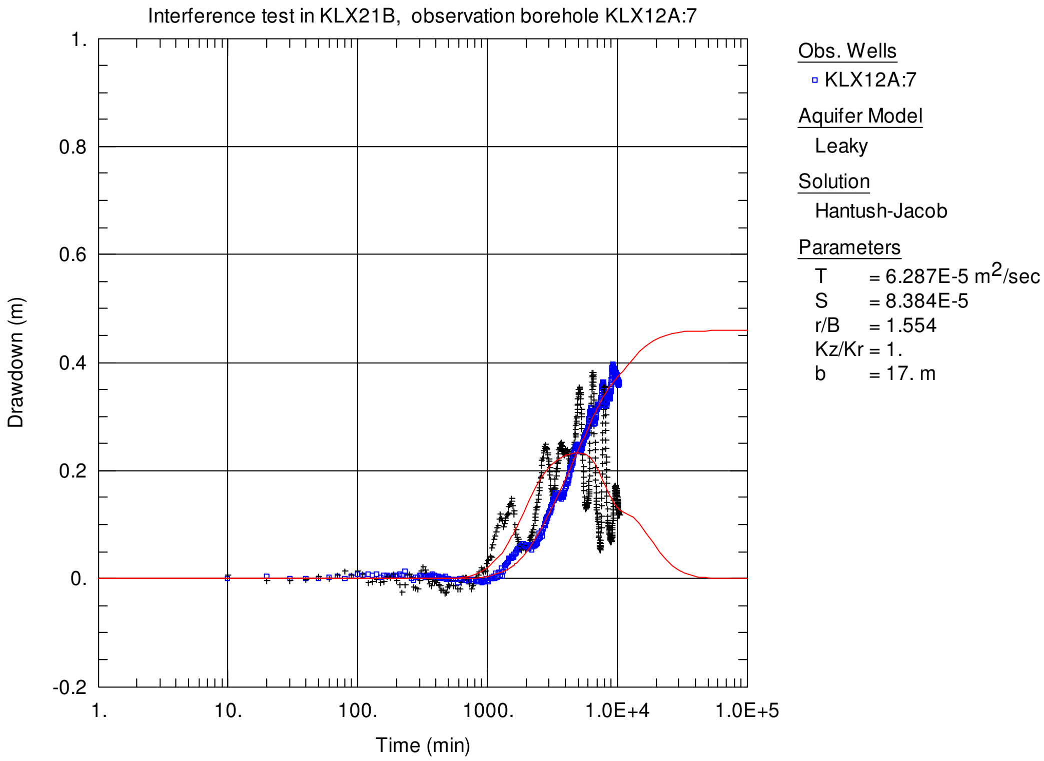


Figure 1-62. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:7 during pumping in borehole KLX21B.*

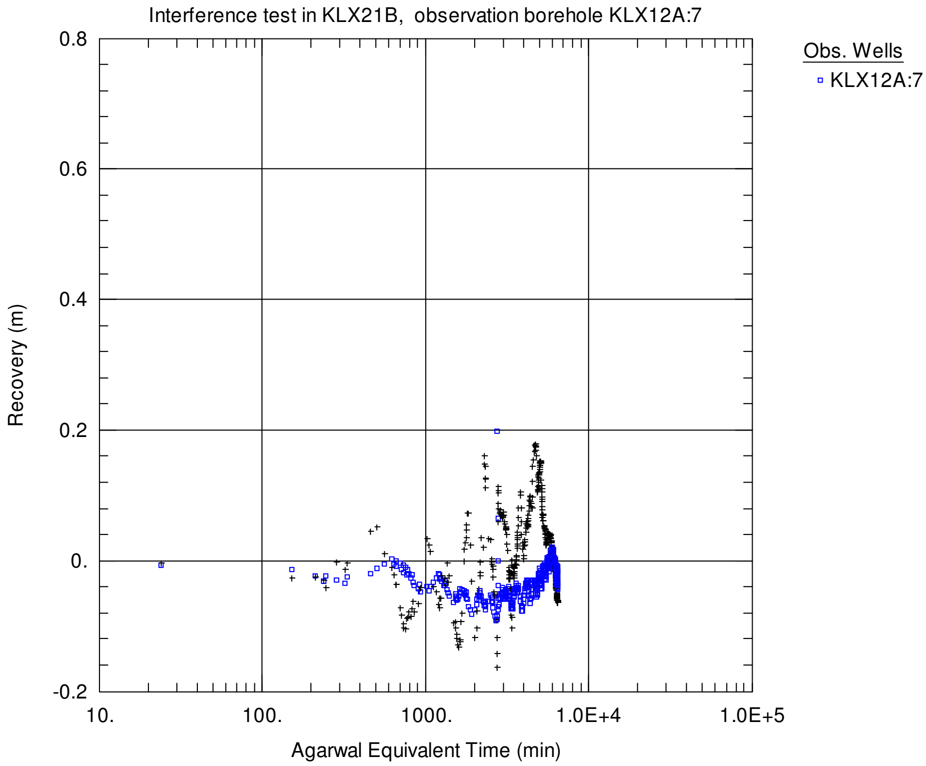


Figure 1-63. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX12A:7 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

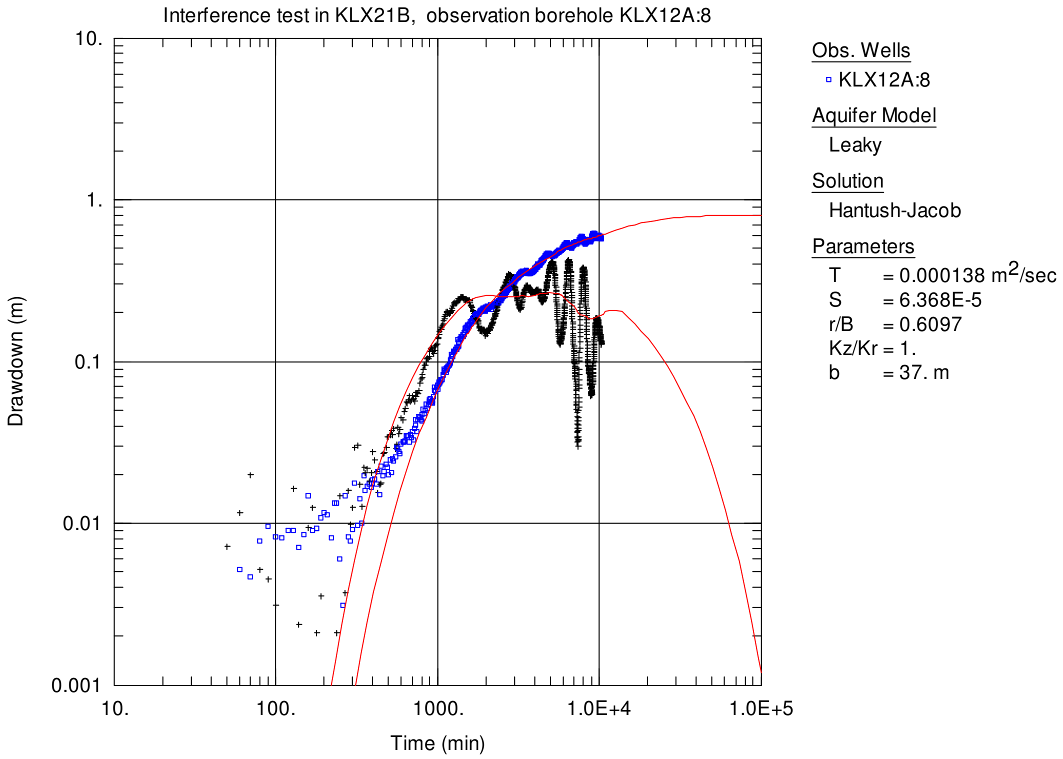


__Figure 1-64.__ Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:8 during pumping in borehole KLX21B.

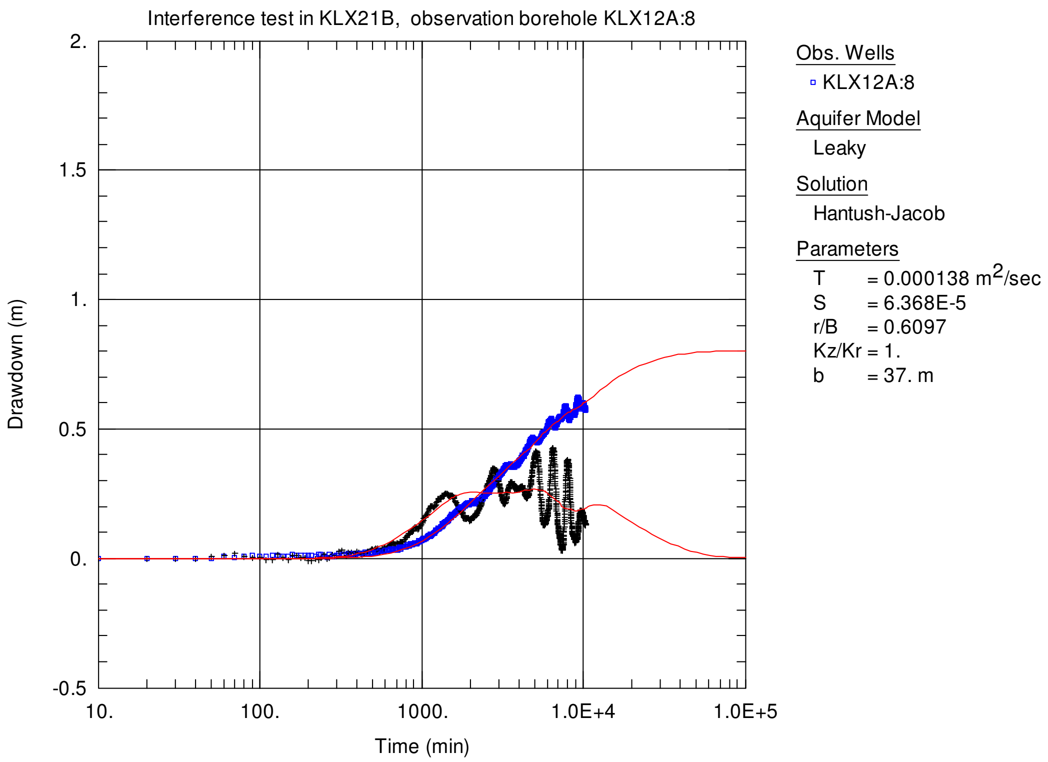


__Figure 1-65.__ Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:8 during pumping in borehole KLX21B.

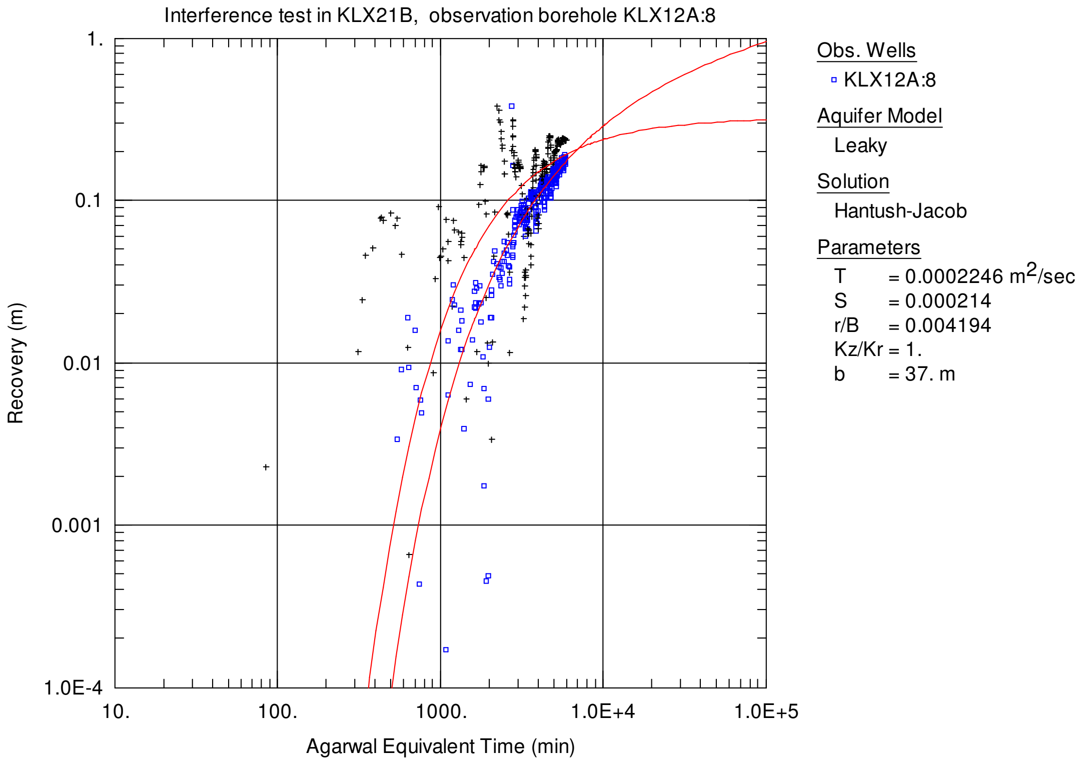


Figure 1-66. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX12A:8 during pumping in borehole KLX21B.*

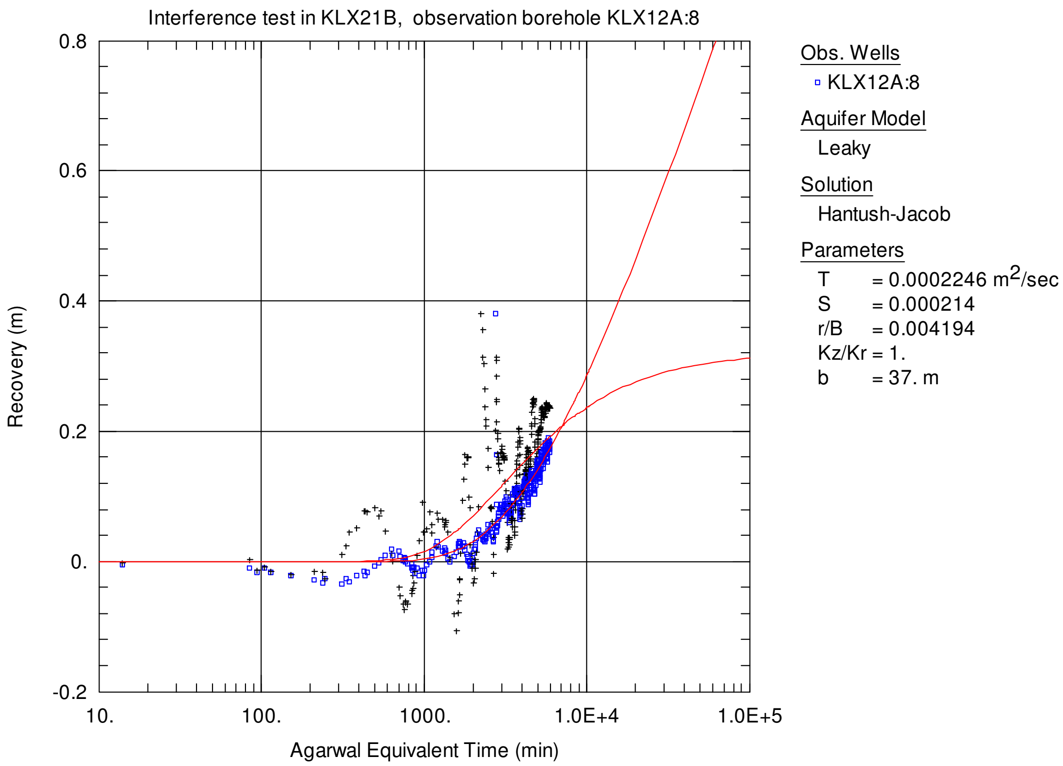


Figure 1-67. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX12A:8 during pumping in borehole KLX21B.*

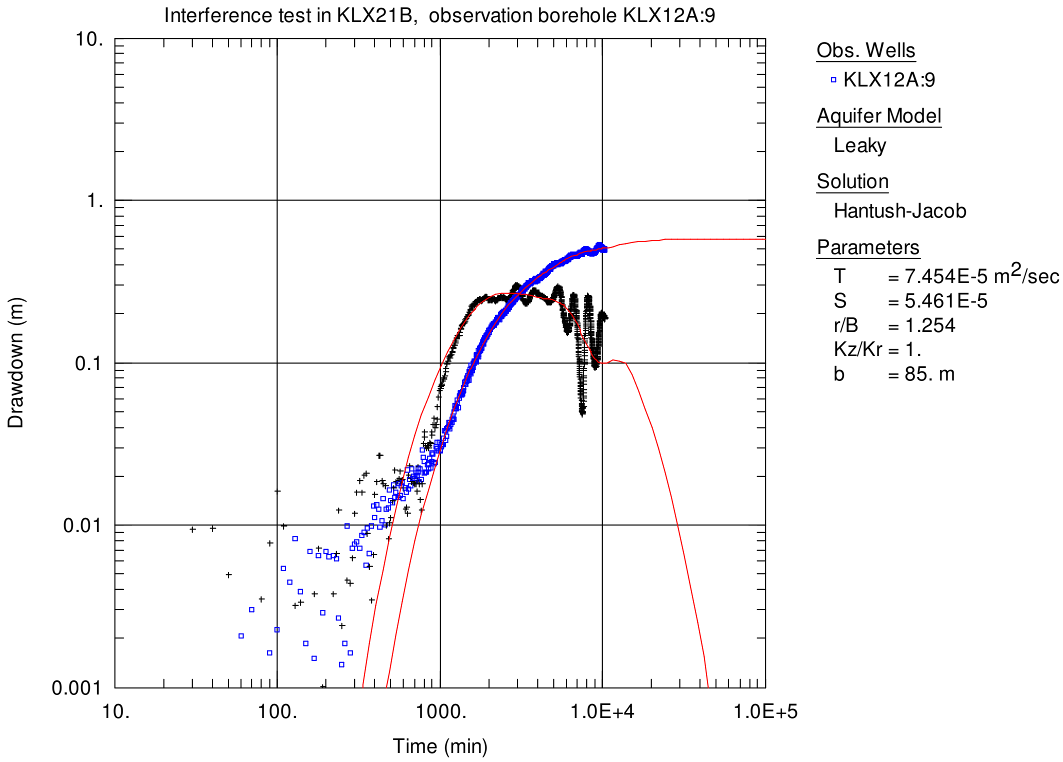


Figure 1-68. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:9 during pumping in borehole KLX21B.*

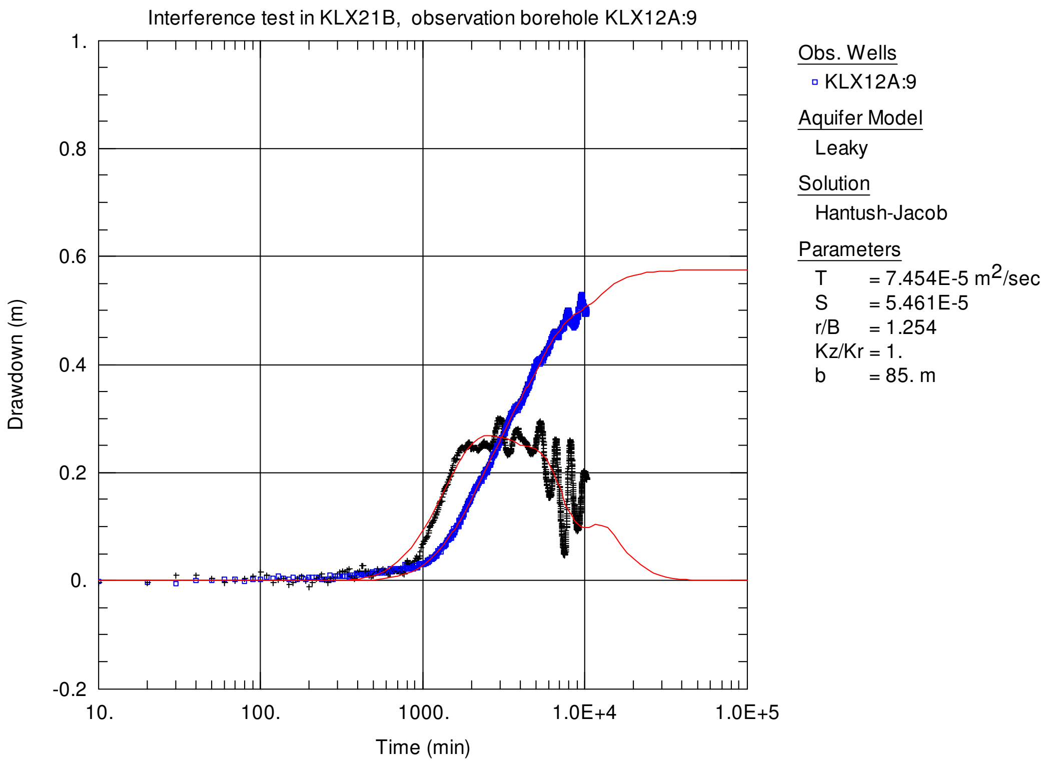


Figure 1-69. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX12A:9 during pumping in borehole KLX21B.*

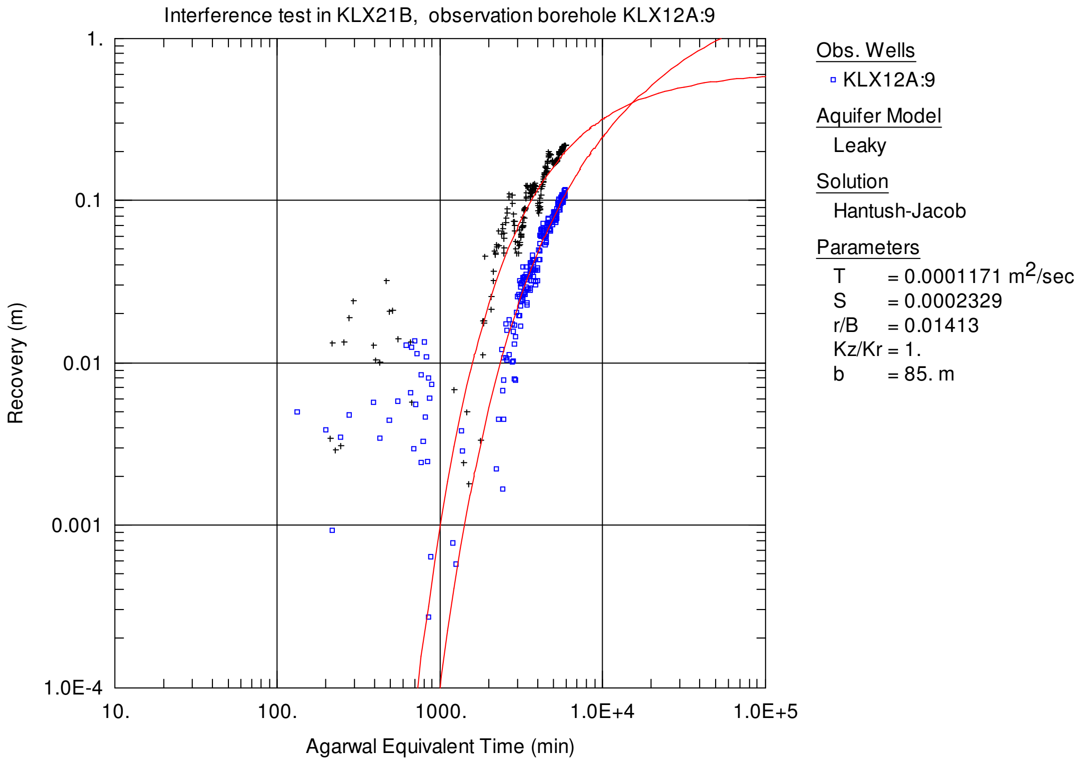


Figure 1-70. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX12A:9 during pumping in borehole KLX21B.*

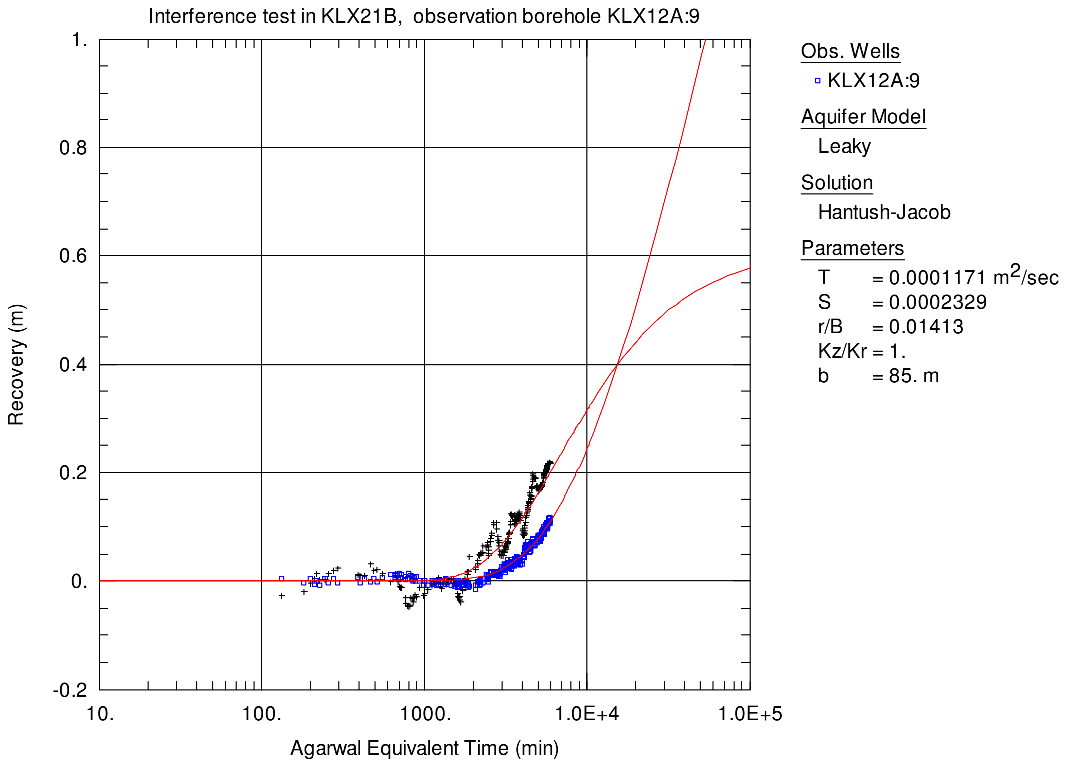


Figure 1-71. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX12A:9 during pumping in borehole KLX21B.*

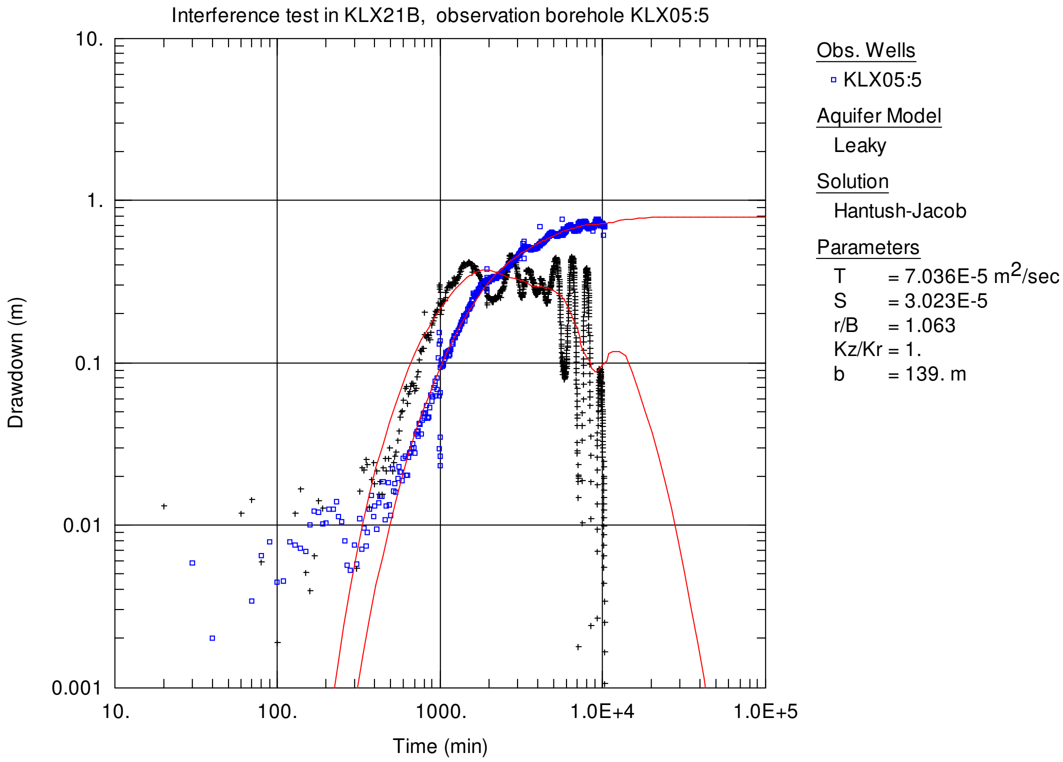


Figure 1-72. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:5 during pumping in borehole KLX21B.*

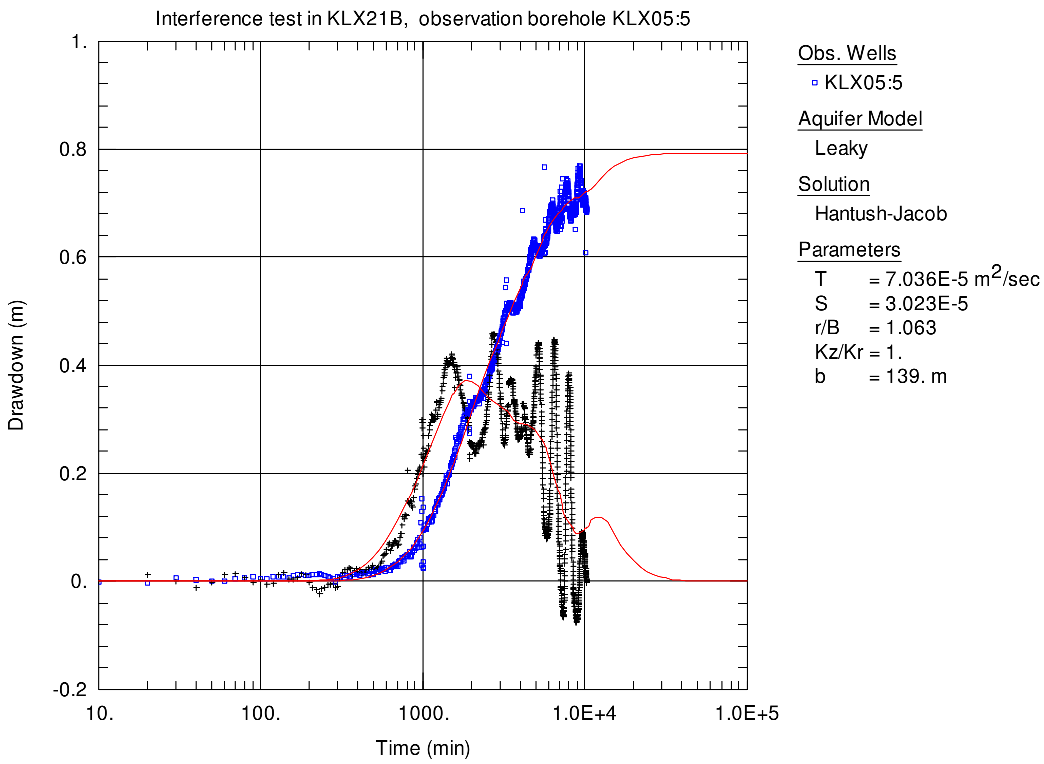


Figure 1-73. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:5 during pumping in borehole KLX21B.*

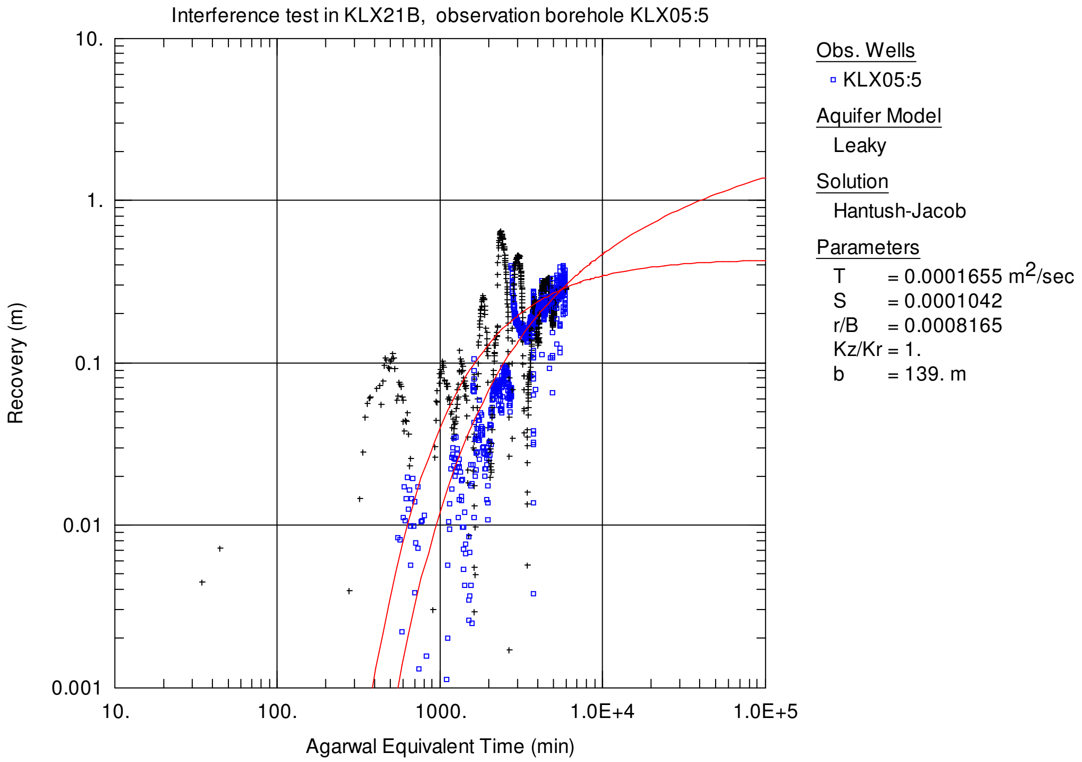


Figure 1-74. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:5 during pumping in borehole KLX21B.*

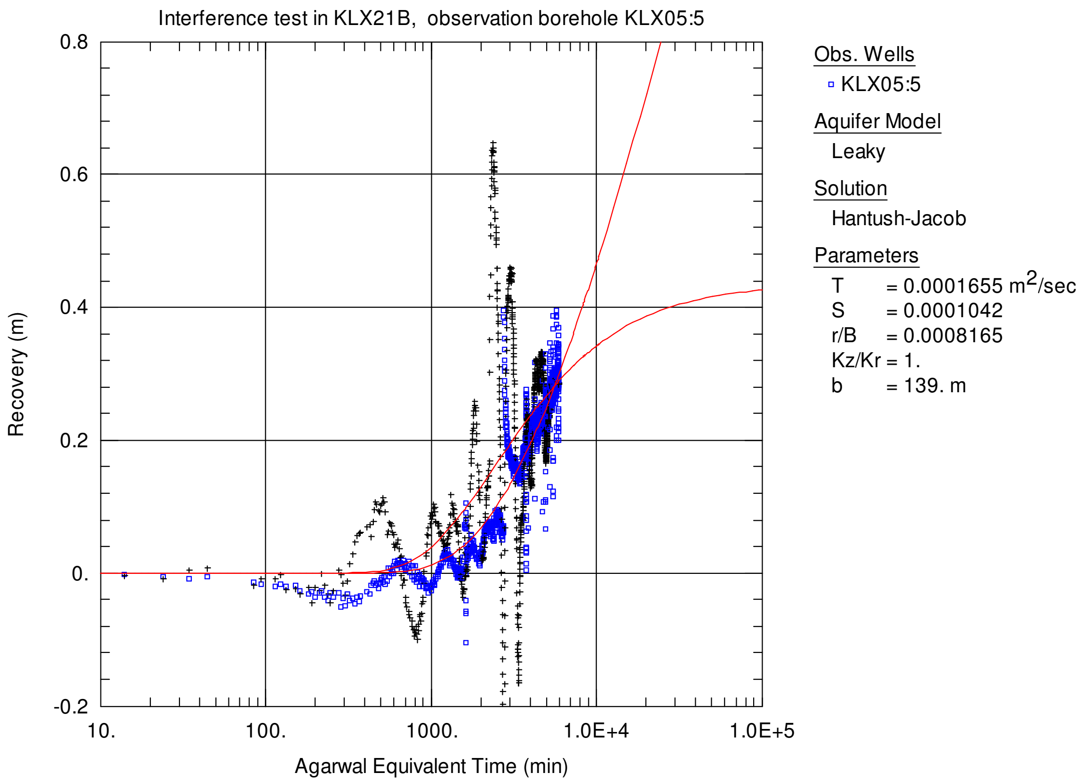


Figure 1-75. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:5 during pumping in borehole KLX21B.*

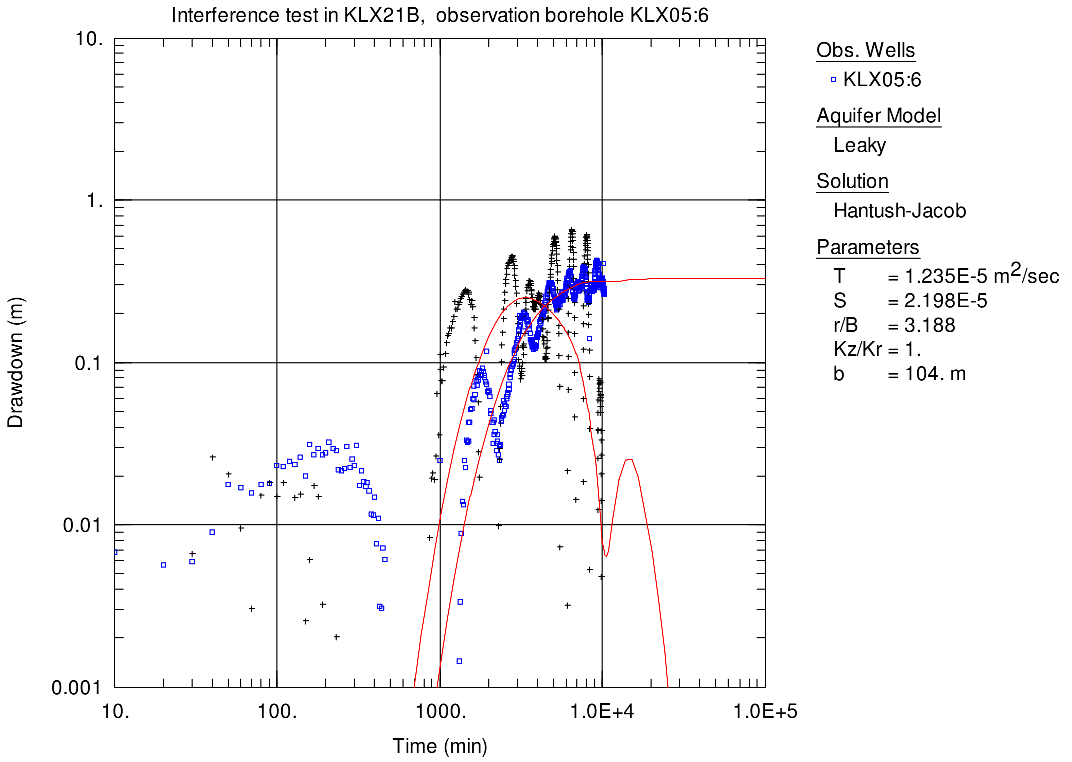


Figure 1-76. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:6 during pumping in borehole KLX21B.*

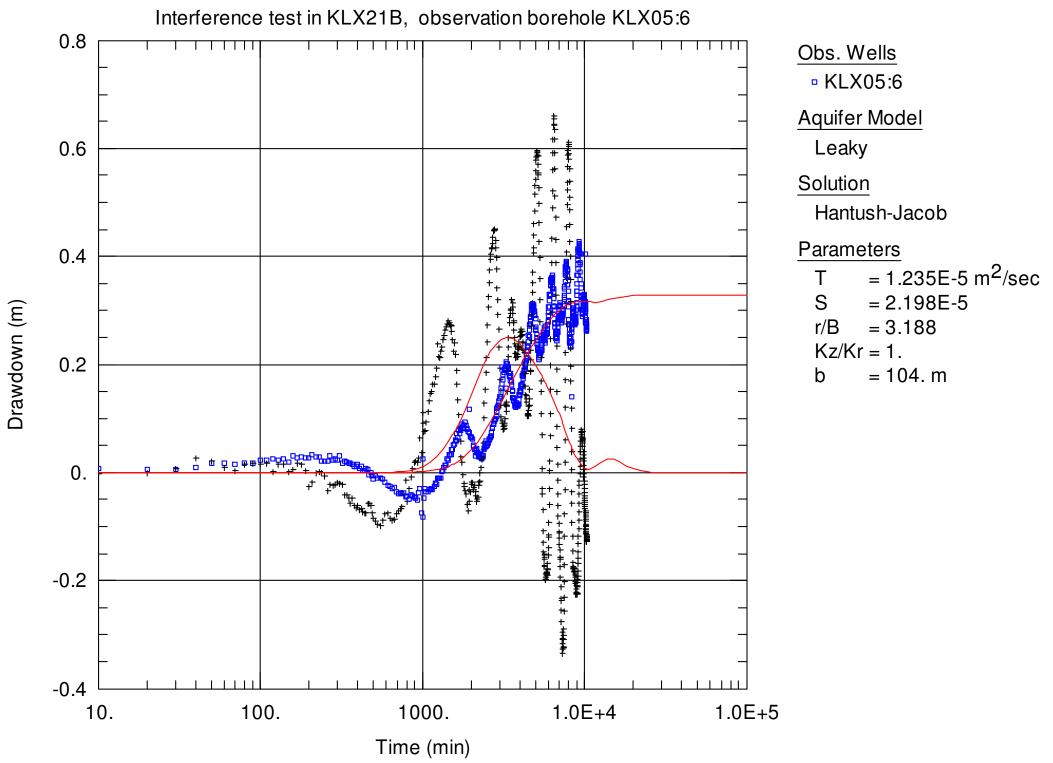


Figure 1-77. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:5 during pumping in borehole KLX21B.*

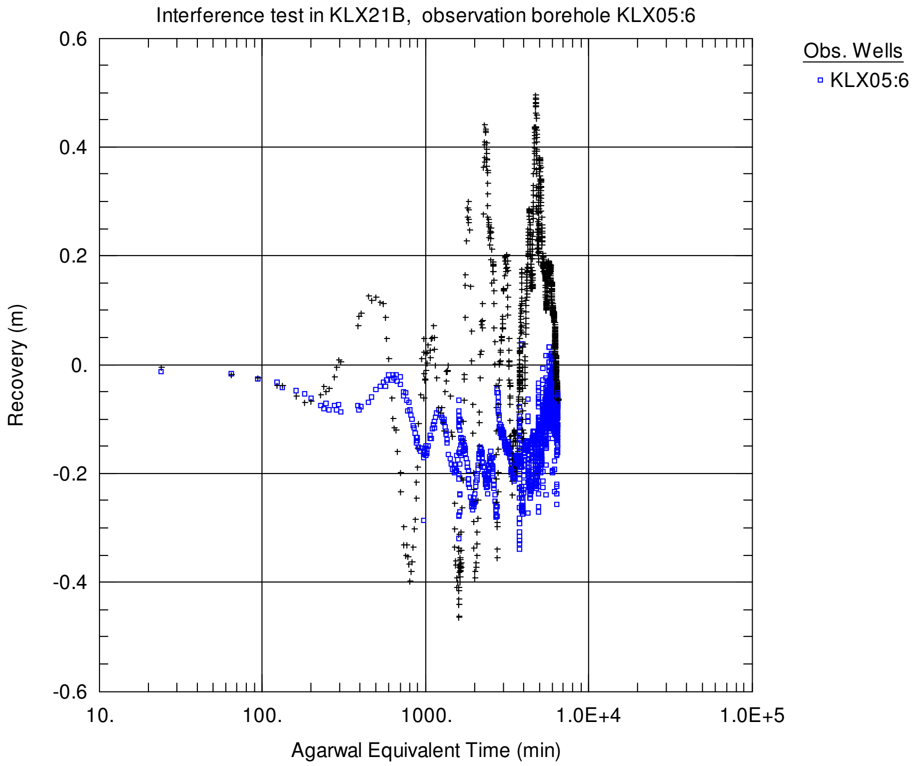


Figure 1-78. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:6 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

