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Details of predicted flow in deposition tunnels at SFR, Forsmark

Details of future flow in deposition tunnels as predicted by the hydrogeological modelling of future groundwater flow at SFR

Johan G Holmén, Martin Stigsson
Golder Associates

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Svensk Kärnbränslehantering AB
Swedish Nuclear Fuel
and Waste Management Co
Box 5864
SE-102 40 Stockholm Sweden
Tel 08-459 84 00
+46 8 459 84 00
Fax 08-661 57 19
+46 8 661 57 19

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1 Introduction and purpose

The Swedish Nuclear Fuel and Waste Management Co. (SKB) is operating the SFR repository for low- and intermediate-level nuclear waste. SKB has launched the project, SAFE (Safety Assessment of Final Disposal of Operational Radioactive Waste), the aim of the project is to update the safety analysis of SFR and to prepare a safety report that will be submitted to the Swedish authorities. This report is a part of the SAFE project, and concerns details of the predicted future groundwater flow at the SFR deposition tunnels.

1.1 Purpose and methodology

The purpose of this report is to present details of the predicted future groundwater flow in the deposition tunnels at SFR. These details are based on the results of the modelling of future hydrogeological conditions at SFR Forsmark /Holmén and Stigsson, 2001/.

Hence, the results presented in this report are calculated as a part of the modelling of future hydrogeological conditions at SFR. The methodology of these calculations is presented in Holmén and Stigsson /2001/. This report is to be looked upon as an appendix to that study. All the different cases for which results are given in this report are also discussed and presented in Holmén and Stigsson /2001/.

The future flow pattern of the groundwater is of interest, since components of the waste emplaced in a closed and abandoned repository will dissolve in the groundwater and be transported by the groundwater to the ground surface. The details of the flow in the deposition tunnels, as given in this report, will be used as input to the near field transport modelling of the quantitative safety assessment of the SFR.

2 Concept of flow and tunnel sections

2.1 The concept of flow in a tunnel

This study presents predicted values of flow representing the flow in closed tunnels that are abandoned and no longer kept dry. Under such conditions a tunnel receives water from the rock mass at different sections along the tunnel, and gives water to the rock mass at other sections along the tunnel. Thus, the flow and velocity of water inside the tunnel varies along the tunnel. We note that the tunnel is not a tube that receives water at one end and gives it away at the other end, it receives water along an upstream part (inflow part) and gives it away along a downstream part (outflow part). What is upstream and downstream depends on the direction of the tunnel and the direction of the regional groundwater flow.

2.1.1 Specific flow and Total flow

The flow of water in a tunnel can be studied based on different concepts e.g. "specific flow" and "total flow". In accordance with Holmén /1997/, we will in this study use the following definitions of the specific flow and total flow.

– Specific flow, is defined as a flow per unit area [$L^3 / (L^2\ T) = L / T$]. The specific flow gives information about the flow at a local point. As the specific flow normally varies inside a tunnel, the specific flow of a tunnel it is often given as an average value.

– Total flow, in a tunnel is defined as the flow that enters and/or leaves a tunnel [L^3 / T]. The calculation of total flow is based on a mass balance taken over the envelope of the studied structure (e.g. a tunnel). The total flow gives information about the amount of water that "visits" the tunnel. If the tunnel system is complex, it is possible that water, which previously has been inside the tunnel system, re-enters the tunnel system at some other point downstream. Such water will be added to the total flow every time it enters the tunnel system. The total flow provides no information of the length of the flow paths in the tunnels, a short path or a long path, will both add to the total flow. The total flow depends on both the magnitude of the flow in the surrounding rock mass and on the direction of that flow, as well as on the hydraulic properties of the tunnel.

2.1.2 Net flow

Consider an area, which partly confines a volume, the flow that passes this area can be calculated as a “net flow”. The detailed flow presented in this study will primarily be given as net flows. The net flow is defined as follows.

– Net flow, is taken over an area, which partly confines a volume, e.g. a face of a cube, it is defined based on a mass balance taken over the studied area. The net flow is the difference between (i) the inflow to the volume at the area studied and (ii) the outflow from the volume at the area studied. Hence, a positive net flow reveals that a net inflow takes place at the area studied, and a negative net flow reveals that a net outflow takes place at the area studied. The net flow is the difference between the

inflow and the outflow, if there is no inflow the net flow is equal to the outflow and if there is no outflow, the net flow is equal to the inflow. If both inflow and outflow takes place at the area studied, the net flow is the difference, not the sum, of the flows.

The deposition tunnels are divided into different sections, each section contains several parallelepipeds as given by the finite difference cells of the hydrogeological model /Holmén and Stigsson, 2001/, and these parallelepipeds are the volumes studied. Each parallelepiped has six faces (even if it contains several finite difference cells) and these faces are the areas for which the net flow is calculated, see Figure 2-1 and Figure 2-2.

2.2 Studied sections

In the detailed hydrogeological model /Holmén and Stigsson, 2001/, the horizontal deposition tunnels (BTF, BLA and BMA) are divided into 13 sections along the tunnels. Nine of these sections are along the volume where the waste is stored (waste and barriers) and four sections represent the loading areas which are at the ends of the tunnels. The horizontal deposition tunnels, fracture zone 6 and the lengths and positions of the above discussed sections are given in Figure 2-1. In the detailed hydrogeological model /Holmén and Stigsson, 2001/, the SILO is divided into eighteen sections along the vertical extension of the SILO, see Figure 2-10. The flow was calculated for each section separately and for different times between 2000 AD through 7000 AD.

Considering deliveries to the near field transport model and regarding the horizontal deposition tunnels, the nine sections along the waste domains are summarised into five larger sections, representing the part of the tunnels where the waste is stored, and two sections representing the loading areas at each end of the tunnel.

- BMA tunnel. The positions of the sections are given in Figure 2-3. The different structures inside the BMA tunnel is given in Figure 2-4.

- BTF1 tunnel. The positions of the sections are given in Figure 2-6. The different structures inside the BTF1 tunnel is given in Figure 2-5.

- BTF2 tunnel, The positions of the sections are given in Figure 2-7. The different structures inside the BTF2 tunnel is given in Figure 2-5.

- BLA tunnel. The positions of the sections are given in Figure 2-8. The different structures inside the BLA tunnel is given in Figure 2-9.

Considering the deliveries to the near field transport model and regarding the SILO tunnel, the eighteen vertical layers of the detailed model that represents the SILO tunnel, are summarised in the following way: Five different vertical sections represents the waste inside the encapsulation. One vertical section represents the sand/bentonite at the top of the encapsulation. One vertical section represents the top filling above the sand/bentonite at the top of the encapsulation. And one vertical section represents the sand/bentonite at the base of the encapsulation. The positions of these vertical sections are given in Figure 2-10; this figure presents a vertical cross-section demonstrating the different structures inside the SILO tunnel. A horizontal cross-section through the SILO is given in Figure 2-11.

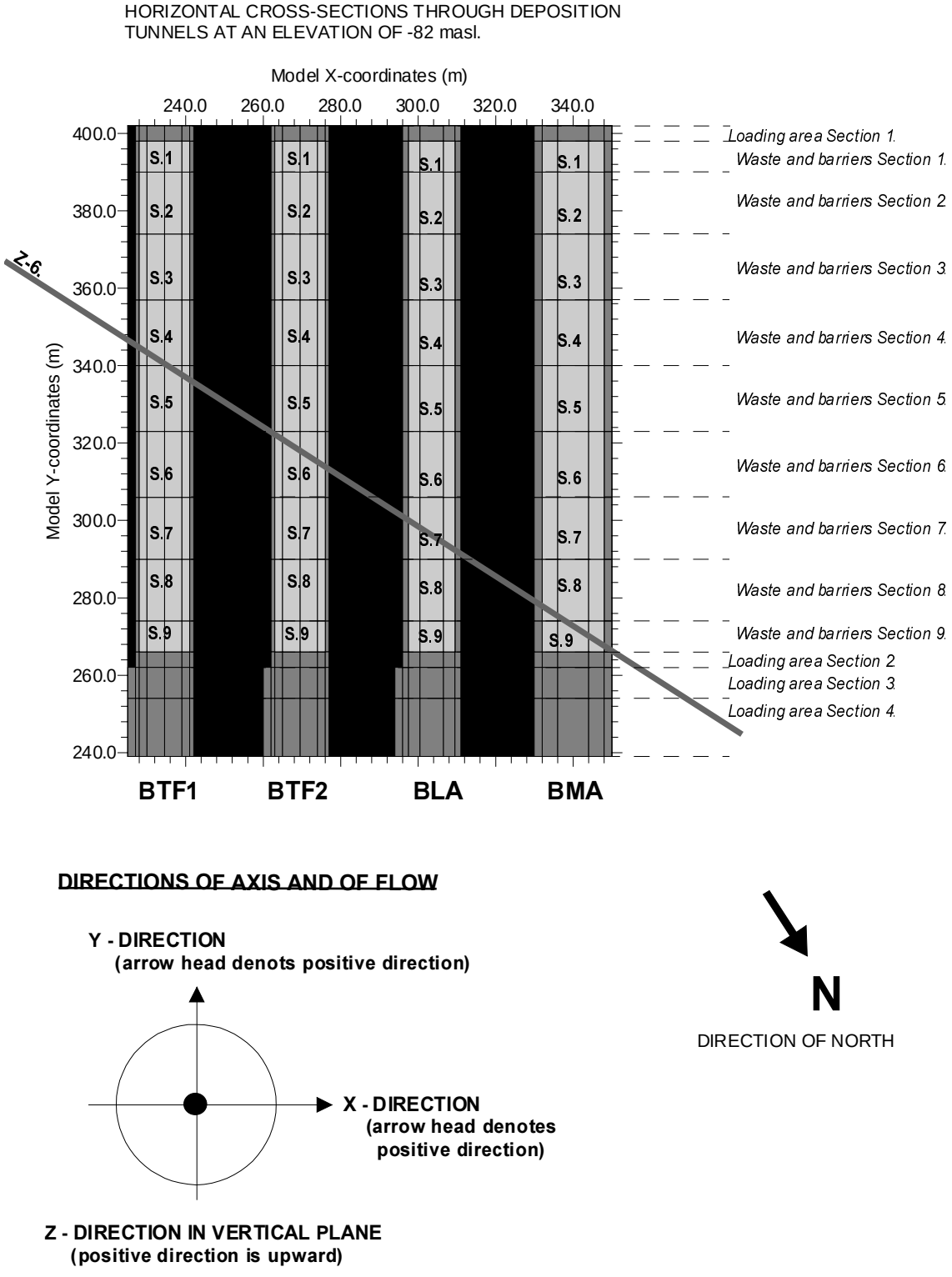

Figure 2-1. *Horizontal cross-section through the detailed model at an elevation of –82 masl. The figure gives the position of the horizontal deposition tunnels and the position of fracture zone 6, as well as the size and locations of the horizontal sections for which the flow is studied.*

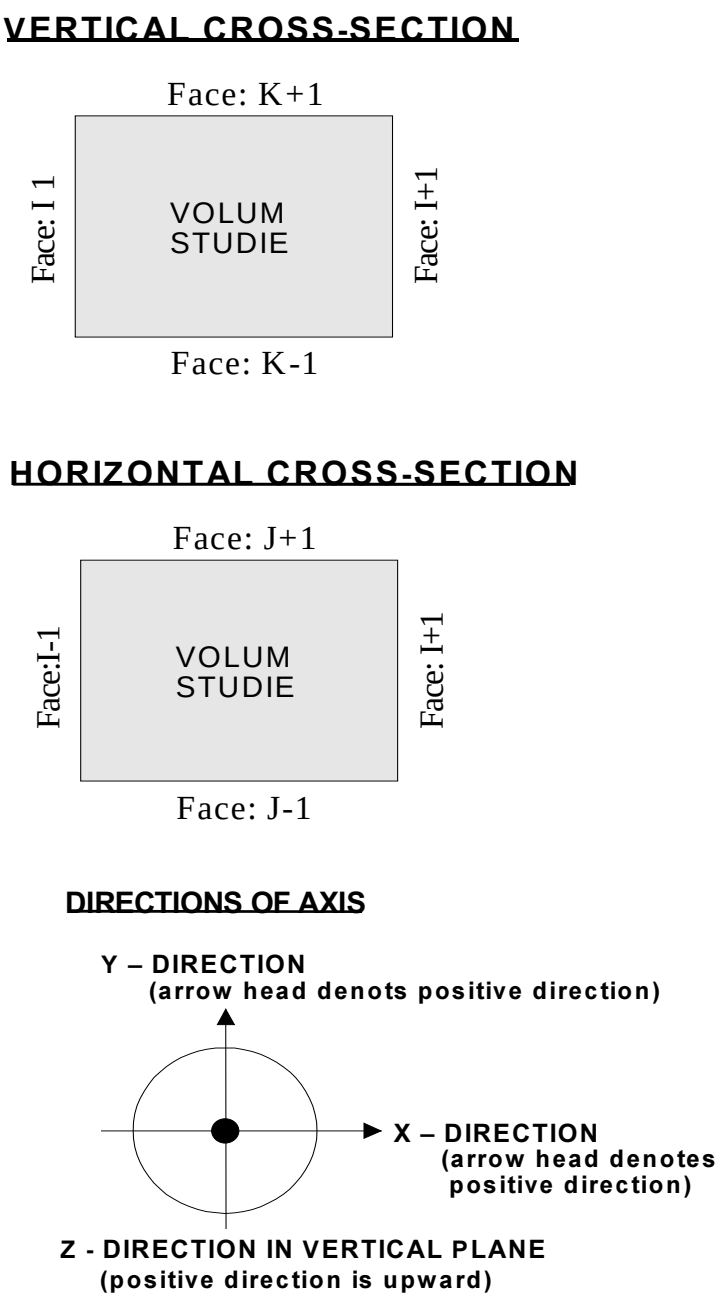

Figure 2-2. *Definition of the different faces that surrounds a three dimensional volume.*

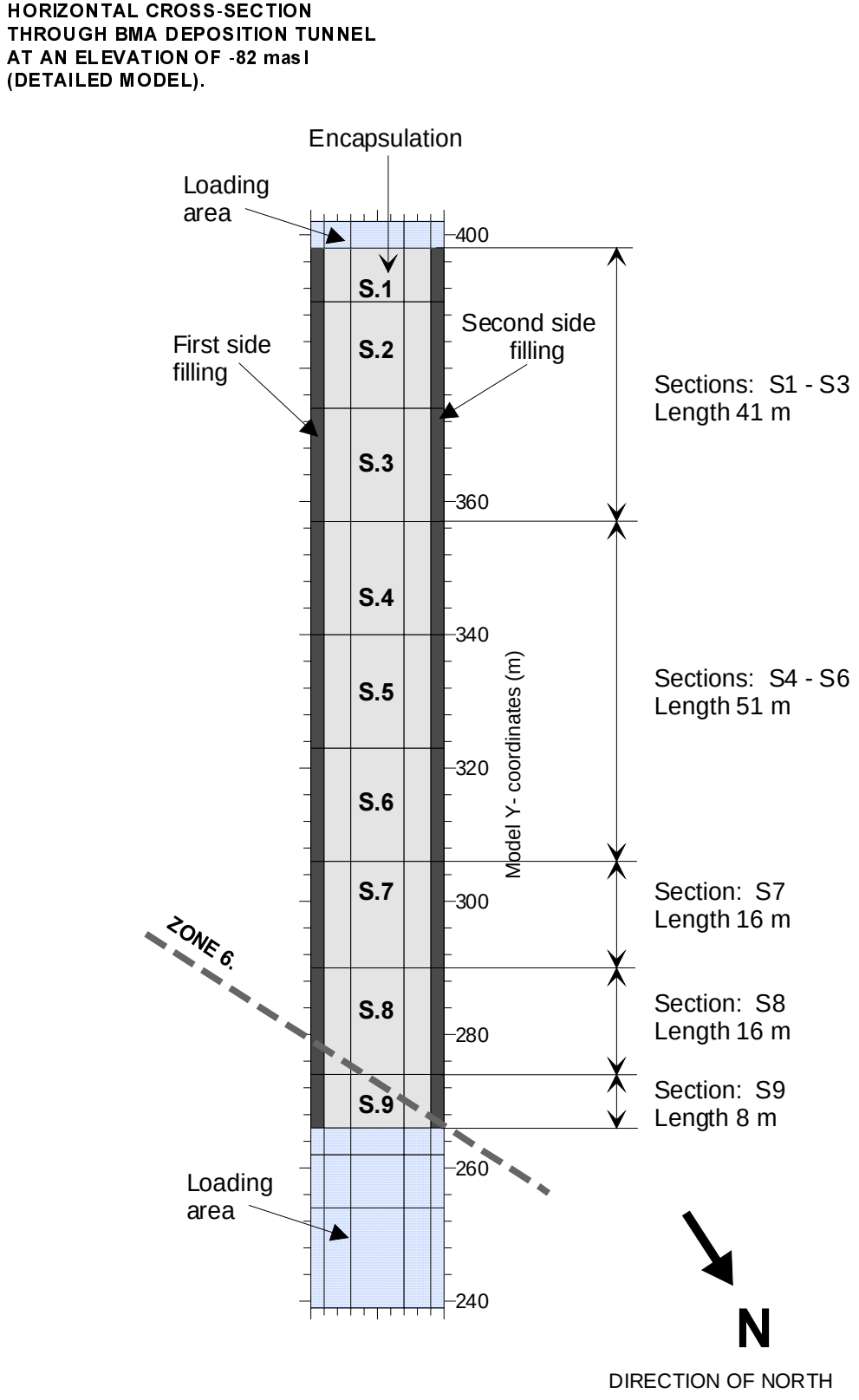

Figure 2-3. *Horizontal cross-section through the detailed model at an elevation of –82 masl. The figure gives the position of the BMA deposition tunnel and the position of fracture zone 6, as well as the size and locations of the horizontal sections for which the flow is studied.*

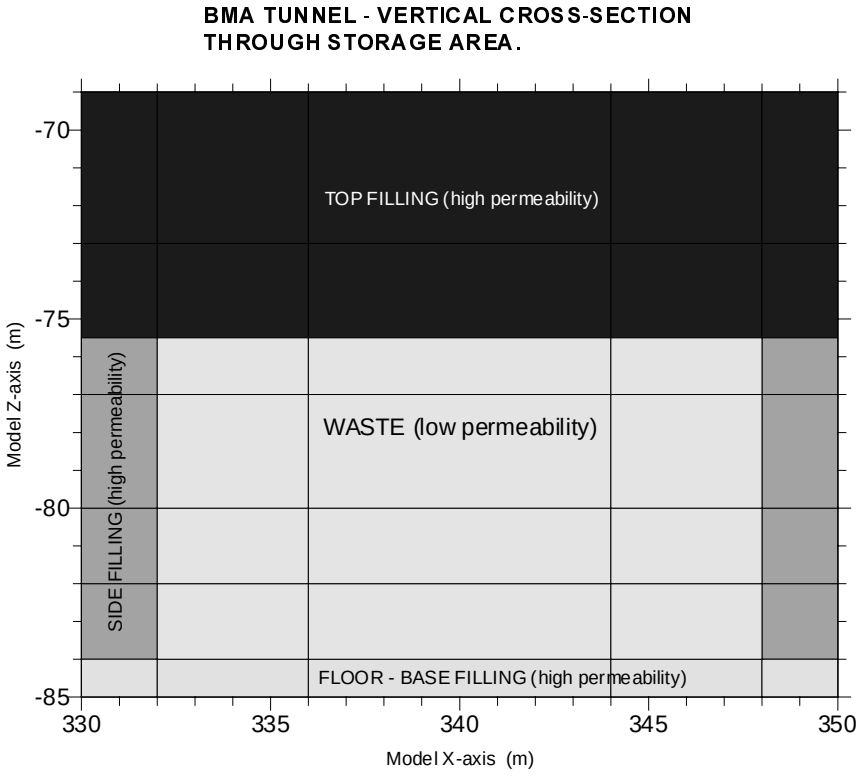

Figure 2-4. *A vertical cross-section through the BMA tunnel, as defined in the detailed model.*