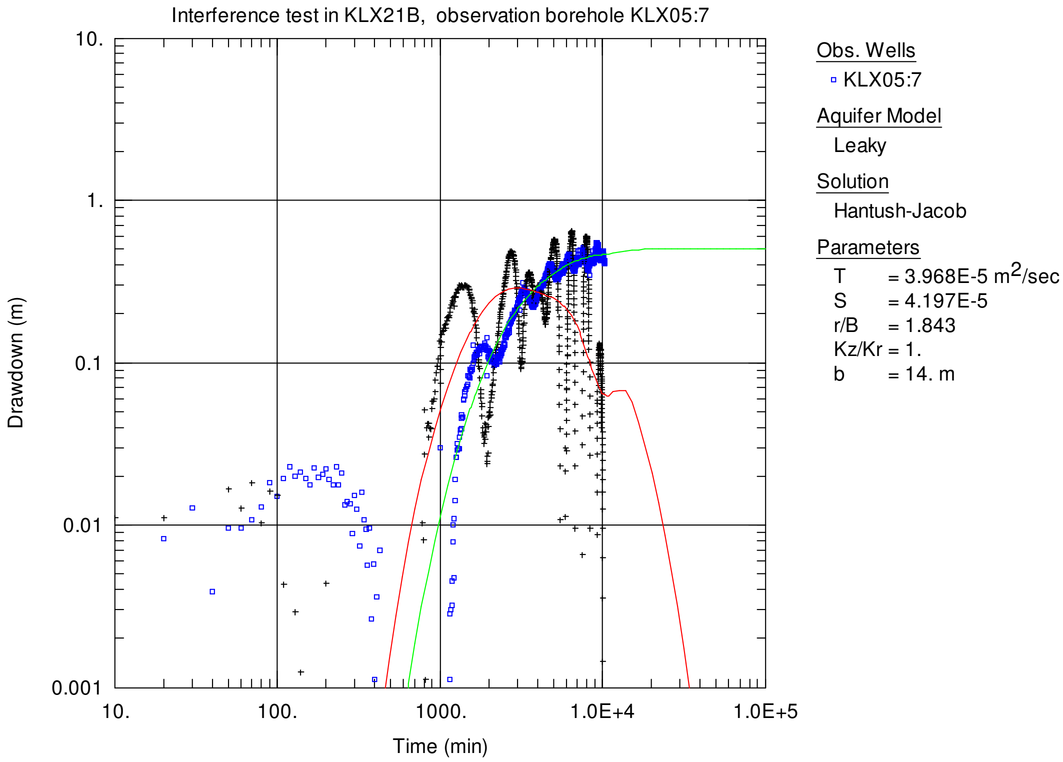


***Figure 1-79.** Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:7 during pumping in borehole KLX21B.*

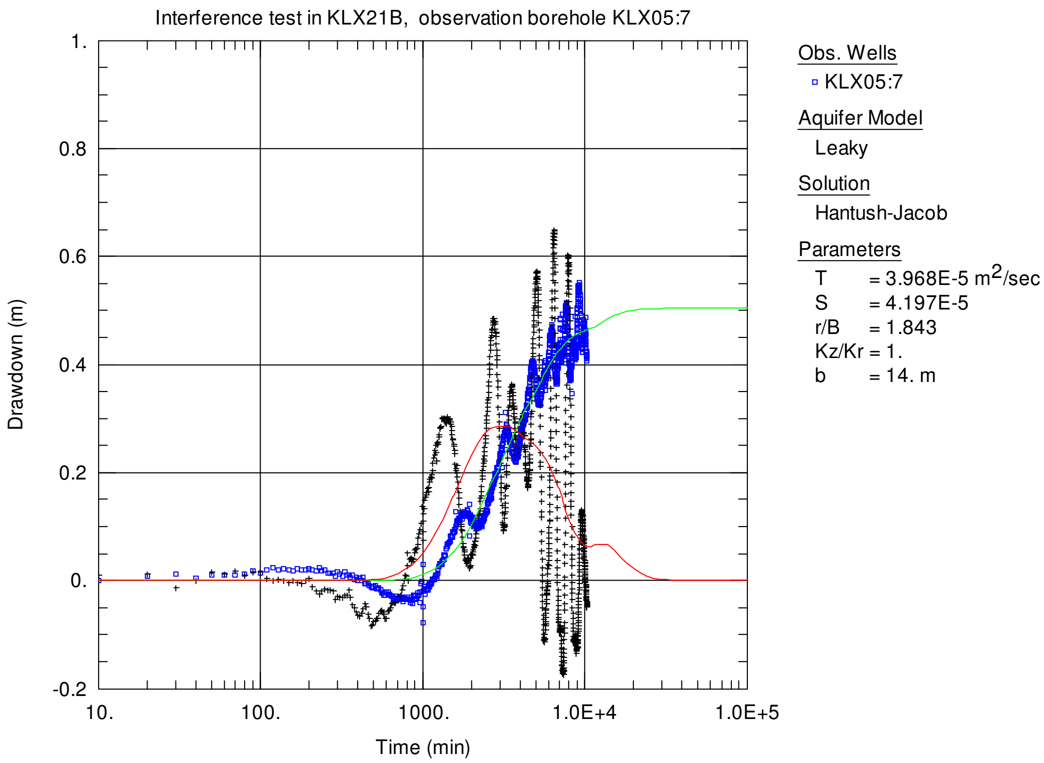


***Figure 1-80.** Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:7 during pumping in borehole KLX21B.*

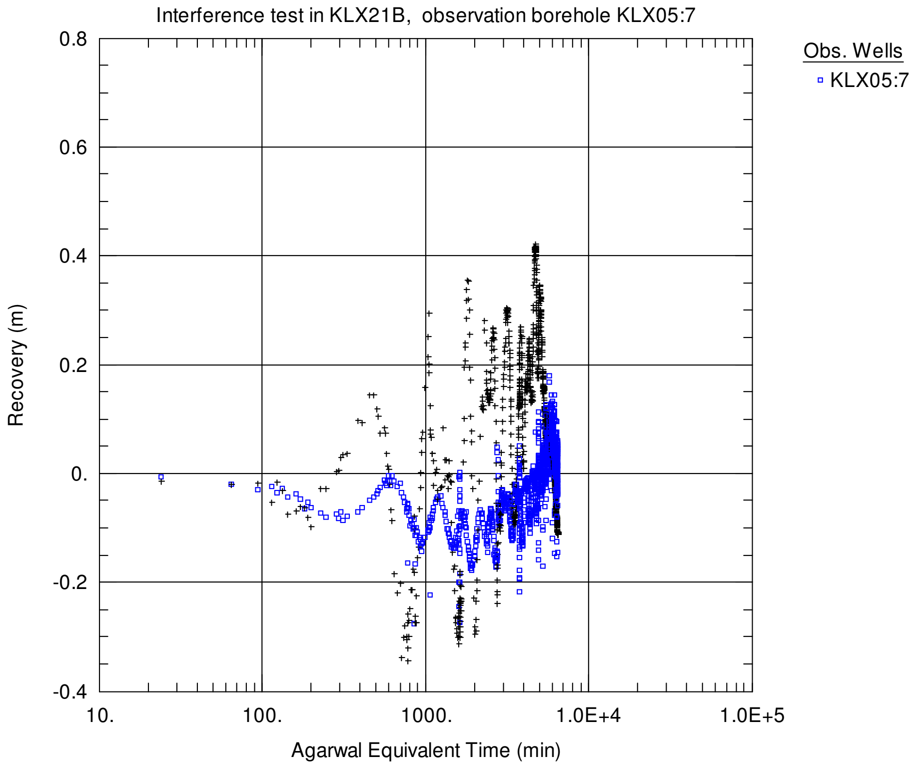


Figure 1-81. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:7 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible.*

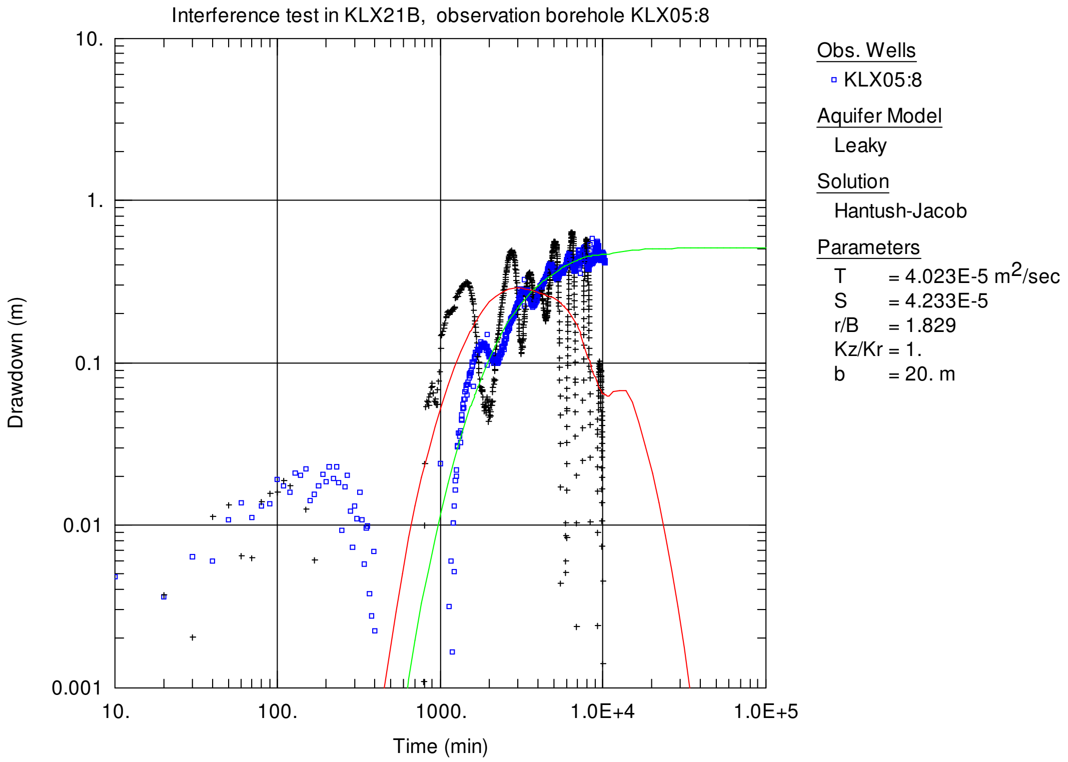


Figure 1-82. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:8 during pumping in borehole KLX21B.*

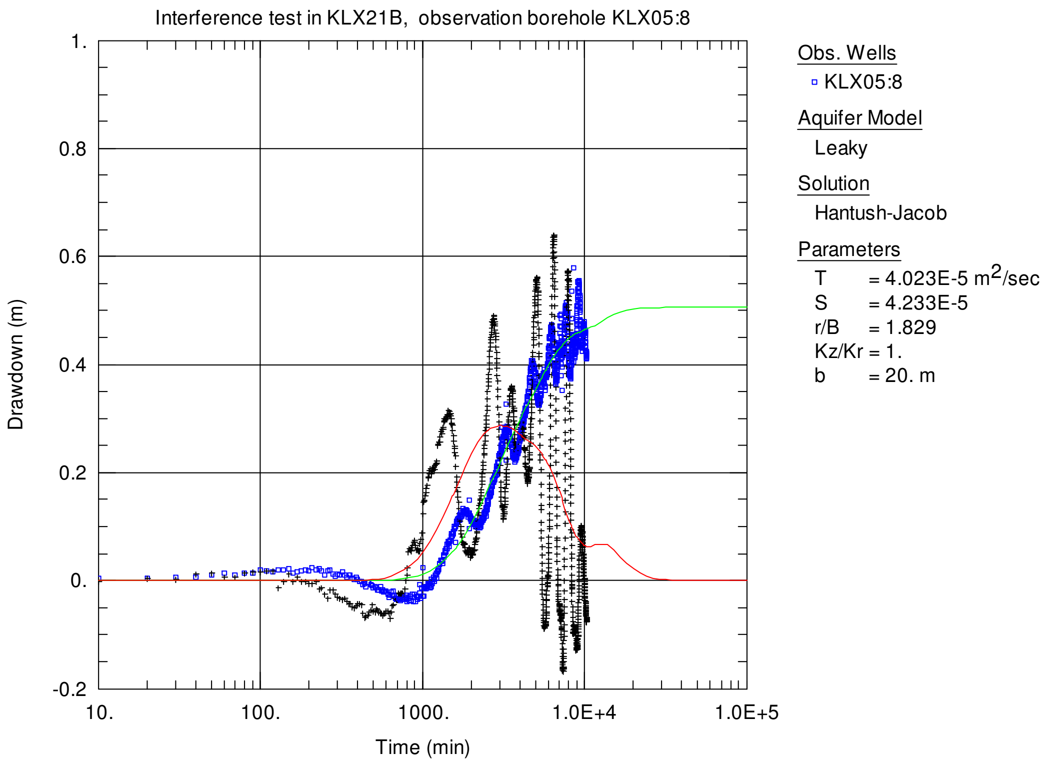


Figure 1-83. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:8 during pumping in borehole KLX21B.*

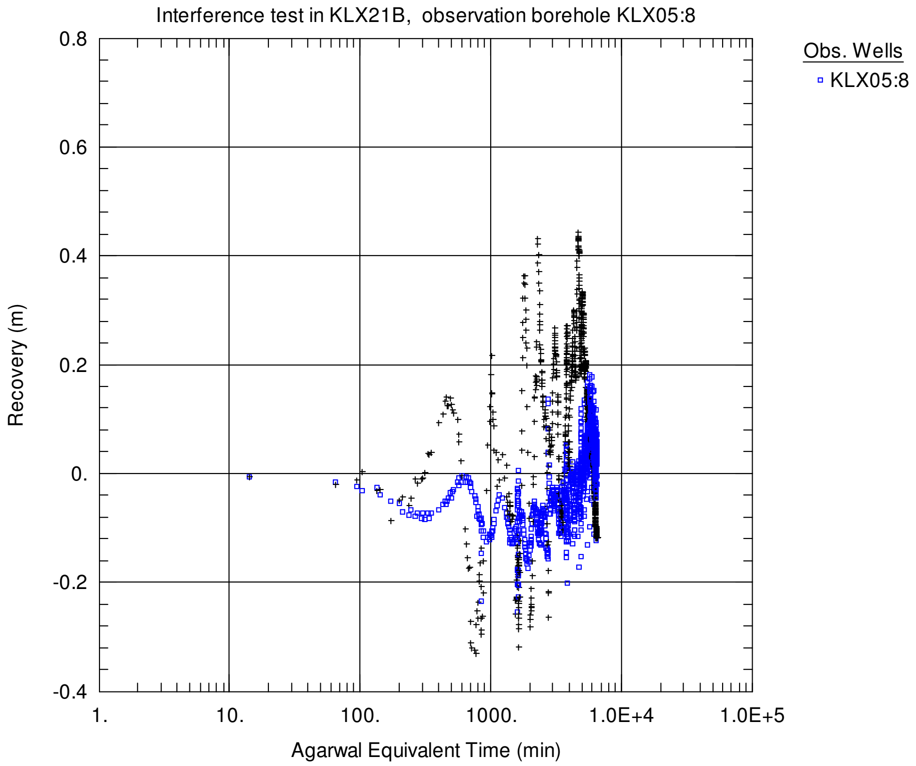


Figure 1-84. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:8 during pumping in borehole KLX21B. No type curve fit is shown since no unambiguous transient evaluation is possible*

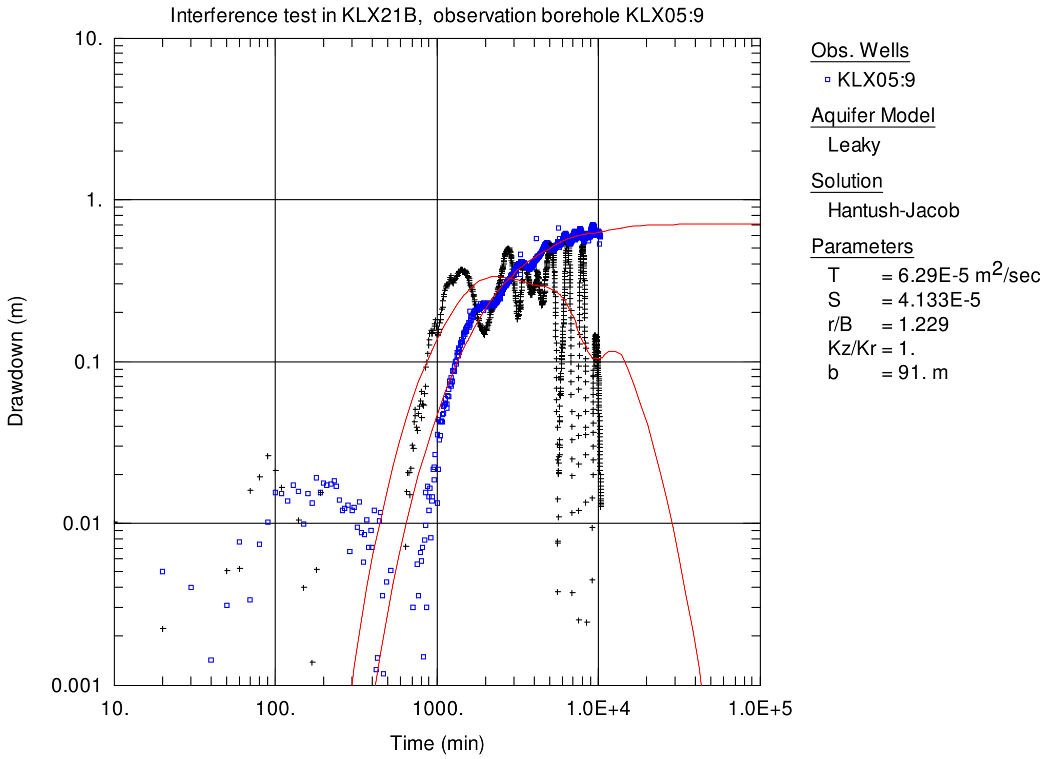


Figure 1-85. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:9 during pumping in borehole KLX21B.*

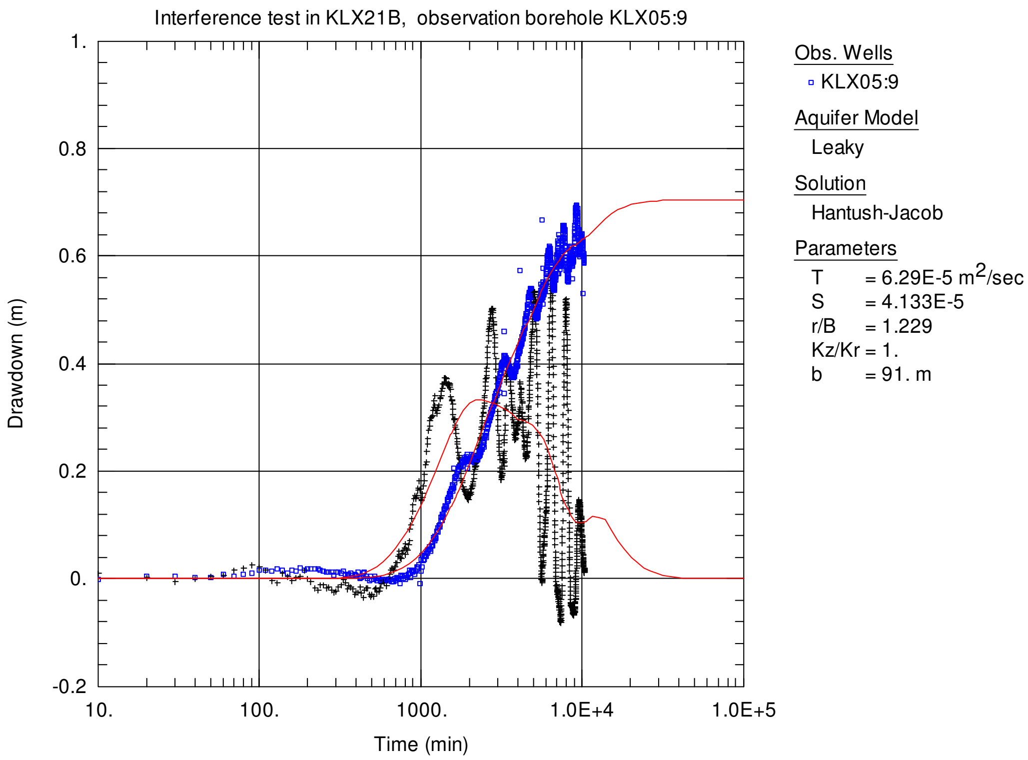


Figure 1-86. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:9 during pumping in borehole KLX21B.*

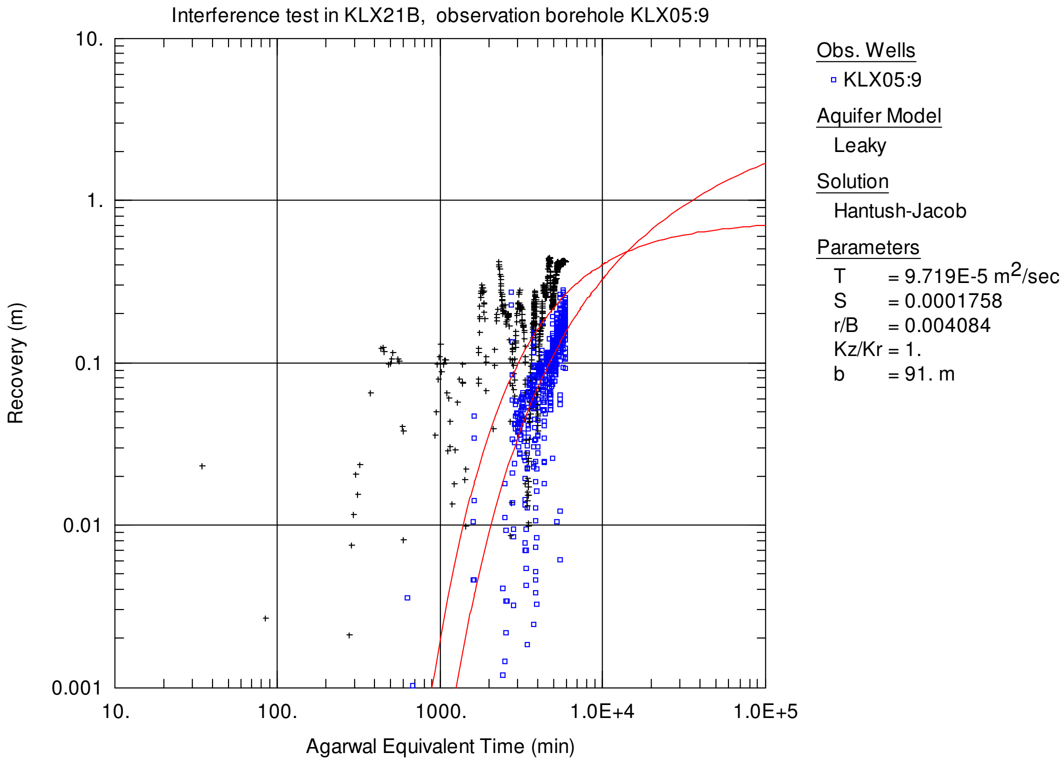


Figure 1-87. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:9 during pumping in borehole KLX21B.*

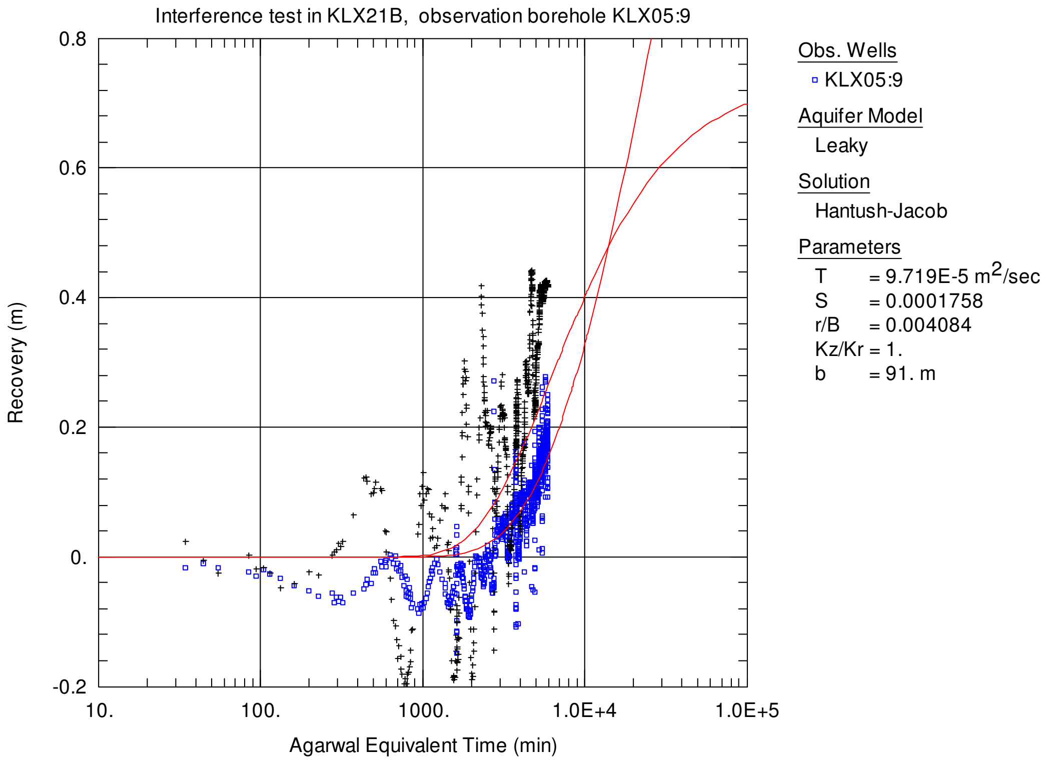


Figure 1-88. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:9 during pumping in borehole KLX21B.*

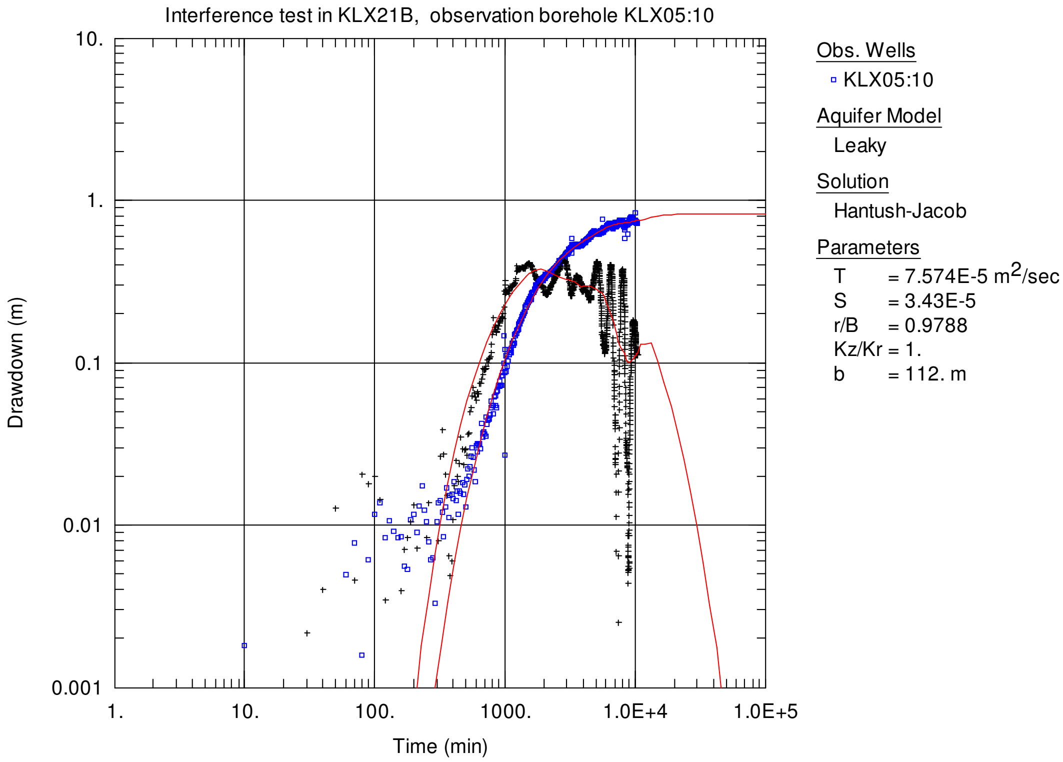


Figure 1-89. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:10 during pumping in borehole KLX21B.*

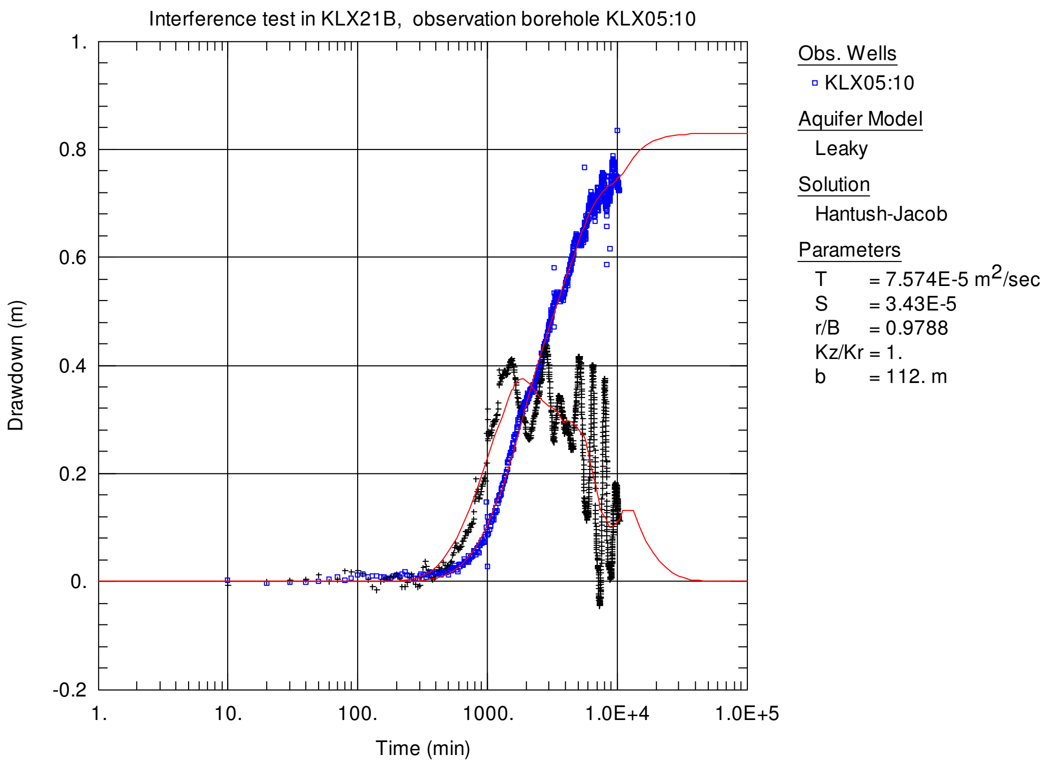


Figure 1-90. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX05:10 during pumping in borehole KLX21B.*

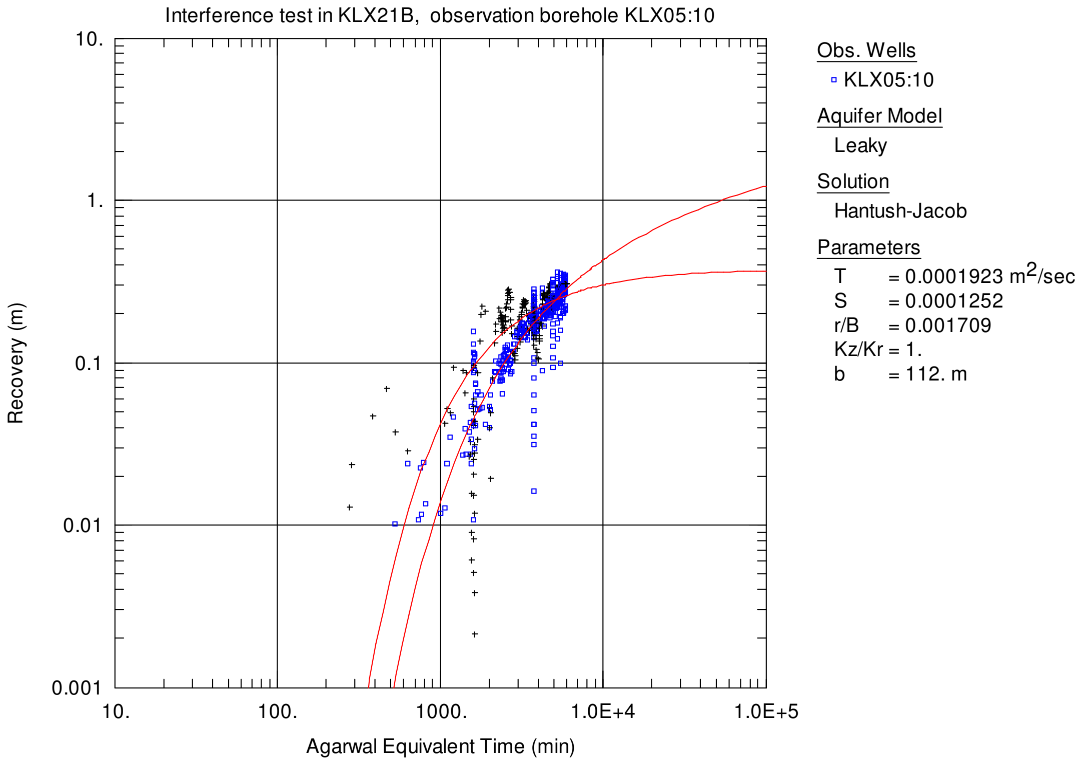


Figure 1-91. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:10 during pumping in borehole KLX21B.*

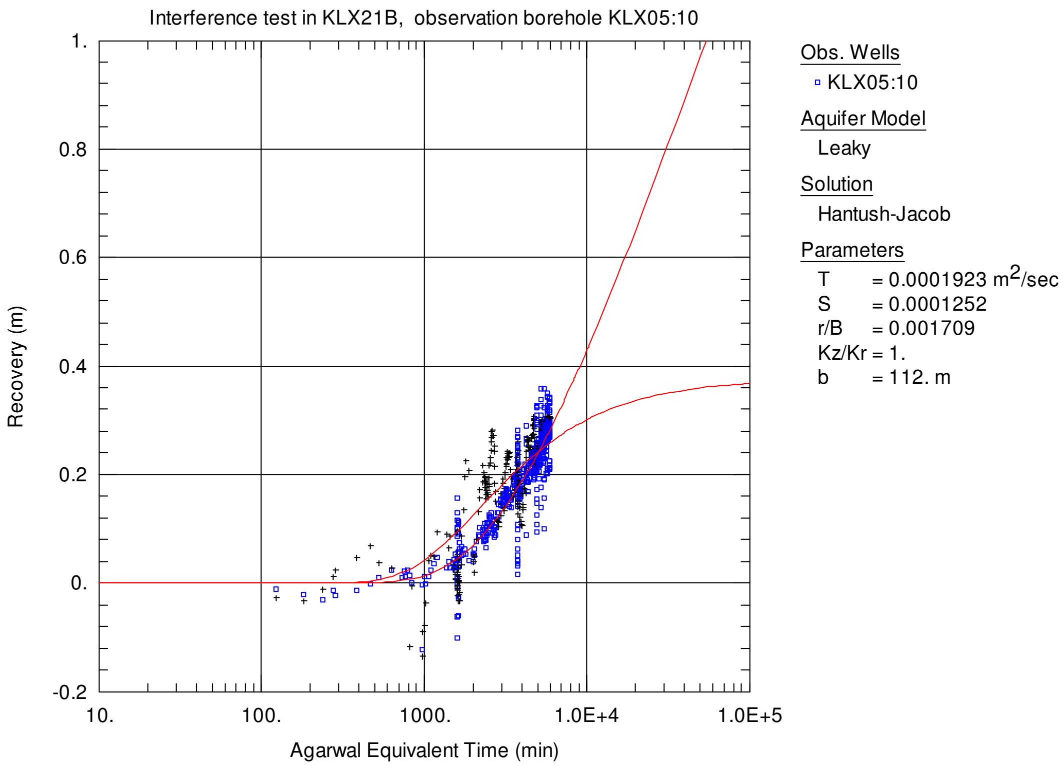


Figure 1-92. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX05:10 during pumping in borehole KLX21B.*

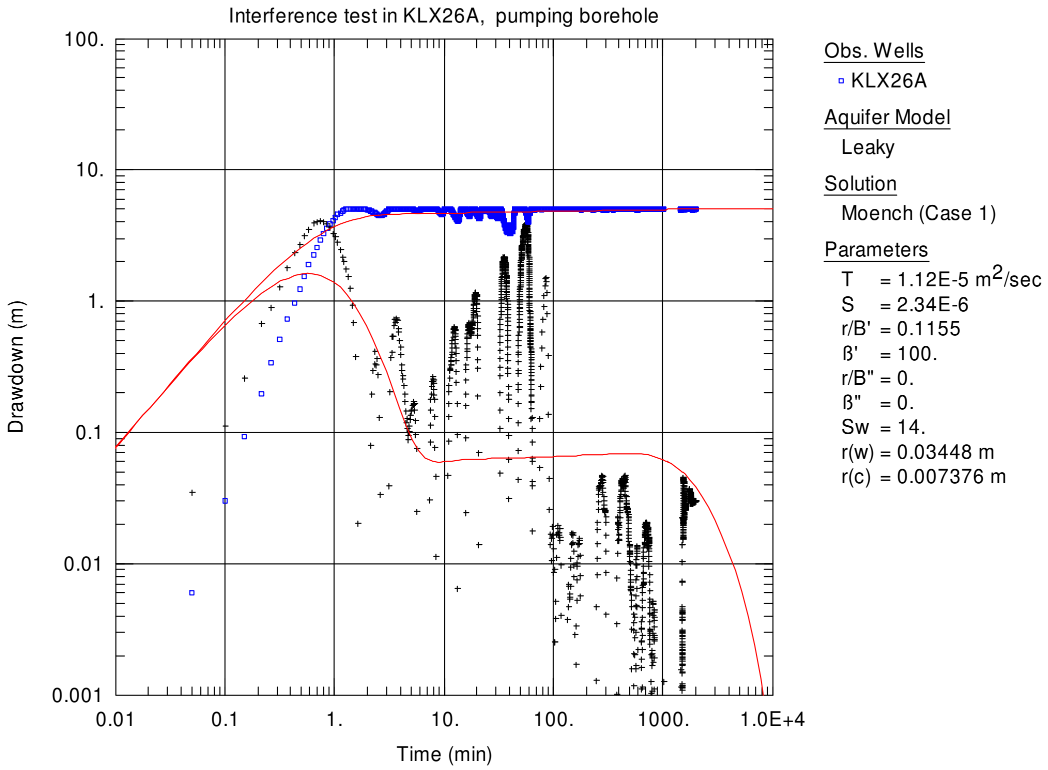


Figure 1-93. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX26A. No unambiguous transient evaluation is possible. The presented evaluation is an example of a possible evaluation.*

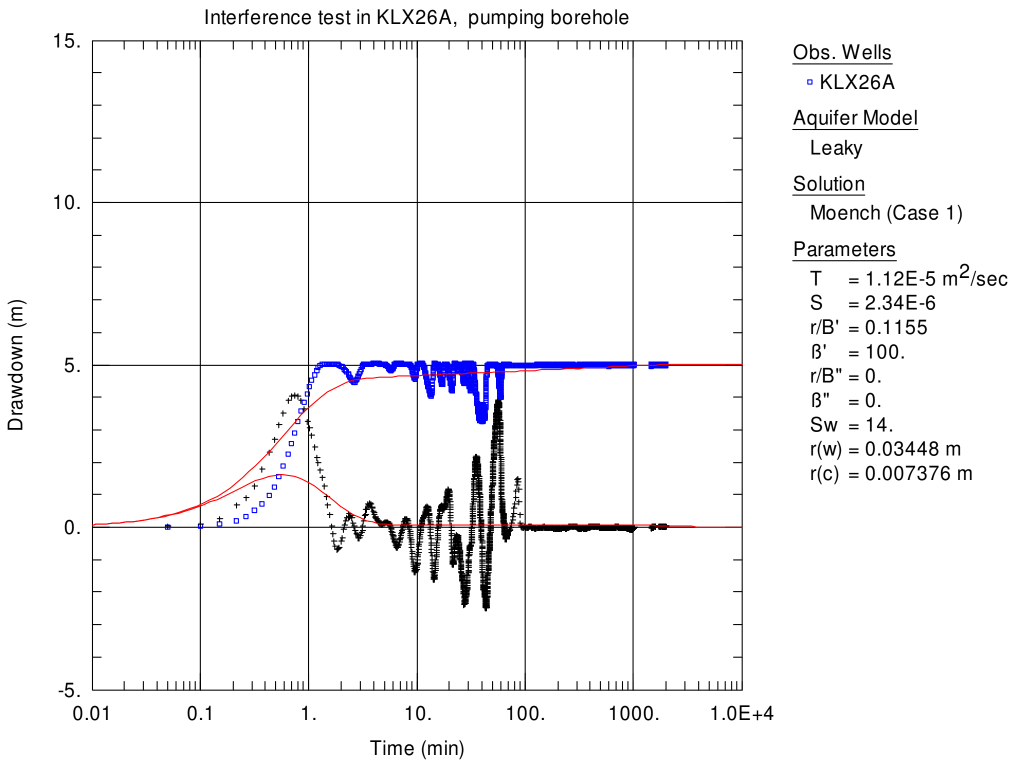


Figure 1-94. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX26A. No unambiguous transient evaluation is possible. The presented evaluation is an example of a possible evaluation.*

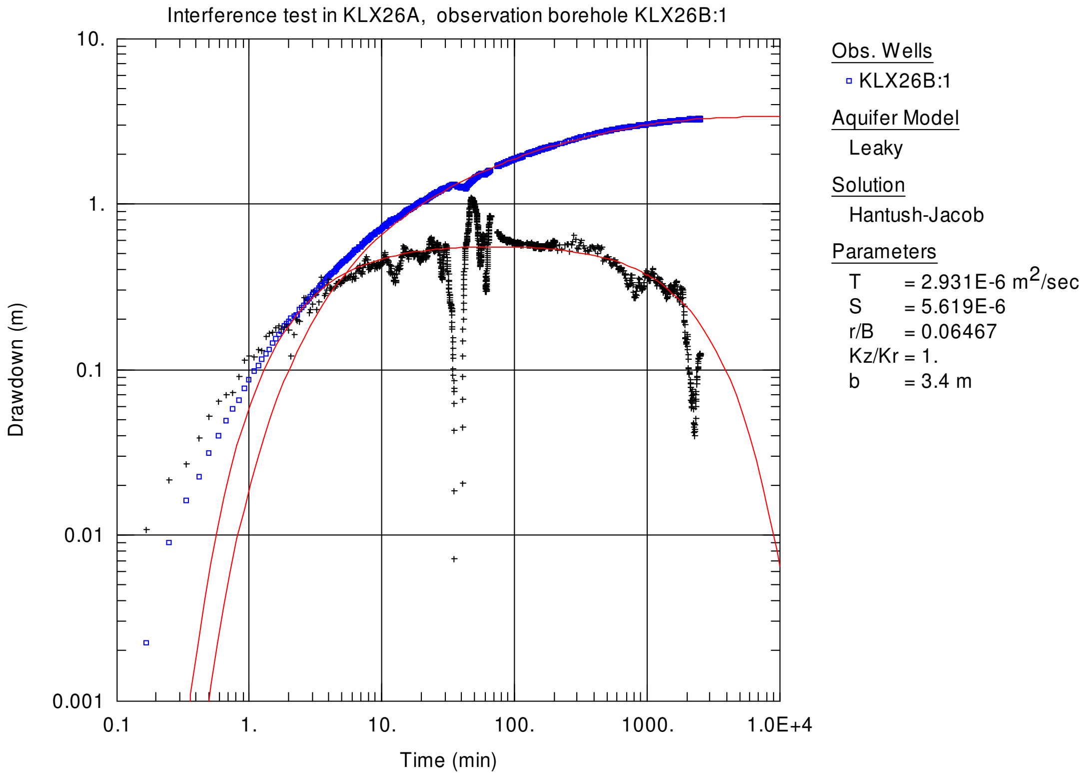


Figure 1-95. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26B:1 during pumping in borehole KLX26A.*

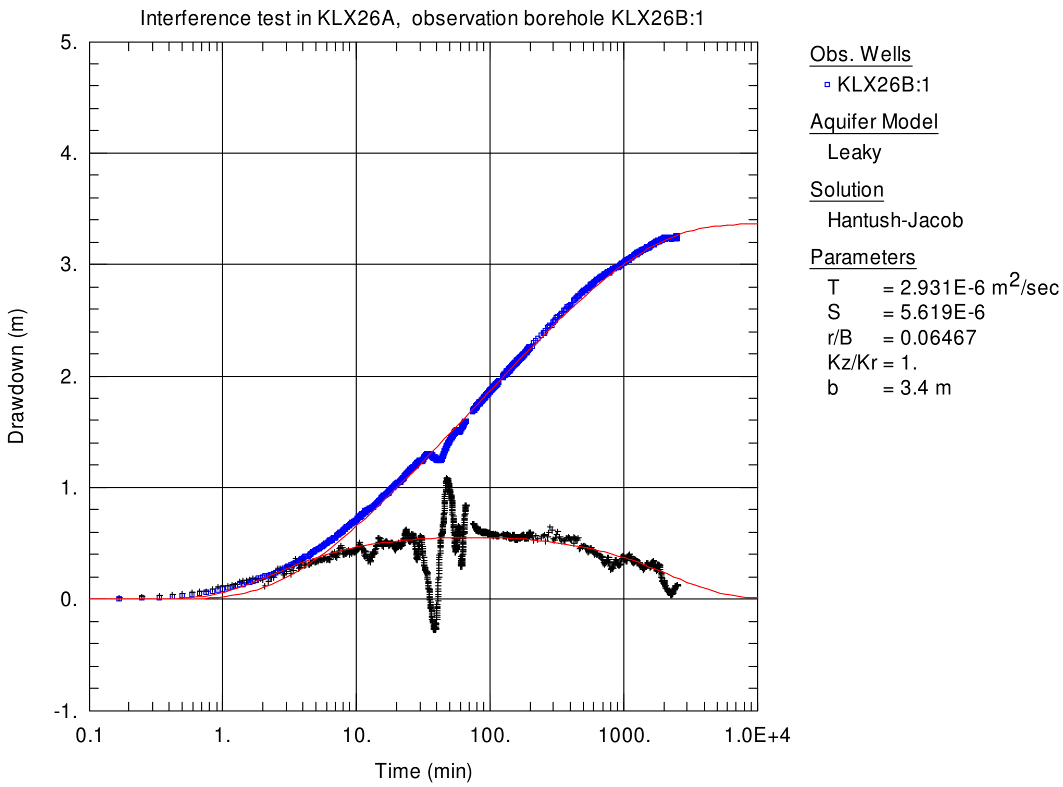


Figure 1-96. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26B:1 during pumping in borehole KLX26A.*

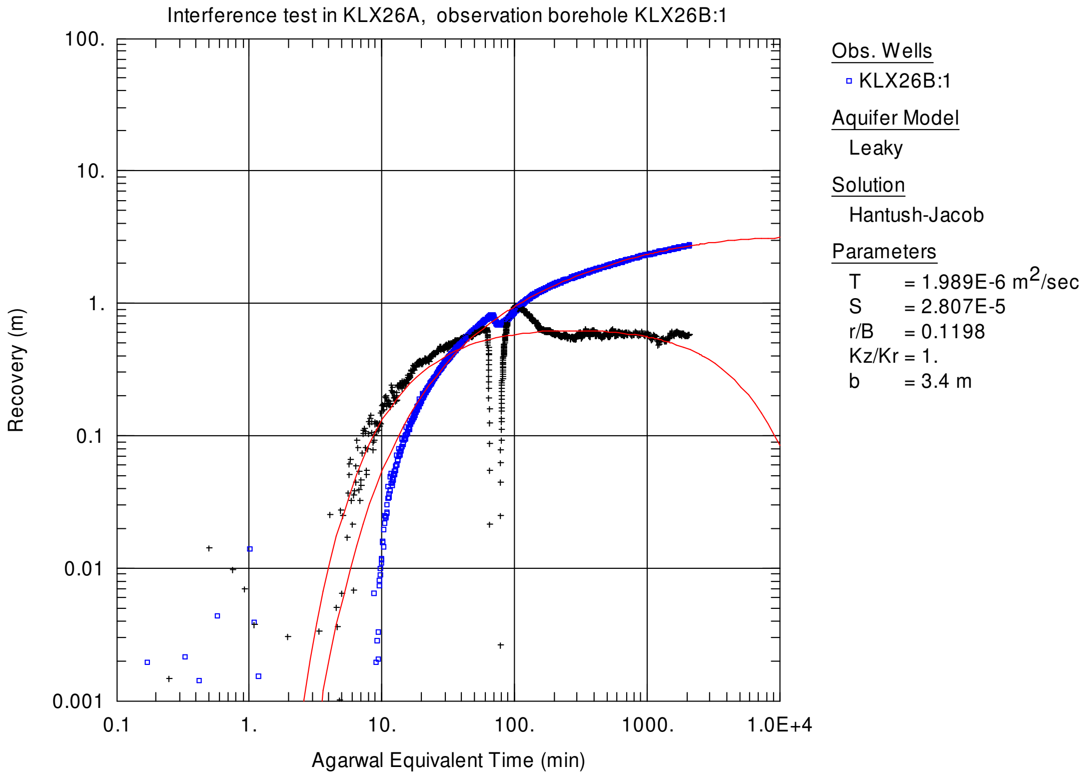


Figure 1-97. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26B:1 during pumping in borehole KLX26A.*