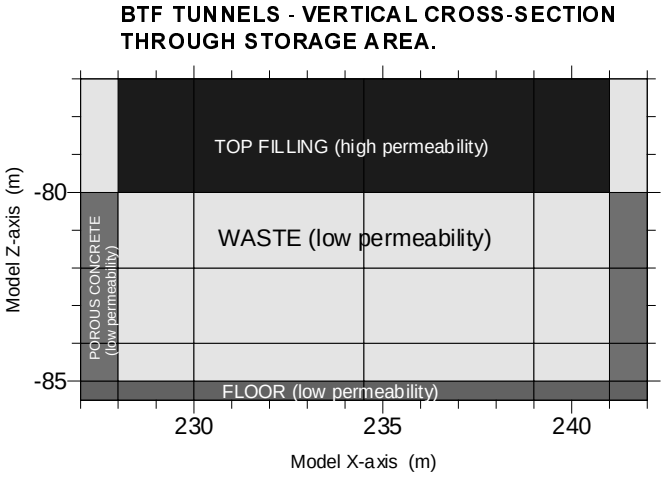

Figure 2-5. *A vertical cross-section through the BTF tunnel, as defined in the detailed model.*

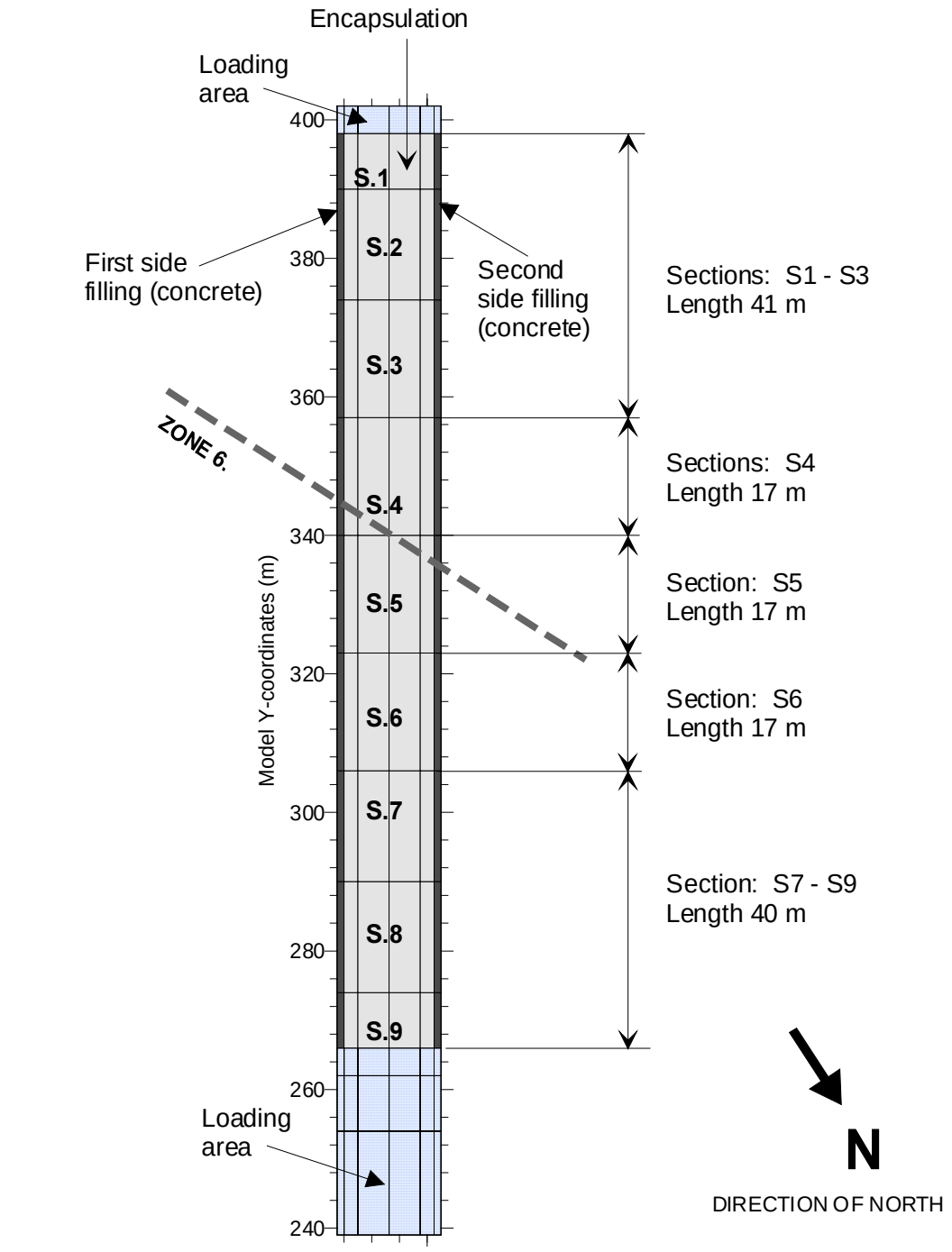

Figure 2-6. *Horizontal cross-section through the detailed model at an elevation of –82 masl. The figure gives the BTF1 deposition tunnel and the position of fracture zone 6, as well as the size and locations of the horizontal sections for which the flow is studied.*

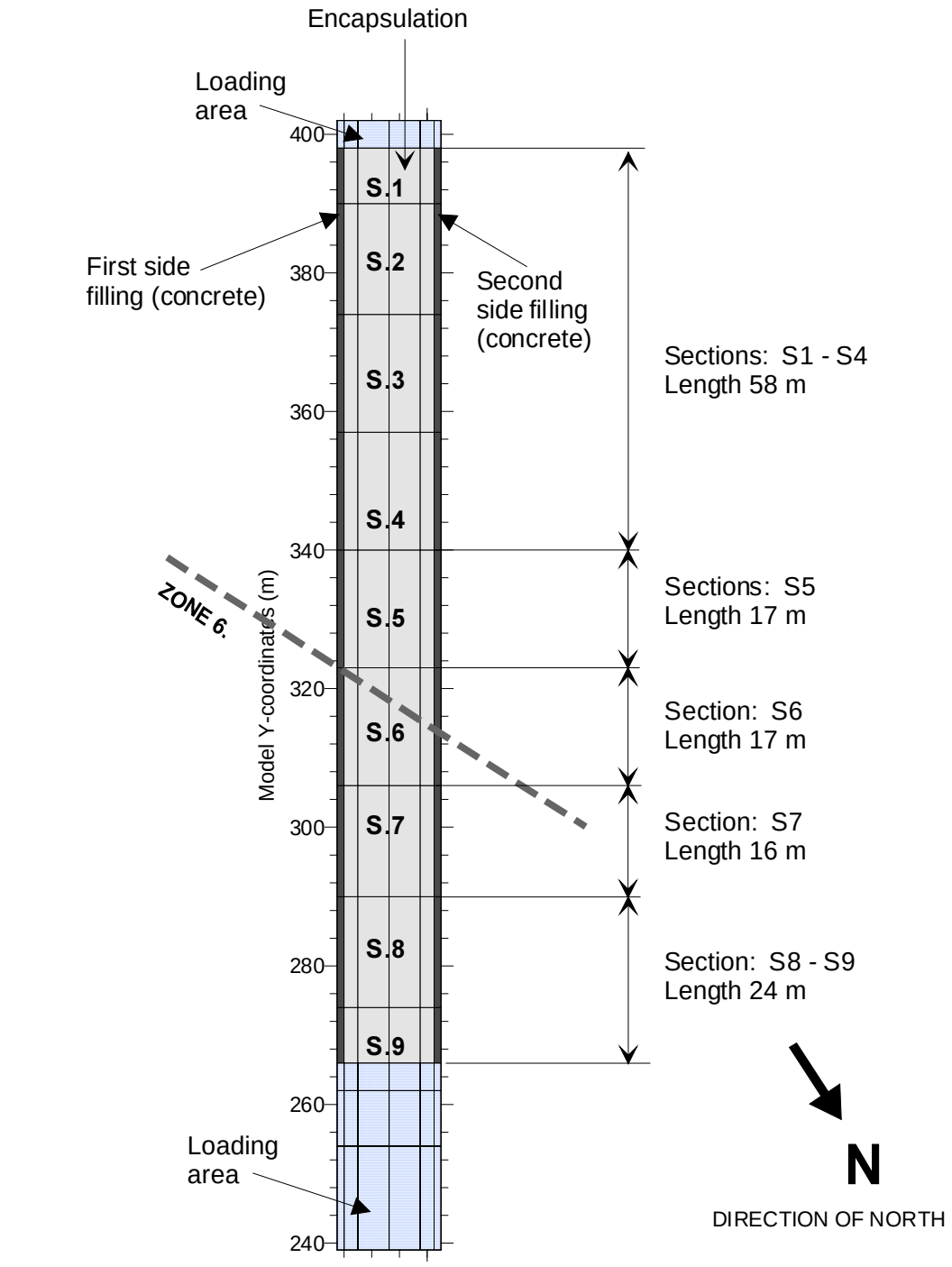

Figure 2-7. *Horizontal cross-section through the detailed model at an elevation of –82 masl. The figure gives the BTF2 deposition tunnel and the position of fracture zone 6, as well as the size and locations of the horizontal sections for which the flow is studied.*

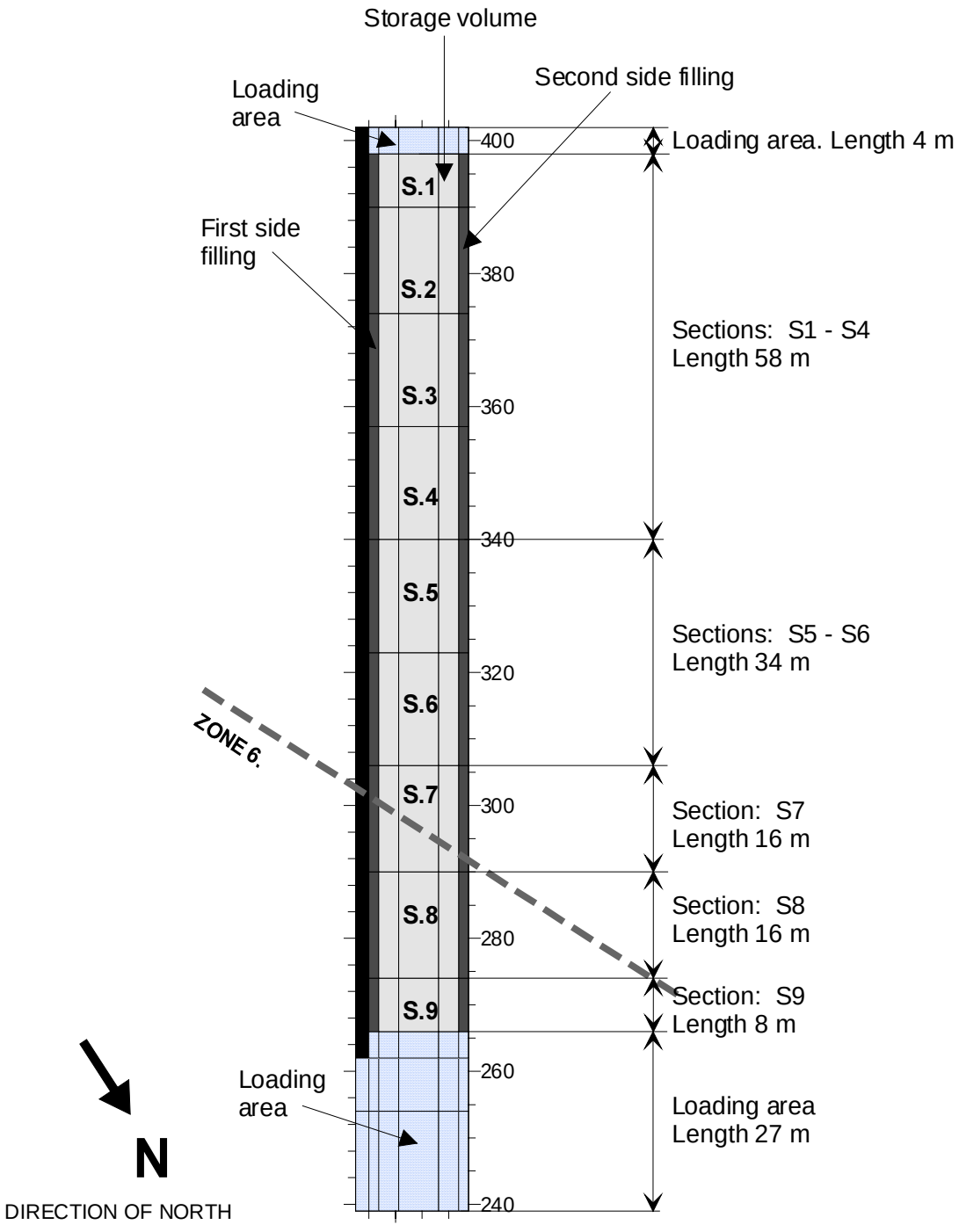

Figure 2-8. *Horizontal cross-section through the detailed model at an elevation of –82 masl. The figure gives the BLA deposition tunnel and the position of fracture zone 6, as well as the size and location of the horizontal sections for which the flow is studied.*

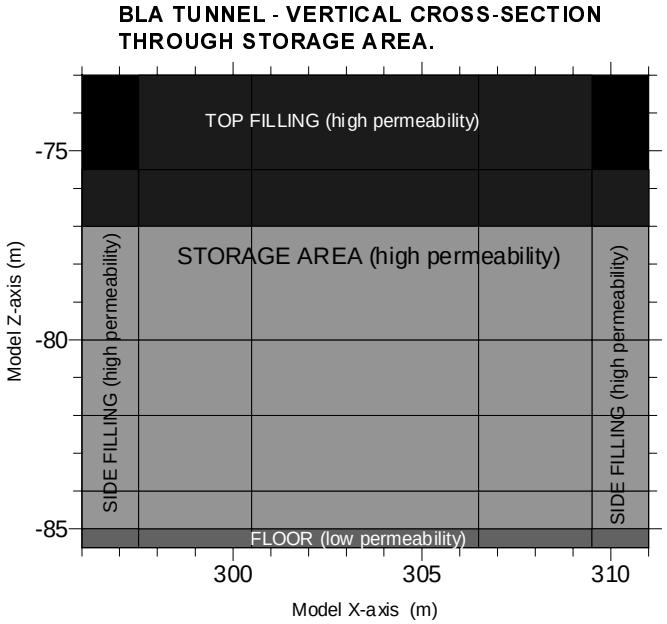

Figure 2-9. *A vertical cross-section through the BLA tunnel, as defined in the detailed model.*

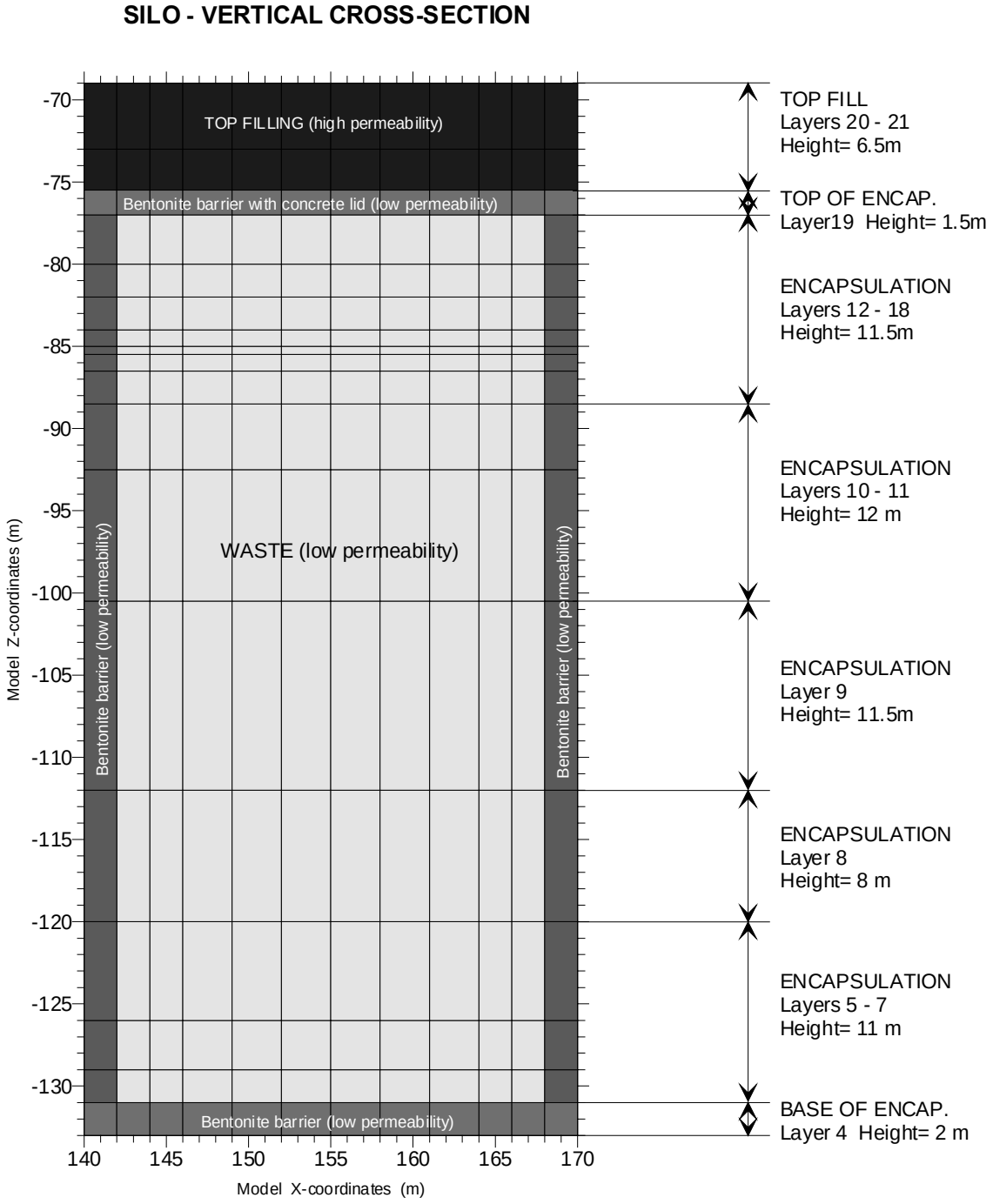

Figure 2-10. *Vertical cross-section through the detailed model. The figure presents the SILO deposition tunnel, and the location of the vertical sections for which the flow is studied.*