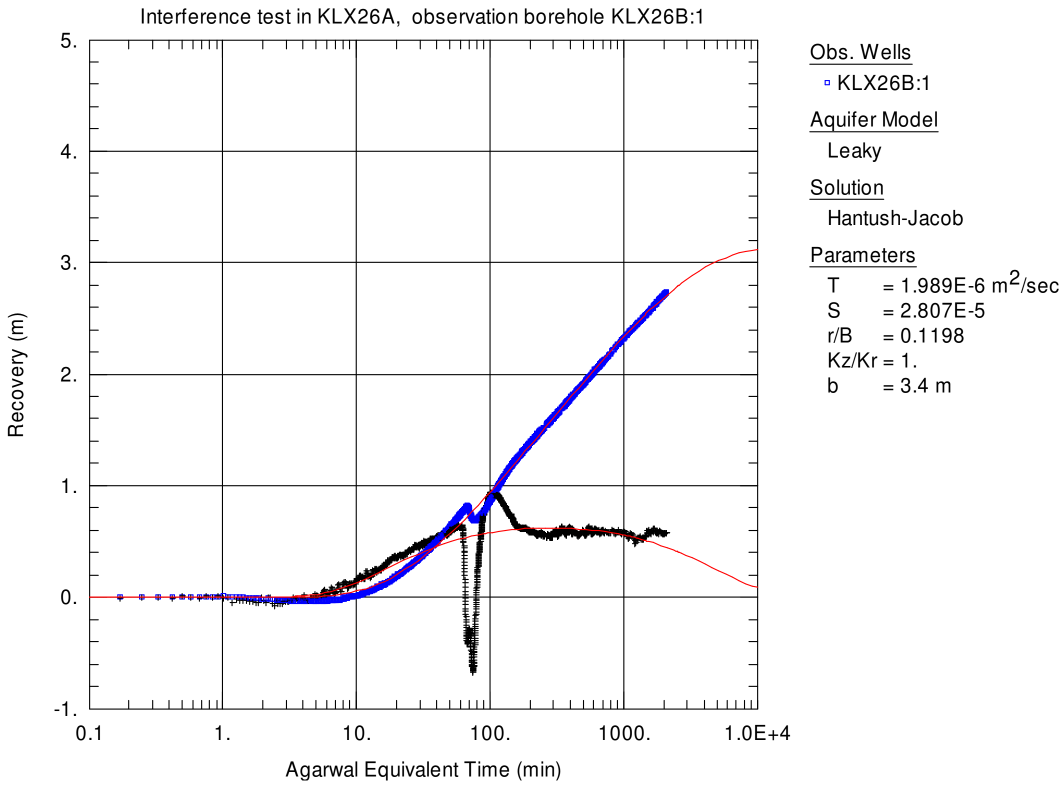


Figure 1-98. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26B:1 during pumping in borehole KLX26A.*

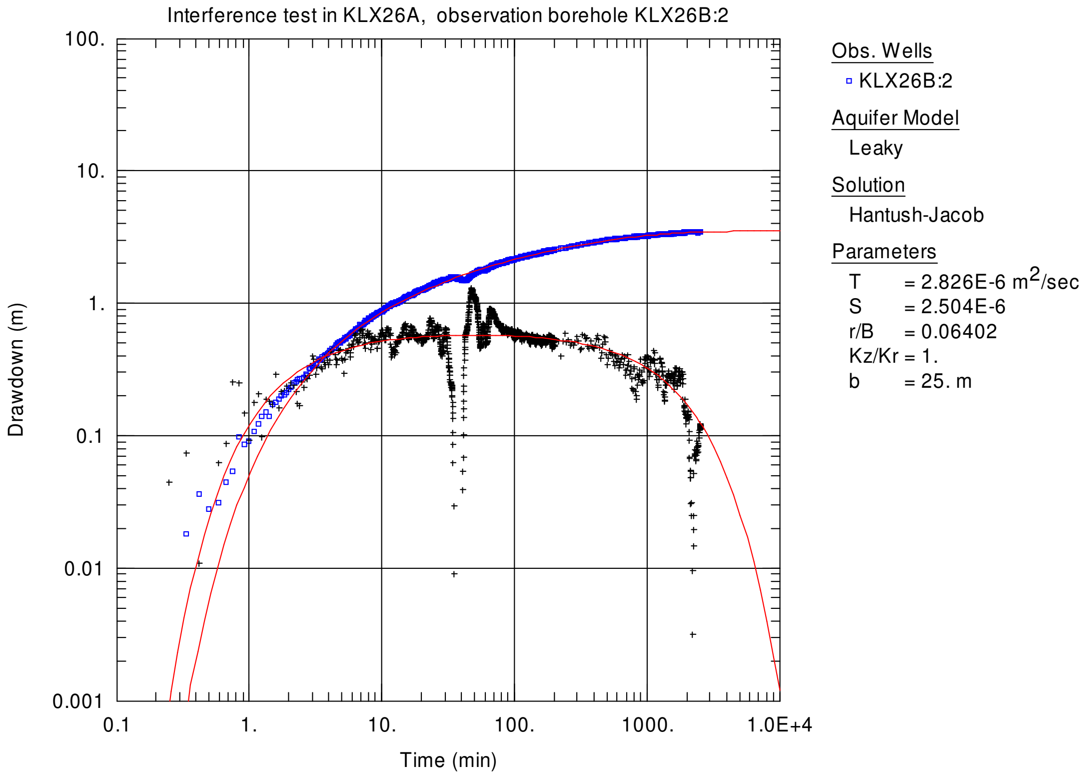


Figure 1-99. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26B:2 during pumping in borehole KLX26A.*

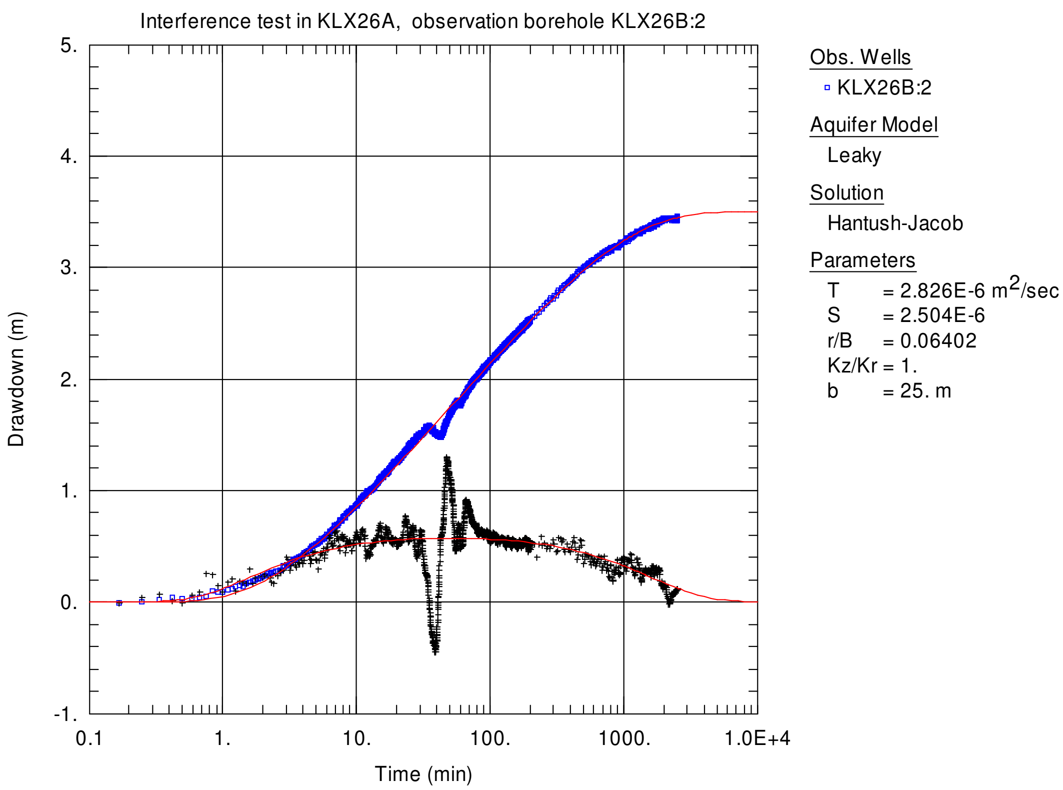


Figure 1-100. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26B:2 during pumping in borehole KLX26A.*

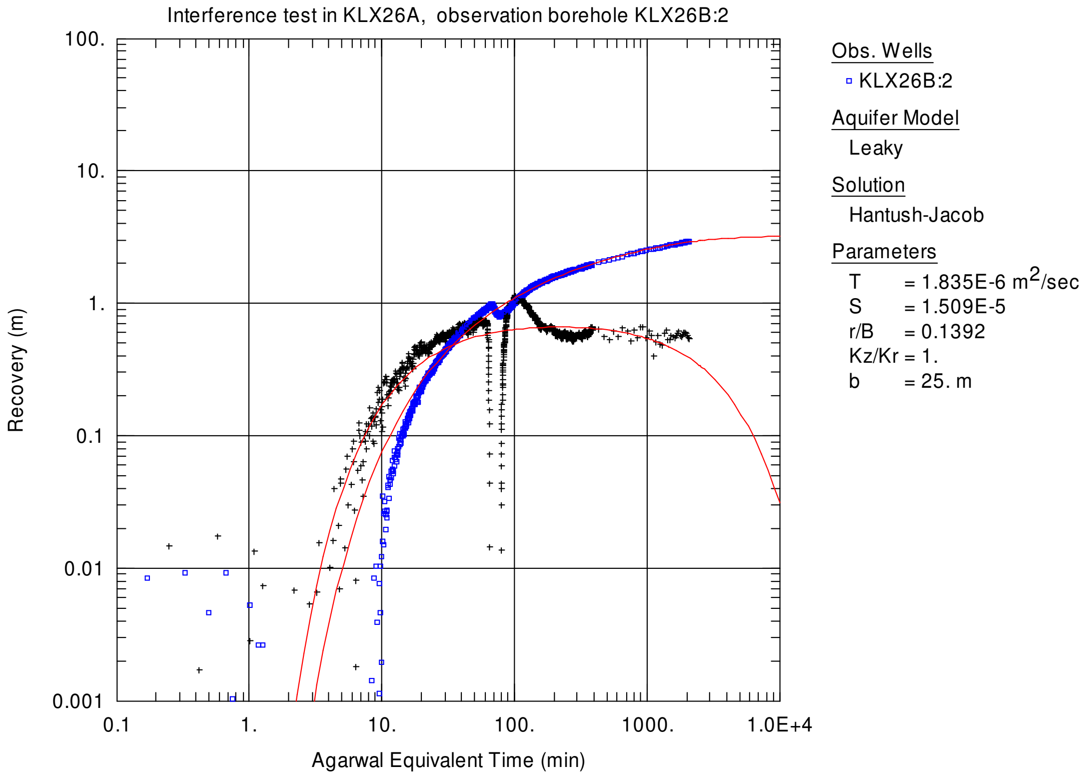


Figure 1-101. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26B:2 during pumping in borehole KLX26A.*

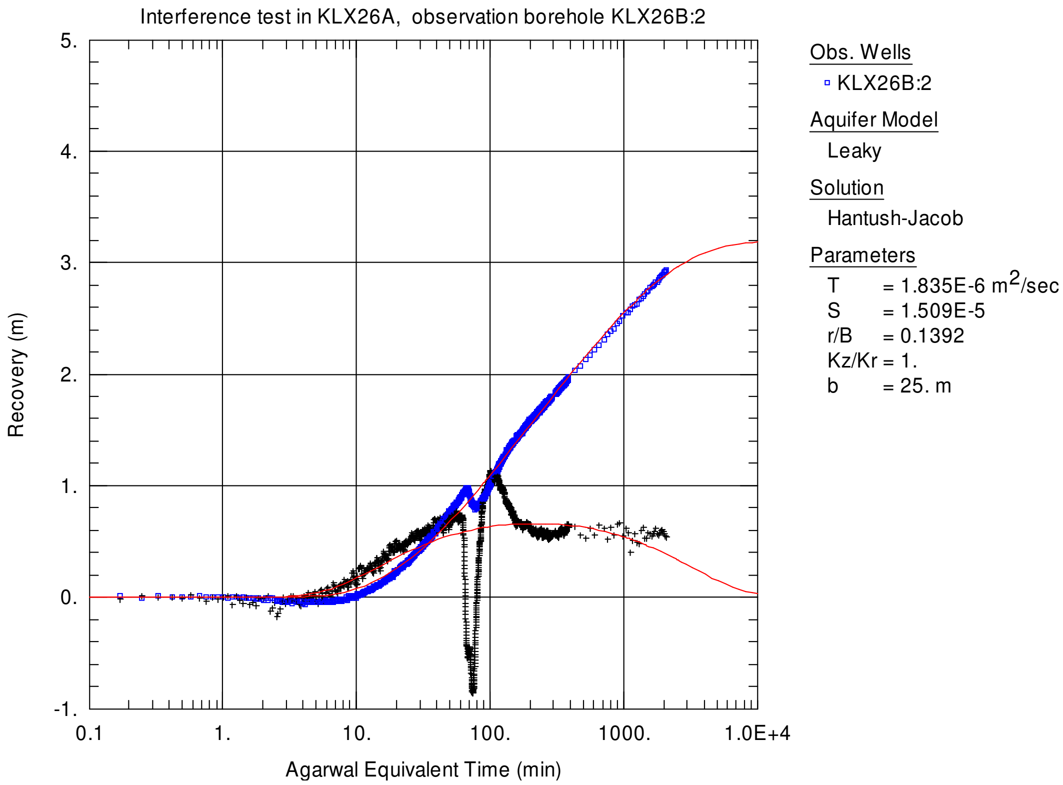


Figure 1-102. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26B:2 during pumping in borehole KLX26A.*

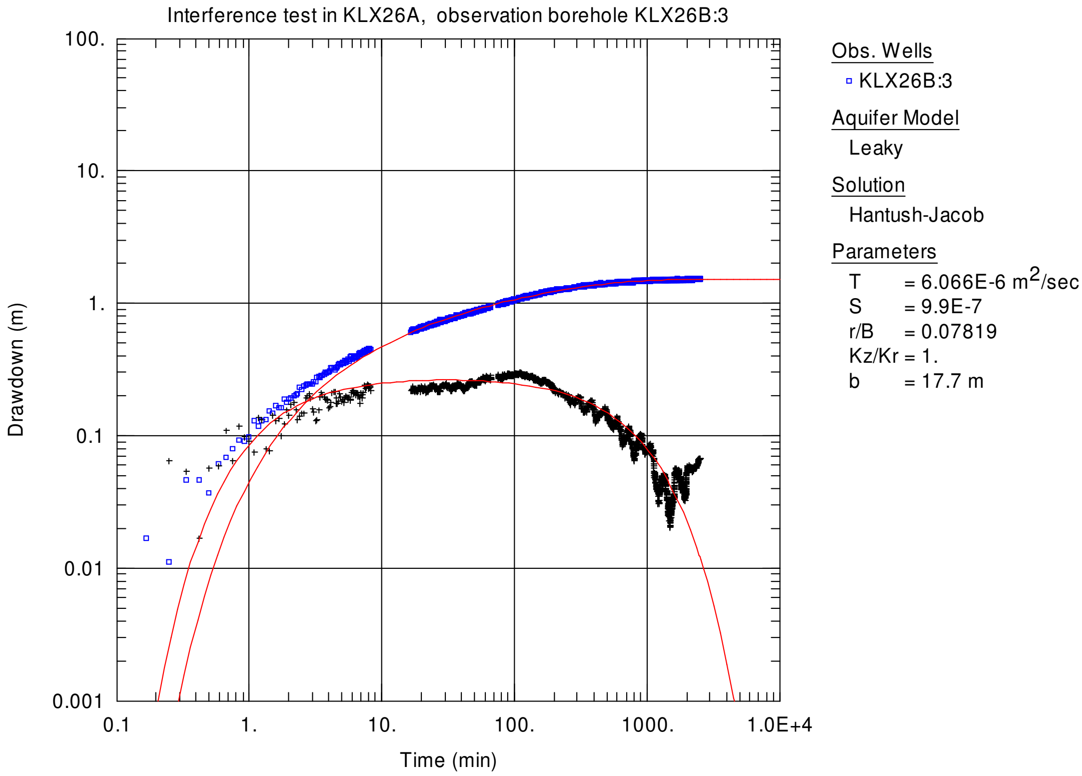


Figure 1-103. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26B:3 during pumping in borehole KLX26A.*

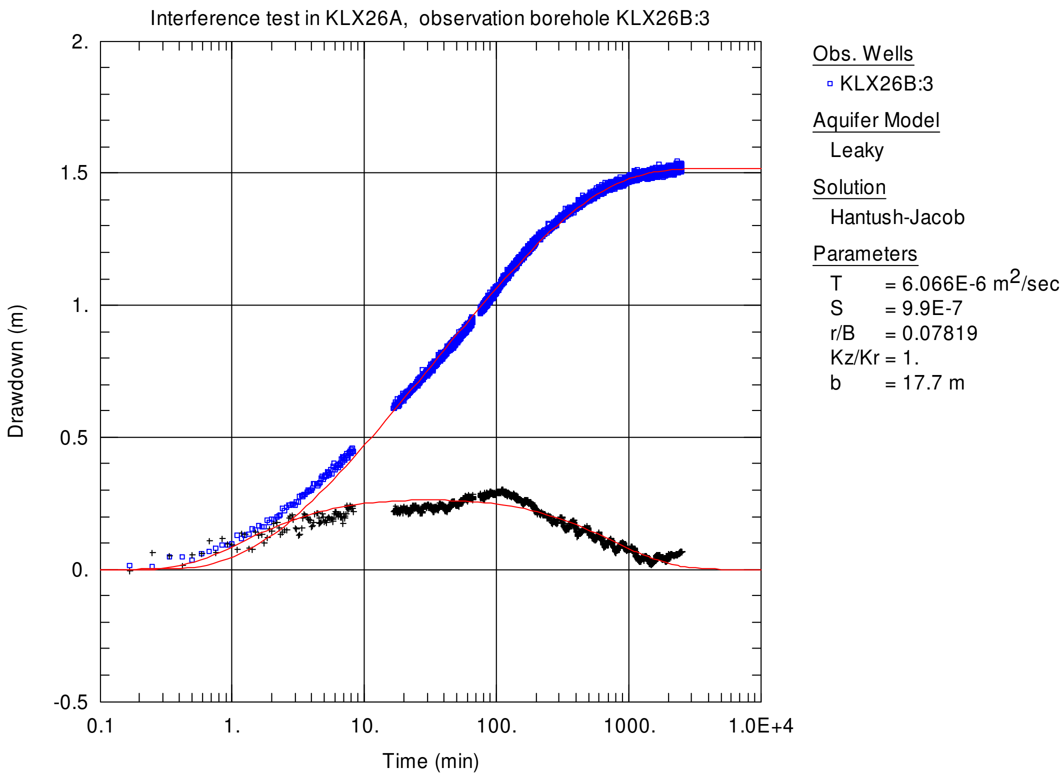


Figure 1-104. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26B:3 during pumping in borehole KLX26A.*

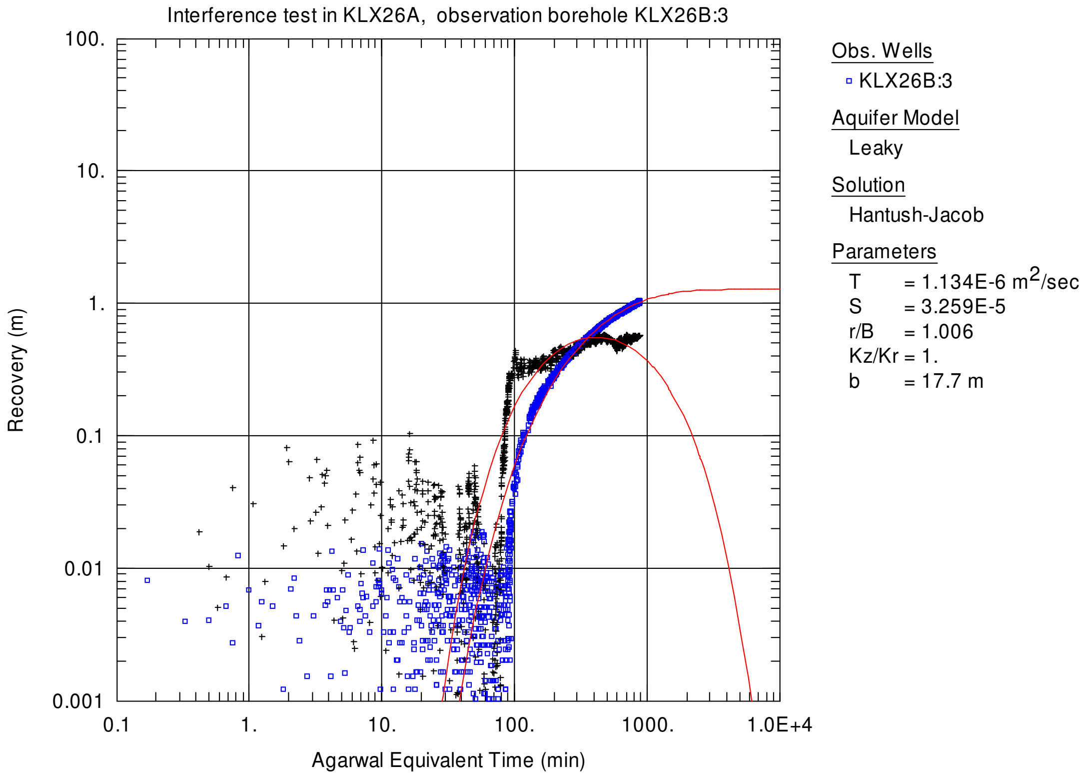


Figure 1-105. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26B:3 during pumping in borehole KLX26A.*

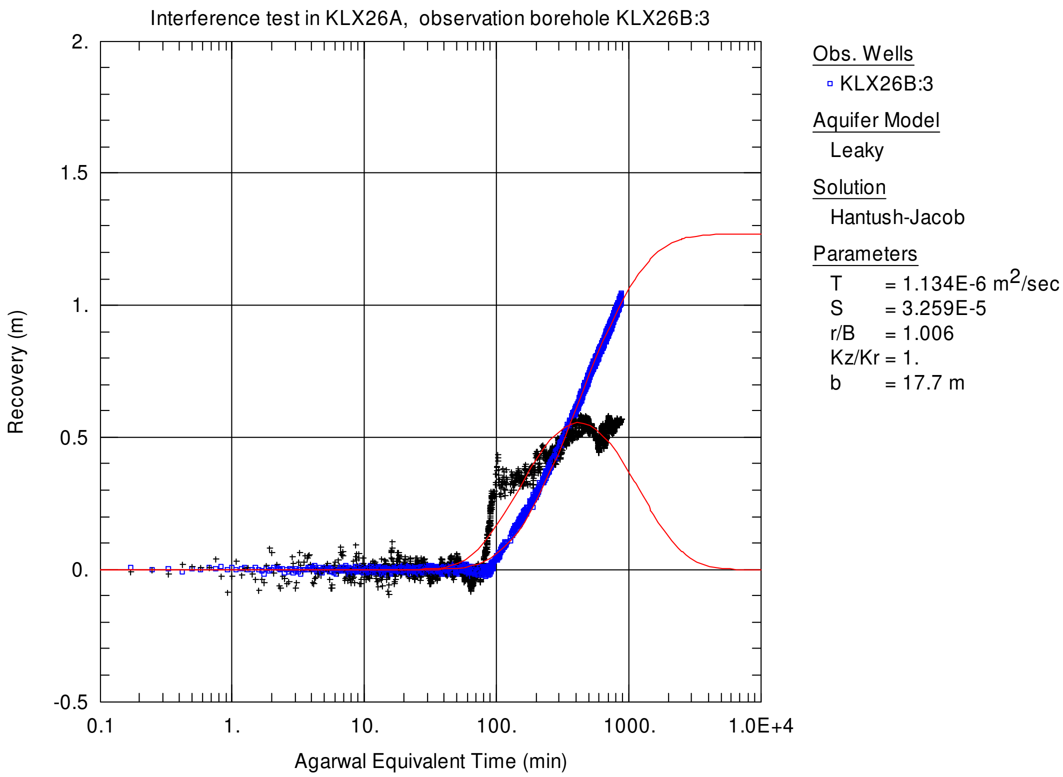


Figure 1-106. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26B:3 during pumping in borehole KLX26A.*

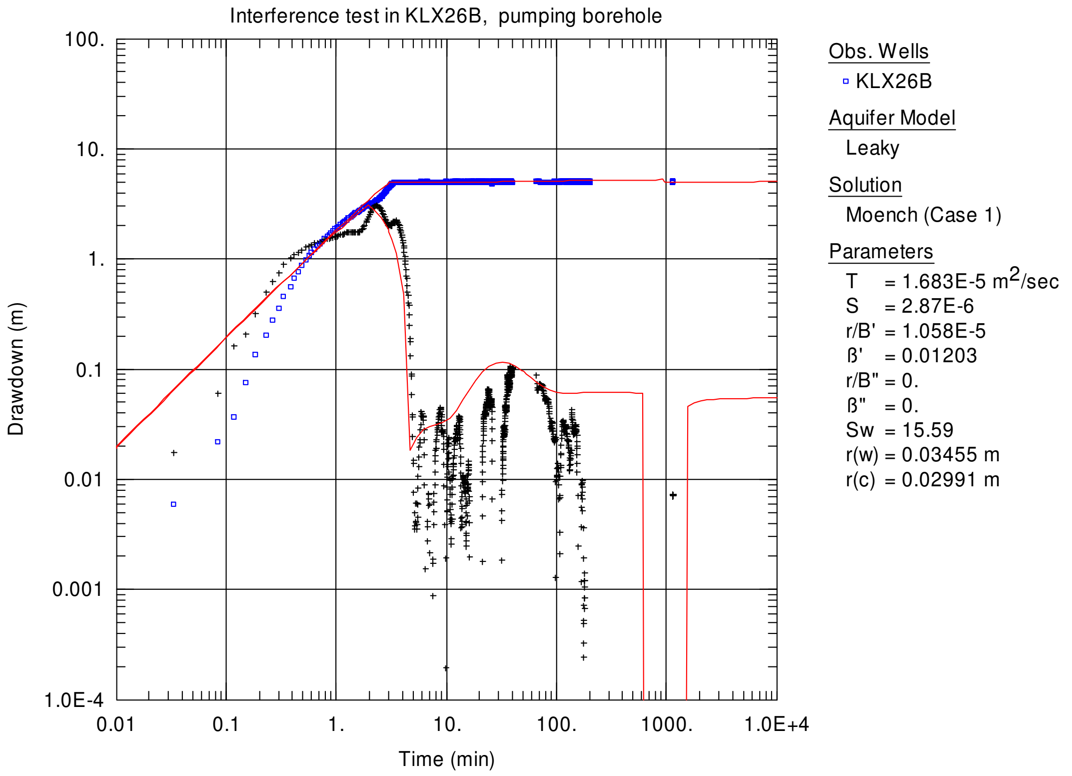


Figure 1-107. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX26B.*

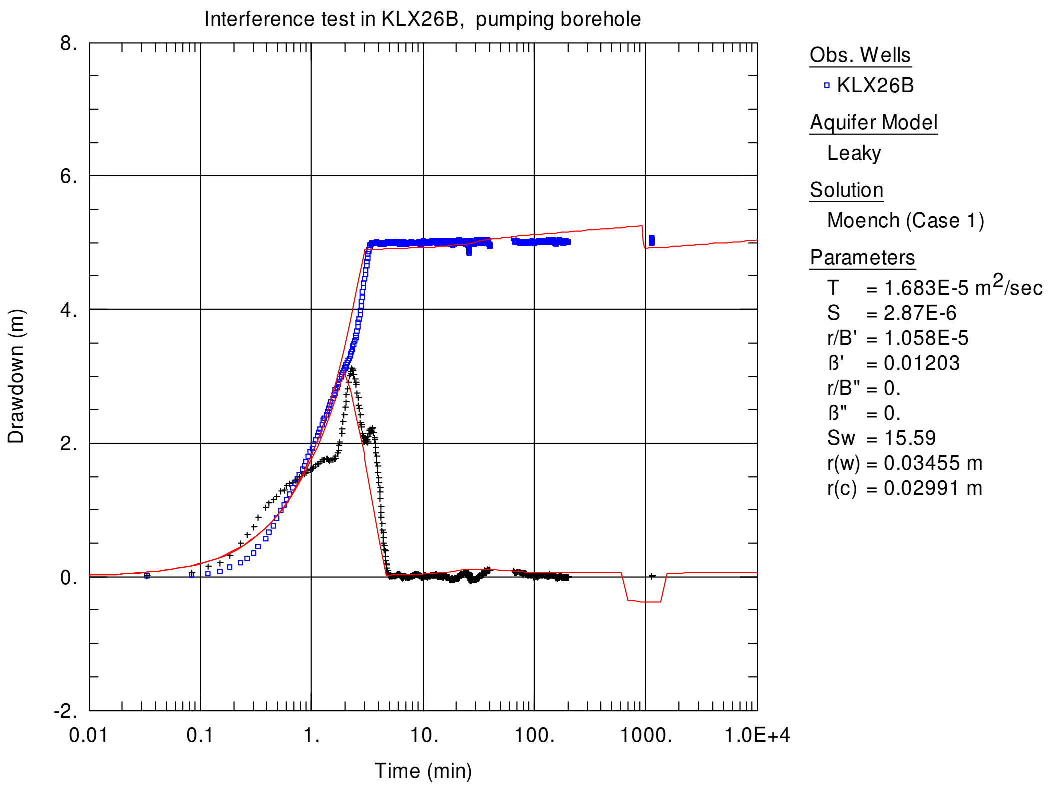


Figure 1-108. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX26B.*

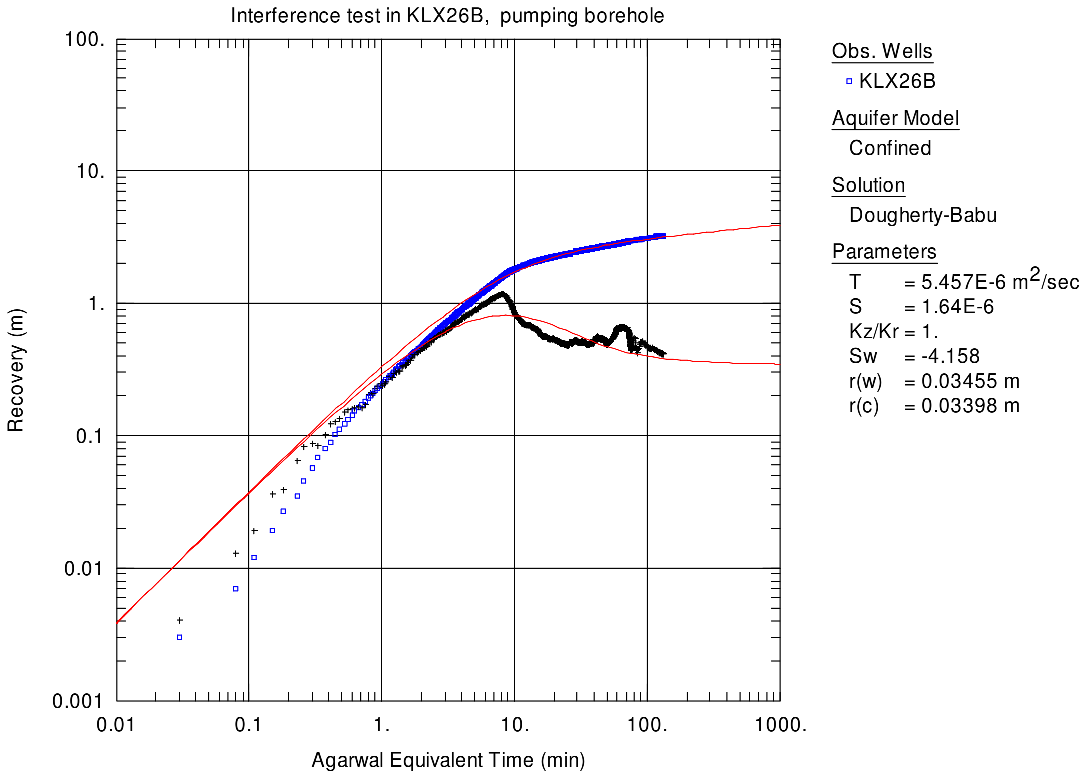


Figure 1-109. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX26B. The evaluation is based on the late-time recovery response.*

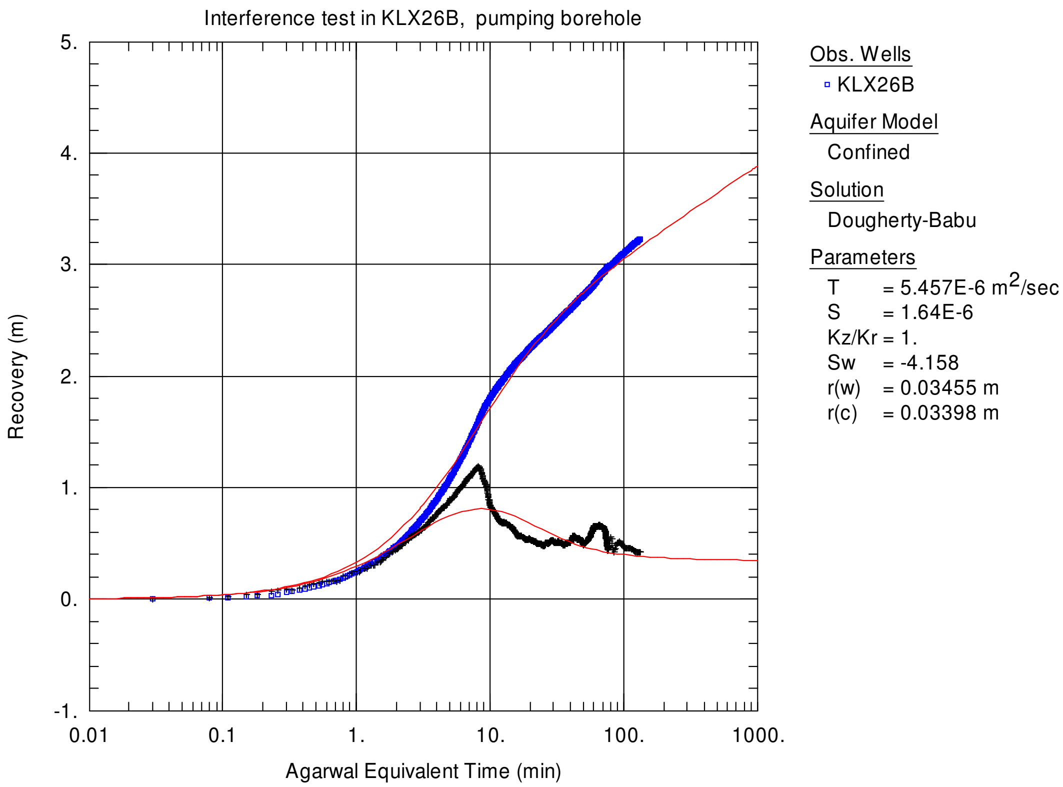


Figure 1-110. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX26B. The evaluation is based on the late-time recovery response.*

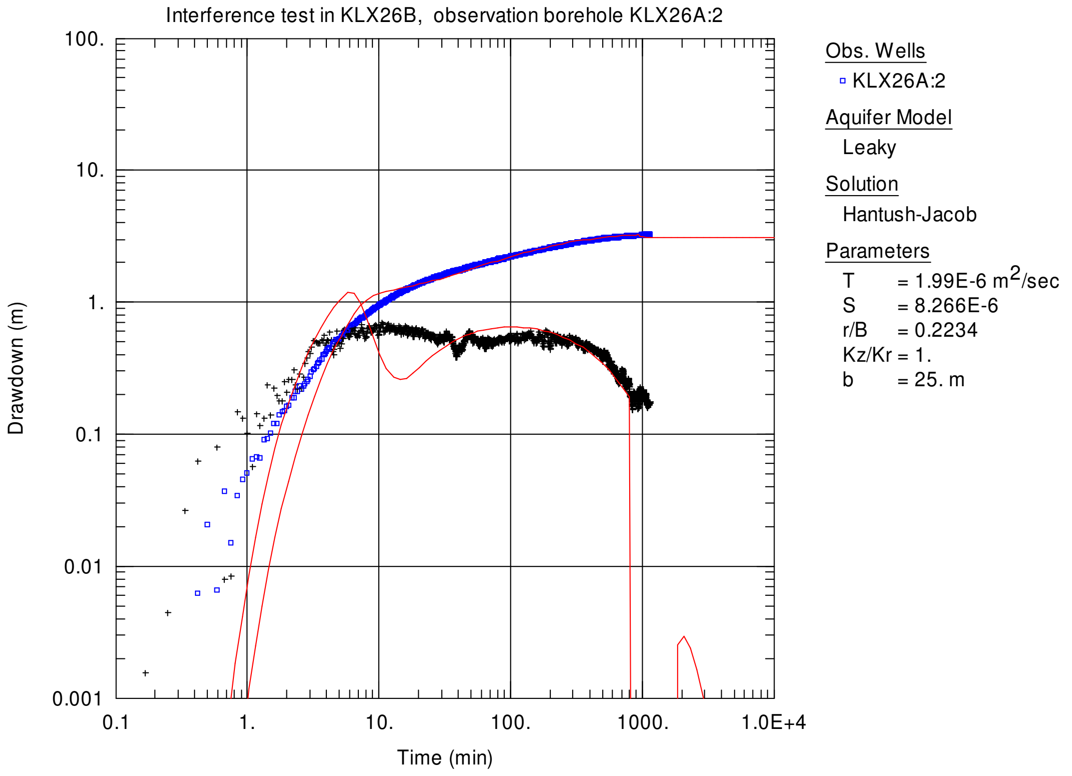


Figure 1-111. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26A:2 during pumping in borehole KLX26B.*

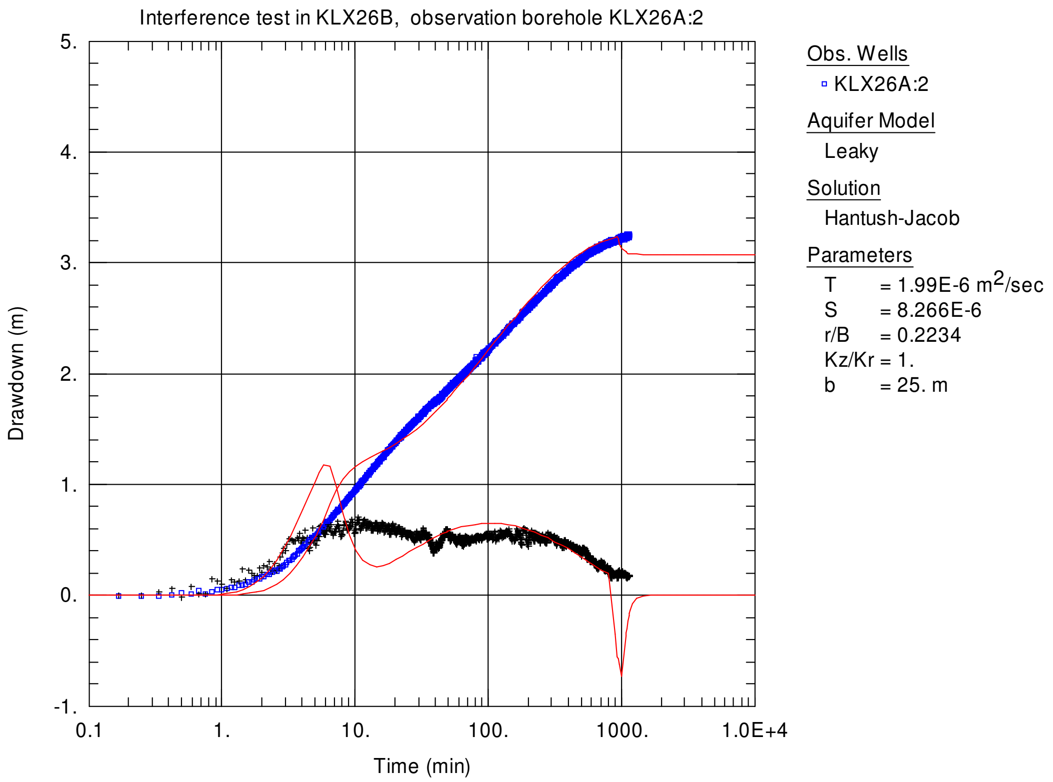


Figure 1-112. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26A:2 during pumping in borehole KLX26B.*

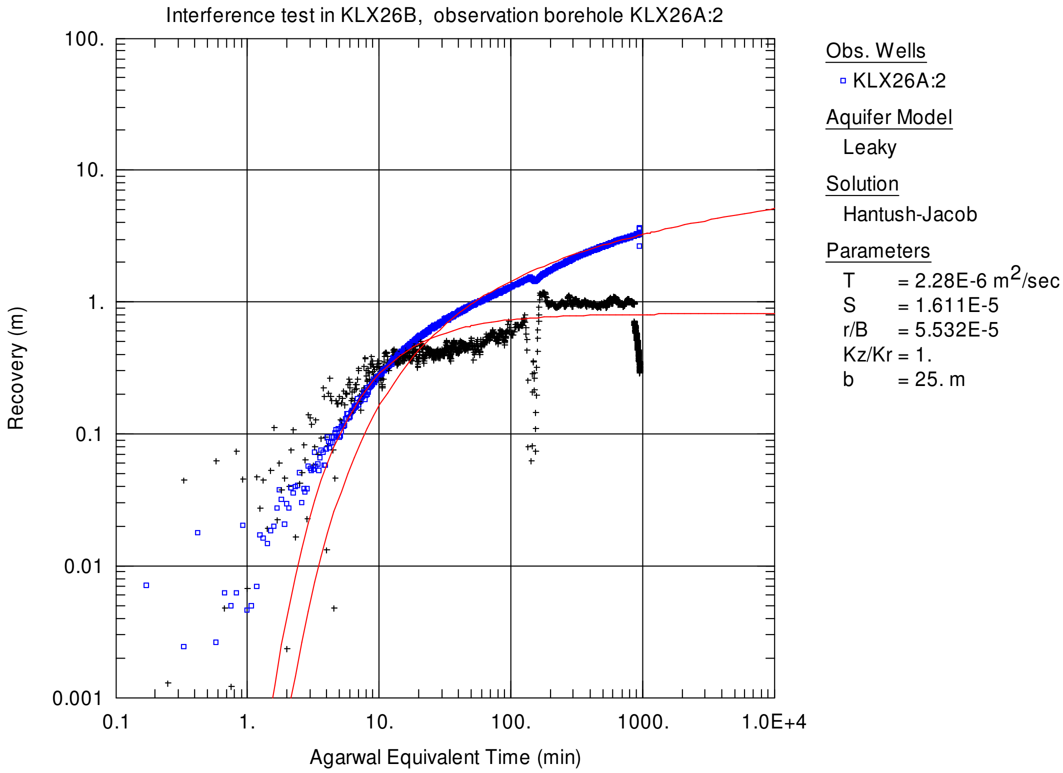


Figure 1-113. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26A:2 during pumping in borehole KLX26B.*

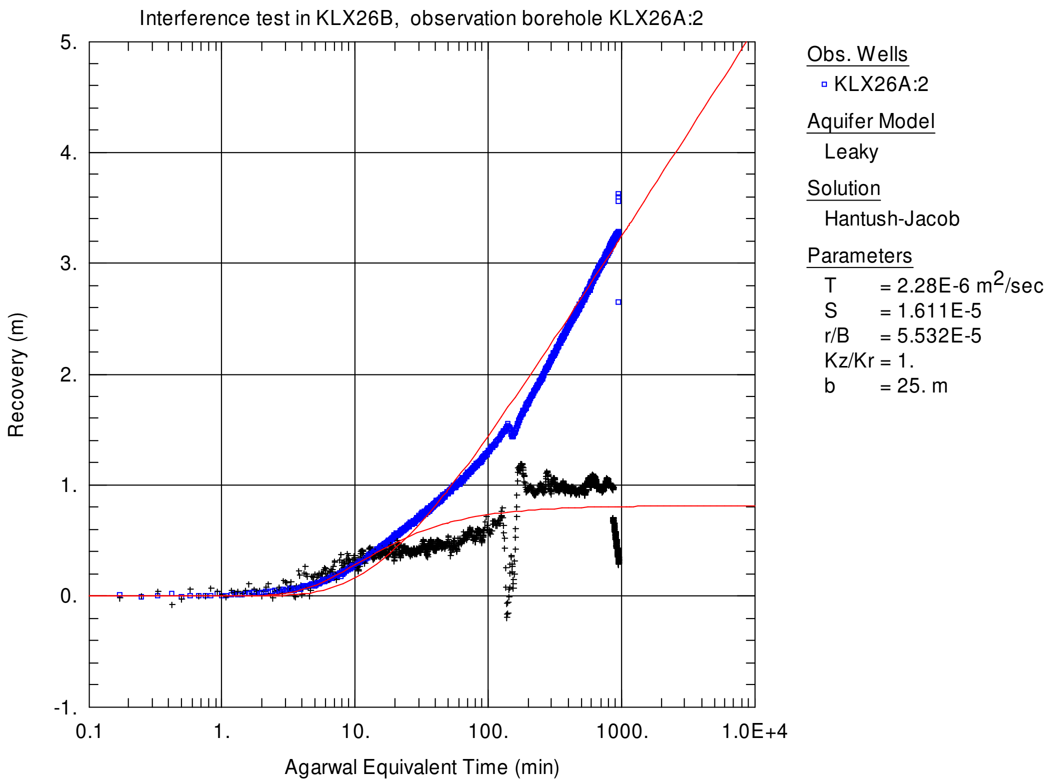


Figure 1-114. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26A:2 during pumping in borehole KLX26B.*

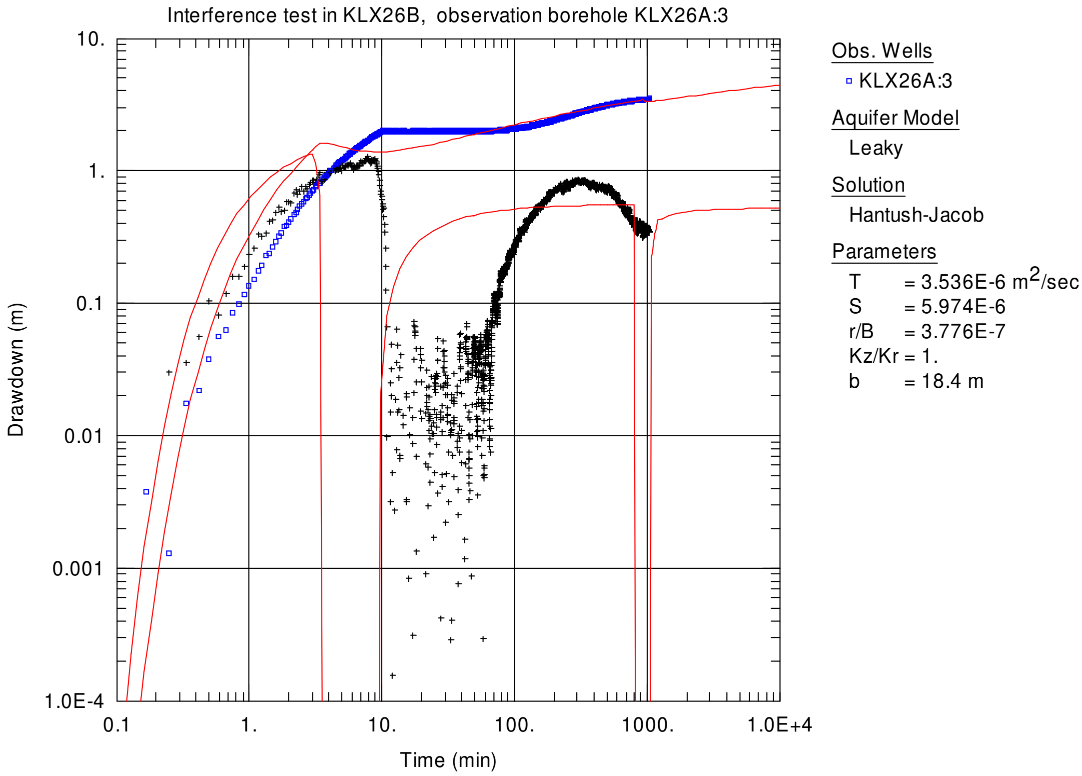


Figure 1-115. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26A:3 during pumping in borehole KLX26B.*