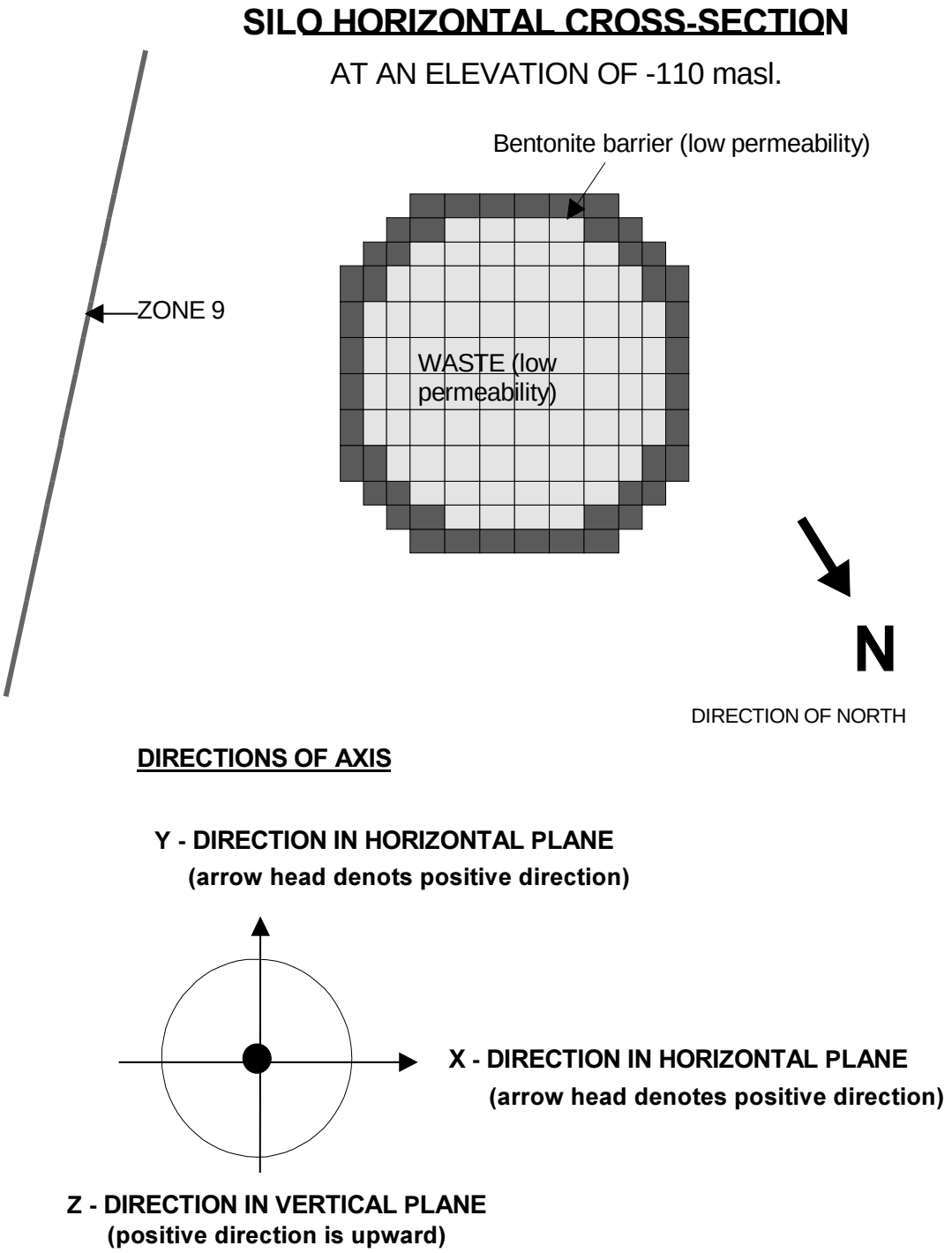

Figure 2-11. *Horizontal cross-section through the detailed model at an elevation of -110 masl. The figure presents the SILO deposition tunnel, and the location of fracture Zone 9. The directions of the co-ordinate axis are also demonstrated, as well as the North-direction.*

3 BMA tunnel – detailed flow

3.1 BMA base case

The radioactivity in the waste that is deposited in the BMA is mainly lower than the activity in the waste intended for the SILO. A concrete construction is installed in the tunnel – an encapsulation; the waste containers will be stored in this encapsulation. At all sides highly permeable flow barriers will protect the encapsulation. Hence, a complete hydraulic cage surrounds the encapsulation of the BMA tunnel.

The conductivity of the BMA as defined in the base case of the detailed model /Holmén and Stigsson, 2001/ is given below.

Table 3-1. The conductivity and the volume of the BMA tunnel, as defined in the base case of the detailed model.

BMA	HYDRAULIC CONDUCTIVITY (m/s)□ IN FLOW DIRECTIONS			VOLUME (m^3)
	X-DIR.	Y-DIR.	Z-DIR.	
Top filling (sand/gravel)	1E-5	1E-5	1E-5	17 160
Waste domain. Encapsulation	1.4E-8	1.7E-8	7.7E-9	17 952
Filling at sides (sand/gravel)	1E-5	1E-5	1E-5	4 480
Filling at base (gravel)	1E-5	1E-5	1E-5	2 640
Loading areas (sand/gravel)	1E-5	1E-5	1E-5	10 610

3.1.1 BMA net flows at time 2000 AD – 7000 AD

Table 3-2. Net flows in BMA tunnel at 2000 AD. Results of detailed model, base case.

TIME 2000 AD BMA BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
S1–S3	I-1	-0.00180	I-1	-0.25087	-0.15492	-5.545E-04	0.01634
	I+1	0.00055	I+1	-0.07032	0.00180	0.08086	0.04957
	J-1	0.00217	J-1	0.79579	0.14302	0.1457	0.17235
L= 41 m	J+1	-0.00257	J+1	-0.14098	-0.04189	-0.06646	-0.14818
	K-1	0.00808	K-1	0.99126	0.45515	0.42213	0.795278
	K+1	-0.00644	K+1	-1.32488	-0.40315	-0.58167	-0.88536
S4–S6	I-1	-0.00288	I-1	-0.31502	-0.16971	-6.844E-04	0.02319
	I+1	0.00068	I+1	-0.05256	0.00288	0.16542	0.06967
	J-1	0.00249	J-1	1.2175	0.2583	0.24659	0.35569
L= 51 m	J+1	-0.00217	J+1	-0.79579	-0.14302	-0.1457	-0.17235
	K-1	0.01228	K-1	1.4951	0.66636	0.60426	1.00669
	K+1	-0.01040	K+1	-1.54922	-0.61481	-0.86989	-1.2829
S7	I-1	-0.00131	I-1	-0.12987	-0.06824	3.8741E-04	0.00867
	I+1	-0.00039	I+1	-0.02507	0.00131	0.04641	0.02272
	J-1	0.00350	J-1	1.1532	0.35762	0.2853	0.66406
L= 16 m	J+1	-0.00249	J+1	-1.2175	-0.2583	-0.24659	-0.35569
	K-1	0.00664	K-1	0.88596	0.39829	0.36381	0.42898
	K+1	-0.00596	K+1	-0.66672	-0.43068	-0.44932	-0.76874
S8	I-1	-0.00262	I-1	-0.1067	-0.07149	0.00265	0.00205
	I+1	-0.00265	I+1	-0.05400	0.00262	0.08027	0.02322
	J-1	-0.02900	J-1	0.47113	-0.07276	0.1697	-0.00755
L= 16 m	J+1	-0.00350	J+1	-1.1532	-0.35762	-0.2853	-0.66406
	K-1	0.05001	K-1	1.7205	1.4627	0.77749	2.93654
	K+1	-0.01224	K+1	-0.87773	-0.96345	-0.74481	-2.2902
S9	I-1	-0.00141	I-1	-0.08423	-0.04544	-1.373E-05	0.00360
	I+1	0.00001	I+1	-0.05187	0.00141	0.04559	0.01565
	J-1	-0.05607	J-1	0.38997	-0.09886	-0.23559	-1.0214
L= 8 m	J+1	0.02900	J+1	-0.47113	0.07276	-0.1697	0.00755
	K-1	0.03337	K-1	0.7667	0.36256	0.82907	2.21959
	K+1	-0.00490	K+1	-0.54944	-0.29244	-0.46936	-1.225

LOADING AREA South of encapsulation, the volume that connects to Sections S1–S2. **NET FLOW** (m^3/year)	I-1	-0.06565
	I+1	-0.00644
	J-1	0.40008
	J+1	-0.21356
	K-1	0.08566
	K+1	-0.20008
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	-0.37953
	I+1	0.04442
	J-1	-0.27350
	J+1	1.02195
	K-1	1.03640
	K+1	-1.44974

Table 3-3. Net flows in BMA tunnel at 3000 AD. Results of detailed model, base case.

TIME 3000 AD BMA BASE CASE	ENCAPSULATION NET FLOW (m^3/year)			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	Net flow over faces Neg. flow= outflow Pos. flow= inflow		**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	FACE	**NET FLOW**					
	I-1	0.01302	I-1	2.2258	2.192706	1.13E-02	0.28145
S1–S3	I+1	-0.01133	I+1	-0.13109	-0.01302	-0.3563	-0.09318
	J-1	-0.03373	J-1	-13.452	-2.3914	-2.423	-2.8445
L= 41 m	J+1	0.07909	J+1	6.5789	1.0971	1.3561	1.5219
	K-1	-0.05182	K-1	-0.57135	-0.18667	0.14657	1.042414
	K+1	0.00477	K+1	5.34974	-0.69872	1.2653	0.09192
	I-1	0.01952	I-1	1.7666	1.8895	0.01939	0.22757
S4–S6	I+1	-0.01939	I+1	-1.4889	-0.01952	-1.80696	-.30222
	J-1	-0.03487	J-1	-14.702	-2.6155	-2.6622	-3.1513
L= 51 m	J+1	0.03373	J+1	13.452	2.3914	2.423	2.8445
	K-1	-0.01134	K-1	-1.4567	-0.89303	-0.17043	-0.69335
	K+1	0.01235	K+1	2.429	-0.75285	2.1972	1.0748
	I-1	0.00694	I-1	.3179	0.49680	0.00713	0.05903
S7	I+1	-0.00713	I+1	-0.75617	-0.00694	-0.77079	-0.12158
	J-1	-0.03233	J-1	-13.082	-2.3996	-2.5241	-3.2156
L= 16 m	J+1	0.03487	J+1	14.702	2.6155	2.6622	3.1513
	K-1	-0.00666	K-1	-0.6395	-0.50366	-0.21173	-0.59520
	K+1	0.00431	K+1	-0.54222	-0.2021	0.83729	0.72205
	I-1	0.00969	I-1	-0.04379	0.089317	0.00710	0.00696
S8	I+1	-0.00710	I+1	-1.0449	-0.00969	-0.99076	-0.14487
	J-1	-0.02088	J-1	-8.4486	-1.3805	-2.1095	-2.5295
L= 16 m	J+1	0.03233	J+1	13.082	2.3996	2.5241	3.2156
	K-1	-0.02486	K-1	-1.4268	-1.2094	-0.73624	-2.5187
	K+1	0.01082	K+1	-2.1179	0.11068	1.3053	1.9705
	I-1	0.00758	I-1	.079869	0.20218	0.00698	0.0203
S9	I+1	-0.00698	I+1	-.90508	-0.00758	-0.89835	-0.12542
	J-1	-0.00239	J-1	-4.7568	-0.8543	0.03237	1.181
L= 8 m	J+1	0.02088	J+1	8.4486	1.3805	2.1095	2.5295
	K-1	-0.02786	K-1	-1.3056	-0.77554	-2.4926	-6.90138
	K+1	0.00877	K+1	-1.56098	0.05473	1.2421	3.296

LOADING AREA South of encapsulation, the volume that connects to Sections S1–S2. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.27924 0.78071 -10.63309 6.49361 0.94337 1.13616
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	2.46030 -3.98470 2.75070 4.40012 -3.65130 -1.97512

Table 3-4. Net flows in BMA tunnel at 4000 AD. Results of detailed model, base case.

TIME 4000 AD BMA BASE CASE	ENCAPSULATION NET FLOW (m^3/year)			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	Net flow over faces Neg. flow= outflow Pos. flow= inflow		**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	FACE	**NET FLOW**					
	I-1	0.01696	I-1	3.2929	3.15418	0.009878	0.37529
S1–S3	I+1	-0.00988	I+1	0.65495	-0.01696	0.287713	-0.04643
	J-1	-0.04961	J-1	-20.166	-3.5884	-3.6536	-4.2916
L= 41 m	J+1	0.03621	J+1	7.9584	1.3404	1.6134	1.882
	K-1	-0.00454	K-1	-1.2853	-0.38456	-0.036491	1.65515
	K+1	0.01086	K+1	9.54505	-0.50466	1.7791	0.42559
	I-1	0.02826	I-1	3.0404	2.94551	0.02158	0.30666
S4–S6	I+1	-0.02158	I+1	-1.1493	-0.02826	-1.8401	-0.37663
	J-1	-0.05912	J-1	-25.198	-4.5585	-4.6437	-5.6041
L= 51 m	J+1	0.04961	J+1	20.166	3.5884	3.6536	4.2916
	K-1	-0.02612	K-1	-3.5491	-1.7861	-0.87258	-1.30233
	K+1	0.02895	K+1	6.6900	-0.16105	3.6812	2.6848
	I-1	0.01168	I-1	0.80252	0.86416	0.0080003	0.07674
S7	I+1	-0.00800	I+1	-0.7708	-0.01168	-0.9563103	-0.17718
	J-1	-0.05997	J-1	-23.882	-4.5873	-4.7027	-6.4032
L= 16 m	J+1	0.05912	J+1	25.198	4.5585	4.6437	5.6041
	K-1	-0.01951	K-1	-2.3914	-1.3121	-0.87899	-1.31106
	K+1	0.01668	K+1	1.04368	0.48842	1.8863	2.2106
	I-1	0.01891	I-1	0.3069	0.37881	0.004514	0.01812
S8	I+1	-0.00451	I+1	-1.0959	-0.01891	-1.306714	-0.22064
	J-1	-0.04077	J-1	-17.861	-2.8267	-4.1928	-4.7547
L= 16 m	J+1	0.05997	J+1	23.882	4.5873	4.7027	6.4032
	K-1	-0.07140	K-1	-5.0711	-3.9298	-2.4317	-7.87888
	K+1	0.03780	K+1	-0.16090	1.8093	3.224	6.4329
	I-1	0.01401	I-1	0.28625	0.35655	0.008054	0.02047
S9	I+1	-0.00805	I+1	-1.0069	-0.01401	-1.213455	-0.19371
	J-1	-0.01196	J-1	-13.155	-2.1371	-.6391	2.0909
L= 8 m	J+1	0.04077	J+1	17.861	2.8267	4.1928	4.7547
	K-1	-0.05870	K-1	-3.3707	-1.7371	-4.9901	-13.4583
	K+1	0.02394	K+1	-0.61465	0.70496	2.6418	6.7859

LOADING AREA South of encapsulation, the volume that connects to Sections S1–S2. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.55966 1.02707 -12.83041 7.43412 1.14424 1.66532
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.94820 -5.99505 0.64256 13.85226 -7.79610 -2.65187

Table 3-5. Net flows in BMA tunnel at 5000 AD. Results of detailed model, base case.

TIME 5000 AD BMA BASE CASE	ENCAPSULATION NET FLOW (m^3/year)			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	Net flow over faces Neg. flow= outflow Pos. flow= inflow		**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	FACE	**NET FLOW**					
	I-1	0.01747	I-1	3.3927	3.230985	0.0096997	0.37689
S1–S3	I+1	-0.00970	I+1	0.72948	-0.017465	0.3279002	-0.0497
	J-1	-0.05057	J-1	-20.571	-3.661	-3.7294	-4.3811
L= 41 m	J+1	0.03640	J+1	7.9336	1.3385	1.6135	1.8983
	K-1	-0.00604	K-1	-1.495	-0.47418	-0.1211	1.55429
	K+1	0.01244	K+1	10.0102	-0.41684	1.8994	0.60132
	I-1	0.02930	I-1	3.1806	3.039402	0.021637	0.30657
S4–S6	I+1	-0.02164	I+1	-1.0953	-0.029302	-1.849637	-0.39147
	J-1	-0.06083	J-1	-25.928	-4.7044	-4.7892	-5.8003
L= 51 m	J+1	0.05057	J+1	20.571	3.661	3.7294	4.3811
	K-1	-0.02950	K-1	-3.9561	-1.9667	-1.0362	-1.5283
	K+1	0.03210	K+1	7.2278	0.0	3.924	3.0324
	I-1	0.01225	I-1	0.86596	0.90256	0.007867	0.07576
S7	I+1	-0.00787	I+1	-0.75501	-0.01225	-0.972967	-0.18439
	J-1	-0.06223	J-1	-24.635	-4.7767	-4.8723	-6.7239
L= 16 m	J+1	0.06083	J+1	25.928	4.7044	4.7892	5.8003
	K-1	-0.02190	K-1	-2.7064	-1.4532	-1.0041	-1.44697
	K+1	0.01891	K+1	1.30245	0.63519	2.0523	2.4792
	I-1	0.02007	I-1	0.36003	0.416673	0.003586	0.01853
S8	I+1	-0.00359	I+1	-1.069	-0.02007	-1.324286	-0.22915
	J-1	-0.04121	J-1	-18.42	-2.8756	-4.3344	-4.8565
L= 16 m	J+1	0.06223	J+1	24.635	4.7767	4.8723	6.7239
	K-1	-0.07990	K-1	-5.723	-4.4559	-2.7396	-8.93218
	K+1	0.04240	K+1	0.21697	2.1582	3.5224	7.2754
	I-1	0.01470	I-1	0.32537	0.37465	0.008039	0.01962
S9	I+1	-0.00804	I+1	-0.98525	-0.014701	-1.22525	-0.20027
	J-1	-0.01032	J-1	-13.688	-2.1773	-0.61579	2.4038
L= 8 m	J+1	0.04121	J+1	18.42	2.8756	4.3344	4.8565
	K-1	-0.06360	K-1	-3.6844	-1.8799	-5.3381	-14.3612
	K+1	0.02605	K+1	-0.38772	0.82165	2.8367	7.2816

LOADING AREA South of encapsulation, the volume that connects to Sections S1–S2. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.56611 1.02993 -12.82030 7.38257 1.12837 1.71332
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	2.00010 -6.04311 0.47795 14.08761 -8.23602 -2.28653

Table 3-6. Net flows in BMA tunnel at 6000 AD. Results of detailed model, base case.