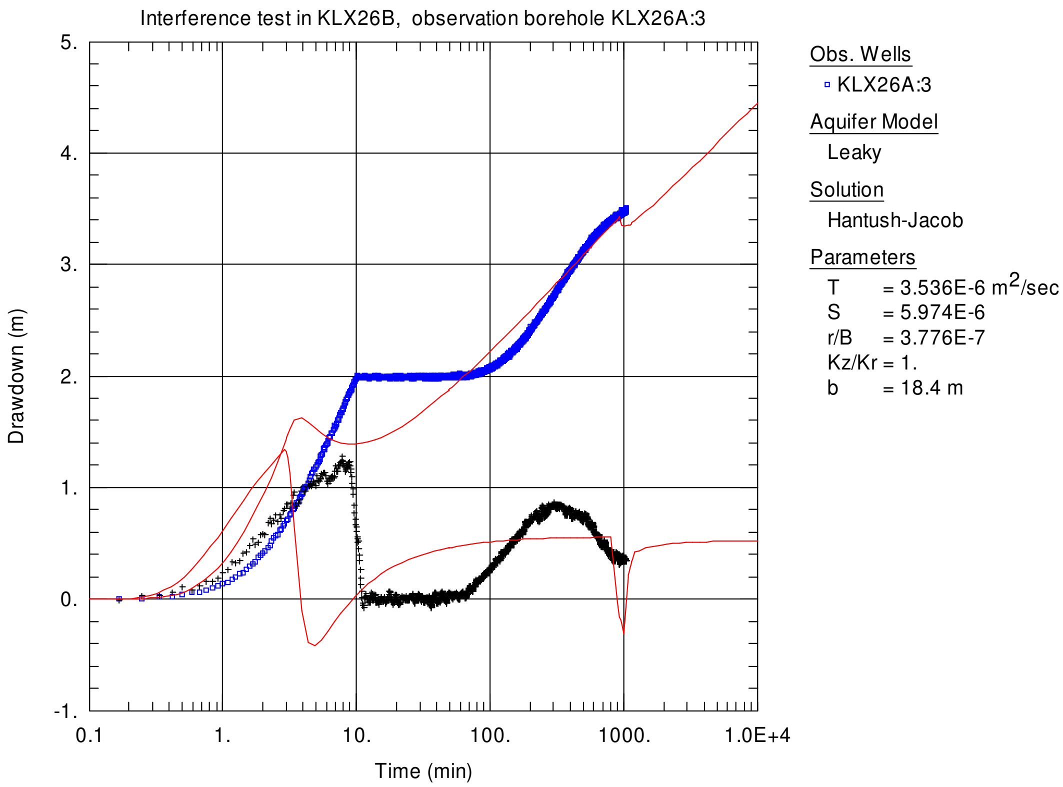


Figure 1-116. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX26A:3 during pumping in borehole KLX26B.*

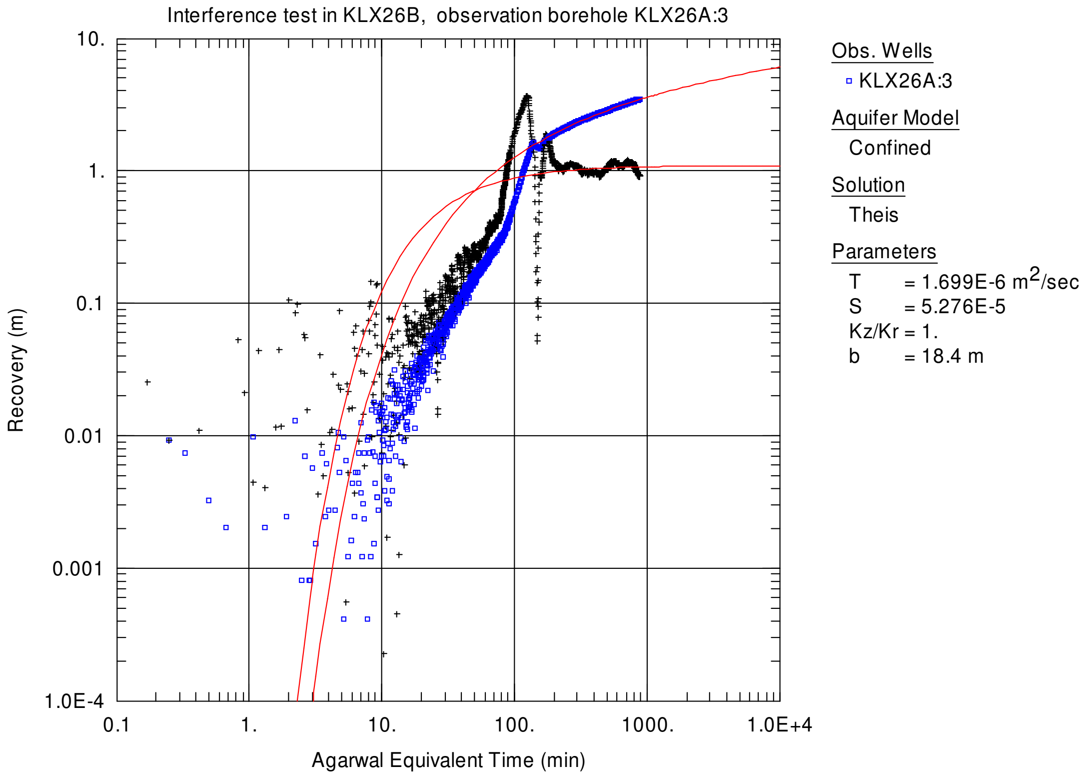


Figure 1-117. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26A:3 during pumping in borehole KLX26B.*

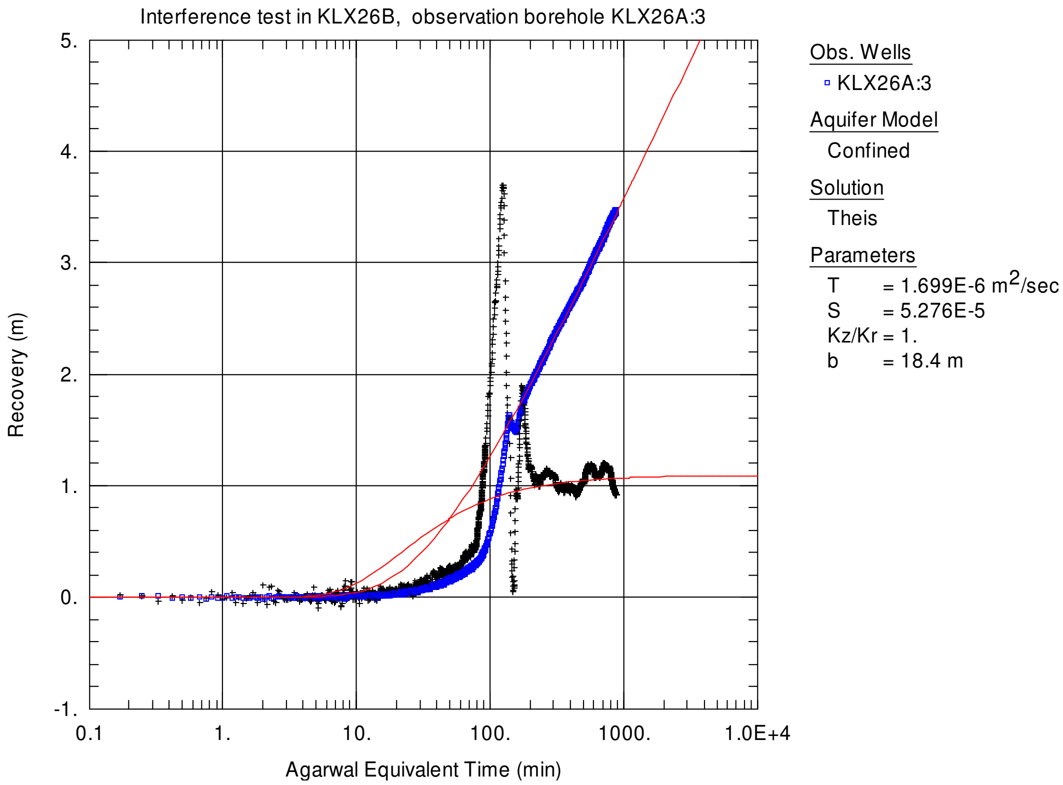


Figure 1-118. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX26A:3 during pumping in borehole KLX26B.*

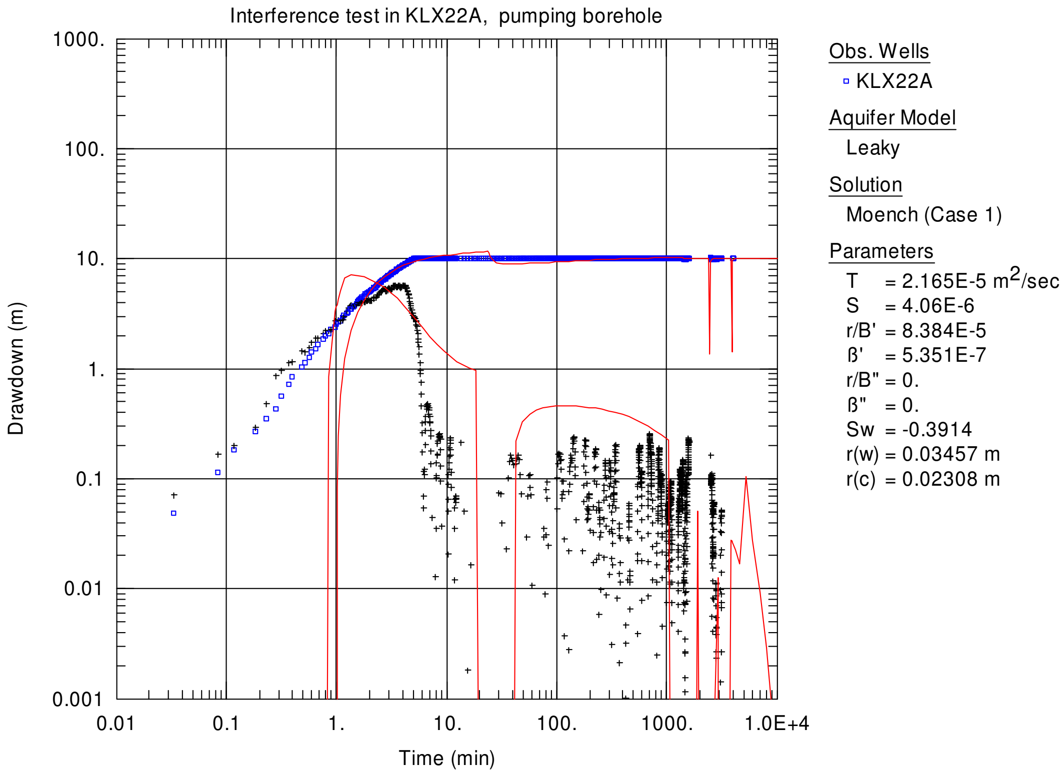


Figure 1-119. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX22A.*

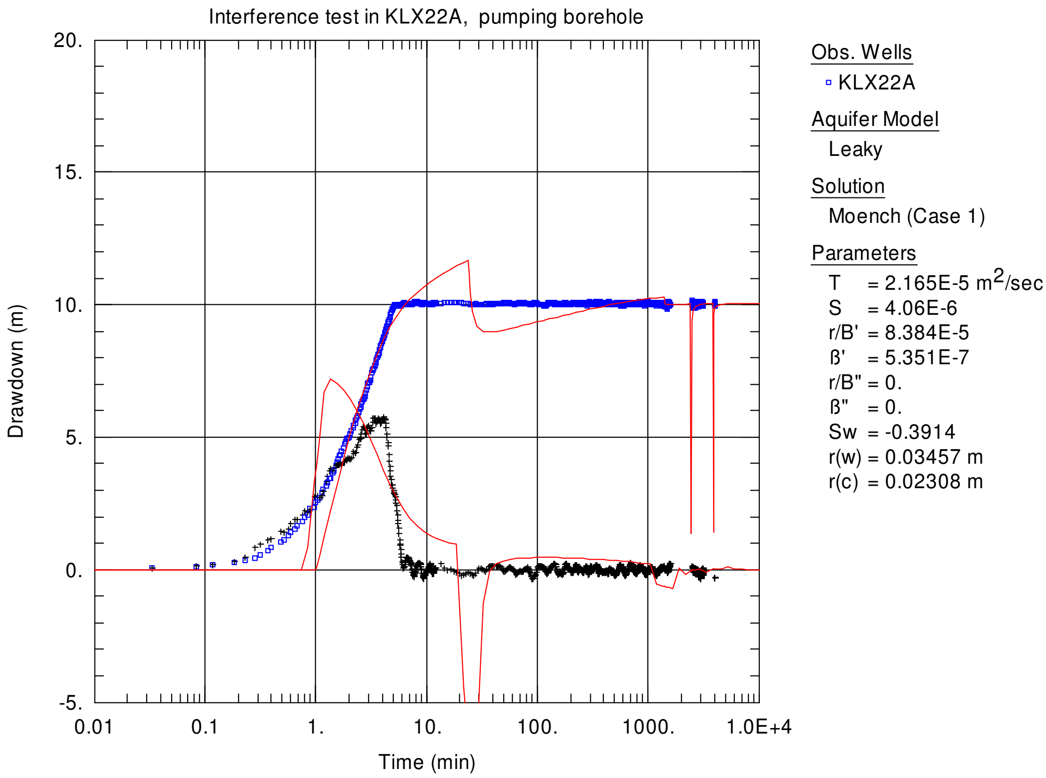


Figure 1-120. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX22A.*

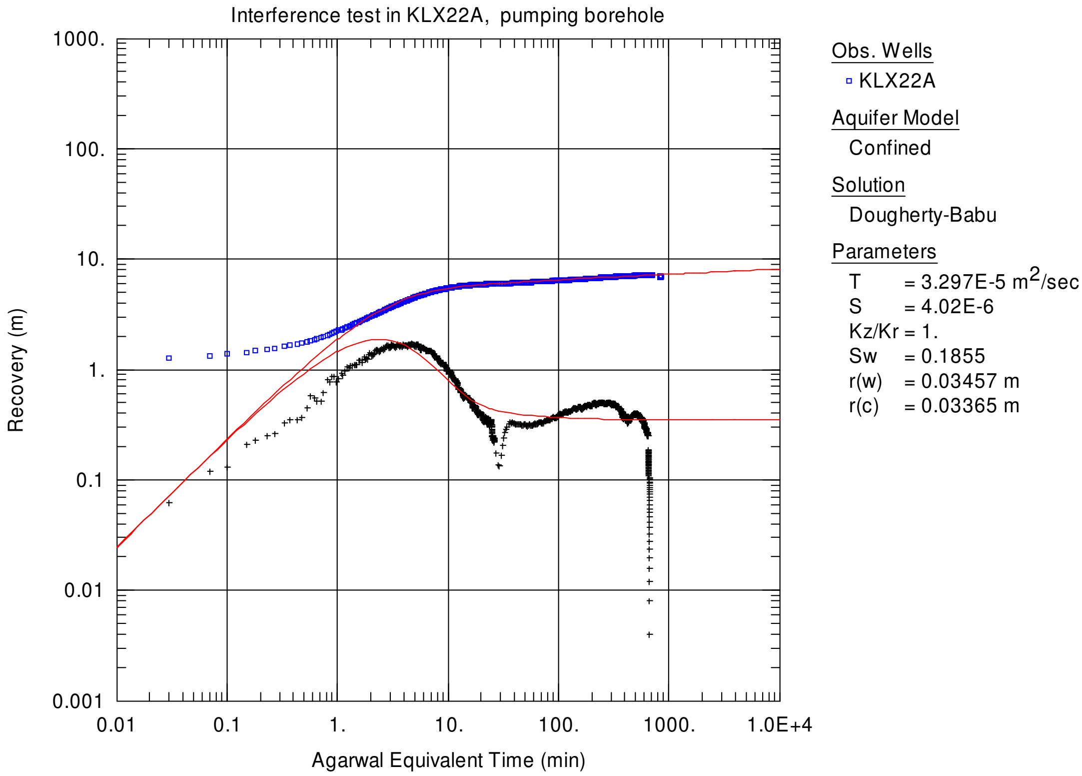


Figure 1-121. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX22A.*

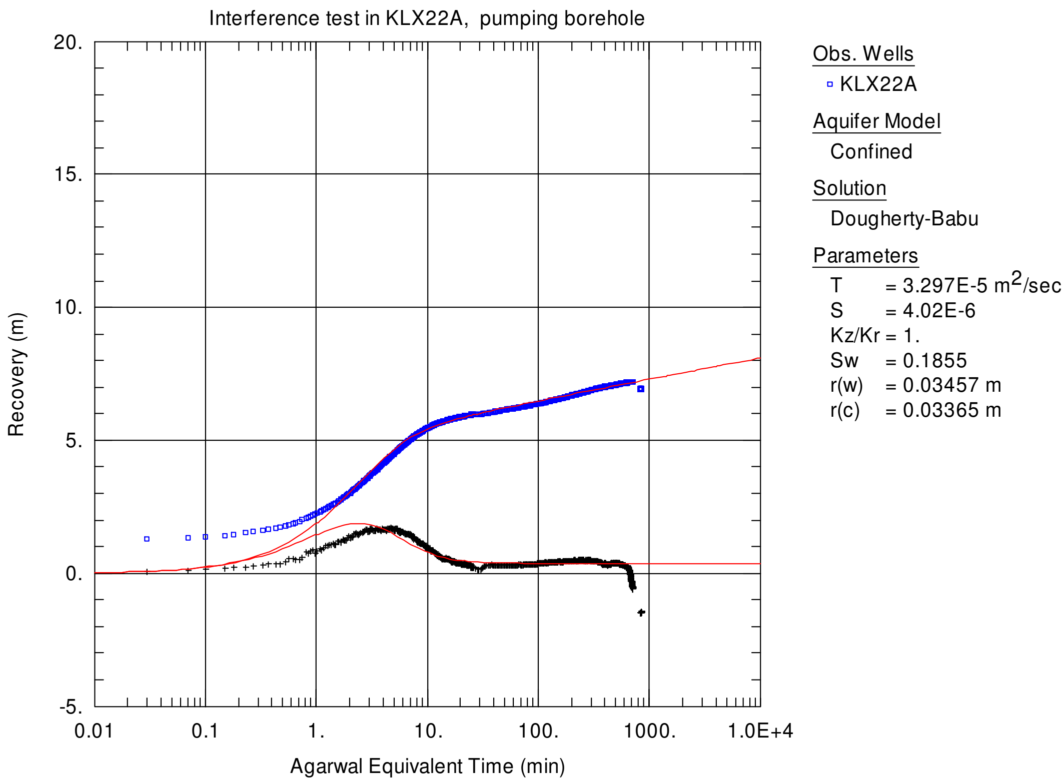


Figure 1-122. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX22A.*

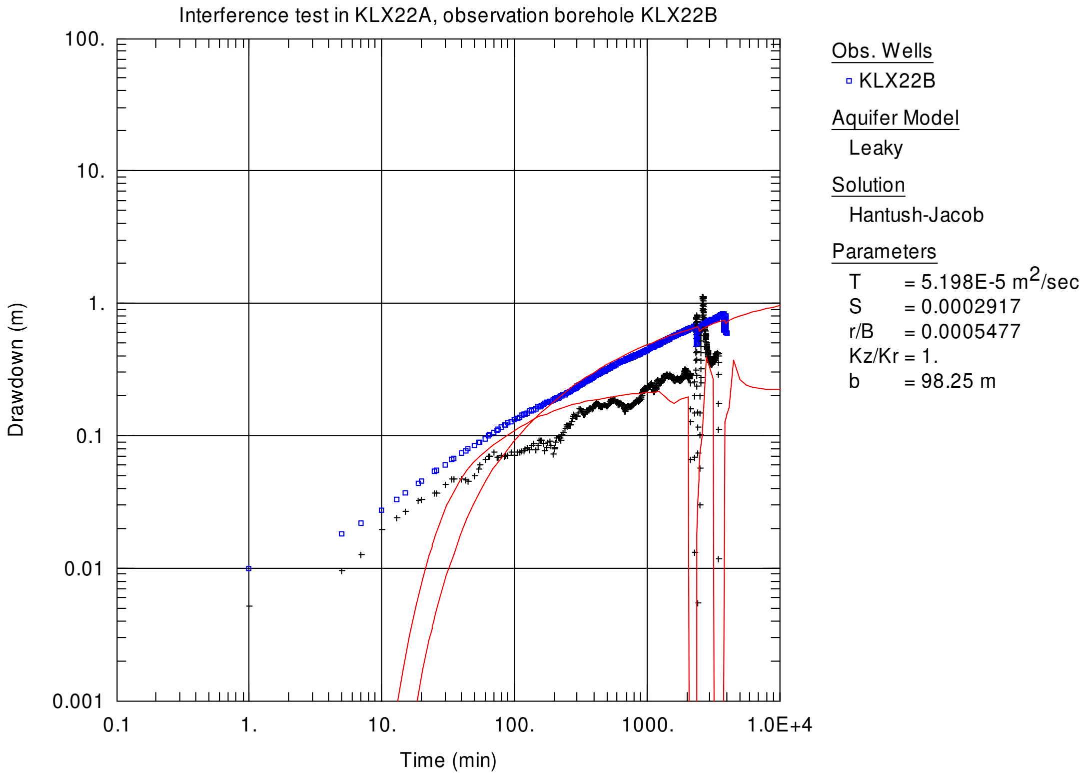


Figure 1-123. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX22B during pumping in borehole KLX22A.*

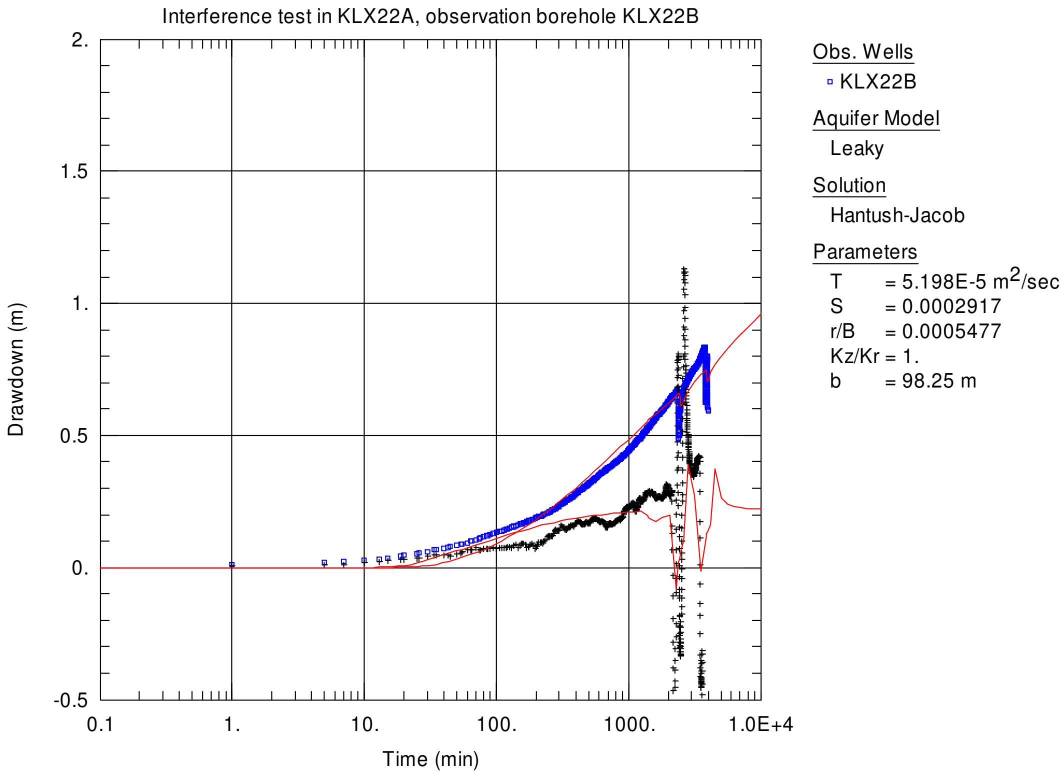


Figure 1-124. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX22B during pumping in borehole KLX22A.*

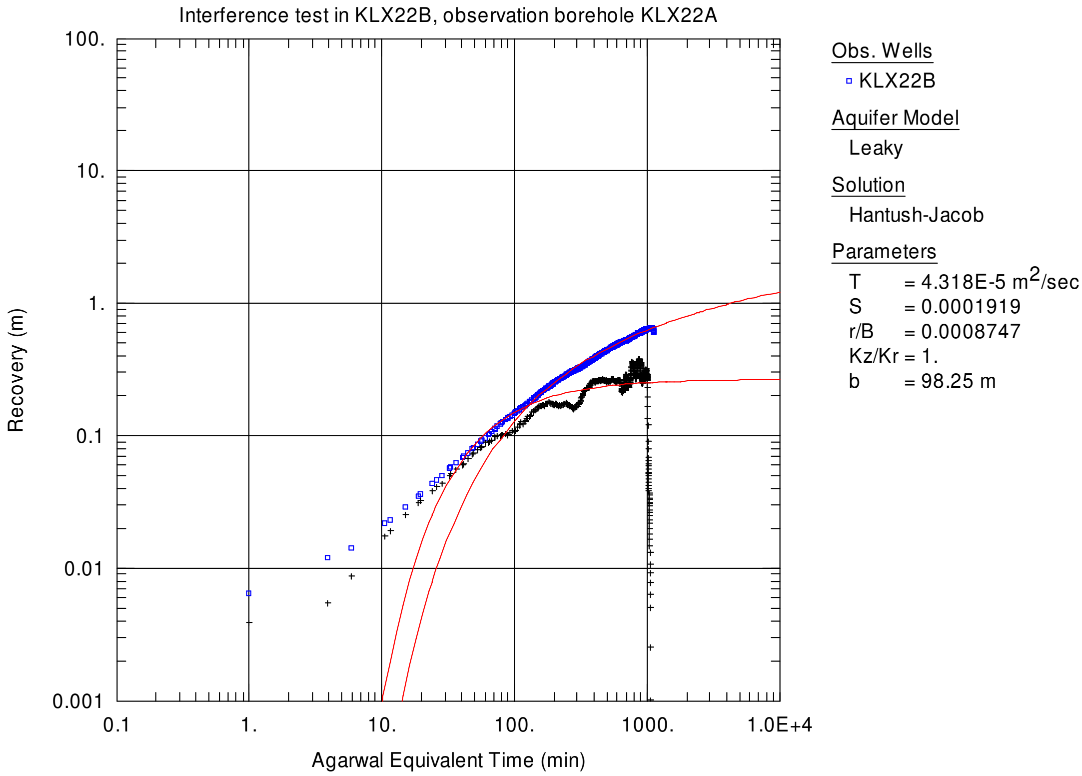


Figure 1-125. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX22B during pumping in borehole KLX22A.*

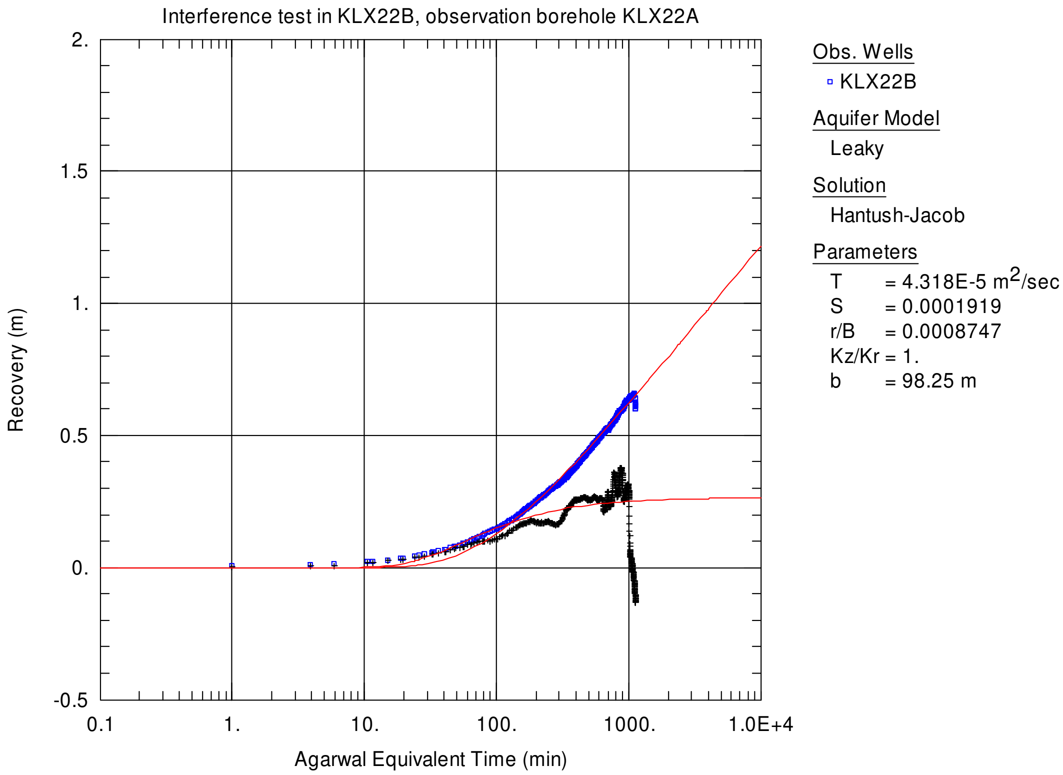


Figure 1-126. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX22B during pumping in borehole KLX22A.*

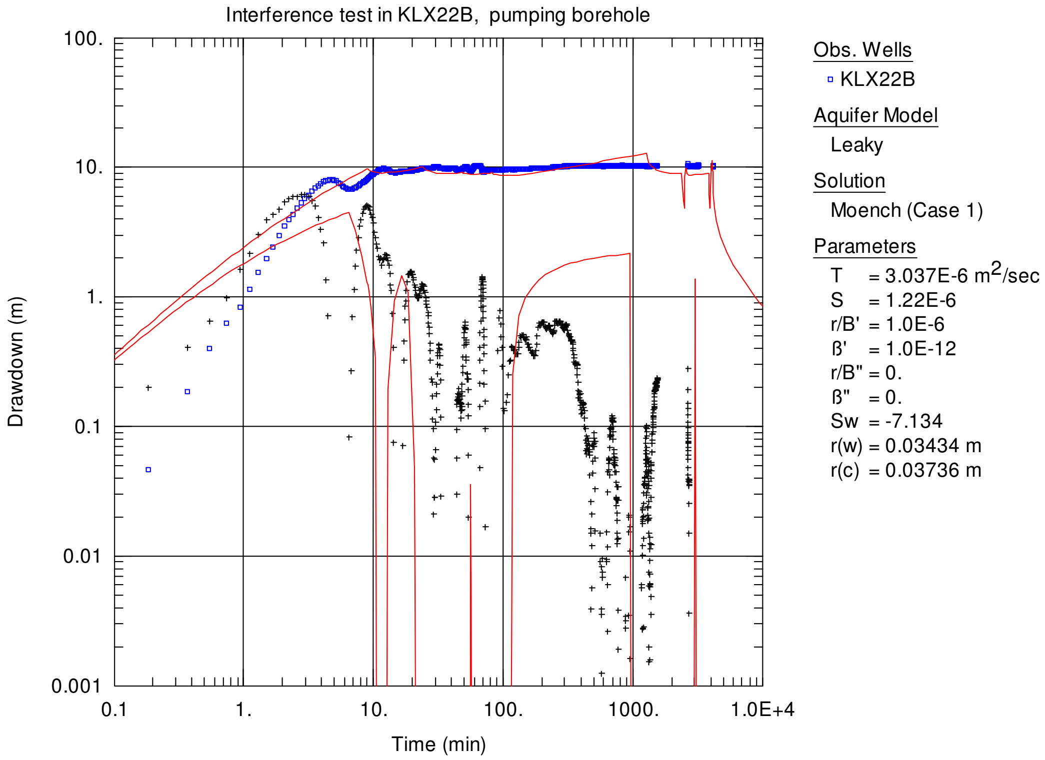


Figure 1-127. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX22B.*

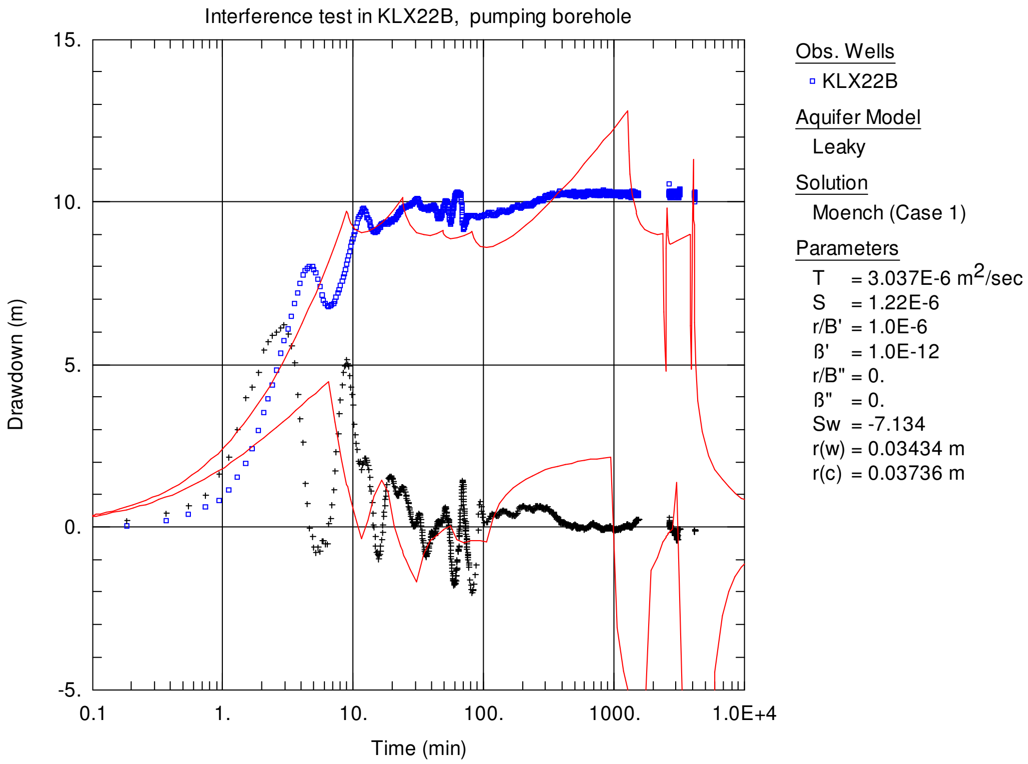


Figure 1-128. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX22B.*

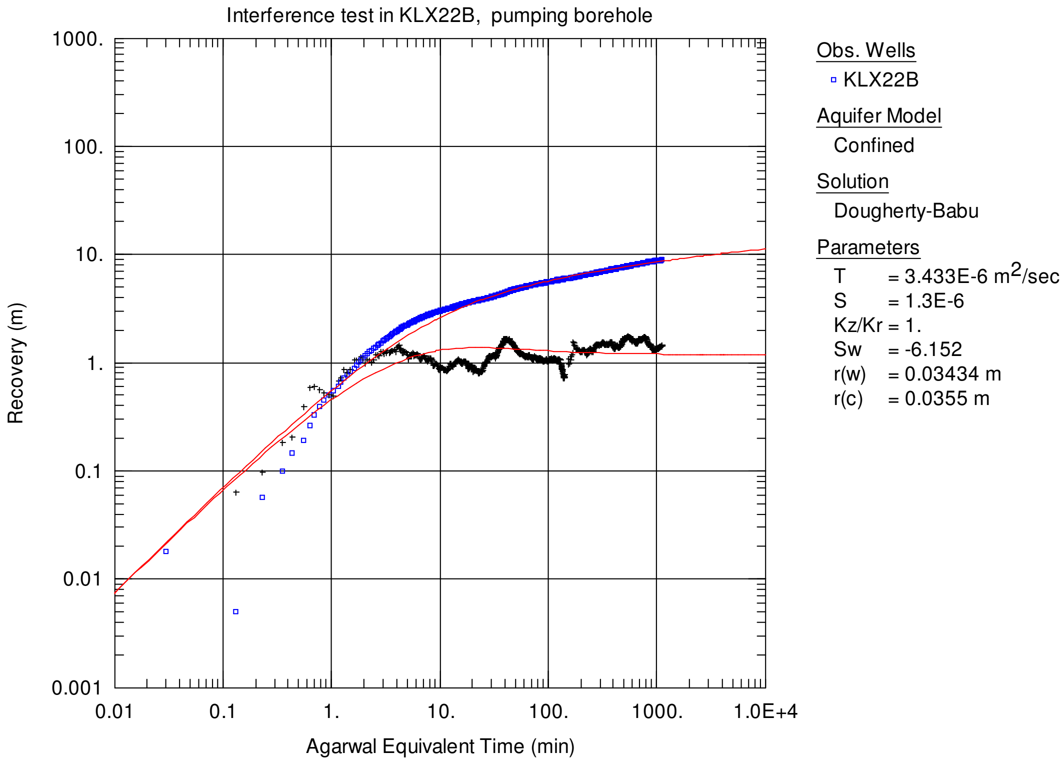


Figure 1-129. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX22B.*

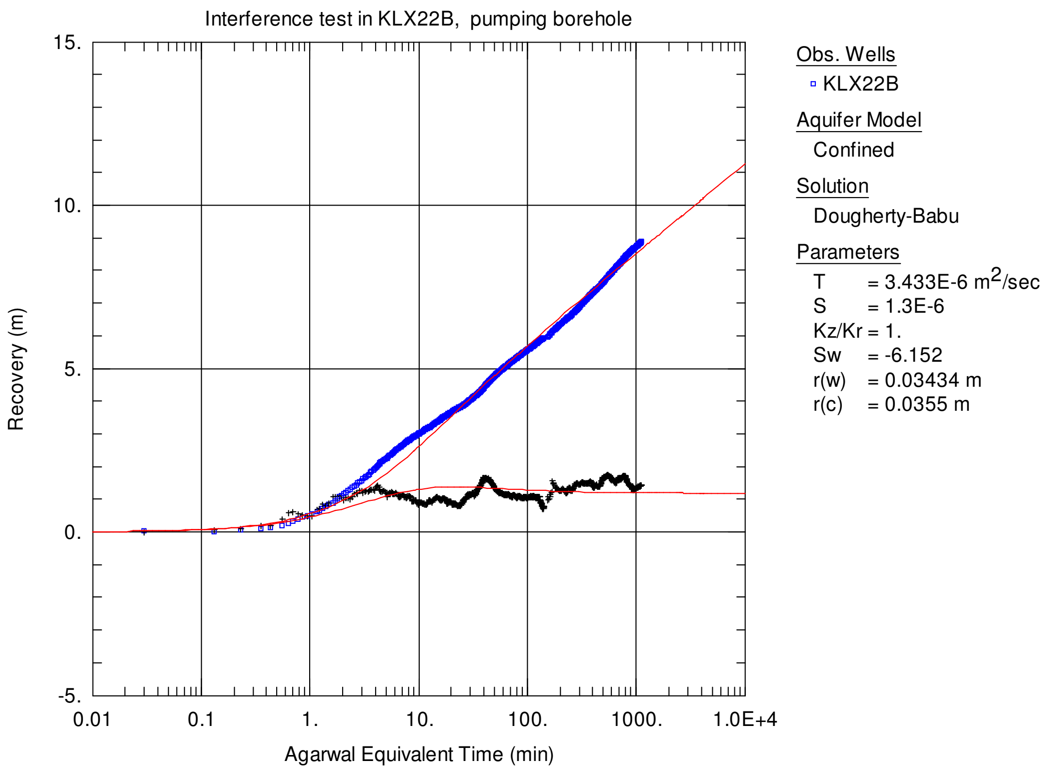


Figure 1-130. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX22B.*

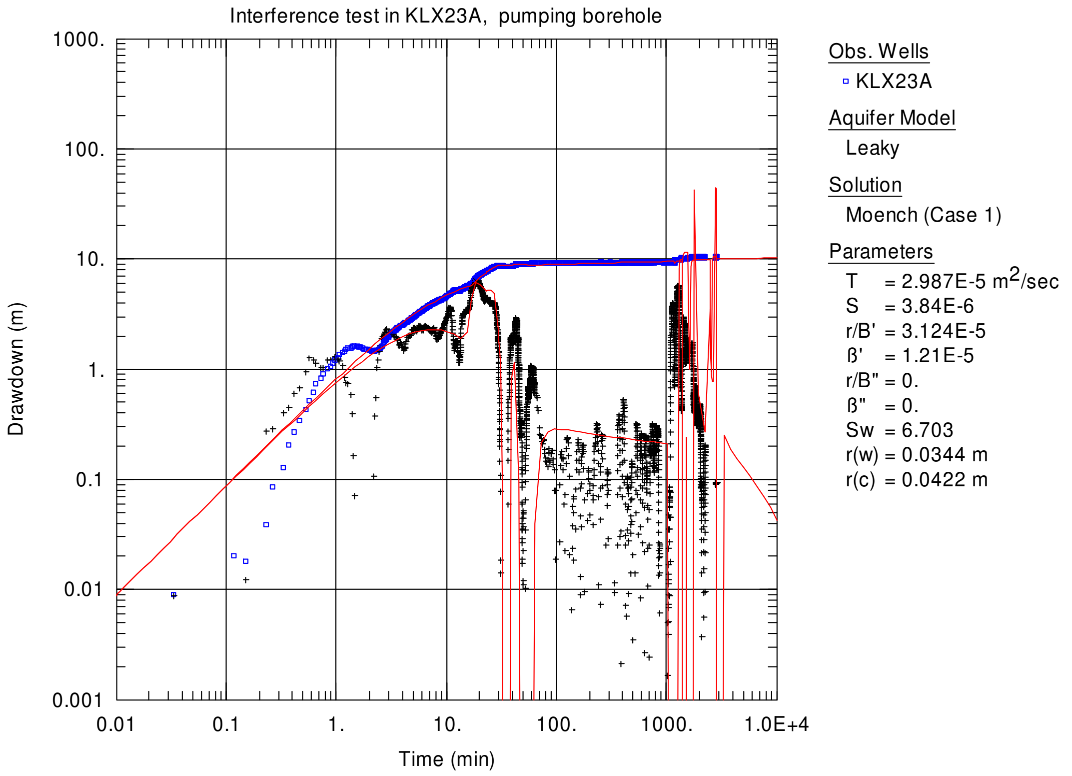


Figure 1-131. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX23A.*

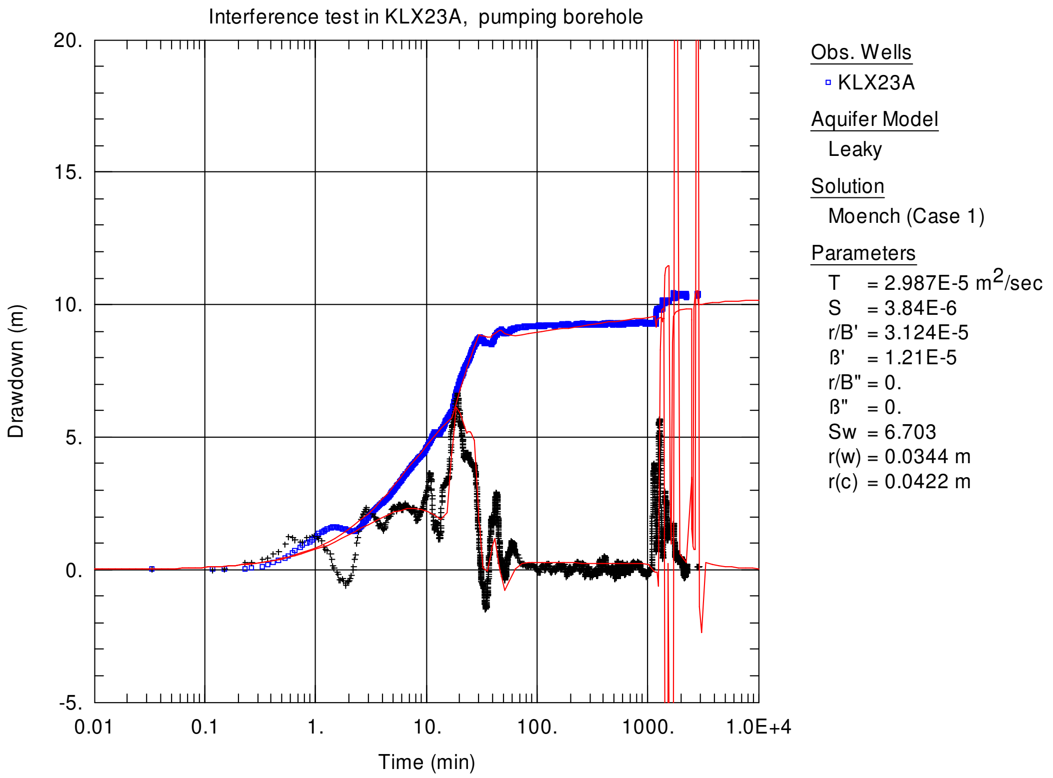


Figure 1-132. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX23A.*

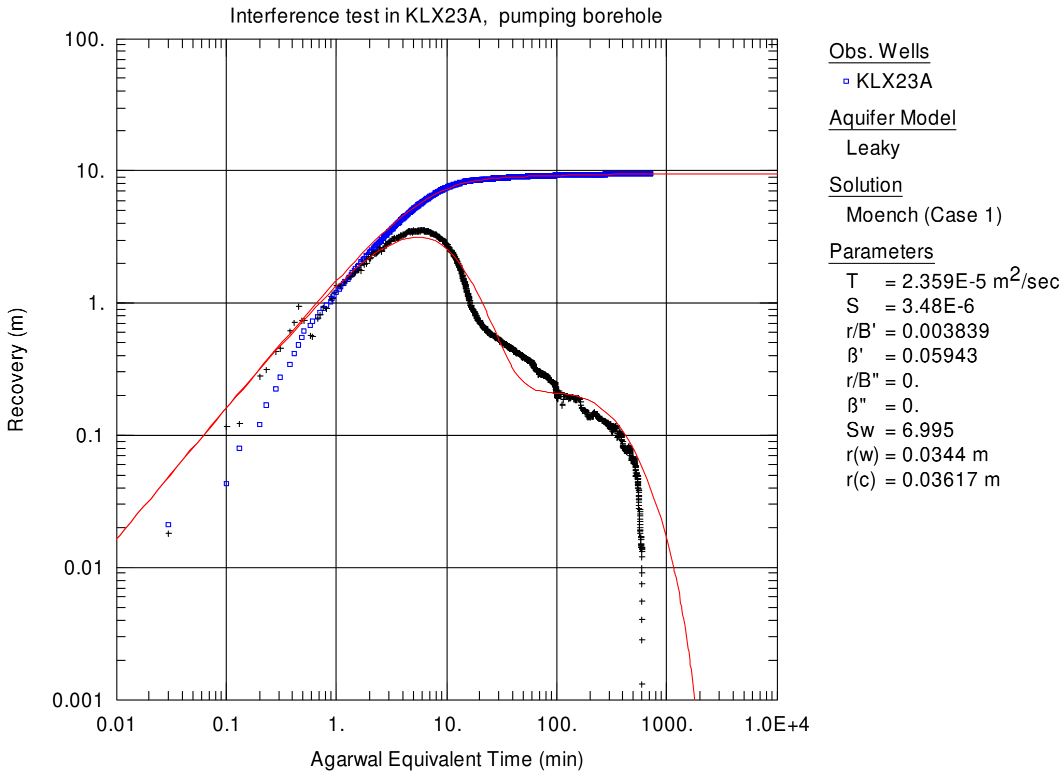


Figure 1-133. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX23A.*

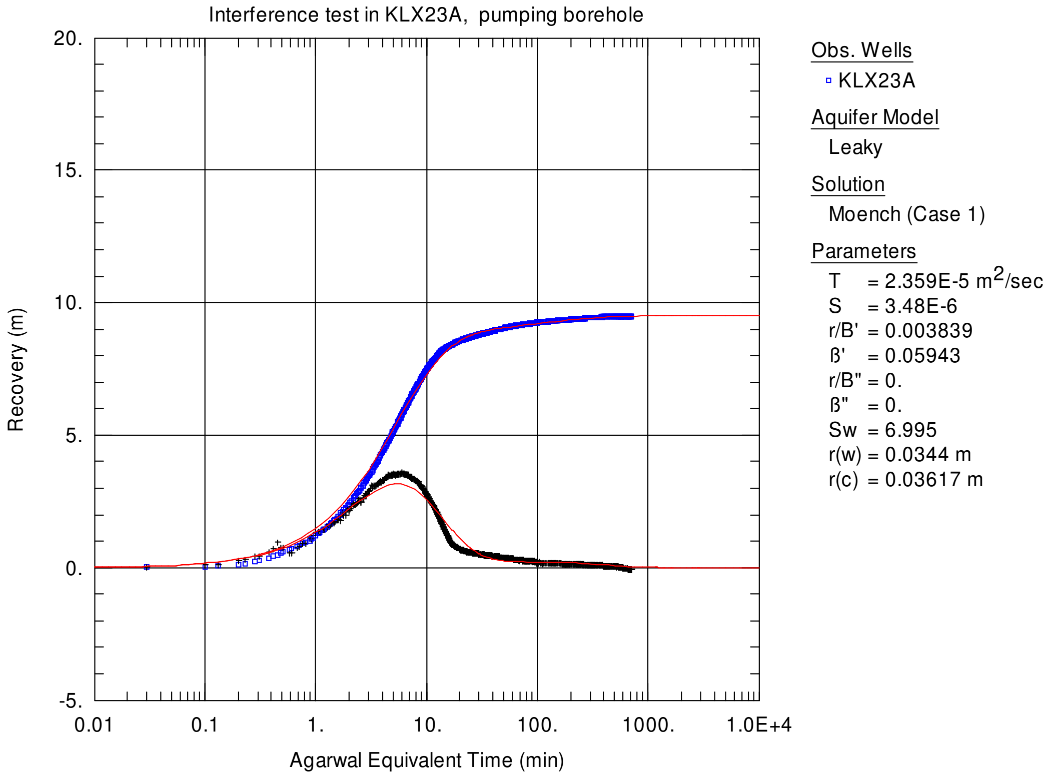


Figure 1-134. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX23A.*

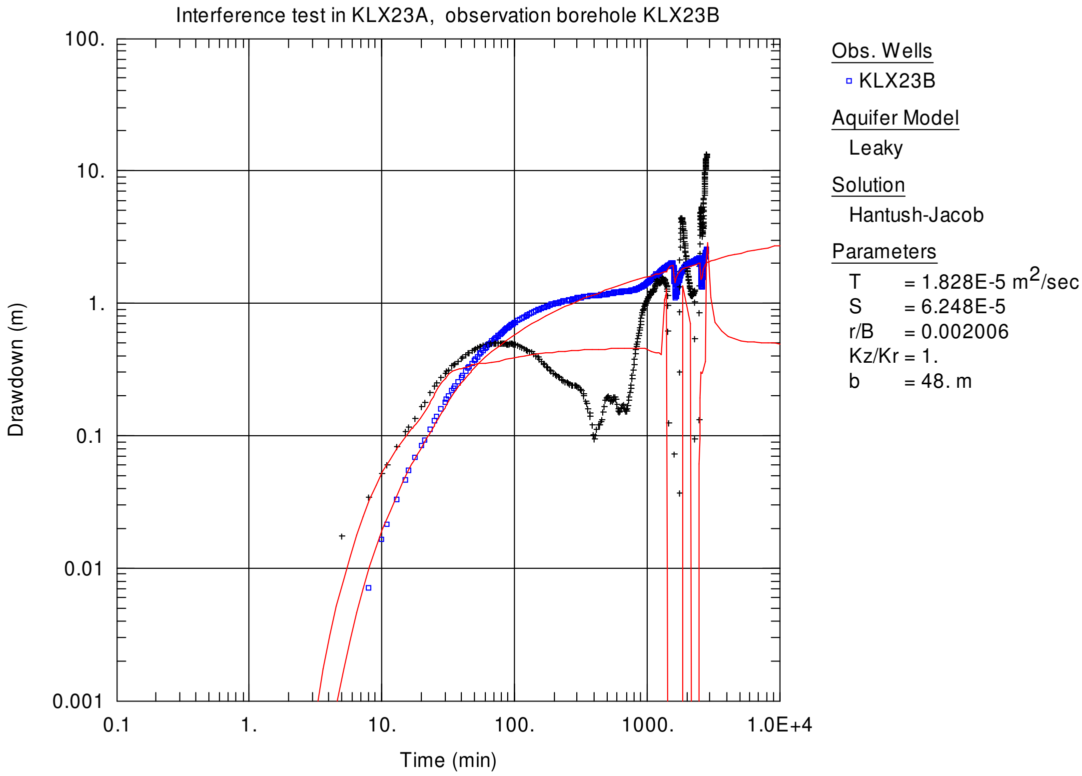


Figure 1-135. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX23B during pumping in borehole KLX23A.*