TIME 6000 AD BMA BASE CASE	ENCAPSULATION NET FLOW (m^3/year)			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	Net flow over faces Neg. flow= outflow Pos. flow= inflow		**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	FACE	**NET FLOW**					
	I-1	0.01737	I-1	3.3864	3.223371	0.009493	0.37537
S1–S3	I+1	-0.00949	I+1	0.74936	-0.017371	0.356617	-0.046579
	J-1	-0.05047	J-1	-20.558	-3.6588	-3.7278	-4.3792
L= 41 m	J+1	0.03631	J+1	7.8851	1.3305	1.6019	1.8867
	K-1	-0.00604	K-1	-1.4913	-0.47078	-0.12611	1.560779
	K+1	0.01232	K+1	10.0284	-0.40692	1.8859	0.60293
	I-1	0.02922	I-1	3.1798	3.037371	0.021435	0.30461
S4–S6	I+1	-0.02144	I+1	-1.0753	-0.029222	-1.837635	-0.38934
	J-1	-0.06071	J-1	-25.945	-4.7105	-4.7944	-5.8109
L= 51 m	J+1	0.05047	J+1	20.558	3.6588	3.7278	4.3792
	K-1	-0.02970	K-1	-3.9818	-1.9769	-1.0464	-1.53657
	K+1	0.03215	K+1	7.26429	0.020451	3.9292	3.053
	I-1	0.01226	I-1	0.87072	0.9000071	0.007770	0.074901
S7	I+1	-0.00777	I+1	-0.74683	-0.012257	-0.961871	-0.18409
	J-1	-0.06224	J-1	-24.663	-4.7906	-4.8813	-6.7521
L= 16 m	J+1	0.06071	J+1	25.945	4.7105	4.7944	5.8109
	K-1	-0.02210	K-1	-2.7452	-1.4693	-1.0234	-1.464411
	K+1	0.01915	K+1	1.33931	0.66165	2.0644	2.5148
	I-1	0.02014	I-1	0.36687	0.419041	0.003361	0.018367
S8	I+1	-0.00336	I+1	-1.0563	-0.020141	-1.320661	-0.2289
	J-1	-0.04102	J-1	-18.451	-2.8733	-4.3404	-4.8516
L= 16 m	J+1	0.06224	J+1	24.663	4.7906	4.8813	6.7521
	K-1	-0.08100	K-1	-5.8078	-4.5297	-2.7749	-9.075567
	K+1	0.04300	K+1	0.28523	2.2135	3.5513	7.3856
	I-1	0.01473	I-1	0.32968	0.3755388	0.0079611	0.019199
S9	I+1	-0.00796	I+1	-0.97445	-0.014729	-1.218141	-0.20002
	J-1	-0.01010	J-1	-13.744	-2.1783	-0.61712	2.4351
L= 8 m	J+1	0.04102	J+1	18.451	2.8733	4.3404	4.8516
	K-1	-0.06400	K-1	-3.7171	-1.8943	-5.3654	-14.42958
	K+1	0.02631	K+1	-0.345129	0.83849	2.8523	7.3237

LOADING AREA South of encapsulation, the volume that connects to Sections S1–S2. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.55656 1.02708 -12.74051 7.32117 1.12335 1.71236
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.97920 -6.01507 0.41155 14.11442 -8.26514 -2.22496

Table 3-7. Net flows in BMA tunnel at 7000 AD. Results of detailed model, base case.

TIME 7000 AD BMA BASE CASE	ENCAPSULATION NET FLOW (m^3/year)			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	Net flow over faces Neg. flow= outflow Pos. flow= inflow		**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	FACE	**NET FLOW**					
	I-1	0.01735	I-1	3.3843	3.22034	0.0094616	0.37509
S1–S3	I+1	-0.00946	I+1	0.7501	-0.01735	0.3605484	-0.04633
	J-1	-0.05045	J-1	-20.557	-3.6585	-3.7275	-4.379
L= 41 m	J+1	0.03627	J+1	7.8811	1.33	1.6011	1.8856
	K-1	-0.00603	K-1	-1.4863	-0.46757	-0.12451	1.56653
	K+1	0.01232	K+1	10.0278	-0.40692	1.8809	0.59811
	I-1	0.02922	I-1	3.1778	3.03816	0.021403	0.30428
S4–S6	I+1	-0.02140	I+1	-1.0745	-0.029215	-1.823103	-0.38911
	J-1	-0.06061	J-1	-25.947	-4.711	-4.7949	-5.8117
L= 51 m	J+1	0.05045	J+1	20.557	3.6585	3.7275	4.379
	K-1	-0.02980	K-1	-3.9715	-1.9769	-1.0498	-1.53897
	K+1	0.03215	K+1	7.25820	0.020451	3.9189	3.0565
	I-1	0.01226	I-1	0.87033	0.9036081	0.007759	0.07477
S7	I+1	-0.00776	I+1	-0.74645	-0.012258	-0.959459	-0.18404
	J-1	-0.06226	J-1	-24.665	-4.7915	-4.8817	-6.7539
L= 16 m	J+1	0.06061	J+1	25.947	4.711	4.7949	5.8117
	K-1	-0.02210	K-1	-2.7428	-1.4725	-1.0234	-1.46653
	K+1	0.01925	K+1	1.33692	0.66165	2.0619	2.518
	I-1	0.02014	I-1	0.3668	0.4215409	0.003337	0.018312
S8	I+1	-0.00334	I+1	-1.0557	-0.020141	-1.317637	-0.22886
	J-1	-0.04096	J-1	-18.452	-2.8727	-4.3406	-4.8505
L= 16 m	J+1	0.06226	J+1	24.665	4.7915	4.8817	6.7539
	K-1	-0.08110	K-1	-5.8102	-4.5361	-2.7781	-9.088152
	K+1	0.04300	K+1	0.286099	2.2159	3.5513	7.3953
	I-1	0.01473	I-1	0.32957	0.37673	0.007955	0.019135
S9	I+1	-0.00796	I+1	-0.97388	-0.01473	-1.21771	-0.19998
	J-1	-0.00994	J-1	-13.746	-2.1785	-.61734	2.4369
L= 8 m	J+1	0.04096	J+1	18.452	2.8727	4.3406	4.8505
	K-1	-0.06410	K-1	-3.7195	-1.8959	-5.367	-14.4336
	K+1	0.02630	K+1	-0.342189	0.8397	2.8535	7.327

LOADING AREA South of encapsulation, the volume that connects to Sections S1–S2. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.55568 1.02682 -12.73407 7.31654 1.12307 1.71195
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.97550 -6.01062 0.40576 14.11488 -8.26261 -2.22290

3.1.2 BMA average specific flow in surroundings at 2000 AD – 7000 AD

Table 3-8. Specific flow outside of BMA tunnel at 2000 AD. Results of detailed model, base case.

TIME 2000 AD **BMA BASE CASE**	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.740406E-11 -2.693825E-12 1.033594E-12 3.715327E-11	1.008908E-11 -6.340311E-12 3.103061E-13 6.39264E-12	1.674882E-11 -1.362268E-11 6.851877E-13 9.514538E-12	3.172352E-11 -1.265738E-12 1.477949E-13 3.14729E-11
S4–S6 L= 51 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.719534E-11 -3.258524E-12 -4.721685E-13 3.693561E-11	1.03767E-11 -6.095403E-12 1.991942E-13 6.798361E-12	1.944933E-11 -1.664941E-11 3.090734E-13 9.995839E-12	3.481527E-11 -1.426559E-12 2.742983E-13 3.45283E-11
S7 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	4.775857E-11 -4.517485E-12 -1.368063E-11 4.529762E-11	1.328541E-11 -7.271908E-12 -2.513158E-12 8.760159E-12	2.032265E-11 -1.71583E-11 2.07107E-13 1.079946E-11	4.014569E-11 -1.330447E-12 5.702439E-12 3.923641E-11
S8 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	2.388473E-10 9.251414E-11 -7.339971E-12 2.055769E-10	1.477546E-09 -2.901051E-11 7.009148E-13 1.47721E-09	2.028309E-11 -1.57531E-11 4.237035E-13 1.24887E-11	3.384002E-10 -1.100919E-10 2.060024E-11 3.070232E-10
S9 L= 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	4.029006E-10 -1.365006E-10 1.716539E-10 2.684326E-10	1.643283E-11 -1.101013E-11 3.51734E-12 9.887046E-12	2.523515E-11 -1.601113E-11 2.013193E-12 1.869728E-11	4.477728E-10 -9.236378E-12 -3.109456E-11 4.416715E-10

Table 3-9. Specific flow outside of BMA tunnel at 3000 AD. Results of detailed model, base case.

TIME 3000 AD **BMA BASE CASE**	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.765064E-10 4.943242E-11 -2.781638E-11 -1.654863E-10	1.678413E-10 1.655756E-10 -1.853389E-11 1.629996E-12	7.875021E-11 5.303215E-11 -2.458767E-11 -1.06137E-11	6.420609E-11 1.325413E-11 -4.188068E-12 3.889295E-11
S4–S6 L= 51 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	9.385046E-11 5.252246E-11 -1.532146E-11 -6.298496E-11	1.182117E-10 1.178804E-10 -4.4267E-12 4.569552E-13	1.353081E-10 1.341098E-10 -6.666983E-12 -1.322075E-11	5.891661E-11 1.534579E-11 -3.362827E-12 -2.772876E-11
S7 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	9.8754E-11 5.375487E-11 -5.31448E-11 5.165407E-11	9.675313E-11 9.63068E-11 -7.350153E-12 4.360451E-12	1.786739E-10 1.774643E-10 -8.799883E-12 -1.045464E-11	7.316597E-11 1.677298E-11 -8.235089E-12 -5.335156E-11
S8 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.435534E-09 1.010738E-09 -5.656813E-10 4.895532E-10	9.030322E-10 3.776415E-10 -2.979511E-12 7.895707E-10	2.1578E-10 2.130079E-10 -2.66638E-11 -6.80487E-12	6.434794E-10 3.734031E-10 -2.882799E-10 -2.620731E-10
S9 L= 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.803829E-09 1.259408E-09 -8.082836E-10 6.081973E-10	7.931641E-11 7.91166E-11 4.17205E-12 2.194298E-12	3.640541E-10 3.166888E-10 -1.761844E-10 -7.523895E-12	2.154806E-09 9.793641E-10 -9.752411E-10 -1.337973E-09

Table 3-10. Specific flow outside of BMA tunnel at 4000 AD. Results of detailed model, base case.