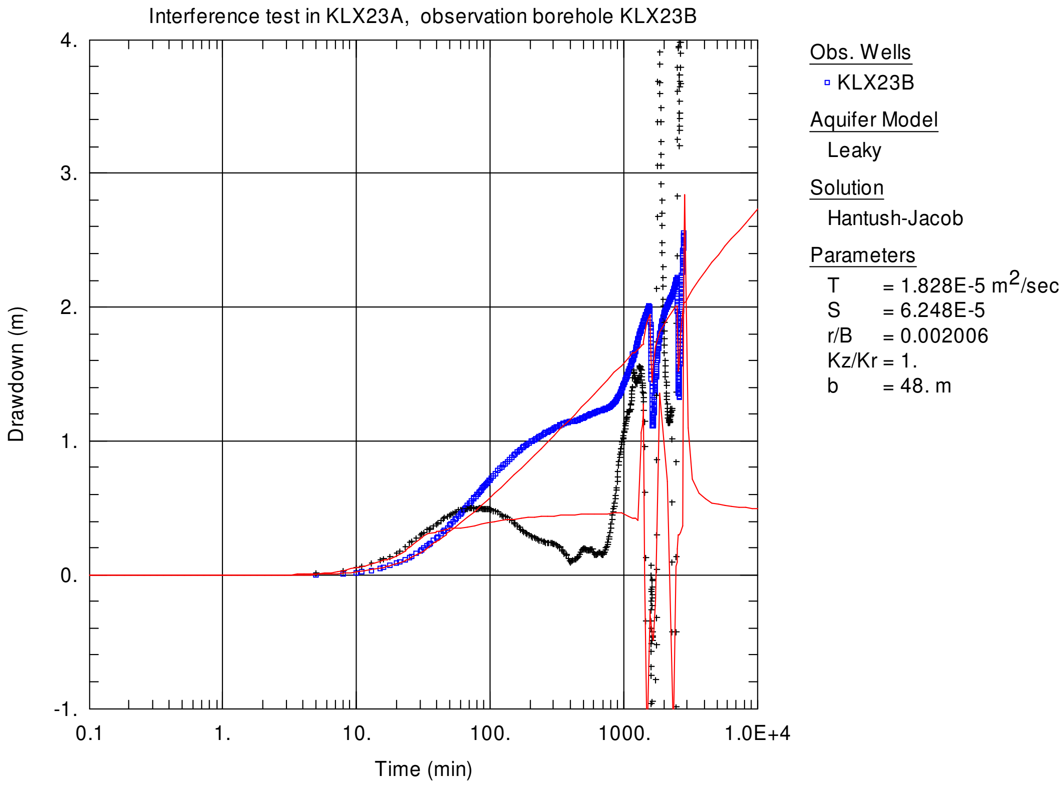


Figure 1-136. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX23B during pumping in borehole KLX23A.*

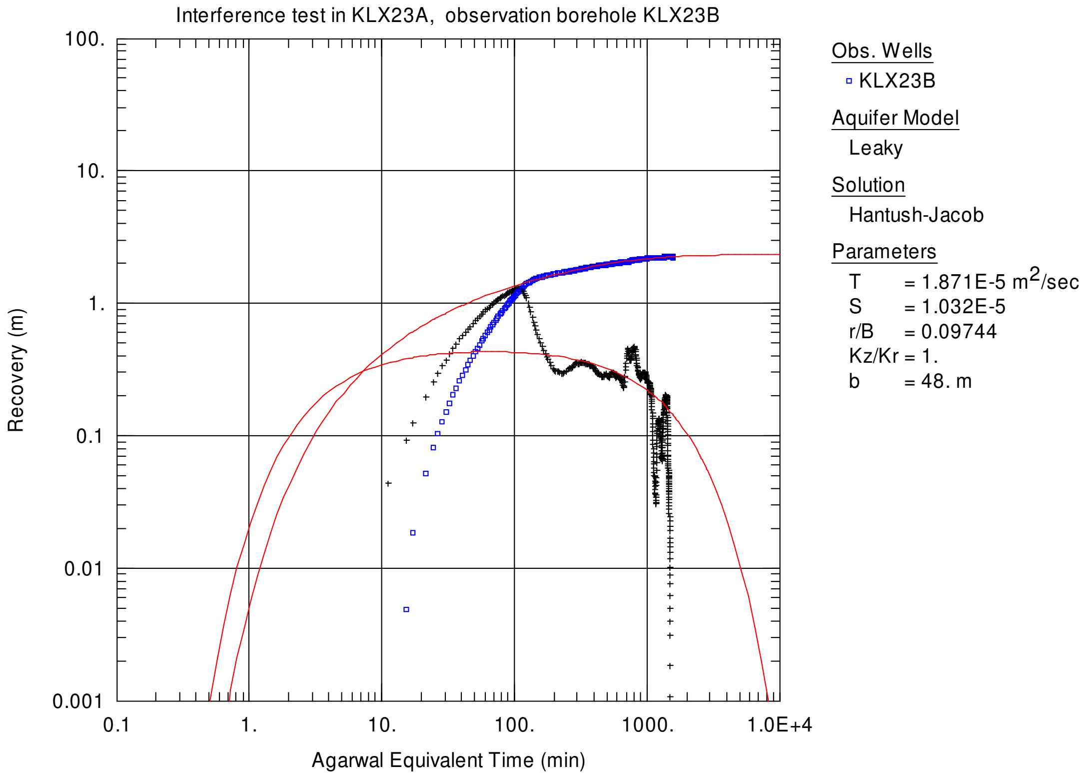


Figure 1-137. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX23B during pumping in borehole KLX23A.*

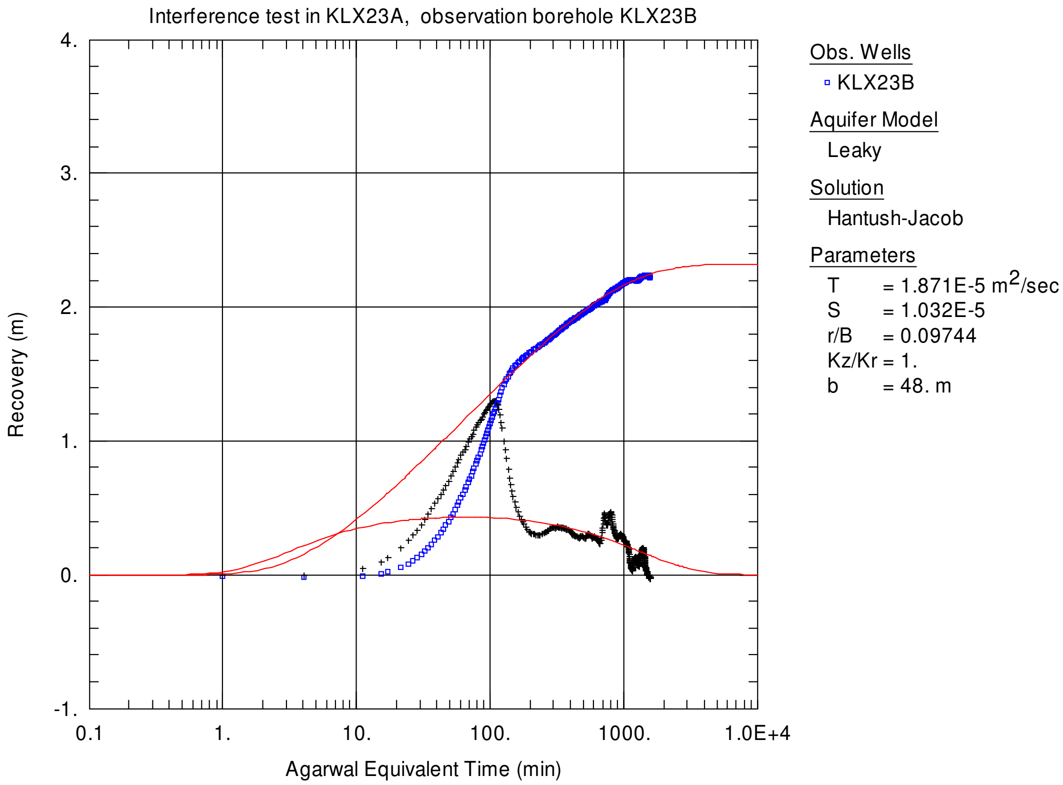


Figure 1-138. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX23B during pumping in borehole KLX23A.*

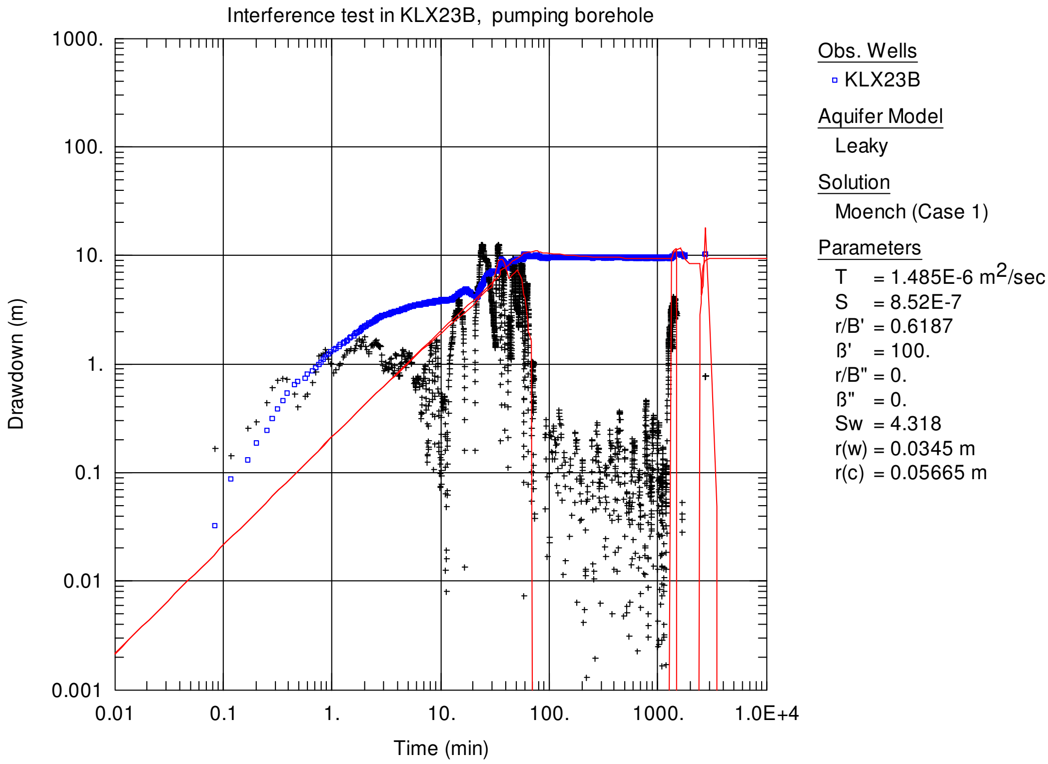


Figure 1-139. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX23B.*

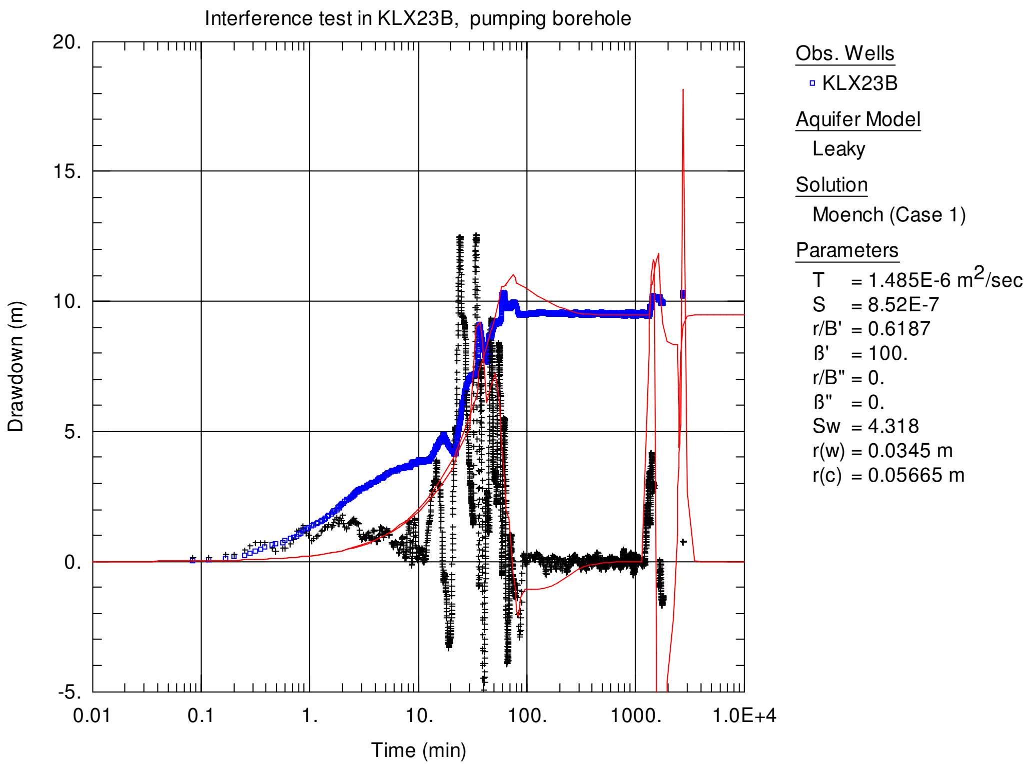


Figure 1-140. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX23B.*

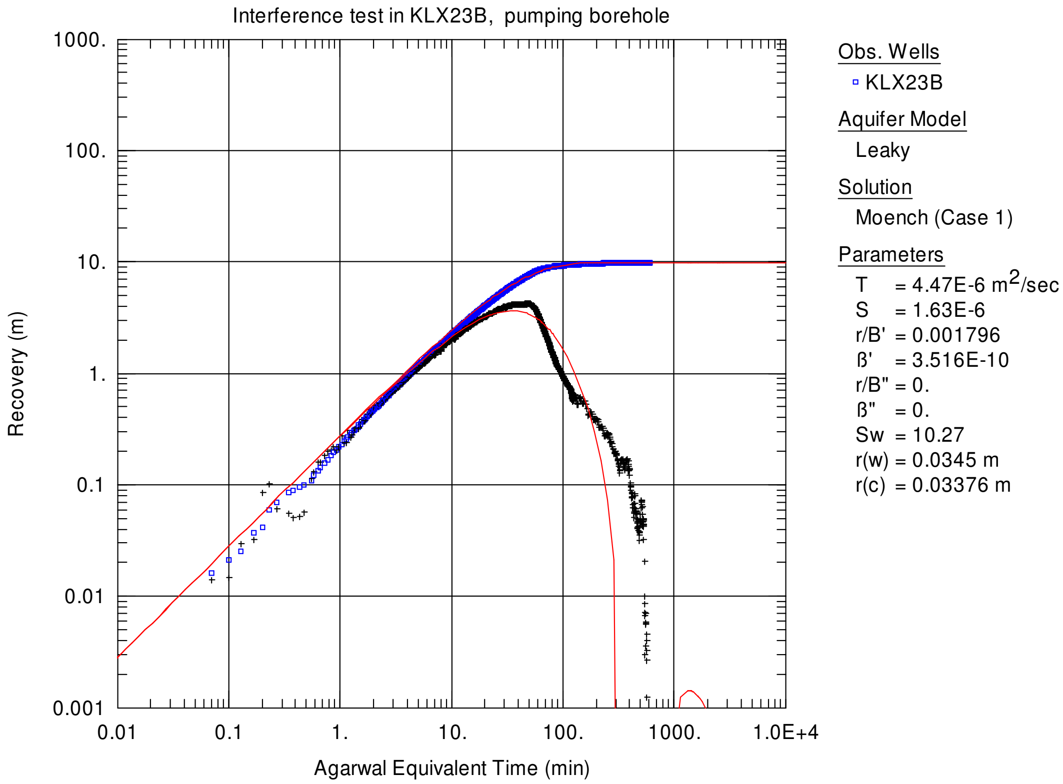


Figure 1-141. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX23B.*

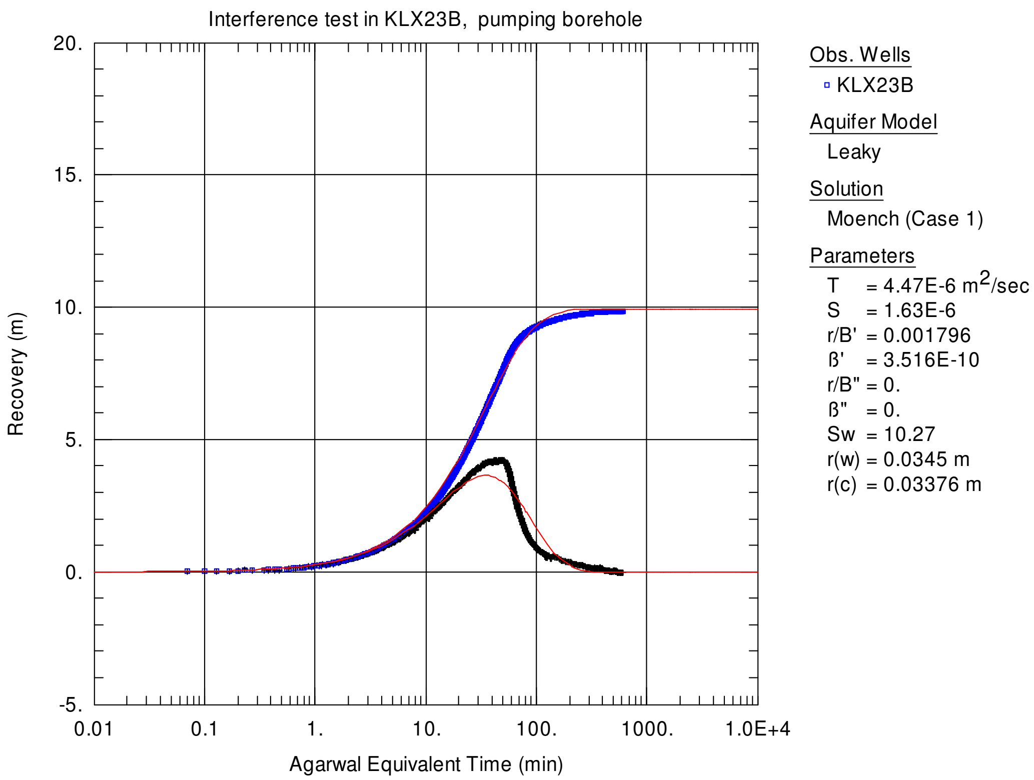


Figure 1-142. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX23B.*

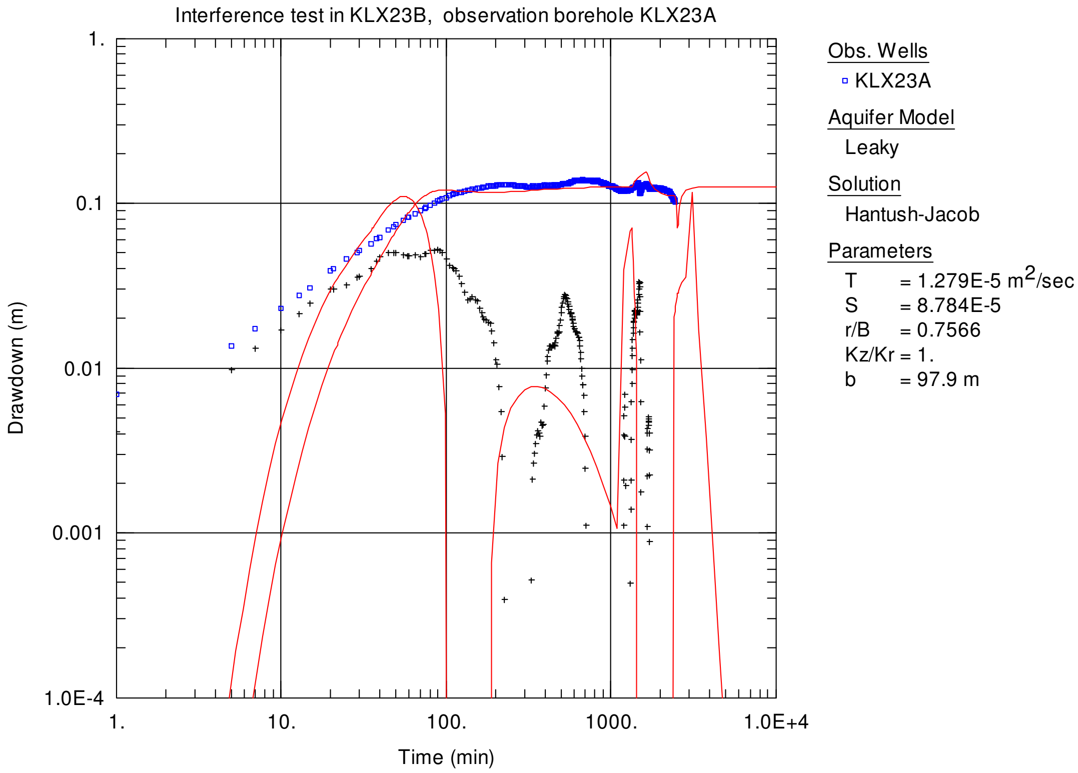


Figure 1-143. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX23A during pumping in borehole KLX23B.*

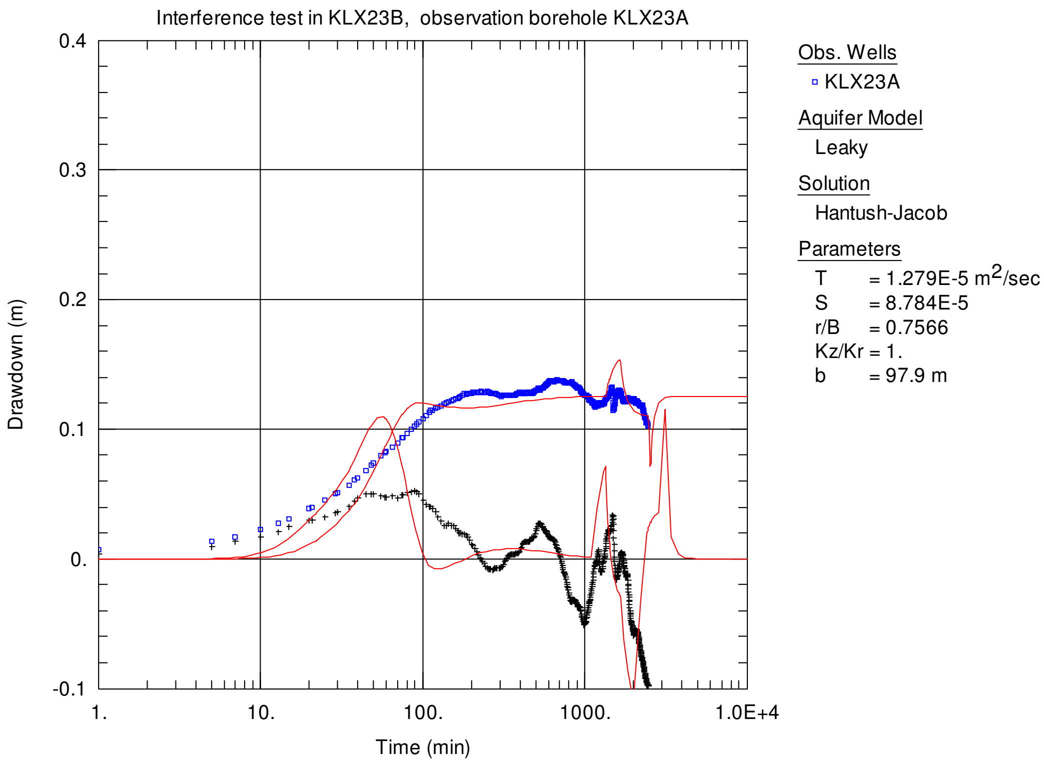


Figure 1-144. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX23A during pumping in borehole KLX23B.*

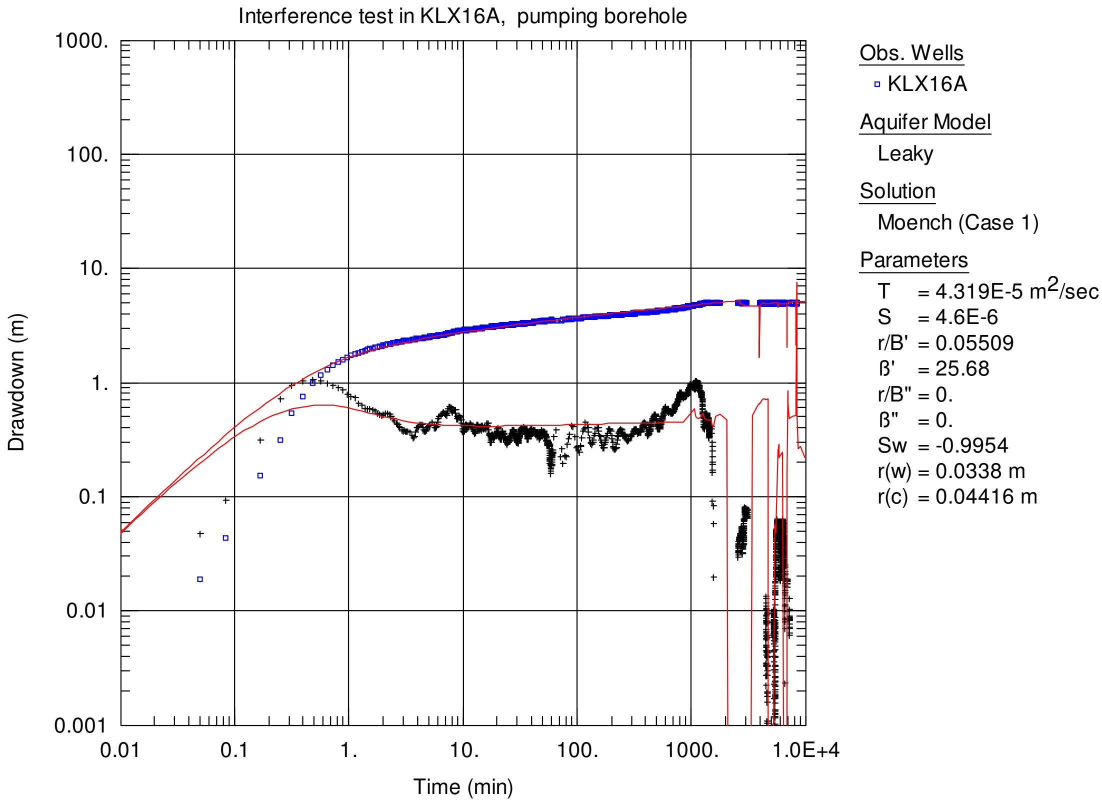


Figure 1-145. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX16A.*

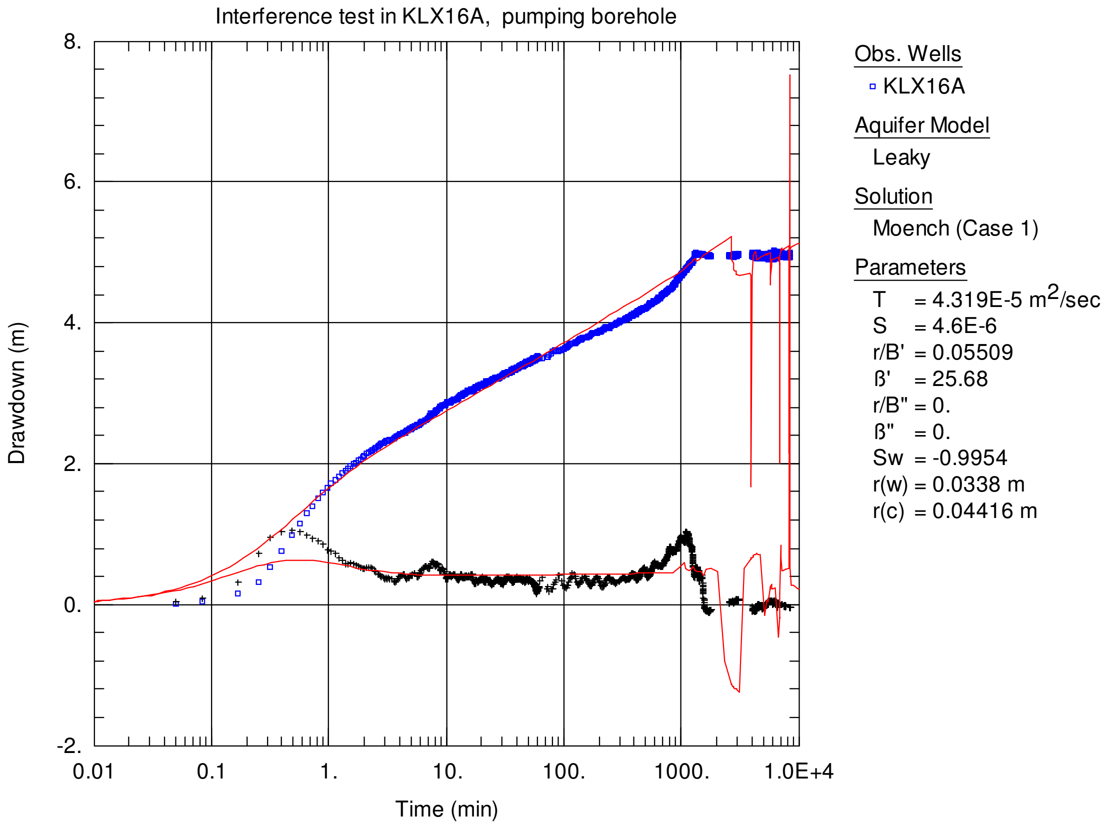


Figure 1-146. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX16A.*

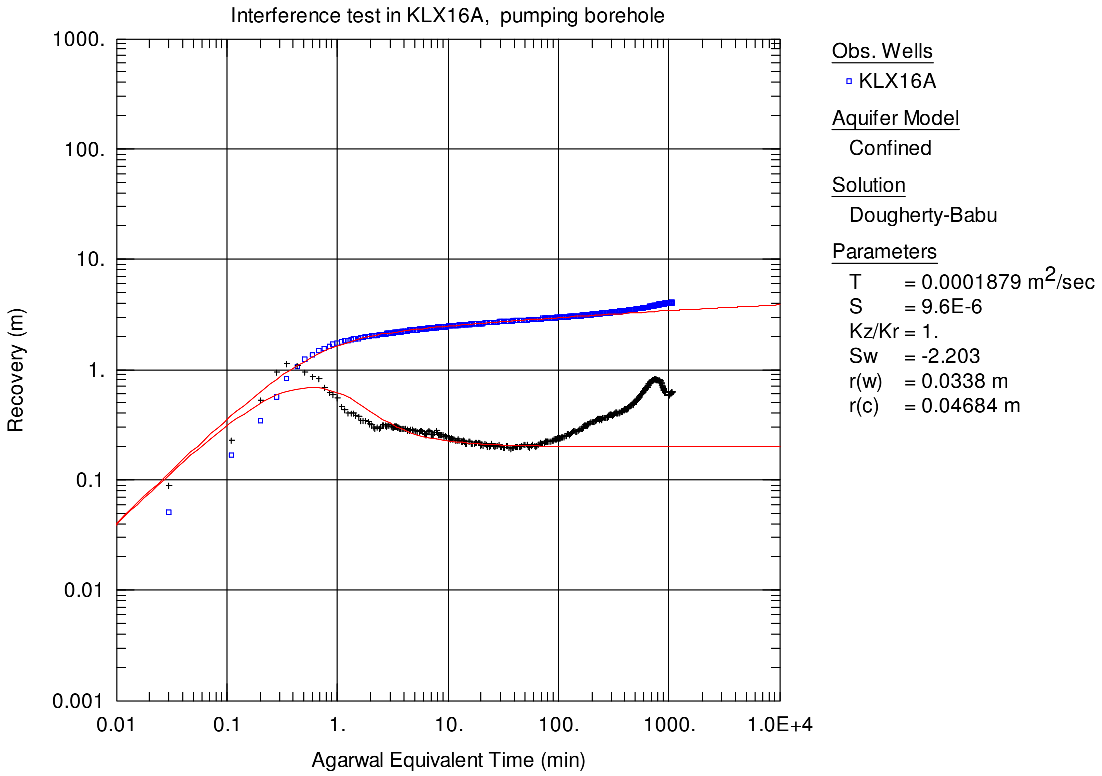


Figure 1-147. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX16A. This type-curve fit is made on the early part of the recovery period.*

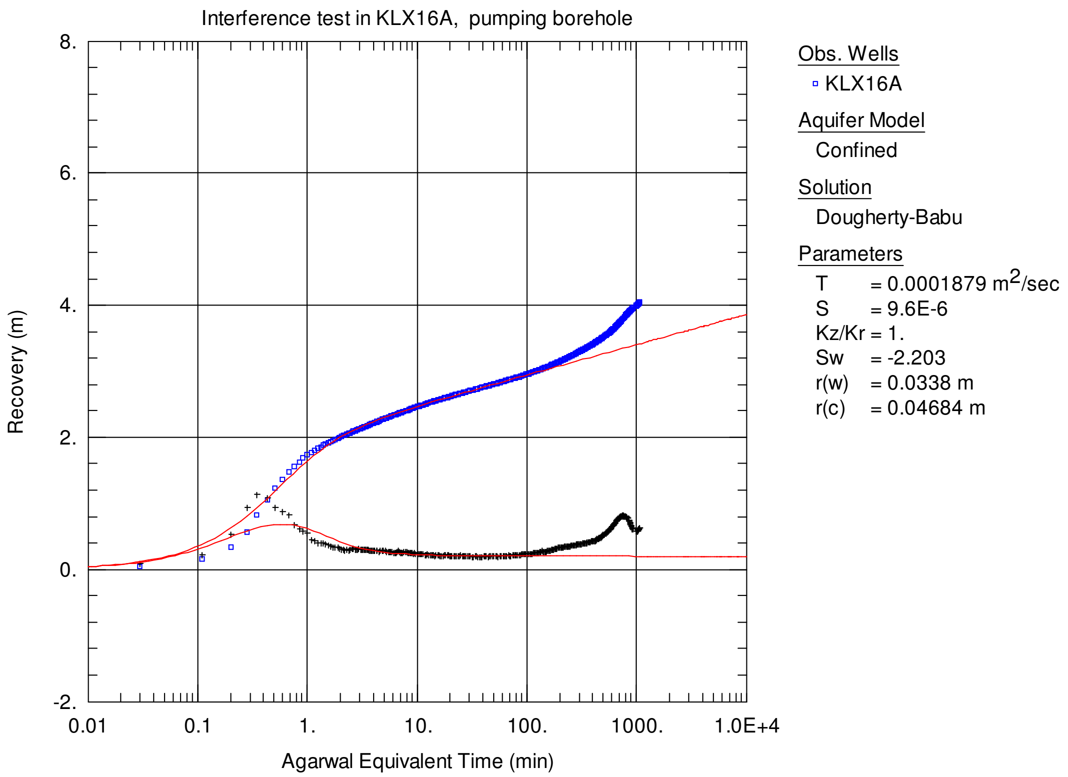


Figure 1-148. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX16A. This type-curve fit is made on the early part of the recovery period.*

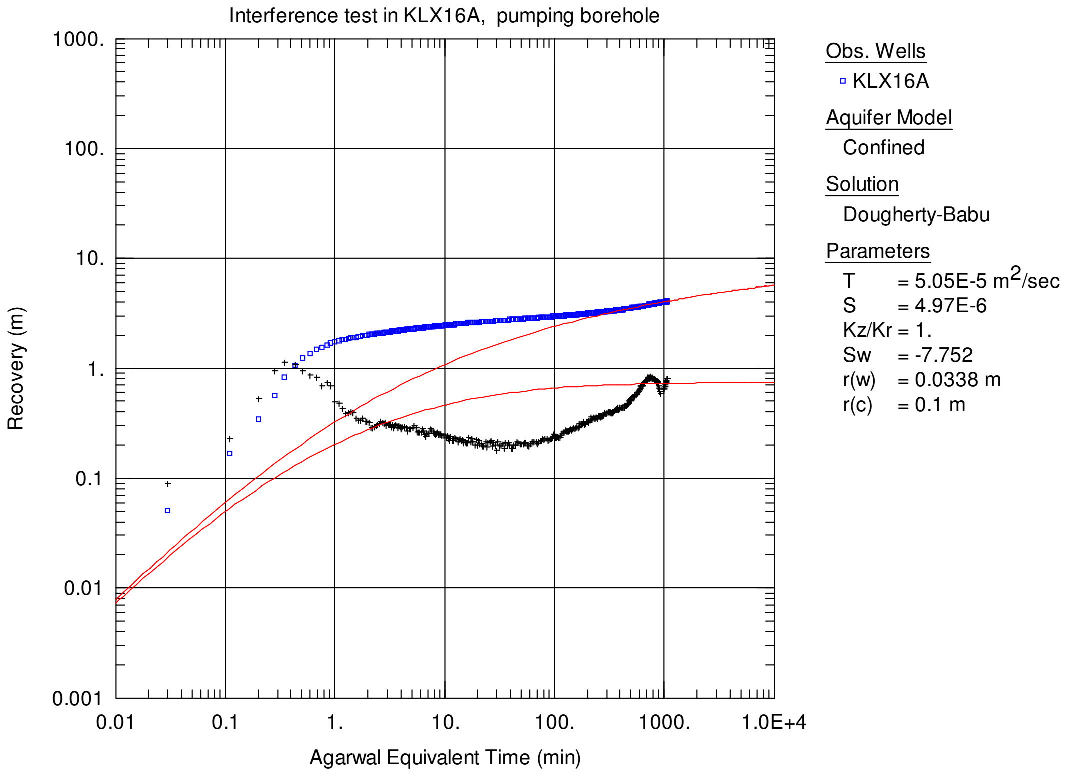


Figure 1-149. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX16A. This type-curve fit is made on the later part of the recovery period.*

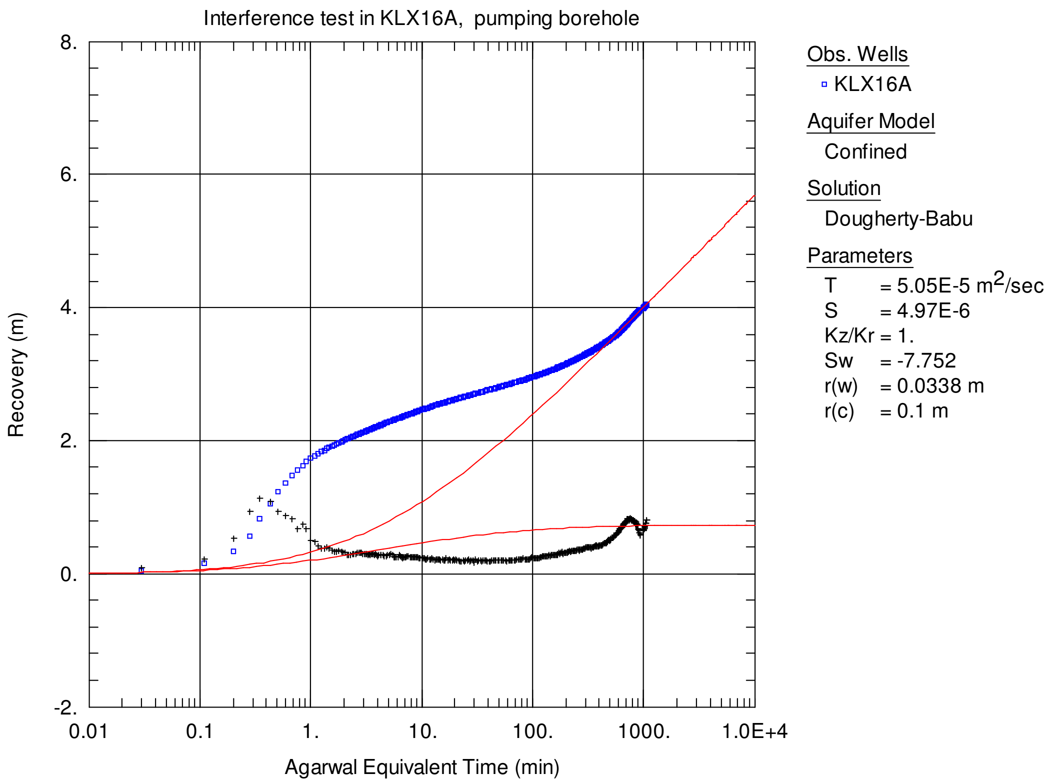


Figure 1-150. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX16A. This type-curve fit is made on the later part of the recovery period.*

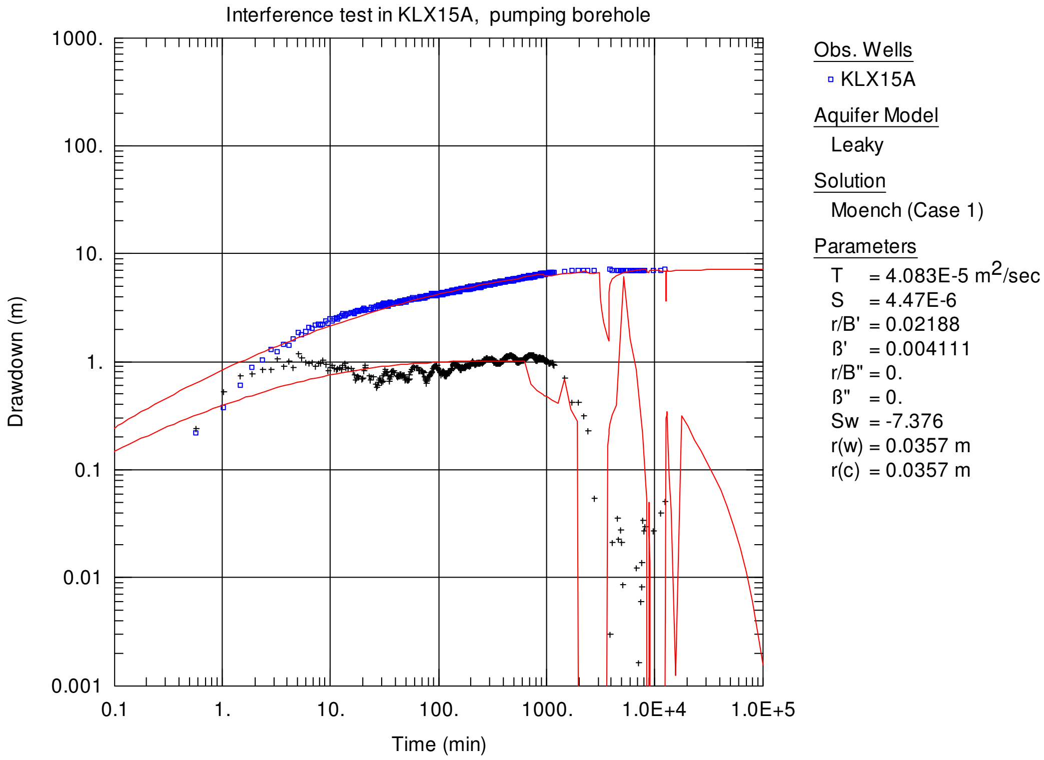


Figure 1-151. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX15A.*

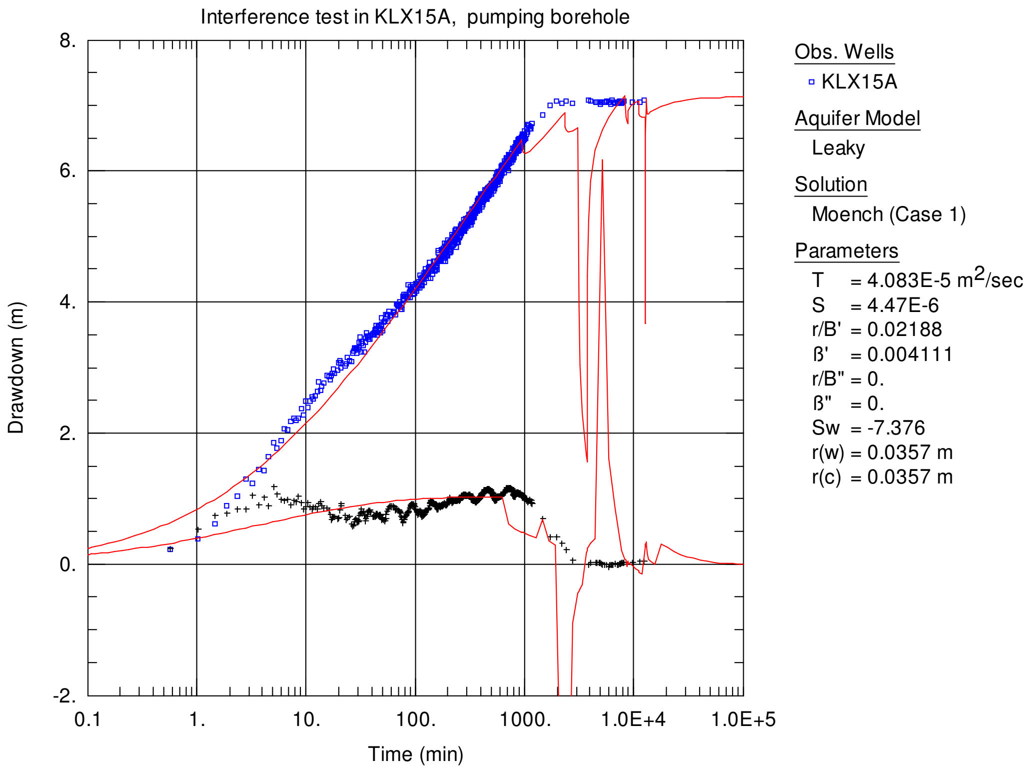


Figure 1-152. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX15A.*

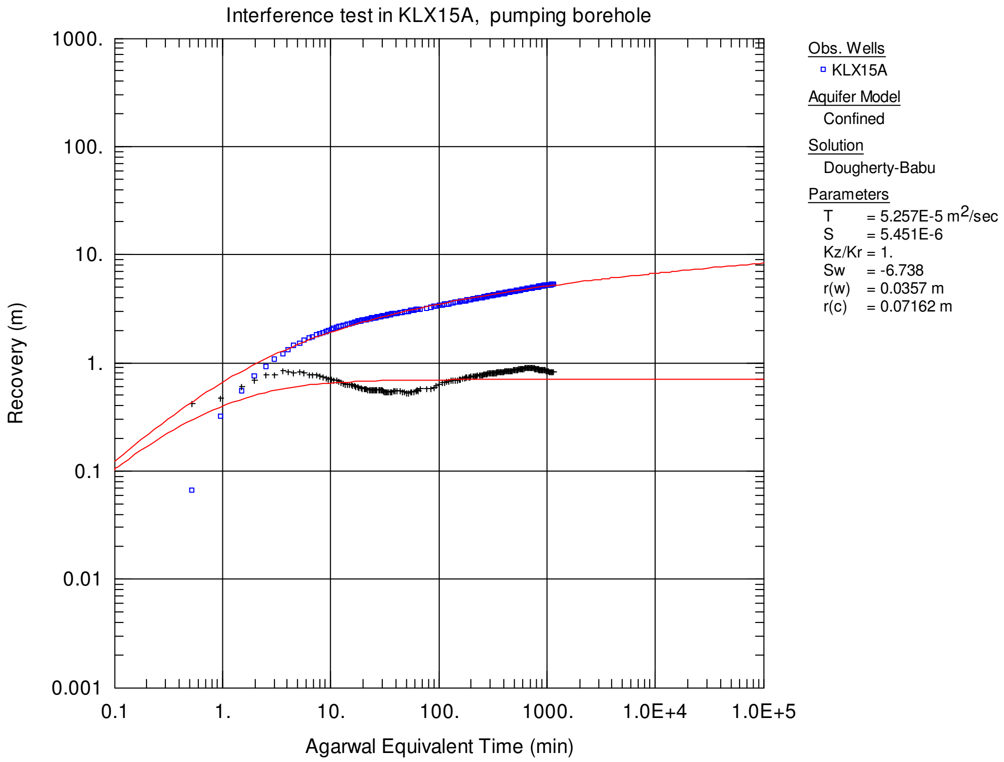


Figure 1-153. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX15A.*

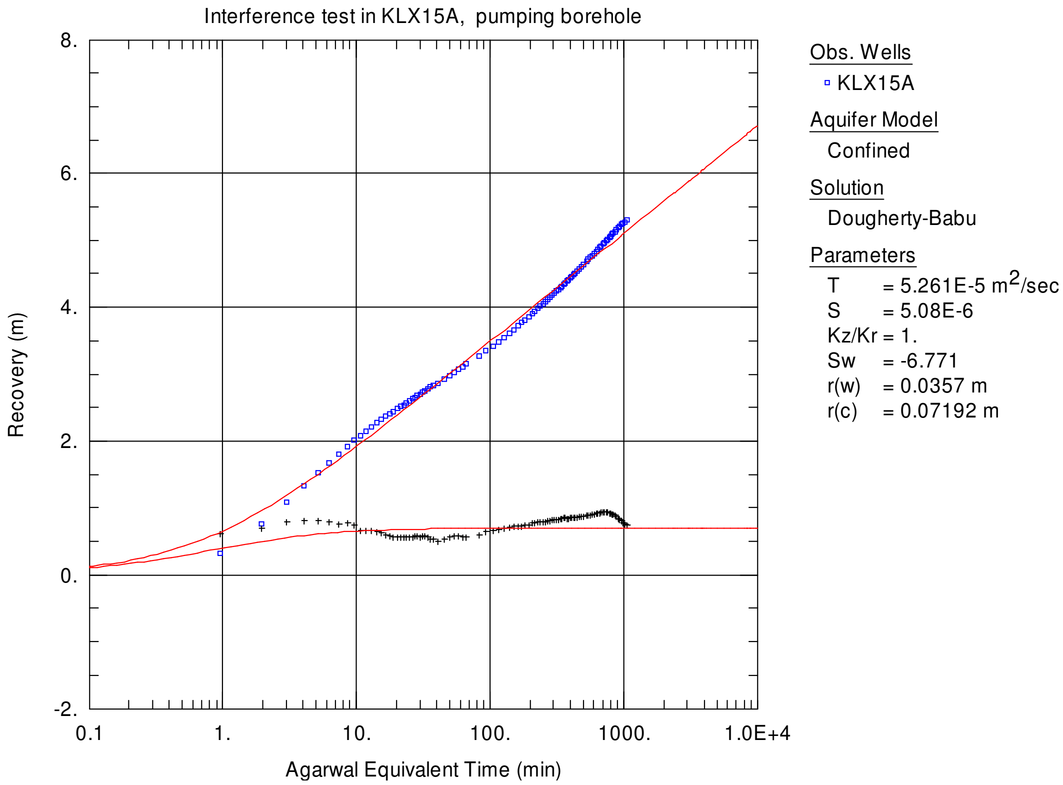


Figure 1-154. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX15A.*

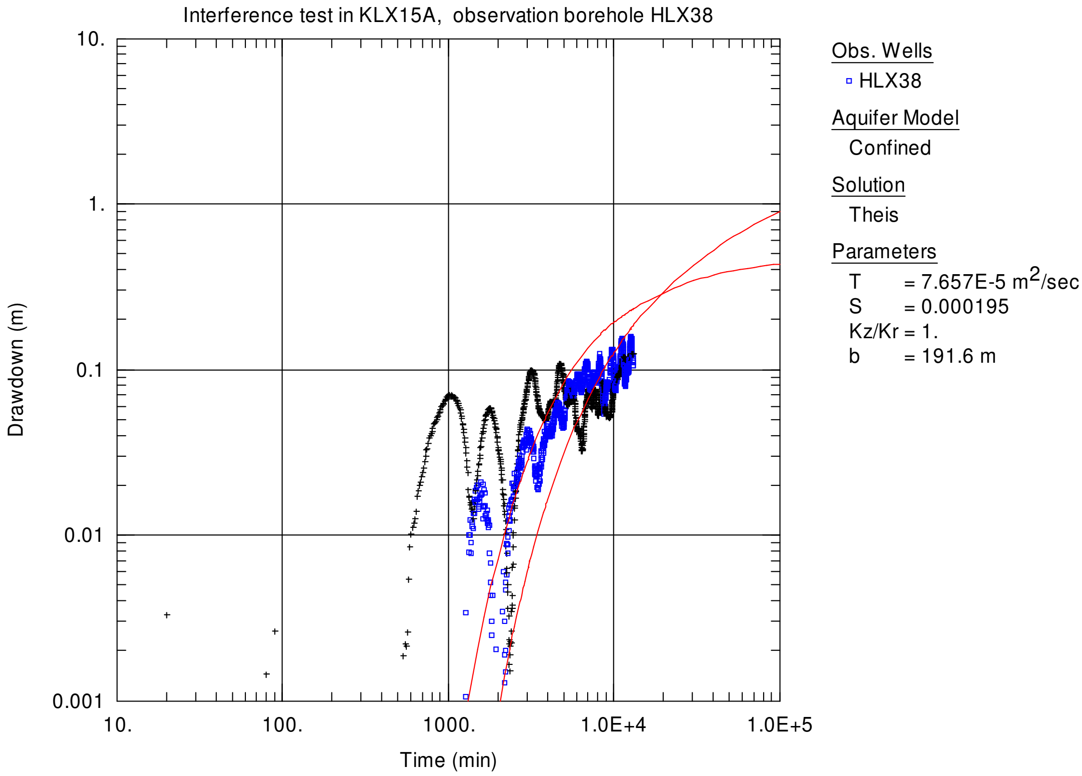


Figure 1-155. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX38 during pumping in borehole KLX15A.*

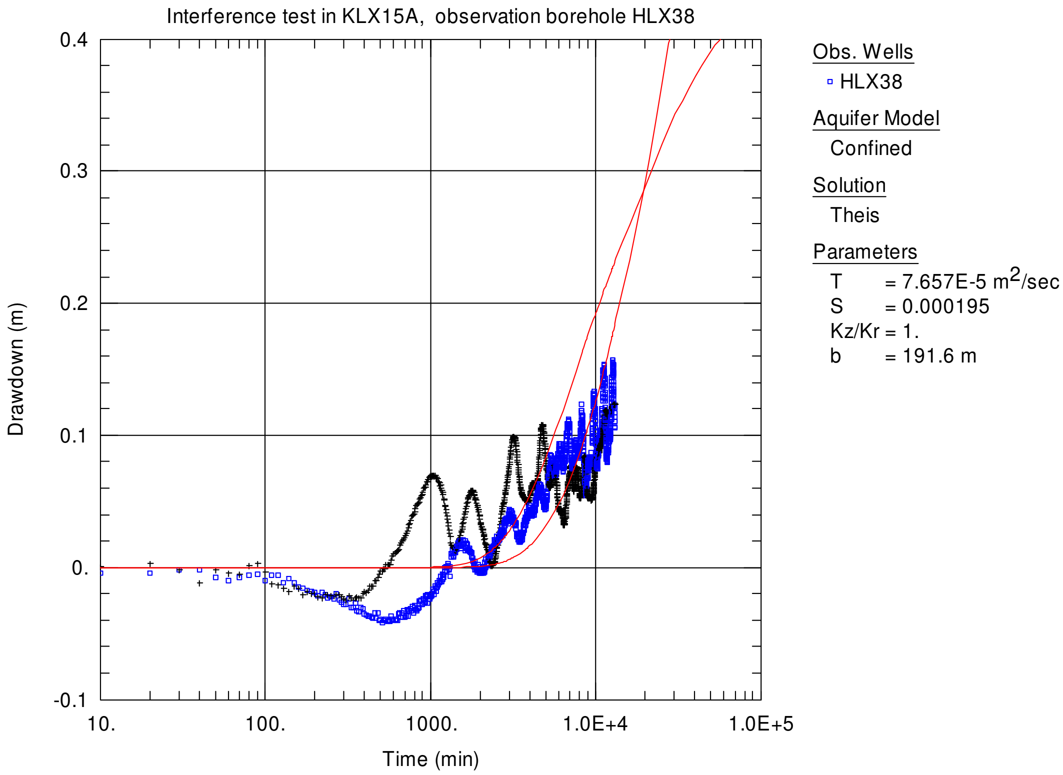


Figure 1-156. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX38 during pumping in borehole KLX15A.*

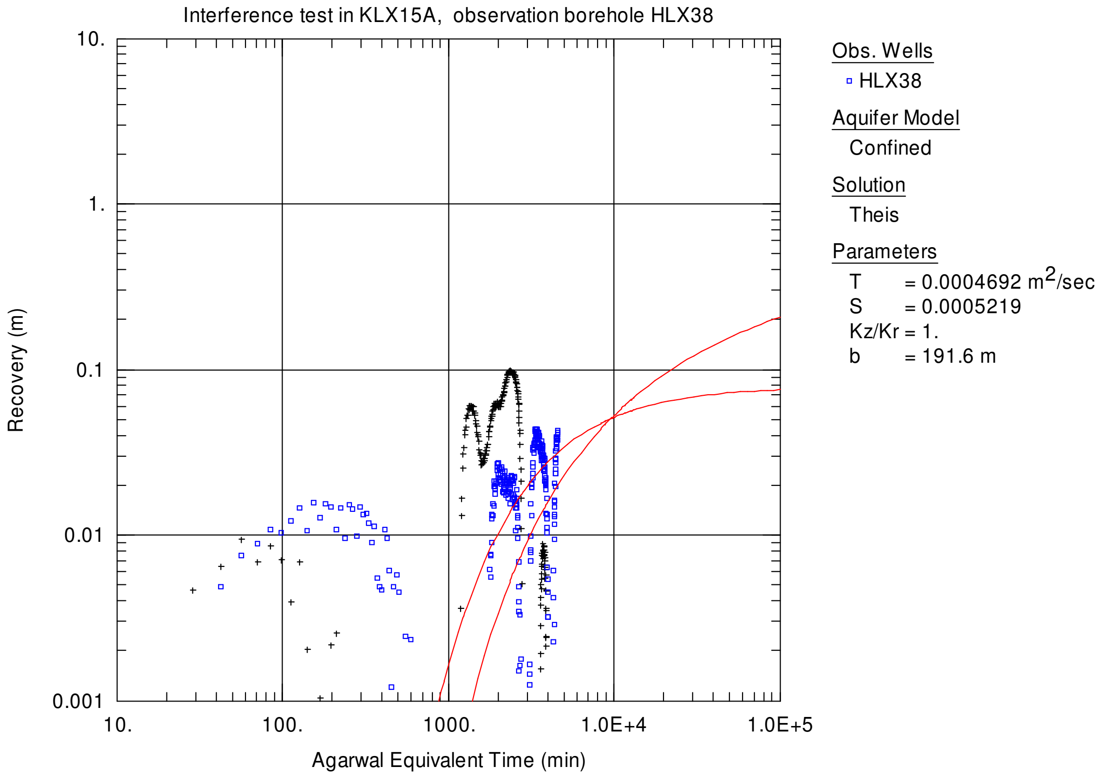


Figure 1-157. Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX38 during pumping in borehole KLX15A.

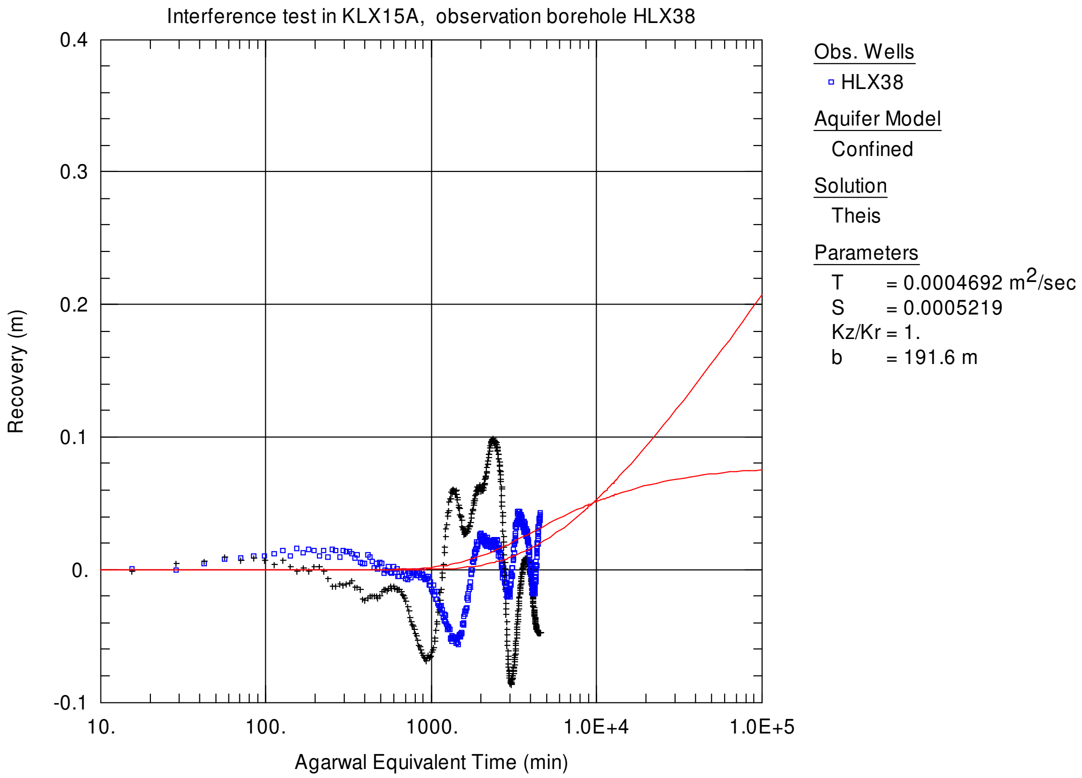


Figure 1-158. Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX38 during pumping in borehole KLX15A.

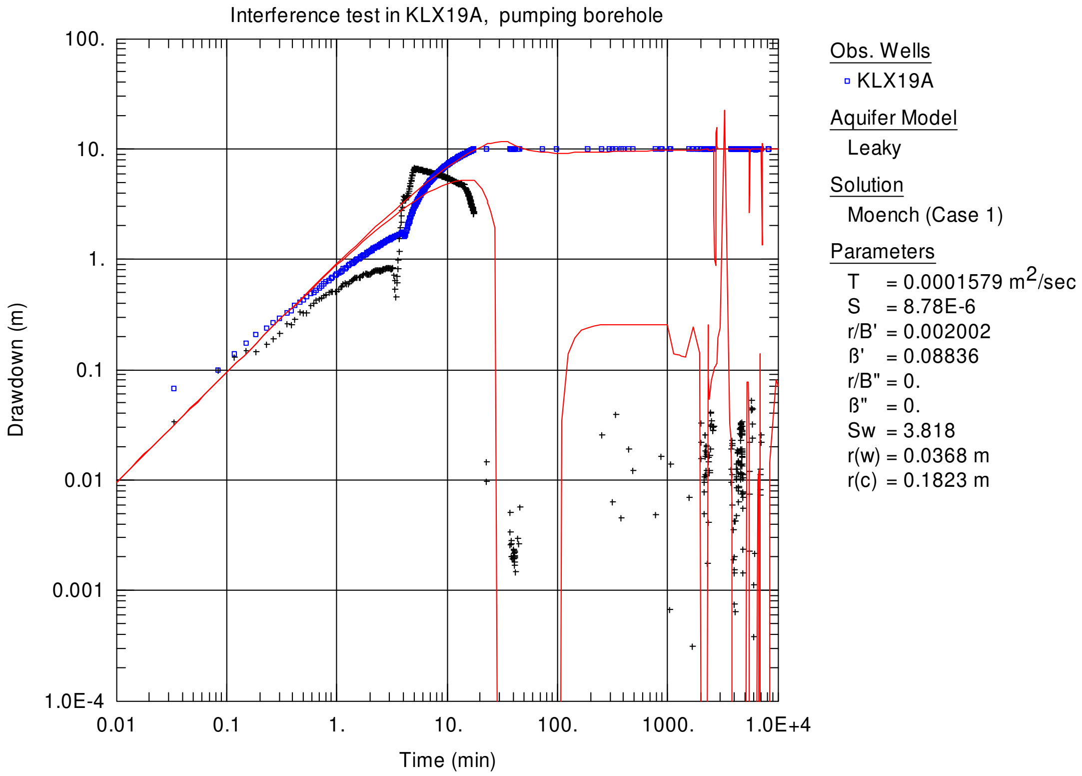


Figure 1-159. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX19A.*

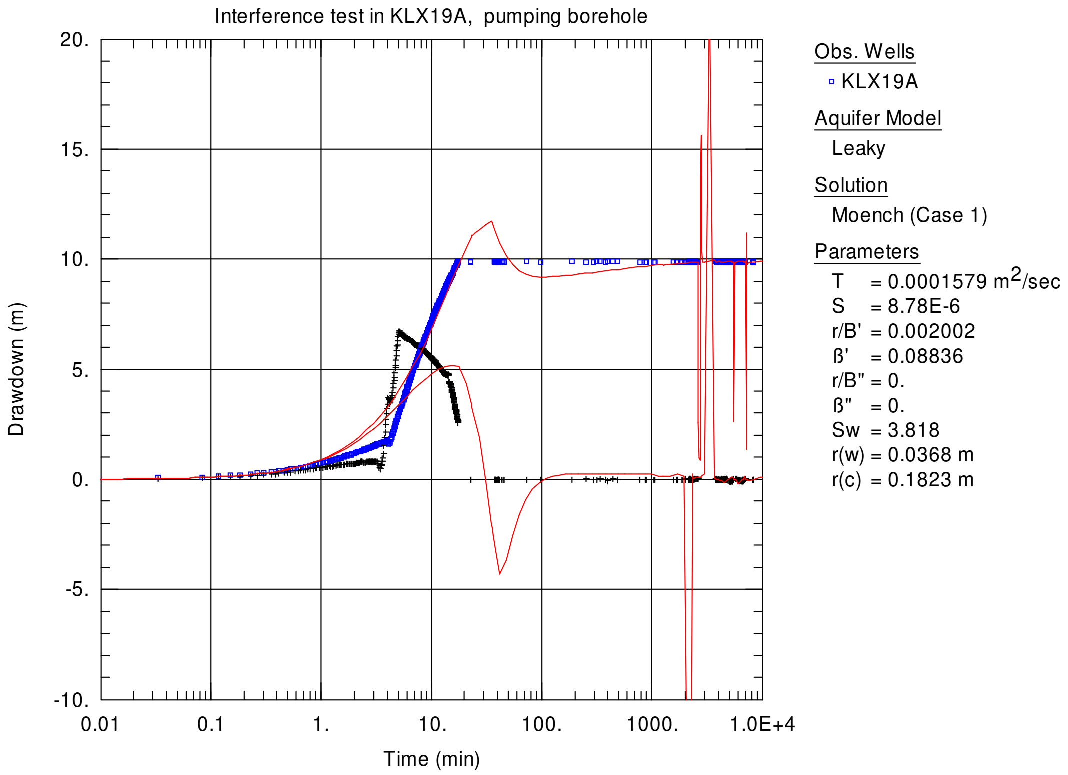


Figure 1-160. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX19A.*

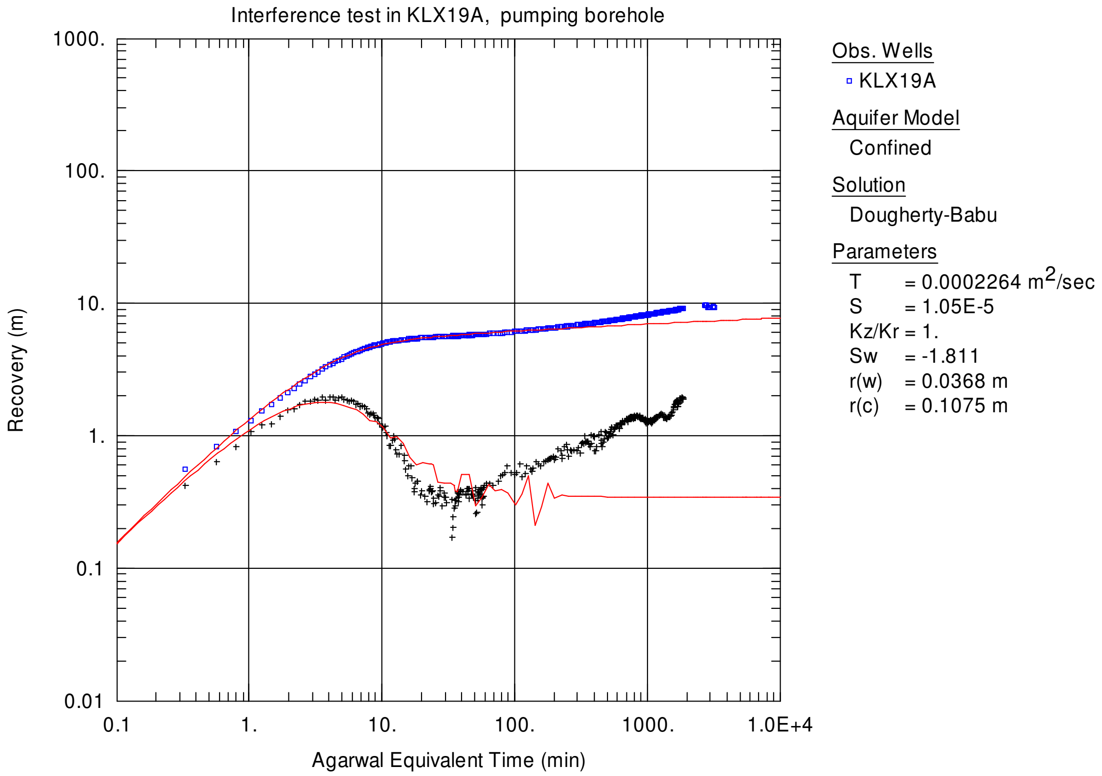


Figure 1-161. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX19A. The evaluation is based on the early-time recovery response.*

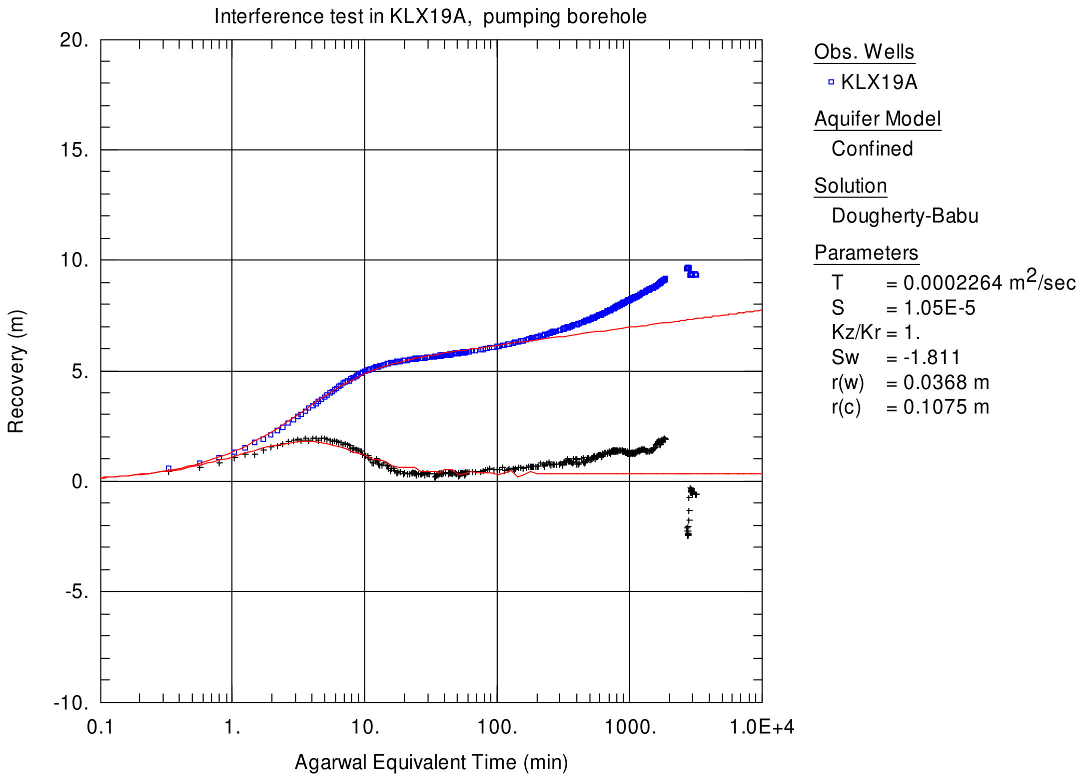


Figure 1-162. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with corresponding simulated curves (red) in the pumping borehole KLX19A. The evaluation is based on the early-time recovery response.*

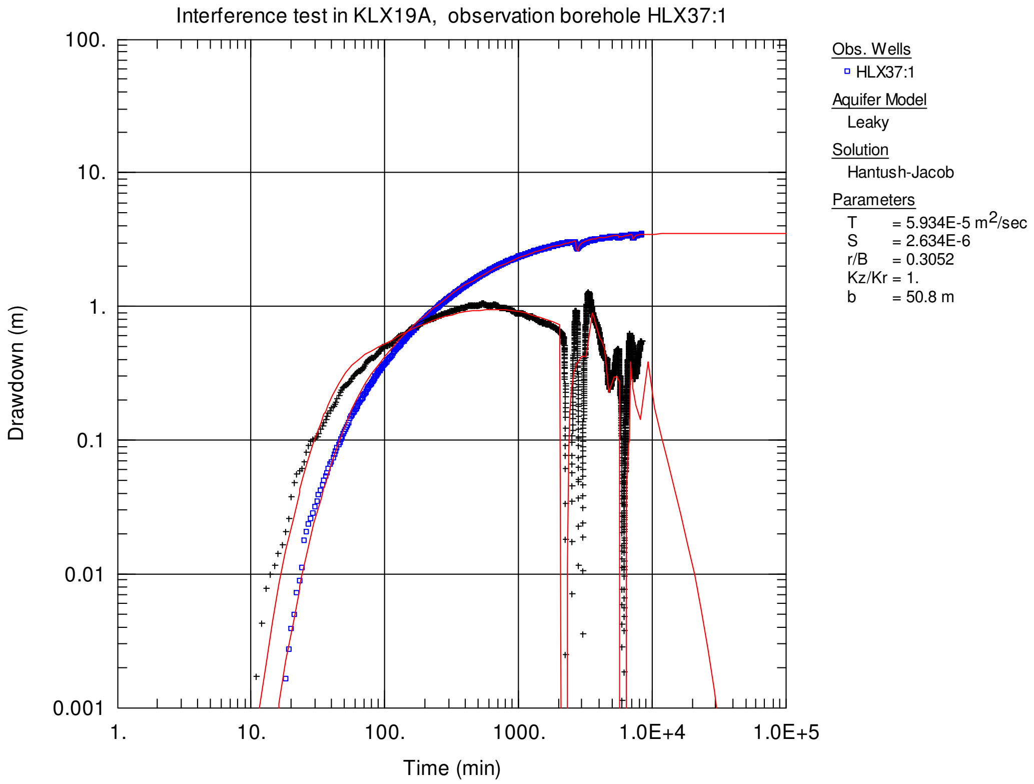


__Figure 1-163.__ Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX37:1 during pumping in borehole KLX19A.

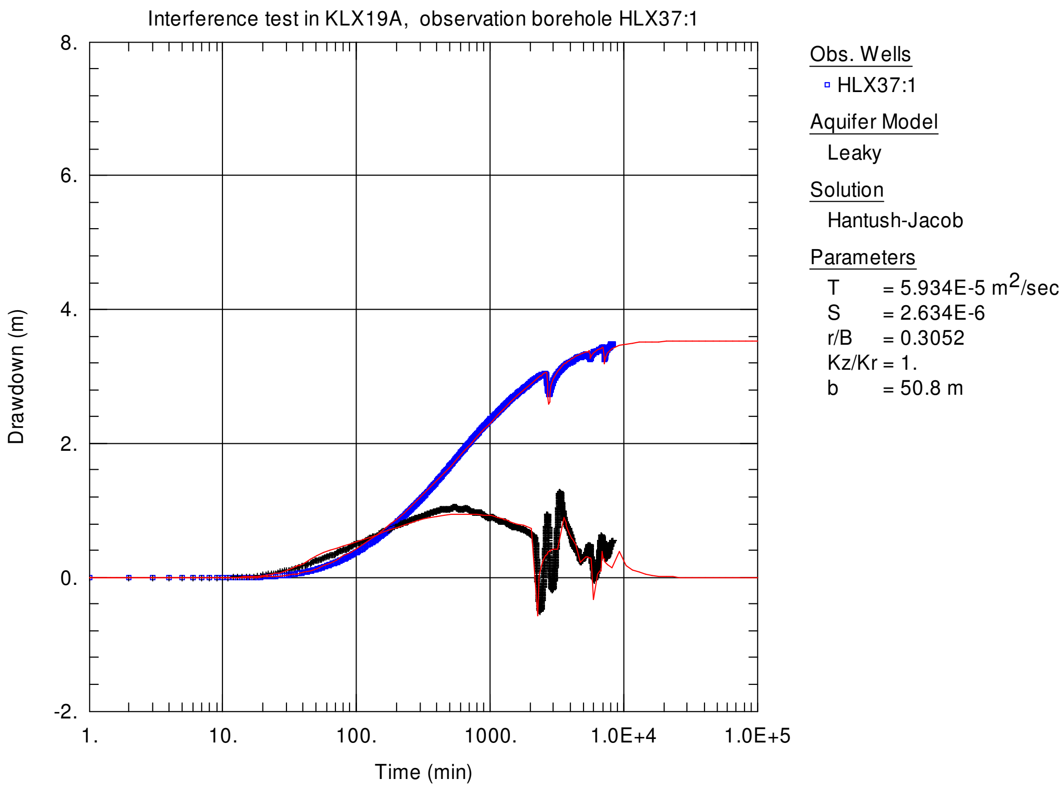


__Figure 1-164.__ Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX37:1 during pumping in borehole KLX19A.

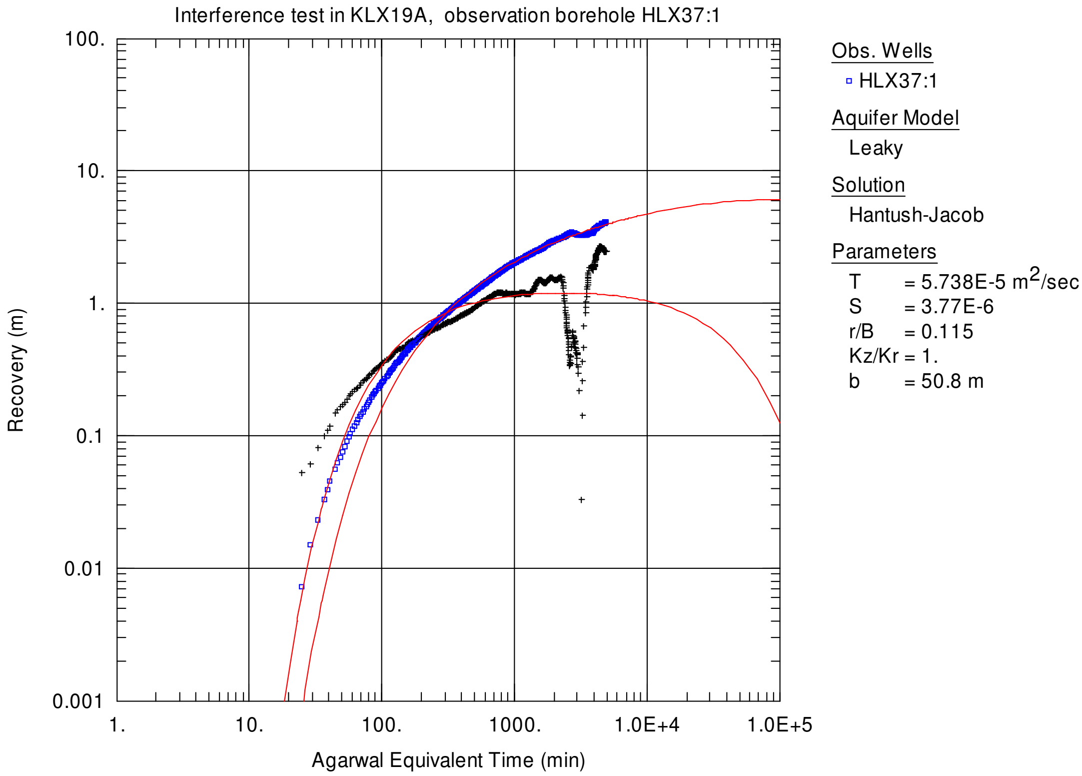


Figure 1-165. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX37:1 during pumping in borehole KLX19A.*

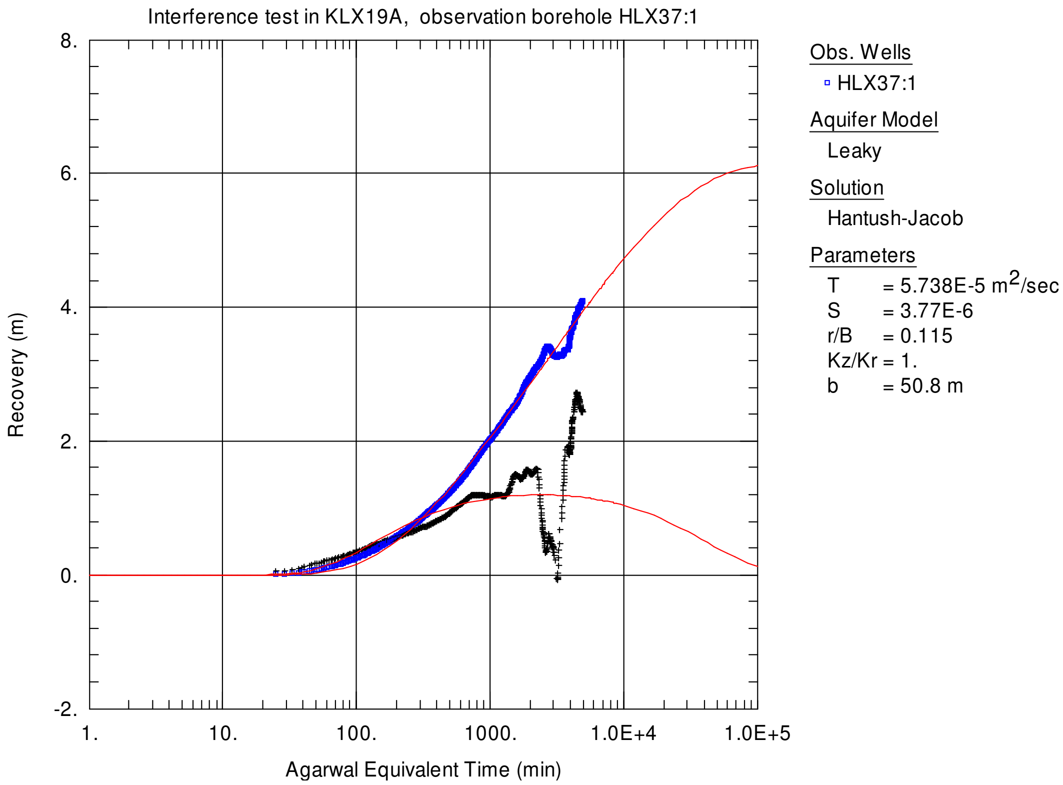


Figure 1.-166. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX37:1 during pumping in borehole KLX19A.*

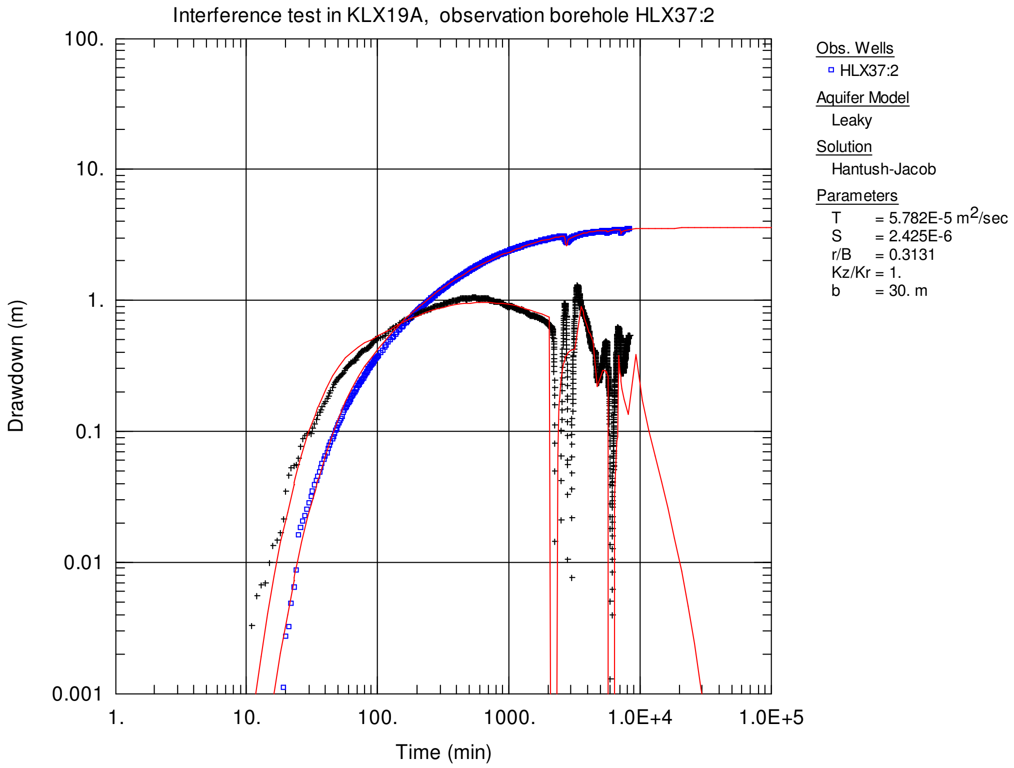


Figure 1-167. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX37:2 during pumping in borehole KLX19A.*

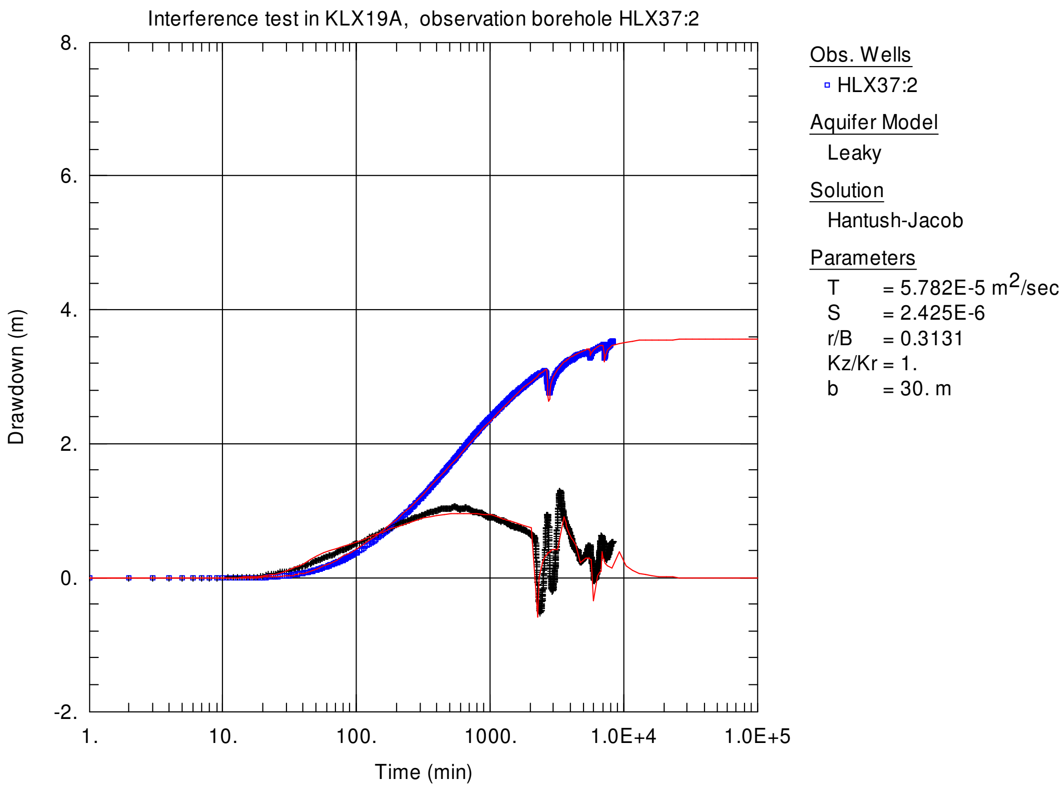


Figure 1-168. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX37:2 during pumping in borehole KLX19A*

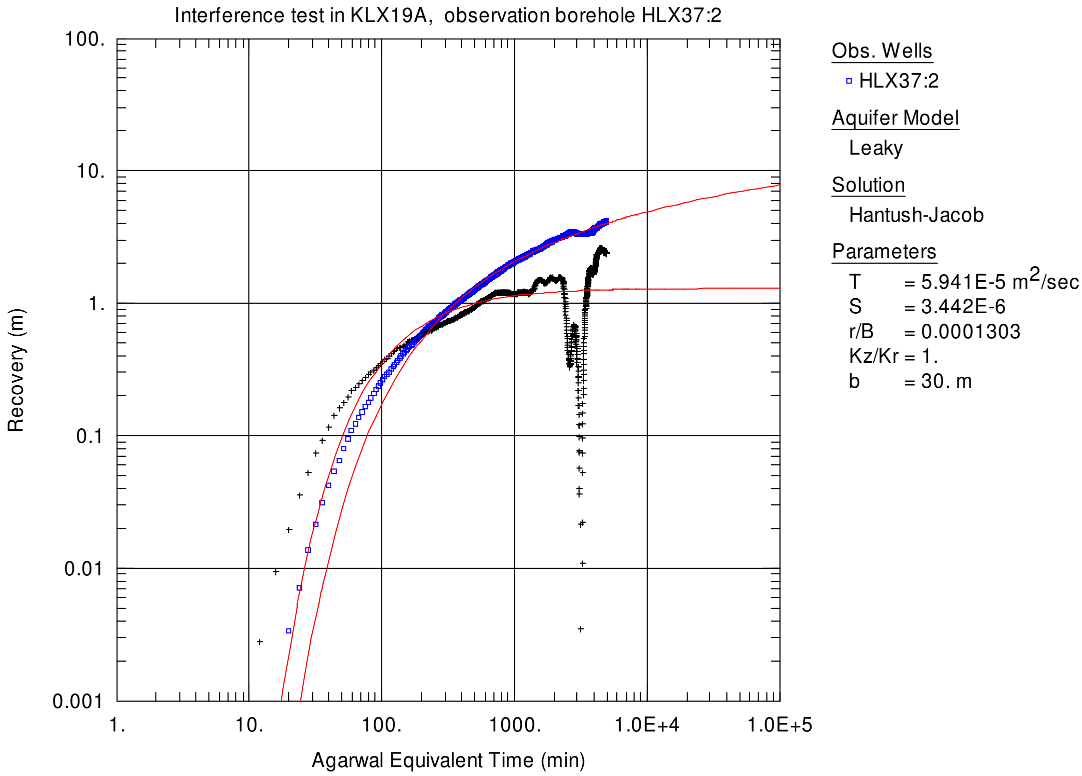


Figure 1-169. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX37:2 during pumping in borehole KLX19A.*

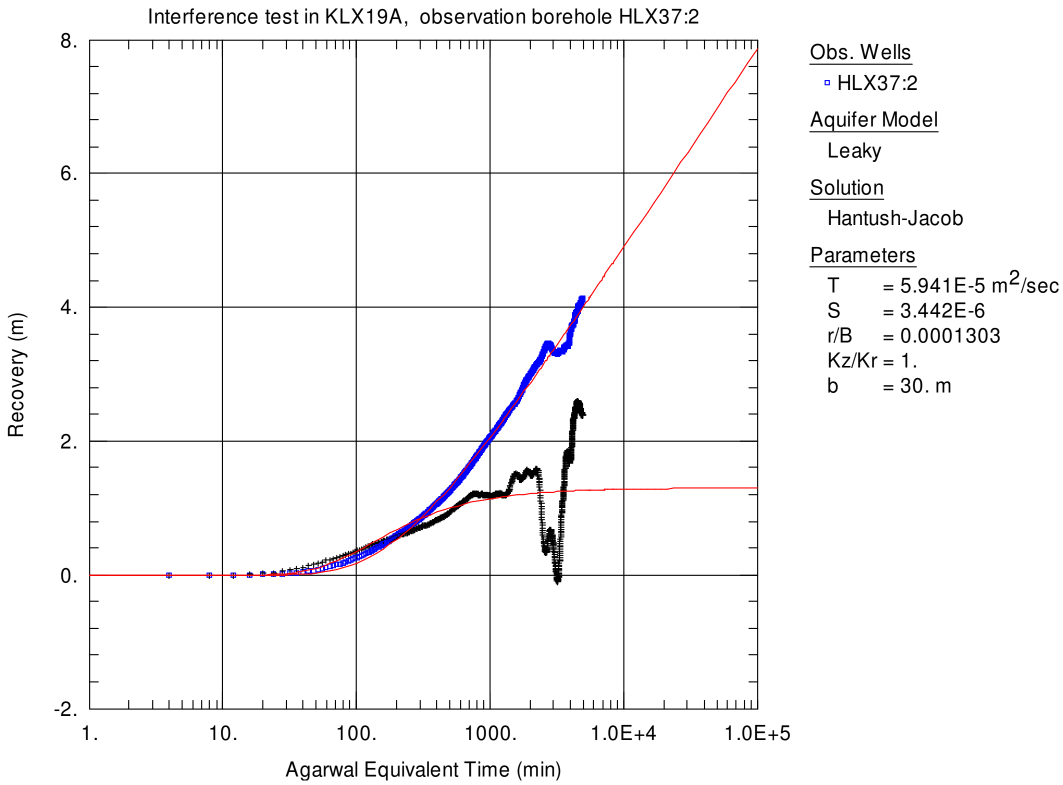


Figure 1-170. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX37:2 during pumping in borehole KLX19A.*

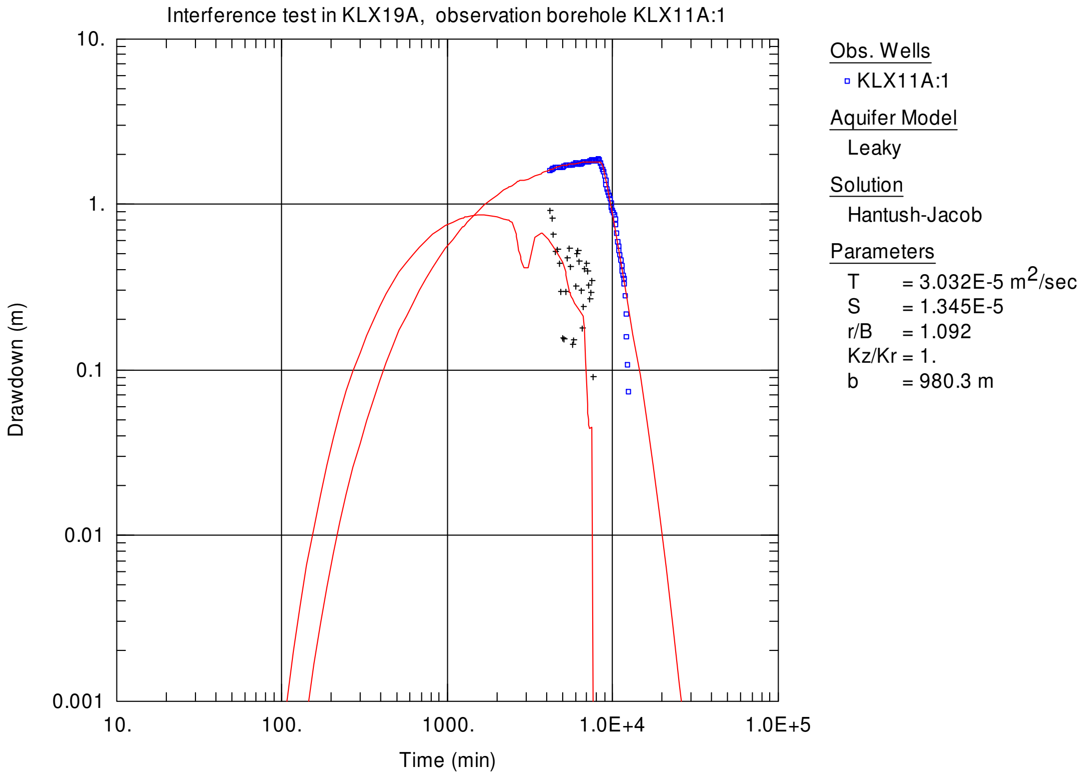


Figure 1-171. *Log-log plot of last phase of flow period together with recovery period (blue □) and corresponding derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX11A:1 during pumping in borehole KLX19A.*

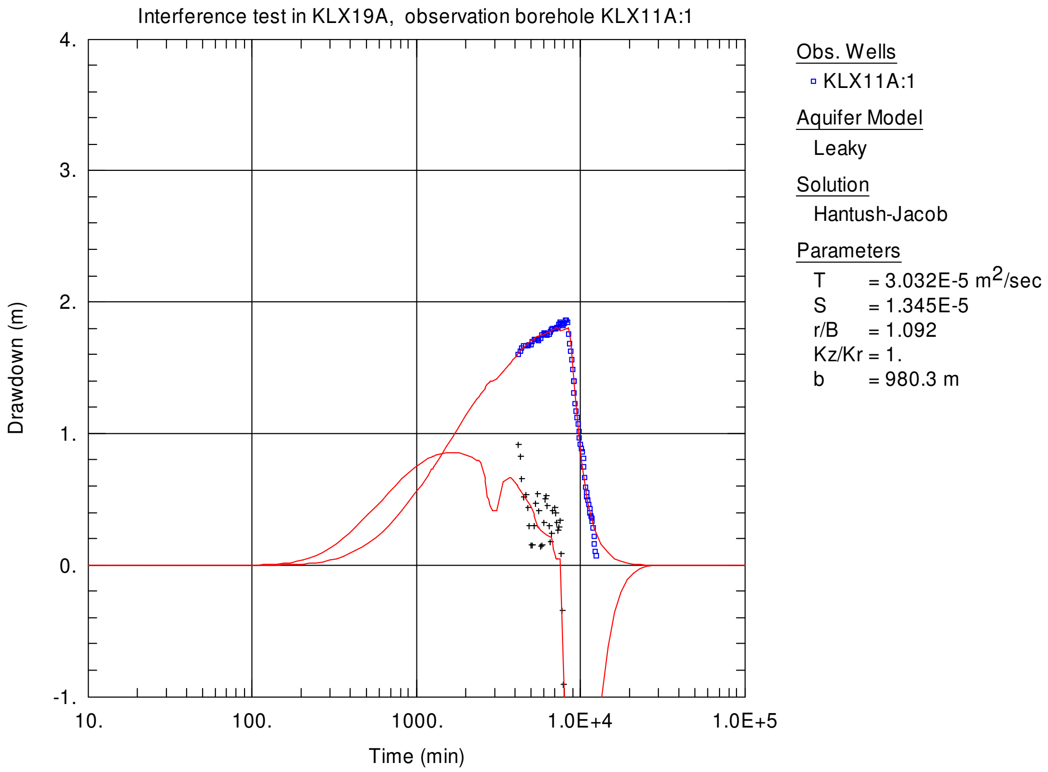


Figure 1-172. *Lin-log plot of last phase of flow period together with recovery period (blue □) and corresponding derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX11A:1 during pumping in borehole KLX19A.*

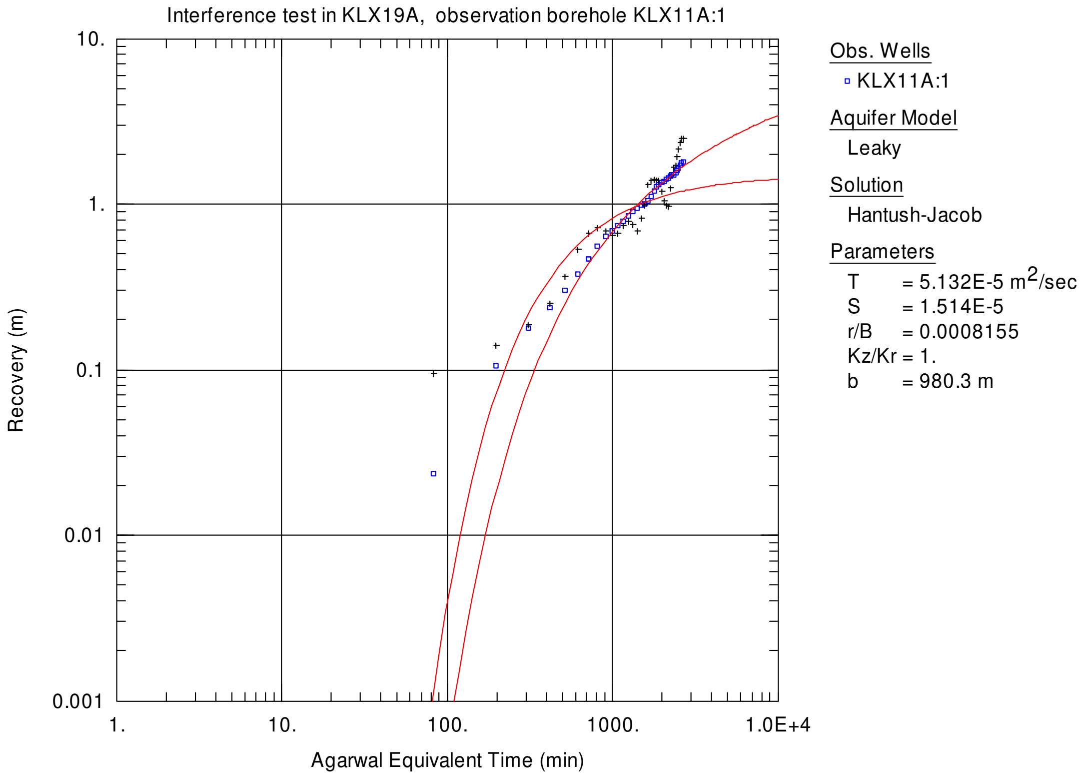


Figure 1-173. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX11A:1 during pumping in borehole KLX19A.*

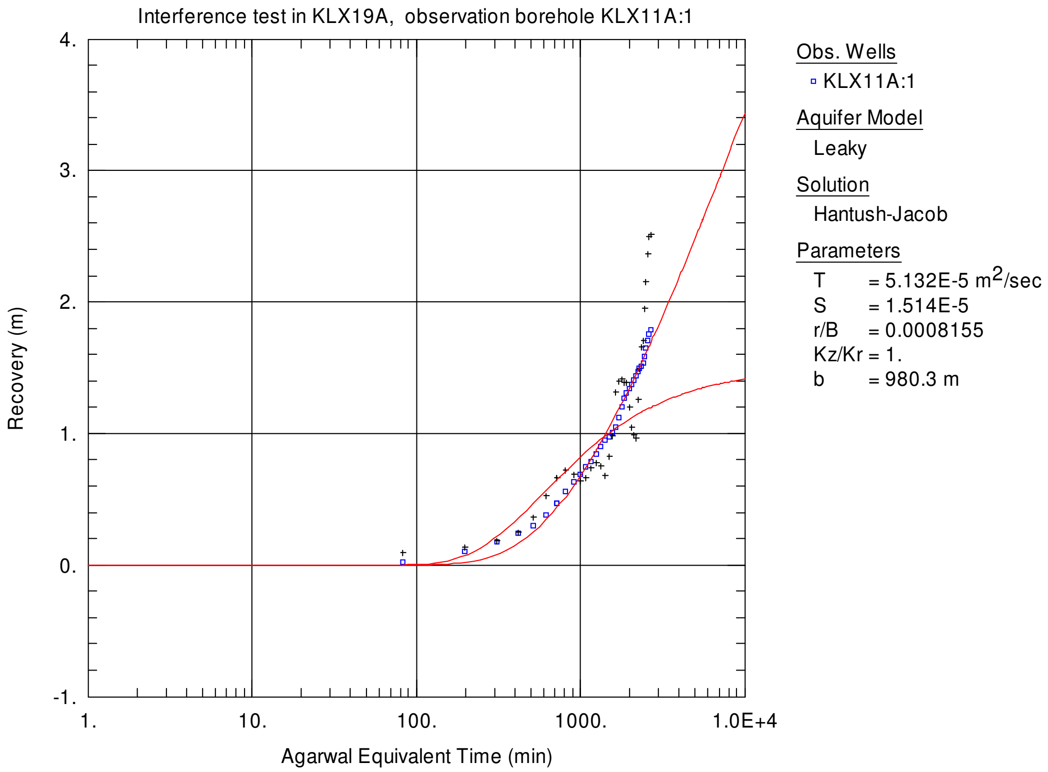


Figure 1-174. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX11A:1 during pumping in borehole KLX19A.*

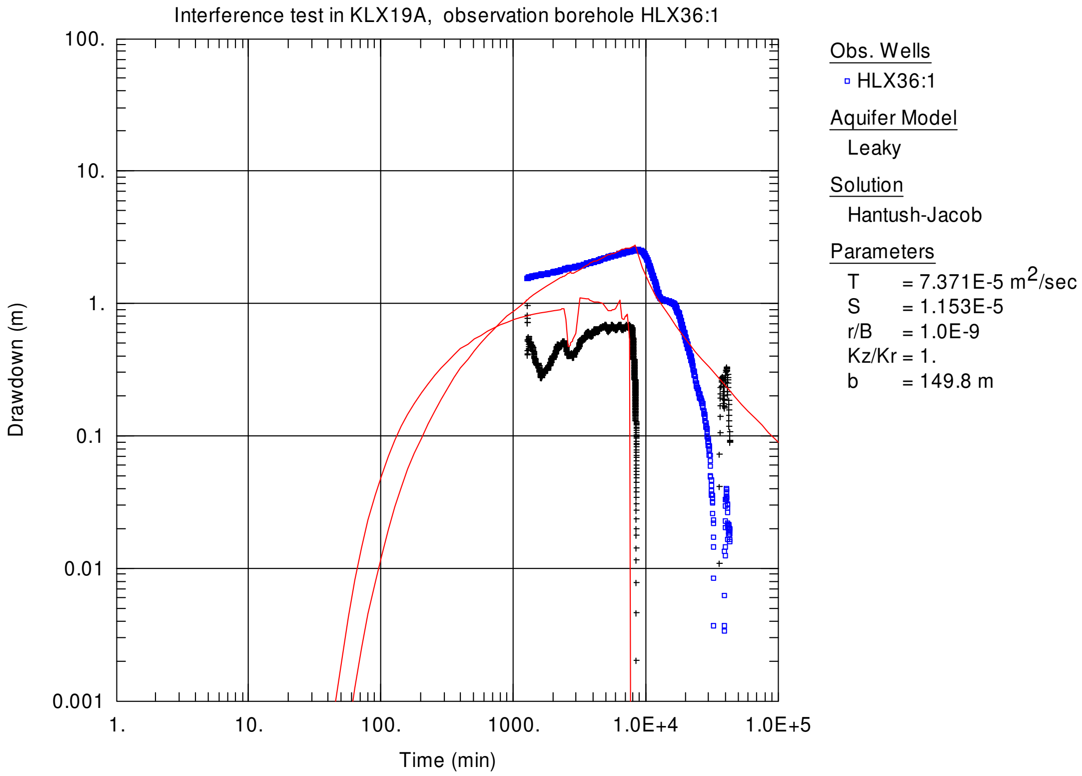


Figure 1-175. *Log-log plot of last phase of flow period together with recovery period (blue □) and corresponding derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX36:1 during pumping in borehole KLX19A.*

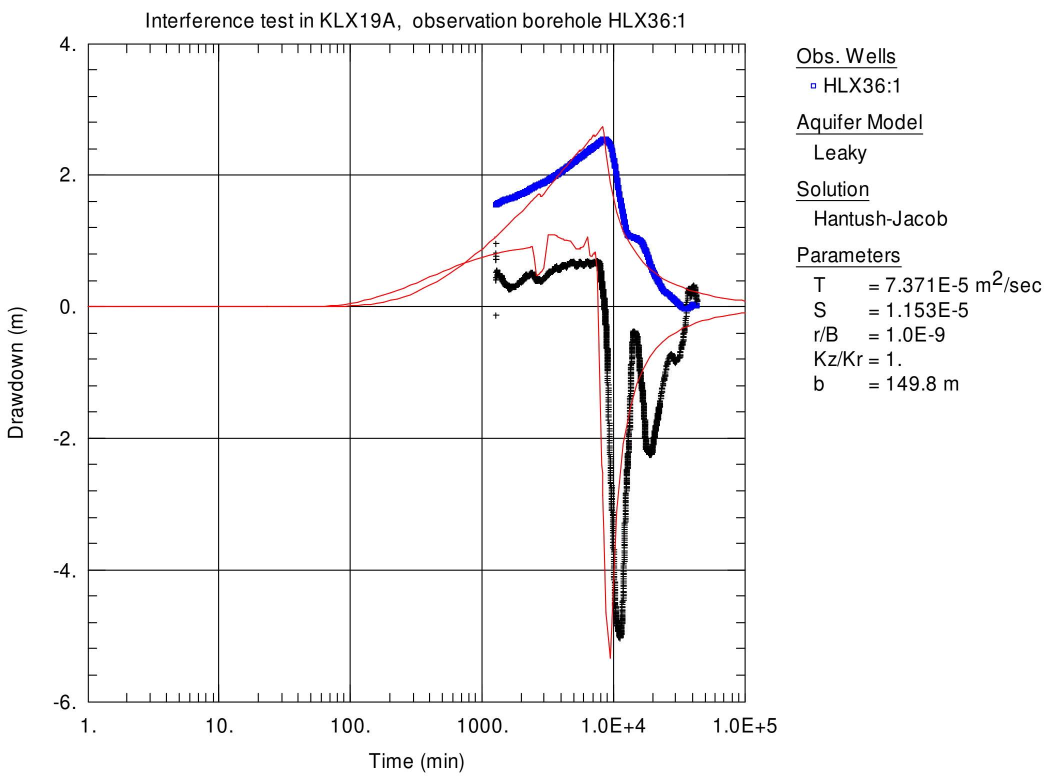


Figure 1-176. *Lin-log plot of last phase of flow period together with recovery period (blue □) and corresponding derivative (black +) versus time together with simulated curves (red) in the observation borehole HLX36:1 during pumping in borehole KLX19A.*

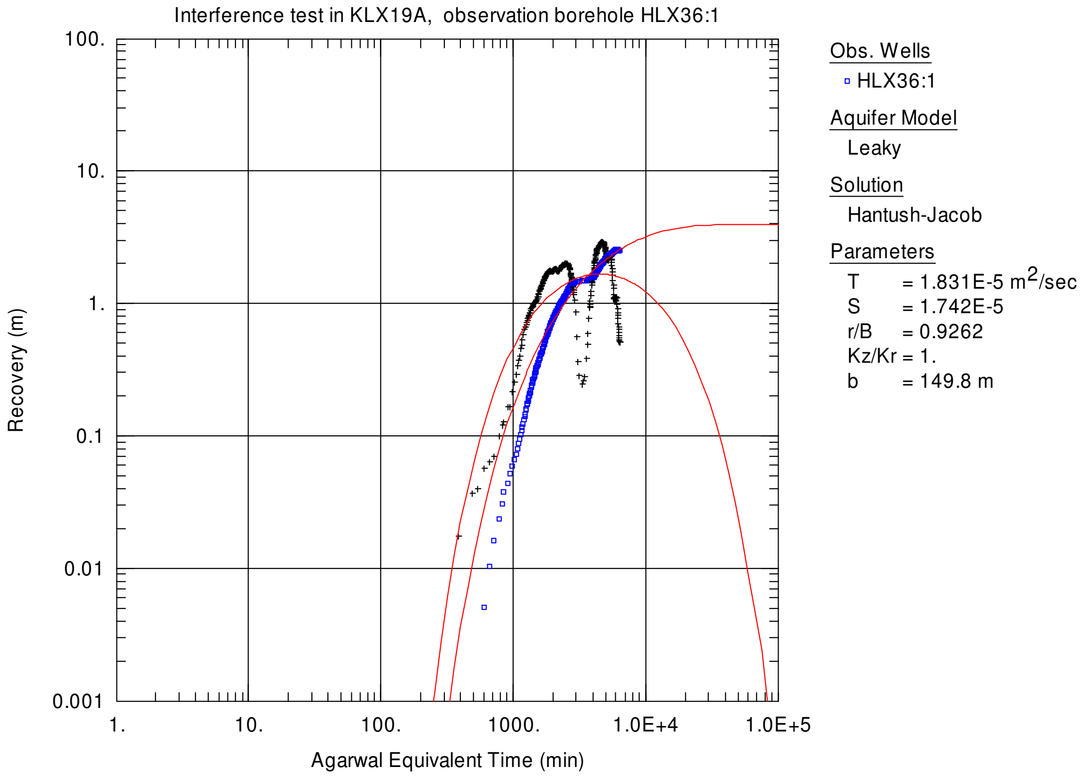


Figure 1-177. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX36:1 during pumping in borehole KLX19A.*

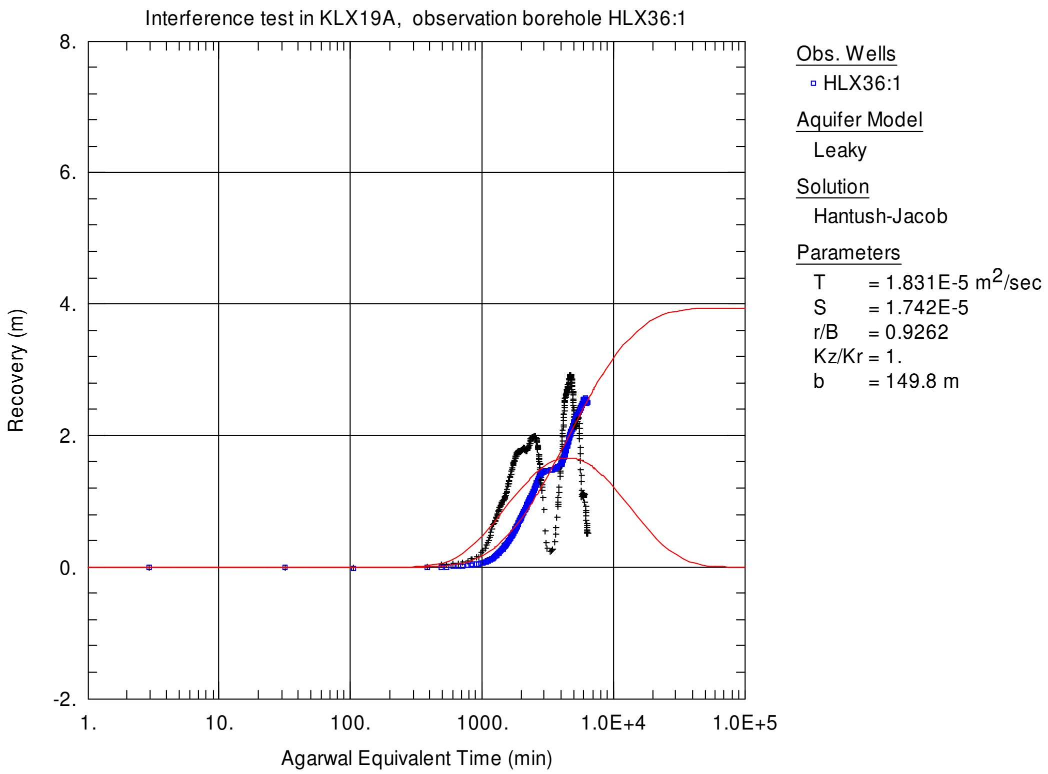


Figure 1-178. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole HLX36:1 during pumping in borehole KLX19A.*

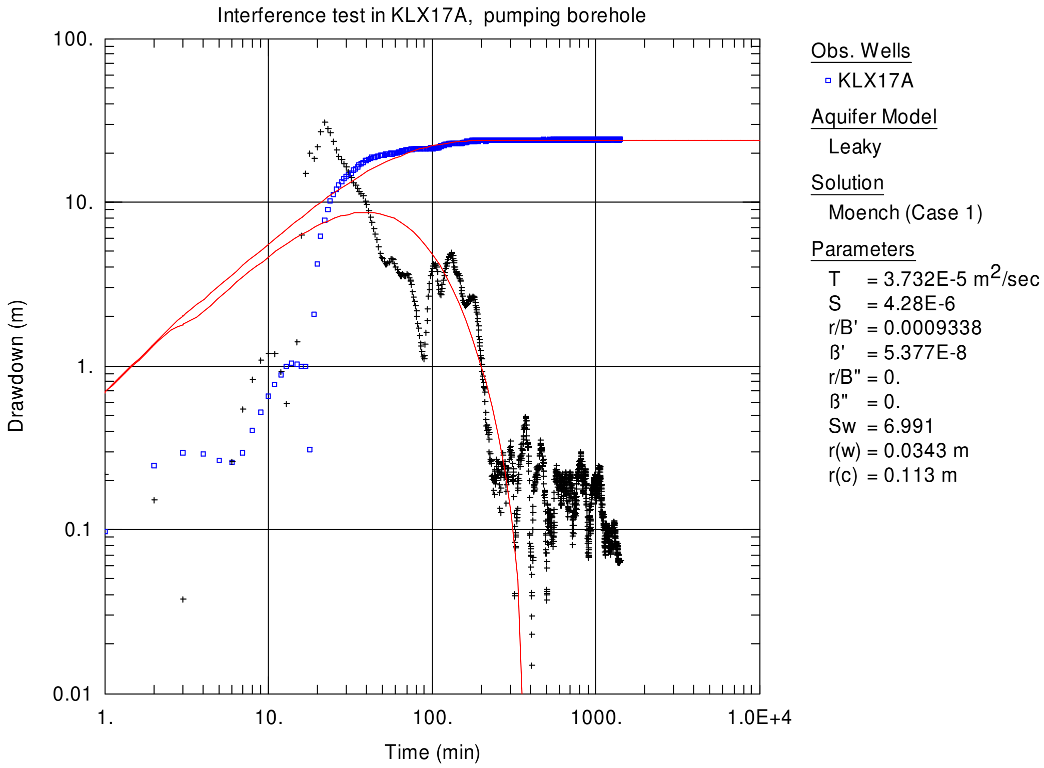


Figure 1-179. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX17A. No unambiguous transient evaluation could be made. Examples of possible transient evaluations are shown.*

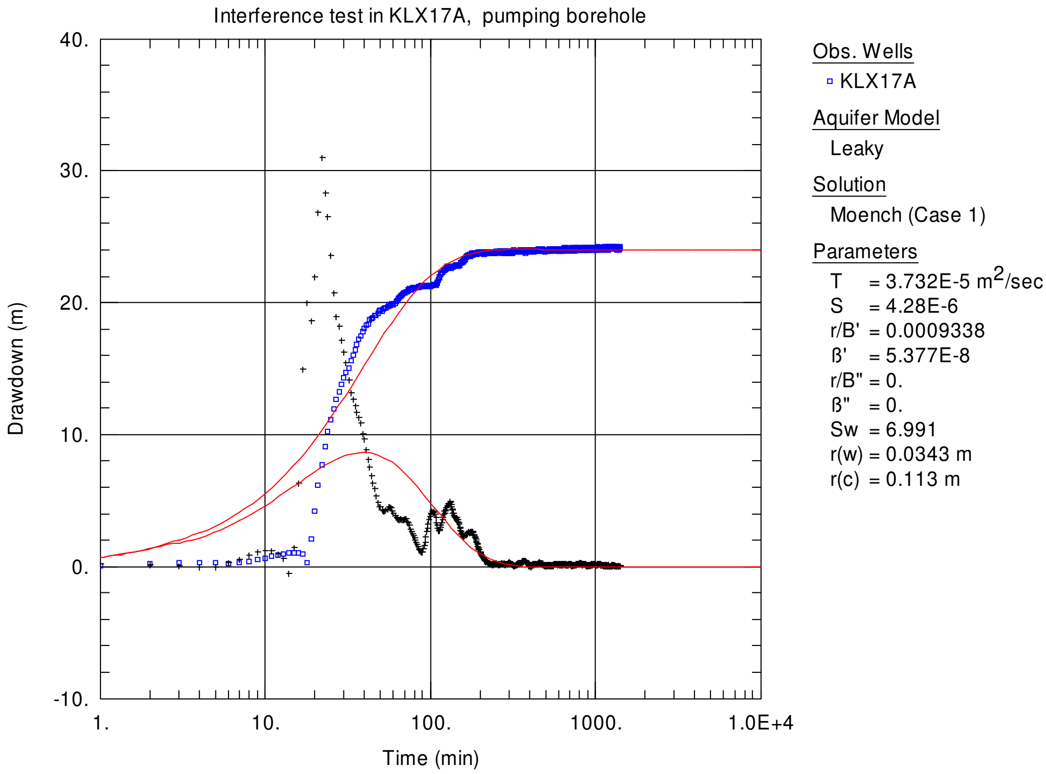


Figure 1-180. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the pumping borehole KLX17A. No unambiguous transient evaluation could be made. Examples of possible transient evaluations are shown.*

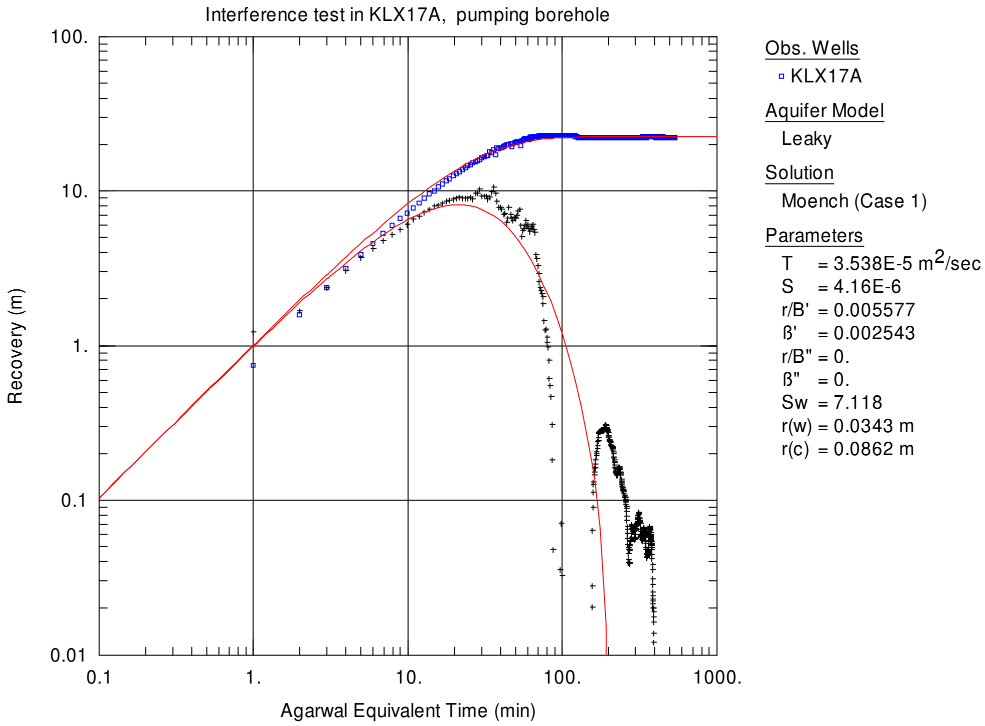


Figure 1-181. *Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX17A. No unambiguous transient evaluation could be made. Examples of possible transient evaluations are shown.*

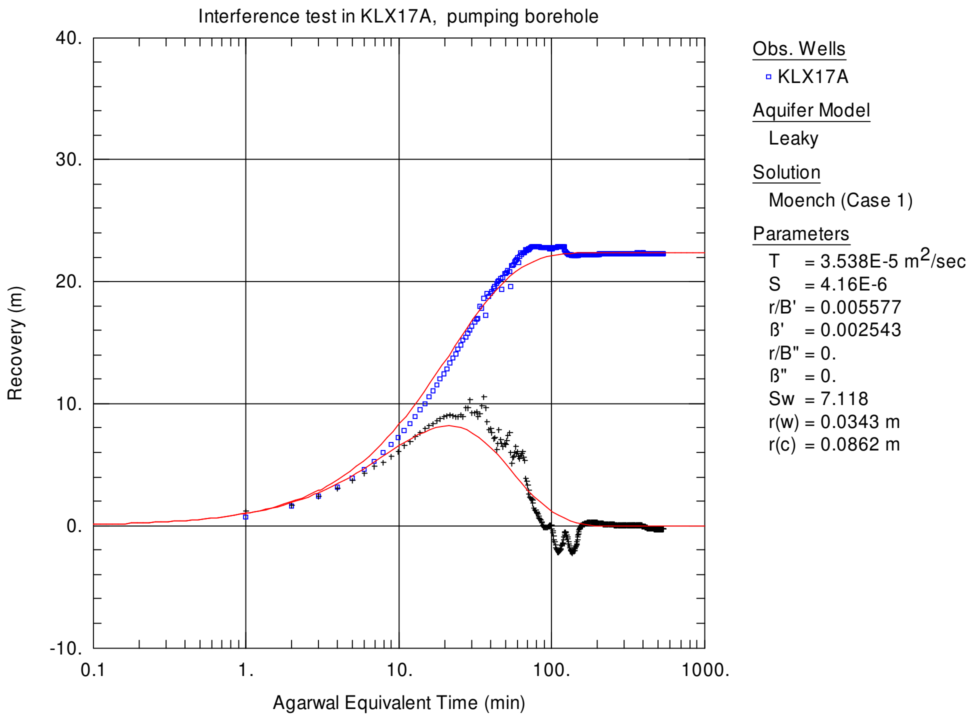


Figure 1-182. *Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) together with simulated curves (red) in the pumping borehole KLX17A. No unambiguous transient evaluation could be made. Examples of possible transient evaluations are shown*

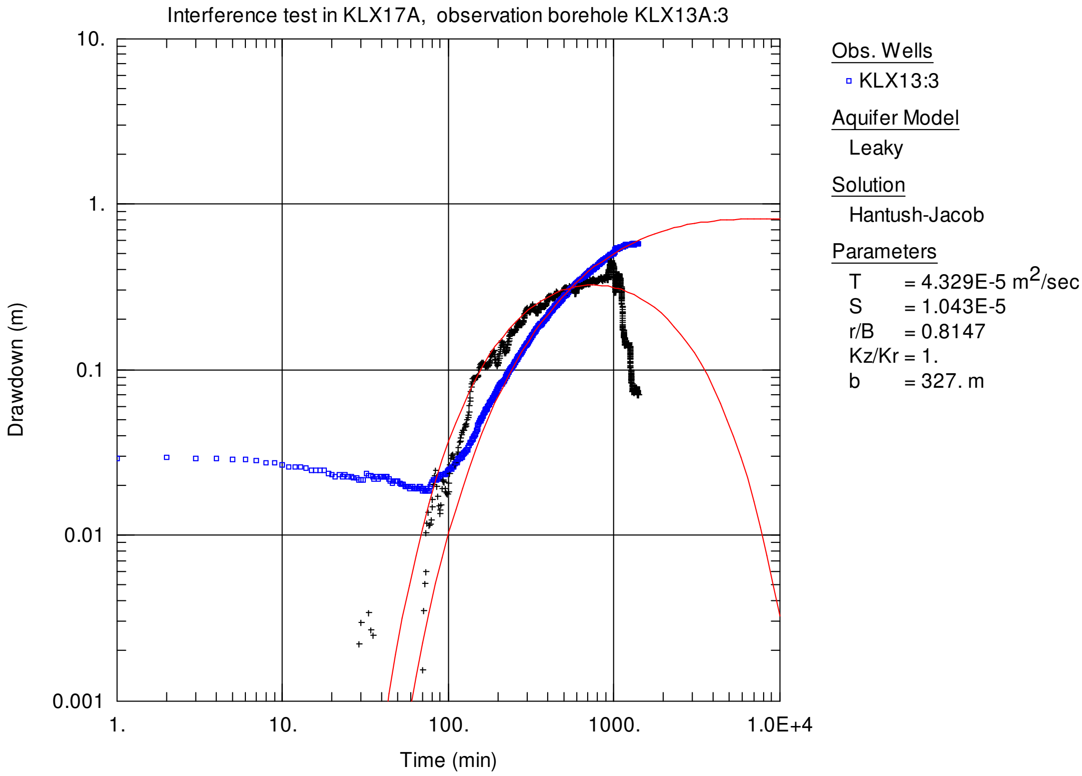


Figure 1-183. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX13A:3 during pumping in borehole KLX17A.*

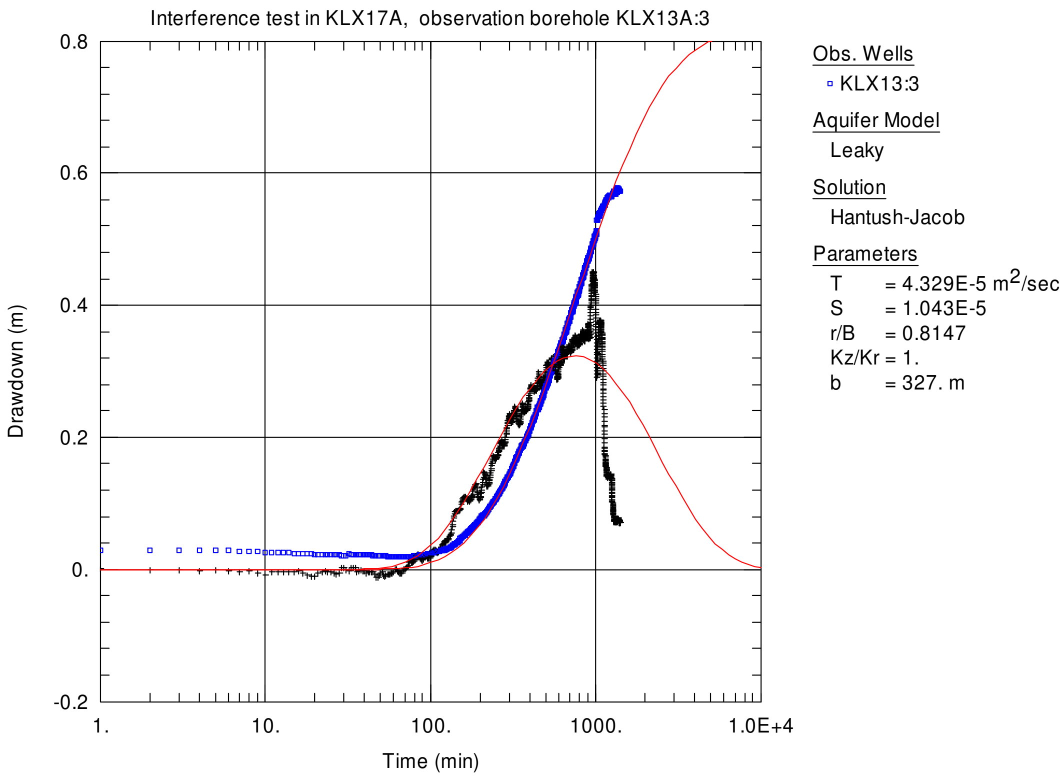


Figure 1-184. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with simulated curves (red) in the observation borehole KLX13A:3 during pumping in borehole KLX17A.*

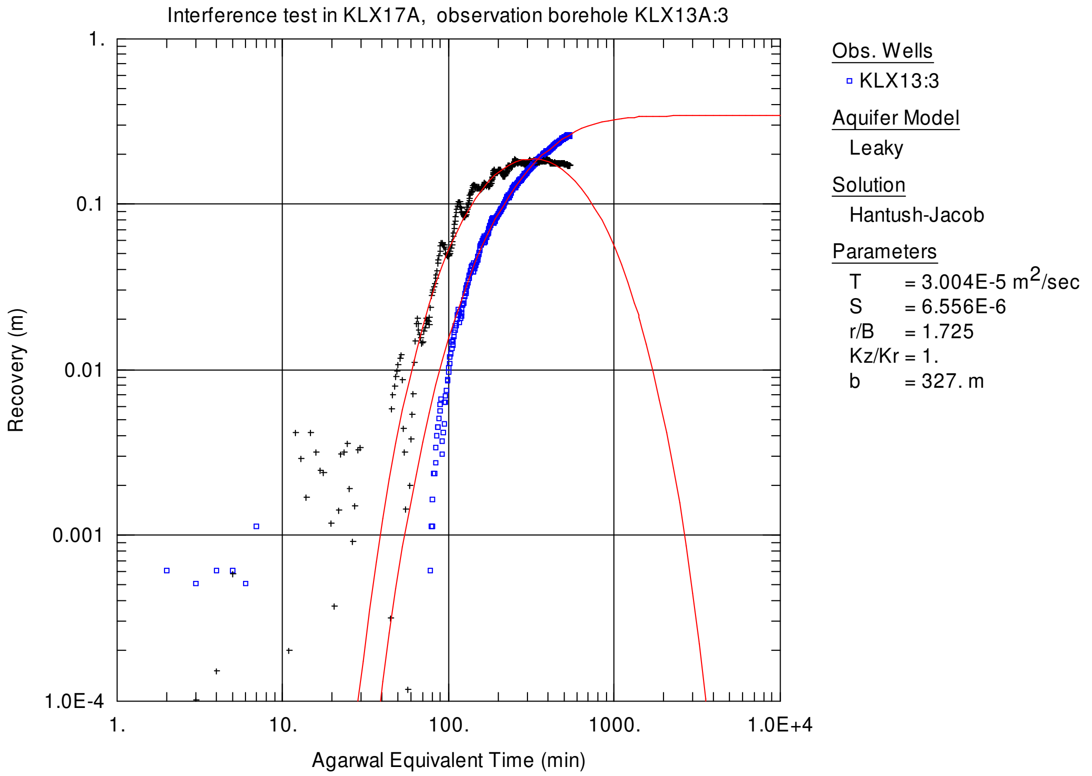


Figure 1-185. Log-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX13A:3 during pumping in borehole KLX17A.

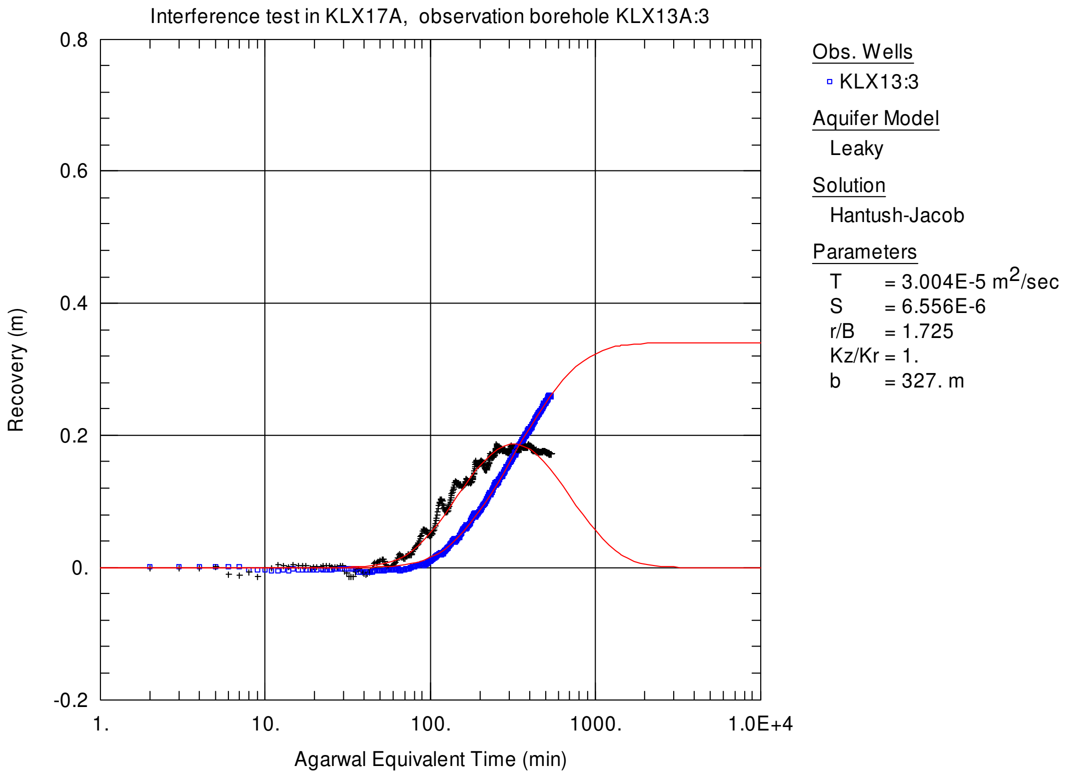
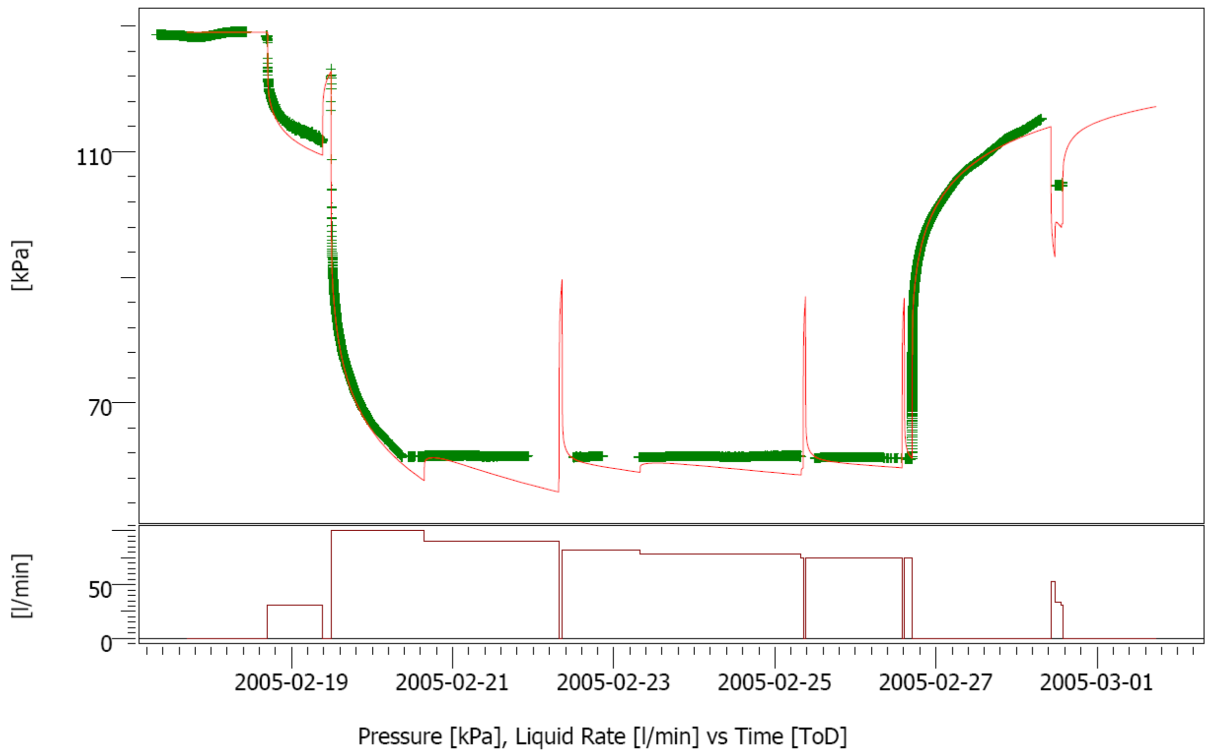


Figure 1-186. Lin-log plot of pressure recovery (blue □) and -derivative (black +) versus equivalent time (dte) in the observation borehole KLX13A:3 during pumping in borehole KLX17A.



Pressures 2 build-up #5
Rate 0 l/min
Rate change 75 l/min
P@dt=0 61.066 kPa
Pi 129 kPa
Smoothing 0.1

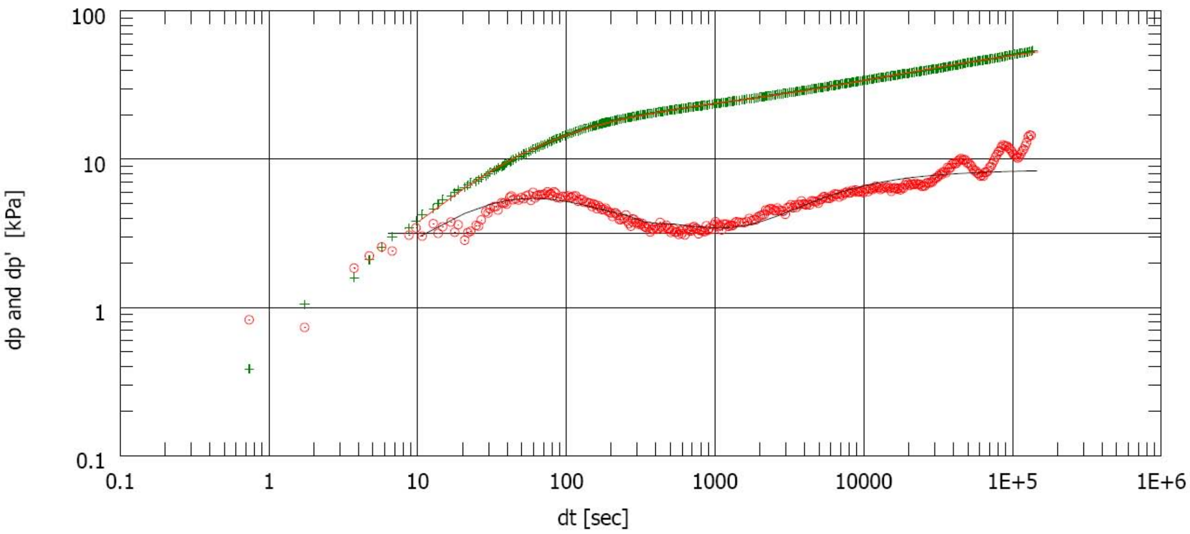
Selected Model
Model Option Standard Model
Well Vertical
Reservoir Homogeneous
Boundary Intersecting faults - Any angle

Main Model Parameters
TMatch 0.0792 1/sec
PMatch 0.159 1/kPa
C 2.51E-6 m3/Pa
Total Skin -6.21
T 3.05E-4 m2/s
K 3.07E-7 m/s
Pi 129 kPa

Model Parameters
Well & Wellbore parameters (KLX06)
C 2.51E-6 m3/Pa
Skin -6.21
Reservoir & Boundary parameters
Pi 129 kPa
T 3.05E-4 m2/s
K 3.07E-7 m/s
L1 - No flow 1290 m
L2 - No flow 1260 m
Angle 2.31681 Radians

Derived & Secondary Parameters
Delta P (Total Skin) -38.99 kPa
Delta P Ratio (Total Skin) -0.738351 Fraction

Figure 1-187. *Lin-lin plot of pressure versus time during the pumping test in borehole KLX06 together with evaluated data.*



Pressures 2 build-up #5
Rate 0 l/min
Rate change 75 l/min
P@dt=0 61.066 kPa
Pi 129 kPa
Smoothing 0.1

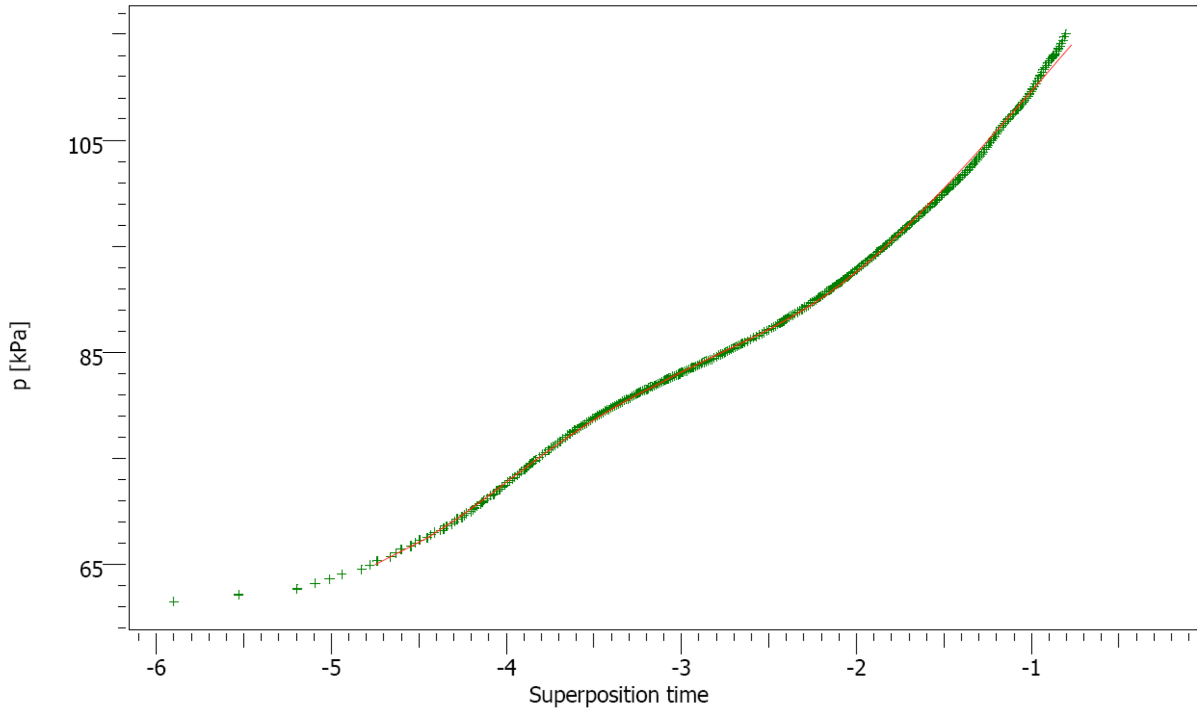
Selected Model
Model Option Standard Model
Well Vertical
Reservoir Homogeneous
Boundary Intersecting faults - Any angle

Main Model Parameters
TMatch 0.0792 1/sec
PMatch 0.159 1/kPa
C 2.51E-6 m3/Pa
Total Skin -6.21
T 3.05E-4 m2/s
K 3.07E-7 m/s
Pi 129 kPa

Model Parameters
Well & Wellbore parameters (KLX06)
C 2.51E-6 m3/Pa
Skin -6.21
Reservoir & Boundary parameters
Pi 129 kPa
T 3.05E-4 m2/s
K 3.07E-7 m/s
L1 - No flow 1290 m
L2 - No flow 1260 m
Angle 2.31681 Radians

Derived & Secondary Parameters
Delta P (Total Skin) -38.99 kPa
Delta P Ratio (Total Skin) -0.738351 Fraction

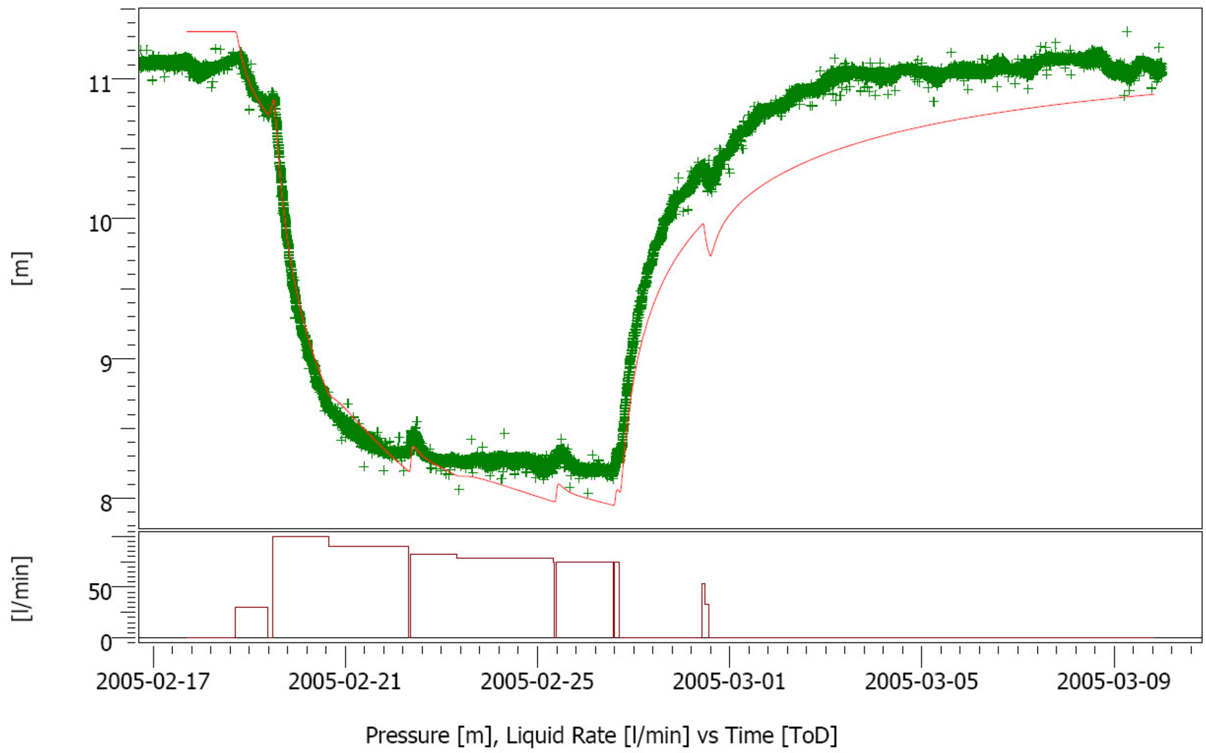
Figure 1-188. *Log-log plot of pressure versus time in the pumping borehole KLX06 together with evaluated data.*



Pressures 2 build-up #5	
Rate	0 l/min
Rate change	75 l/min
P@dt=0	61.066 kPa
Pi	129 kPa
Smoothing	0.1
Selected Model	
Model Option	Standard Model
Well	Vertical
Reservoir	Homogeneous
Boundary	Intersecting faults - Any angle
Main Model Parameters	
TMatch	0.0792 1/sec
PMatch	0.159 1/kPa
C	2.51E-6 m3/Pa
Total Skin	-6.21
T	3.05E-4 m2/s
K	3.07E-7 m/s
Pi	129 kPa

Model Parameters	
Well & Wellbore parameters (KLX06)	
C	2.51E-6 m3/Pa
Skin	-6.21
Reservoir & Boundary parameters	
Pi	129 kPa
T	3.05E-4 m2/s
K	3.07E-7 m/s
L1 - No flow	1290 m
L2 - No flow	1260 m
Angle	2.31681 Radians
Derived & Secondary Parameters	
Delta P (Total Skin)	-38.99 kPa
Delta P Ratio (Total Skin)	-0.738351 Fraction

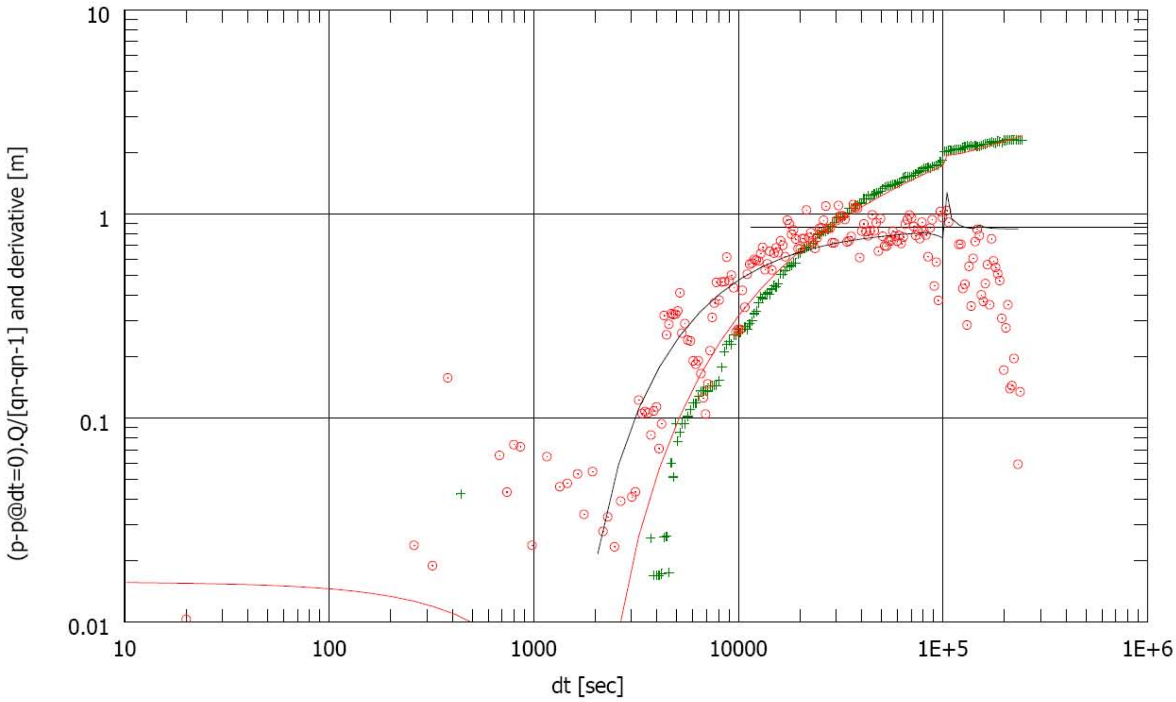
Figure 1-189. *Plot of pressure versus time in the pumping borehole KLX06 together with evaluated data.*



HLX20obs vid KLX06pumpn PFL diff production #2	
Rate	81.9 l/min
Rate change	81.9 l/min
P@dt=0	10.8525 m
Pi	11.3368 m
Smoothing	0.1
Selected Model	
Model Option	Standard Model
Well	Vertical
Reservoir	Homogeneous
Boundary	Infinite
Main Model Parameters	
TMatch	4.36E-5 1/sec
PMatch	0.581 1/m
C	3.77E-6 m3/Pa
S	4.7E-5
T	1.24E-4 m2/s
K	6.41E-7 m/s
Pi	11.3368 m
Well distance	246 m

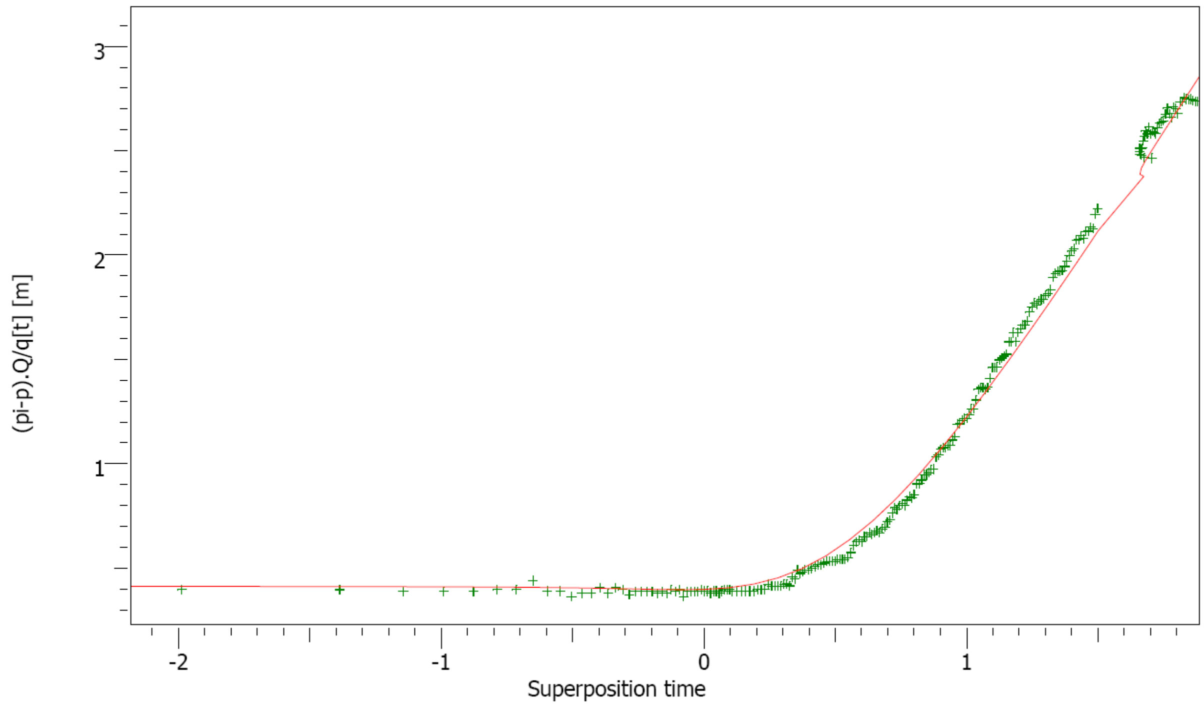
Model Parameters	
Well & Wellbore parameters (Active well)	
C	3.77E-6 m3/Pa
Skin	-0.201
Reservoir & Boundary parameters	
Pi	11.3368 m
T	1.24E-4 m2/s
K	6.41E-7 m/s
S	4.7E-5
Derived & Secondary Parameters	
Rinv	1430 m
Test. Vol.	7.22889 MMm3

Figure 1-190. *Lin-lin plot of drawdown versus time during the pumping test in observation borehole HLX20 during pumping in KLX06, together with evaluated data.*



HLX20obs vid KLX06pumpn PFL diff production #2		Model Parameters	
Rate	81.9 l/min	Well & Wellbore parameters (Active well)	
Rate change	81.9 l/min	C	3.77E-6 m3/Pa
P@dt=0	10.8525 m	Skin	-0.201
Pi	11.3368 m	Reservoir & Boundary parameters	
Smoothing	0.1	Pi	11.3368 m
		T	1.24E-4 m2/s
Selected Model		K	6.41E-7 m/s
Model Option	Standard Model	S	4.7E-5
Well	Vertical		
Reservoir	Homogeneous	Derived & Secondary Parameters	
Boundary	Infinite	Rinv	1430 m
		Test. Vol.	7.22889 MMm3
Main Model Parameters			
TMatch	4.36E-5 1/sec		
PMatch	0.581 1/m		
C	3.77E-6 m3/Pa		
S	4.7E-5		
T	1.24E-4 m2/s		
K	6.41E-7 m/s		
Pi	11.3368 m		
Well distance	246 m		

Figure 1-191. *Log-log plot of pressure data and derivative versus time in the observation borehole HLX20 during pumping in borehole KLX06, together with evaluated data.*



HLX20obs vid KLX06pumpn PFL diff production #2

Rate	81.9 l/min
Rate change	81.9 l/min
P@dt=0	10.8525 m
Pi	11.3368 m
Smoothing	0.1

Selected Model

Model Option	Standard Model
Well	Vertical
Reservoir	Homogeneous
Boundary	Infinite

Main Model Parameters

TMatch	4.36E-5 1/sec
PMatch	0.581 1/m
C	3.77E-6 m3/Pa
S	4.7E-5
T	1.24E-4 m2/s
K	6.41E-7 m/s
Pi	11.3368 m
Well distance	246 m

Model Parameters

Well & Wellbore parameters (Active well)

C	3.77E-6 m3/Pa
Skin	-0.201

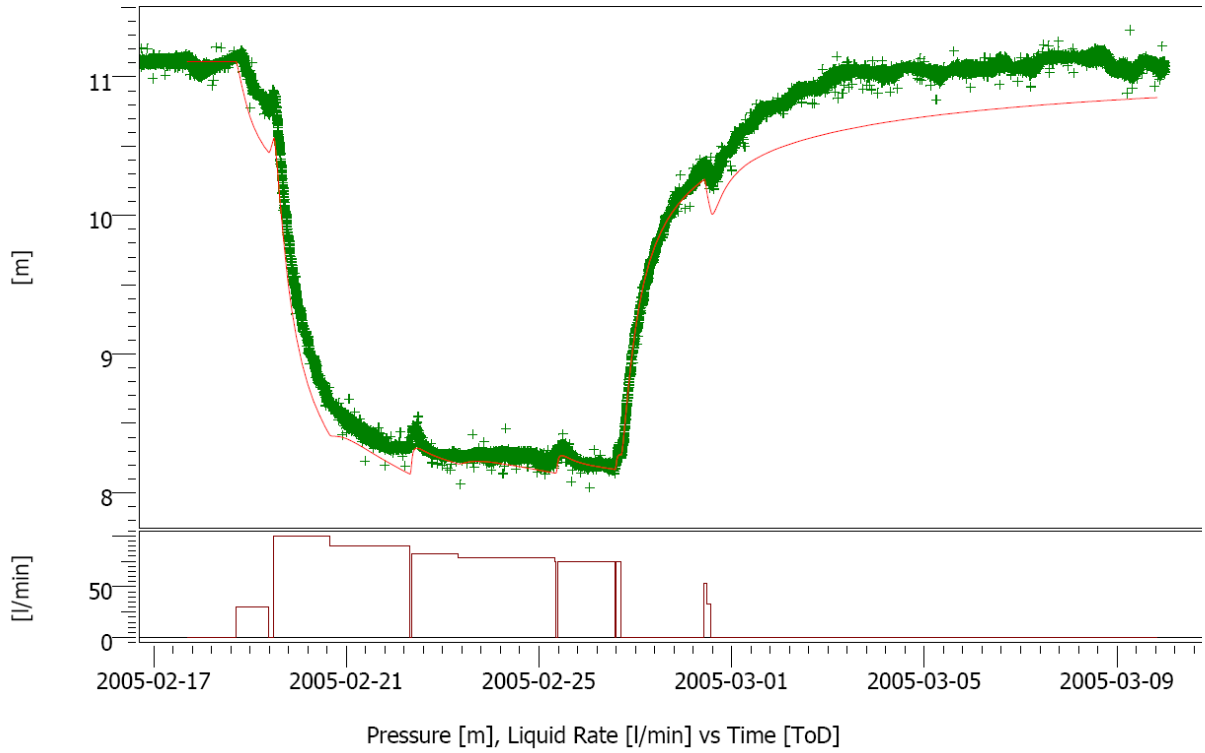
Reservoir & Boundary parameters

Pi	11.3368 m
T	1.24E-4 m2/s
K	6.41E-7 m/s
S	4.7E-5

Derived & Secondary Parameters

Rinv	1430 m
Test. Vol.	7.22889 MMm3

Figure 1-192. *Plot of pressure data versus time in the observation borehole HLX20 during pumping in borehole KLX06, together with evaluated data.*



HLX20obs vid KLX06pumpn PFL diff build-up #5

Rate	0 l/min
Rate change	75 l/min
P@dt=0	8.28384 m
Pi	11.11 m
Smoothing	0.1

Selected Model

Model Option	Standard Model
Well	Vertical
Reservoir	Homogeneous
Boundary	Infinite

Main Model Parameters

TMatch	4.49E-4 1/sec
PMatch	1.12 1/m
C	2.3E-4 m3/Pa
S	8.05E-6
T	2.19E-4 m2/s
K	1.13E-6 m/s
Pi	11.11 m
Well distance	246 m

Model Parameters

Well & Wellbore parameters (Active well)

C	2.3E-4 m3/Pa
Skin	0

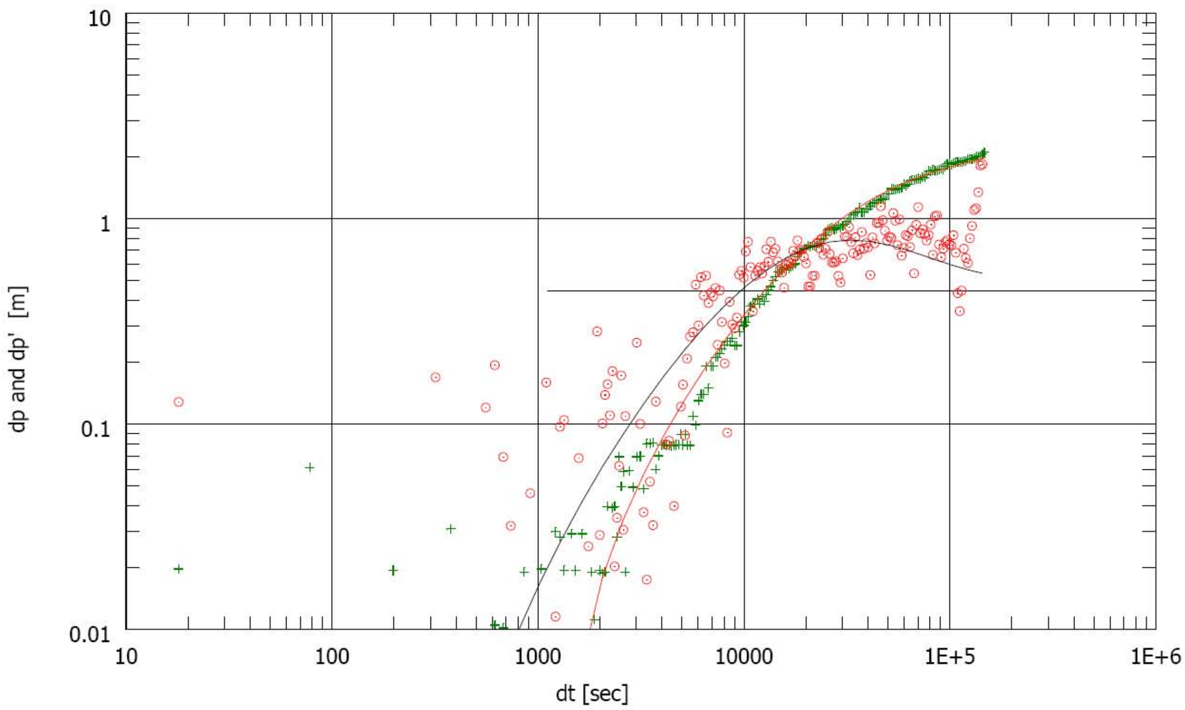
Reservoir & Boundary parameters

Pi	11.11 m
T	2.19E-4 m2/s
K	1.13E-6 m/s
S	8.05E-6

Derived & Secondary Parameters

Rinv	3570 m
Test. Vol.	7.70686 MMm3

Figure 1-193. Lin-lin plot of drawdown versus time during the pumping test in observation borehole HLX20 during pumping in KLX06, together with evaluated data.



HLX20obs vid KLX06pumpn PFL diff build-up #5
Rate 0 l/min
Rate change 75 l/min
P@dt=0 8.28384 m
Pi 11.11 m
Smoothing 0.1

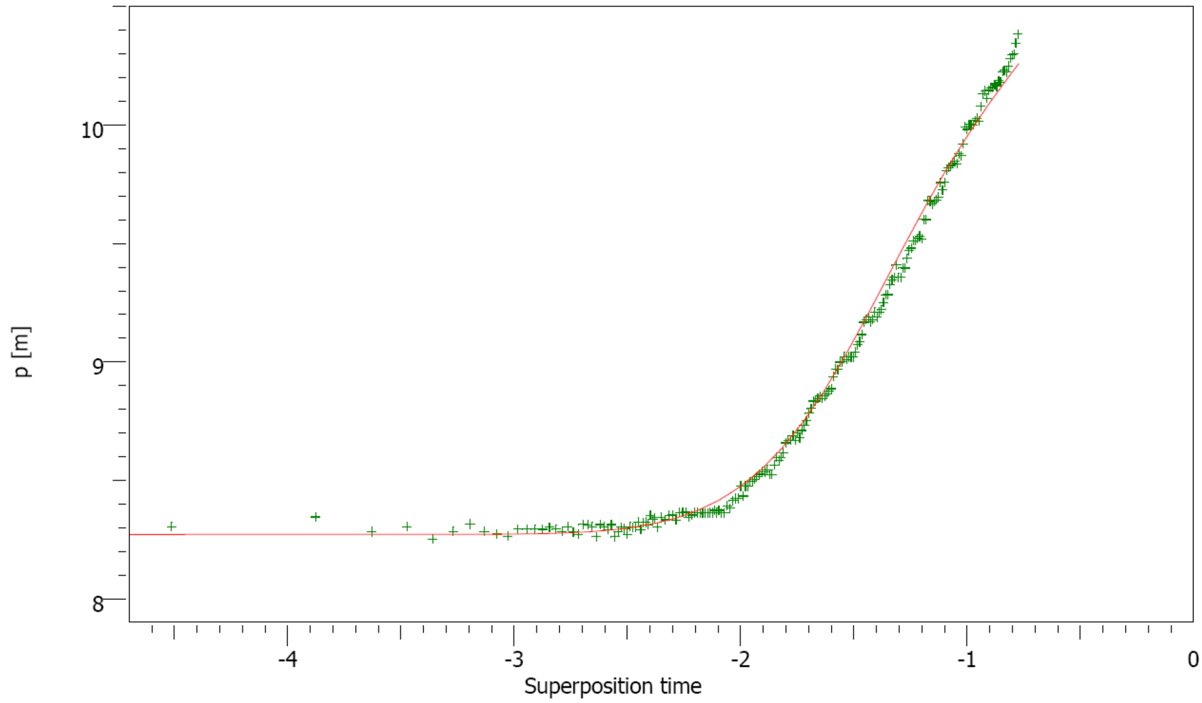
Selected Model
Model Option Standard Model
Well Vertical
Reservoir Homogeneous
Boundary Infinite

Main Model Parameters
TMatch 4.49E-4 1/sec
PMatch 1.12 1/m
C 2.3E-4 m3/Pa
S 8.05E-6
T 2.19E-4 m2/s
K 1.13E-6 m/s
Pi 11.11 m
Well distance 246 m

Model Parameters
Well & Wellbore parameters (Active well)
C 2.3E-4 m3/Pa
Skin 0
Reservoir & Boundary parameters
Pi 11.11 m
T 2.19E-4 m2/s
K 1.13E-6 m/s
S 8.05E-6

Derived & Secondary Parameters
Rinv 3570 m
Test. Vol. 7.70686 MMm3

Figure 1-194. *Log-log plot of drawdown (green +) and drawdown derivative (red ⊙) versus time together with corresponding simulated curves (black) in the observation borehole HLX20 during pumping in borehole KLX06.*



HLX20obs vid KLX06pumpn PFL diff build-up #5

Rate	0 l/min
Rate change	75 l/min
P@dt=0	8.28384 m
Pi	11.11 m
Smoothing	0.1

Selected Model

Model Option	Standard Model
Well	Vertical
Reservoir	Homogeneous
Boundary	Infinite

Main Model Parameters

TMatch	4.49E-4 1/sec
PMatch	1.12 1/m
C	2.3E-4 m3/Pa
S	8.05E-6
T	2.19E-4 m2/s
K	1.13E-6 m/s
Pi	11.11 m
Well distance	246 m

Model Parameters

Well & Wellbore parameters (Active well)

C	2.3E-4 m3/Pa
Skin	0

Reservoir & Boundary parameters

Pi	11.11 m
T	2.19E-4 m2/s
K	1.13E-6 m/s
S	8.05E-6

Derived & Secondary Parameters

Rinv	3570 m
Test. Vol.	7.70686 MMm3

Figure 1-195. *Plot of pressure data versus time in the observation borehole HLX20 during pumping in borehole KLX06, together with evaluated data.*

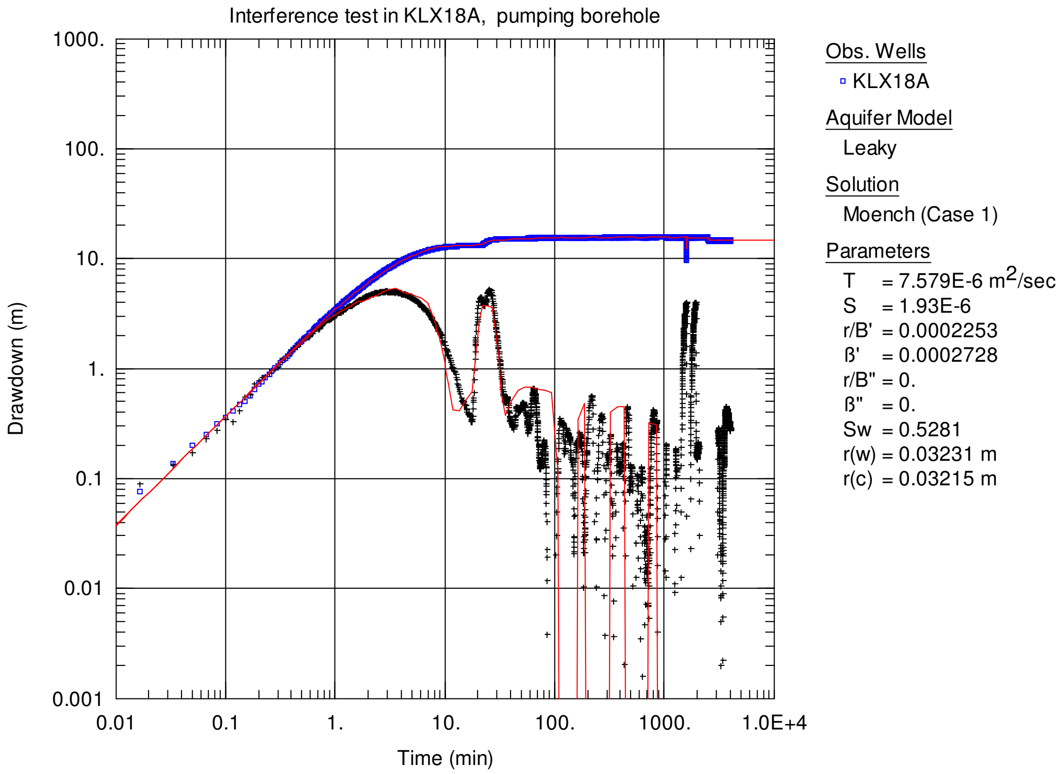


Figure 1-196. *Log-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX18A.*

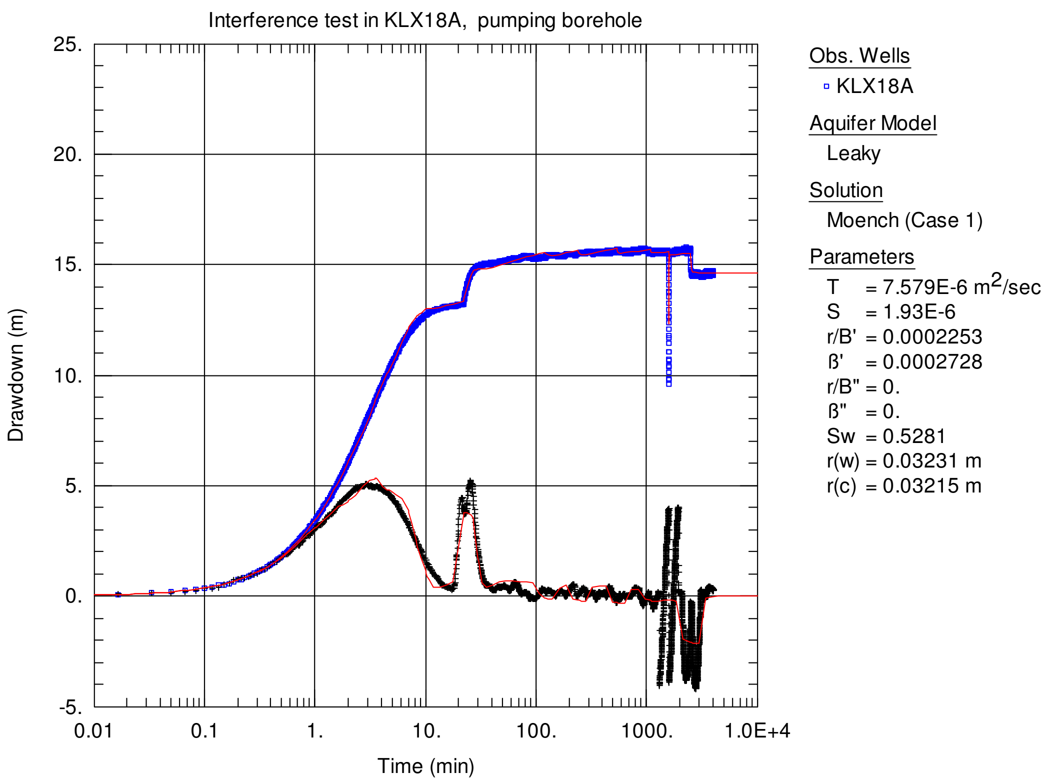


Figure 1-197. *Lin-log plot of drawdown (blue □) and drawdown derivative (black +) versus time together with corresponding simulated curves (red) in the pumping borehole KLX18A.*

Appendix 3

Response matrix

Explanations for the response indices can be found in Section 5, L = low, M = medium, H = high, E = excellent, 0 = no response and blank = not evaluated.

	Pumping Hole	KLX14A			KLX21B			KLX26A			KLX26B			KLX22A			KLX22B			KLX23A			KLX23B			KLX16A			KLX15A			KLX19A			KLX17A			KLX06		
	Section (m.b.TOC)	6.50 - 176.30			11.90 - 858.80			2.60 - 101.10			2.30 - 50.40			2.00 - 100.45			2.00 - 100.25			2.30 - 100.20			2.30 - 50.30			11.25 - 433.50			11.65 - 1000.43			98.80 - 522.50			12.00 - 701.10			11.88- 998.94		
	Flow rate (l/min)	5.23E-04			9.08E-04			1.75E-05			2.33E-05			1.45E-04			5.83E-05			1.11E-04			1.67E-05			4.68E-04			4.94E-04			9.68E-04			4.00E-04			0.00125		
	Drawdown (kPa)	50.20			34.40			49.10			49.20			98.47			100.12			101.60			101.30			48.65			69.20			97.00			236.00			66.73		
Observation borehole	Response indices	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new
	Section (m)																																							
HLX38	15.00 - 199.50	H	M	M																									M	L	L	0	0	0						
KLX07A:1	781.00 - 844.73				H	L	M																																	
KLX07A:2	753.00 - 780.00				M	L	M																																	
KLX07A:3	612.00 - 752.00				M	L	M																																	
KLX07A:4	457.00 - 611.00				E	L	M																																	
KLX07A:5	333.00 - 456.00				E	L	M																																	
KLX07A:6	204.00 - 332.00				H	L	L																																	
KLX07A:7	104.00 - 203.00				H	L	L																																	
KLX07A:8	11.80 - 103.00				H	L	L																																	
KLX07B:1	95.00 - 200.00				M	L	L																																	
KLX07B:2	9.60 - 94.00				M	L	L																																	
KLX12:1	546.00 - 602.29				0	0	0																					0	0	0										
KLX12:2	535.00 - 545.00				0	0	0																					0	0	0										
KLX12:3	426.00 - 534.00				0	0	0																					0	0	0										
KLX12:4	386.00 - 425.00				M	L	L																					0	0	0										
KLX12:5	291.00 - 385.00				0	0	0																					0	0	0										
KLX12:6	160.00 - 290.00				M	L	L																					0	0	0										
KLX12:7	142.00 - 159.00				M	L	L																					0	0	0										
KLX12:8	104.00 - 141.00				H	L	L																					0	0	0										
KLX12:9	17.90 - 103.00				M	L	L																					0	0	0										
KLX05:1	721.00 - 1000.00				0	0	0																					0	0	0	0	0	0							
KLX05:2	634.00 - 720.00				0	0	0																					0	0	0	0	0	0							
KLX05:3	625.00 - 633.00				0	0	0																					0	0	0	0	0	0							
KLX05:4	501.00 - 624.00				0	0	0																					0	0	0	0	0	0							
KLX05:5	361.00 - 500.00				H	L	M																					0	0	0	0	0	0							
KLX05:6	256.00 - 360.00				M	L	L																					0	0	0	0	0	0							
KLX05:7	241.00 - 255.00				M	L	L																					0	0	0	0	0	0							
KLX05:8	220.00 - 240.00				M	L	L																					0	0	0	0	0	0							

	Pumping Hole	KLX14A			KLX21B			KLX26A			KLX26B			KLX22A			KLX22B			KLX23A			KLX23B			KLX16A			KLX15A			KLX19A			KLX17A			KLX06		
	Section (m.b.TOC)	6.50 - 176.30			11.90 - 858.80			2.60 - 101.10			2.30 - 50.40			2.00 - 100.45			2.00 - 100.25			2.30 - 100.20			2.30 - 50.30			11.25 - 433.50			11.65 - 1000.43			98.80 - 522.50			12.00 - 701.10			11.88-998.94		
	Flow rate (l/min)	5.23E-04			9.08E-04			1.75E-05			2.33E-05			1.45E-04			5.83E-05			1.11E-04			1.67E-05			4.68E-04			4.94E-04			9.68E-04			4.00E-04			0.00125		
	Drawdown (kPa)	50.20			34.40			49.10			49.20			98.47			100.12			101.60			101.30			48.65			69.20			97.00			236.00			66.73		
Observation borehole	Response indices	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new	1	2	2 new
	Section (m)																																							
KLX05:9	128.00 - 219.00				H	L	L																			0	0	0	0	0	0									
KLX05:10	15.00 - 127.00				H	L	M																			0	0	0	0	0	0									
HLX22	9.00 - 163.20				H	L	M																																	
HLX23	6.00 - 160.20				0	0	0																																	
HLX18	15.00 - 181.20				0	0	0																																	
KLX26B:1	47.00 - 50.40							M	E	E																														
KLX26B:2	21.00 - 46.00							M	E	E																														
KLX26B:3	2.30 - 20.00							H	H	H																														
KLX26A:1	48.00 - 101.10										0	0	0																											
KLX26A:2	22.00 - 47.00										M	E	H																											
KLX26A:3	2.60 - 21.00										M	E	H																											
KLX22B	2.00 - 100.25													L	M	M																								
KLX23B	2.30 - 50.30																			M	M	H																		
KLX23A	2.30 - 100.20																						L	M	M															
HLX42:2	30.00 - 152.60																									0	0	0												
HLX15	5.00 - 151.90																									0	0	0												
HLX26	11.00 - 151.20																									0	0	0												
HLX28	0.00 - 154.20																									0	0	0												
KLX19A:1	661.00 - 800.00																												0	0	0									
KLX19A:2	518.00 - 660.00																												0	0	0									
KLX19A:3	509.00 - 517.00																												0	0	0									
KLX19A:4	481.00 - 508.00																												0	0	0									
KLX19A:5	311.00 - 480.50																												0	0	0									
KLX19A:6	291.00 - 310.00																												0	0	0									
KLX19A:7	136.00 - 290.00																												0	0	0									
KLX19A:8	98.80 - 135.00																												0	0	0									
HLX36:2	6.00 - 49.00																															0	0	0						
HLX36:1	50.00 - 199.80																															M	L	M						
HLX37:3	12.00 - 117.00																															0	0	0						
HLX37:2	118.00 - 148.00																															E	L	M						
HLX37:1	149.00 - 199.80																															E	L	M						
KLX11A	12.00 - 992.30																															H	L	M						
KLX13A:1	469.00 - 595.90																																		0	0	0			
KLX13A:2	340.00 - 468.00																																		0	0	0			
KLX13A:3	11.80 - 339.00																																		H	L	M			
HLX20	9.00-202.20																																					E	L	M