TIME 4000 AD **BMA BASE CASE**	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.000004E-10 5.35367E-11 -3.430978E-11 -2.912257E-10	2.349094E-10 2.325937E-10 -2.056885E-11 -2.730916E-12	6.784799E-11 1.486589E-11 -2.949688E-11 -1.808881E-11	7.953306E-11 1.475331E-11 -5.520196E-12 5.769399E-11
S4–S6 L= 51 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.85018E-10 6.555352E-11 -1.738784E-11 -1.693071E-10	1.801338E-10 1.795774E-10 -6.413755E-12 -7.964901E-12	1.514165E-10 1.479732E-10 -1.185065E-11 -2.77866E-11	8.466788E-11 1.973072E-11 -5.636454E-12 -5.312063E-11
S7 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.1539E-10 7.703316E-11 -2.568496E-11 -6.345421E-11	1.623365E-10 1.618469E-10 3.928769E-12 -1.102728E-11	2.336918E-10 2.301351E-10 -1.494252E-11 -3.22312E-11	1.361583E-10 2.349492E-11 -2.128614E-11 -1.187913E-10
S8 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.510934E-09 1.049314E-09 -7.828845E-10 -8.253342E-12	2.730051E-09 5.667415E-10 -1.088876E-11 -2.669025E-09	2.924966E-10 2.864126E-10 -3.939285E-11 -3.50645E-11	1.429276E-09 8.251669E-10 -4.647858E-10 -8.308457E-10
S9 L= 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.080197E-09 2.086724E-09 -1.687452E-09 2.390693E-11	1.329477E-10 1.298182E-10 -2.079929E-11 -1.773546E-11	5.011352E-10 4.351532E-10 -2.377561E-10 -5.256662E-11	3.488688E-09 1.364902E-09 -1.283653E-09 -2.635379E-09

Table 3-11. Specific flow outside of BMA tunnel at 5000 AD. Results of detailed model, base case.

TIME 5000 AD **BMA BASE CASE**	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.130983E-10 5.372883E-11 -3.449879E-11 -3.044666E-10	2.395345E-10 2.372793E-10 -2.030068E-11 -4.149768E-12	6.82962E-11 1.332312E-11 -2.945665E-11 -2.009634E-11	7.816907E-11 1.49247E-11 -5.56642E-12 5.341754E-11
S4–S6 L= 51 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.969605E-10 6.661874E-11 -1.713782E-11 -1.822345E-10	1.853204E-10 1.846984E-10 -6.528658E-12 -9.895969E-12	1.542252E-10 1.502471E-10 -1.221801E-11 -3.062411E-11	9.023002E-11 2.016571E-11 -5.806419E-12 -6.133634E-11
S7 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.259333E-10 7.918587E-11 -1.939517E-11 -8.163492E-11	1.686099E-10 1.678548E-10 5.568711E-12 -1.418911E-11	2.389744E-10 2.348923E-10 -1.527489E-11 -3.607173E-11	1.474258E-10 2.406918E-11 -2.344991E-11 -1.31522E-10
S8 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.489384E-09 1.019713E-09 -7.837702E-10 -9.385553E-11	3.34224E-09 5.853125E-10 -1.154563E-11 -3.289899E-09	2.983682E-10 2.916736E-10 -3.991567E-11 -3.998812E-11	1.547888E-09 8.810112E-10 -4.784111E-10 -9.408395E-10
S9 L= 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.205314E-09 2.152314E-09 -1.769048E-09 -9.035554E-11	1.404552E-10 1.363707E-10 -2.351928E-11 -2.180564E-11	5.08699E-10 4.418028E-10 -2.394556E-10 -6.035372E-11	3.633216E-09 1.378571E-09 -1.281374E-09 -2.815573E-09

Table 3-12. Specific flow outside of BMA tunnel at 6000 AD. Results of detailed model, base case.

TIME 6000 AD **BMA BASE CASE**	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.131065E-10 5.317798E-11 -3.441642E-11 -3.045609E-10	2.388323E-10 2.366014E-10 -2.011506E-11 -4.24564E-12	6.740519E-11 1.143117E-11 -2.928637E-11 -2.00039E-11	7.783798E-11 1.475402E-11 -5.548981E-12 5.363222E-11
S4–S6 L= 51 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.969831E-10 6.62789E-11 -1.699612E-11 -1.824633E-10	1.849207E-10 1.842911E-10 -6.527085E-12 -1.011132E-11	1.529581E-10 1.489312E-10 -1.225419E-11 -3.070274E-11	9.018507E-11 2.004446E-11 -5.815506E-12 -6.178058E-11
S7 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.268445E-10 7.903834E-11 -1.802768E-11 -8.38246E-11	1.684284E-10 1.676228E-10 5.764869E-12 -1.469372E-11	2.379236E-10 2.337826E-10 -1.526222E-11 -3.639293E-11	1.483077E-10 2.395812E-11 -2.373633E-11 -1.328008E-10
S8 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.476354E-09 1.007295E-09 -7.786078E-10 -1.090212E-10	3.435775E-09 5.84351E-10 -1.159351E-11 -3.385127E-09	2.971161E-10 2.903497E-10 -3.976866E-11 -4.054455E-11	1.559328E-09 8.841872E-10 -4.772046E-10 -9.564596E-10
S9 L= 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.207501E-09 2.149869E-09 -1.772374E-09 -1.10833E-10	1.406198E-10 1.363656E-10 -2.382183E-11 -2.244087E-11	5.064403E-10 4.397914E-10 -2.381557E-10 -6.131284E-11	3.63437E-09 1.370461E-09 -1.271236E-09 -2.8296E-09

Table 3-13. Specific flow outside of BMA tunnel at 7000 AD. Results of detailed model, base case.

TIME 7000 AD **BMA BASE CASE**	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.129405E-10 5.312341E-11 -3.440455E-11 -3.04402E-10	2.386656E-10 2.364367E-10 -2.009774E-11 -4.248279E-12	6.7328E-11 1.130204E-11 -2.92688E-11 -1.997923E-11	7.779119E-11 1.473475E-11 -5.547108E-12 5.363963E-11
S4–S6 L= 51 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.968343E-10 6.623883E-11 -1.698656E-11 -1.8232E-10	1.847818E-10 1.841519E-10 -6.527315E-12 -1.012064E-11	1.528578E-10 1.488314E-10 -1.225607E-11 -3.068813E-11	9.015306E-11 2.002829E-11 -5.815968E-12 -6.180061E-11
S7 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.268004E-10 7.900655E-11 -1.796977E-11 -8.381457E-11	1.682879E-10 1.6748E-10 5.748433E-12 -1.472115E-11	2.378321E-10 2.336897E-10 -1.526108E-11 -3.639434E-11	1.483402E-10 2.394156E-11 -2.375741E-11 -1.328764E-10
S8 L= 16 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	1.475329E-09 1.006399E-09 -7.781633E-10 -1.096021E-10	3.439085E-09 5.84002E-10 -1.158822E-11 -3.388551E-09	2.970114E-10 2.902425E-10 -3.975887E-11 -4.056063E-11	1.559654E-09 8.83858E-10 -4.769964E-10 -9.576097E-10
S9 L= 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	3.206757E-09 2.149196E-09 -1.772046E-09 -1.116406E-10	1.404941E-10 1.362325E-10 -2.380078E-11 -2.247414E-11	5.062726E-10 4.396393E-10 -2.380734E-10 -6.134648E-11	3.634032E-09 1.369726E-09 -1.27043E-09 -2.830178E-09

3.2 BMA sensitivity case – flow of a failed encapsulation

The BMA encapsulation is divided into different sections separated by concrete walls. As a sensitivity case we have studied the flow through an assumed failed or breached section. This case represents a situation for which a limited part of the BMA encapsulation has a much larger permeability than the surrounding intact parts of the encapsulation. A motivation of the case is a theoretical large fracture intersecting the concrete walls of the encapsulation or a local collapse of the concrete walls. All simulations of a breached section of the BMA encapsulation were carried out with the detailed model.

Compared to the base case of the detailed model, the difference is that a limited part of the encapsulation, located close to Zone 6, is defined as having the same conductivity, equal to 1×10^{-5} m/s, in all directions. This is also the conductivity of the surrounding back fill. All other parts of the model have the same properties as in the previous discussed detailed model (the base case).

The conductivity value of the breached section (1×10^{-5} m/s) used in these simulations is an assumed value that represents the permeability of a completely failed section of the BMA encapsulation or a section intersected by large fractures. Such a large conductivity value represents an encapsulation for which the voids inside the encapsulation are not back filled with a low permeable filling; hence it is a collapse of the base case, not a collapse of the first alternative BMA layout. The breached section is located where Zone 6 intersects the tunnel; this is a conservative assumption as this the part of the BMA where the flow is the largest.

The assumed properties of the breached section are given in Table 3-14, below. The position of the assumed breached section is given in Figure 3-1.

Table 3-14. Conductivity and size of the failed section of the BMA encapsulation, a sensitivity case of the detailed model.

BMA ASSUMED BREACHED SECTION OF ENCAPSULATION	HYDRAULIC CONDUCTIVITY (m/s) IN FLOW DIRECTIONS			SIZE OF SECTION
	X-DIR.	Y-DIR.	Z-DIR.	
Waste domain and encapsulation [1)]	1E-5	1E-5	1E-5	– Length along tunnel: 16 m – Volume of section: 2 176 m^3

[1)] Note, that these properties are applied to a limited section of the encapsulation only, the rest of the BMA encapsulation is assumed to have intact properties (see Table 3-1).

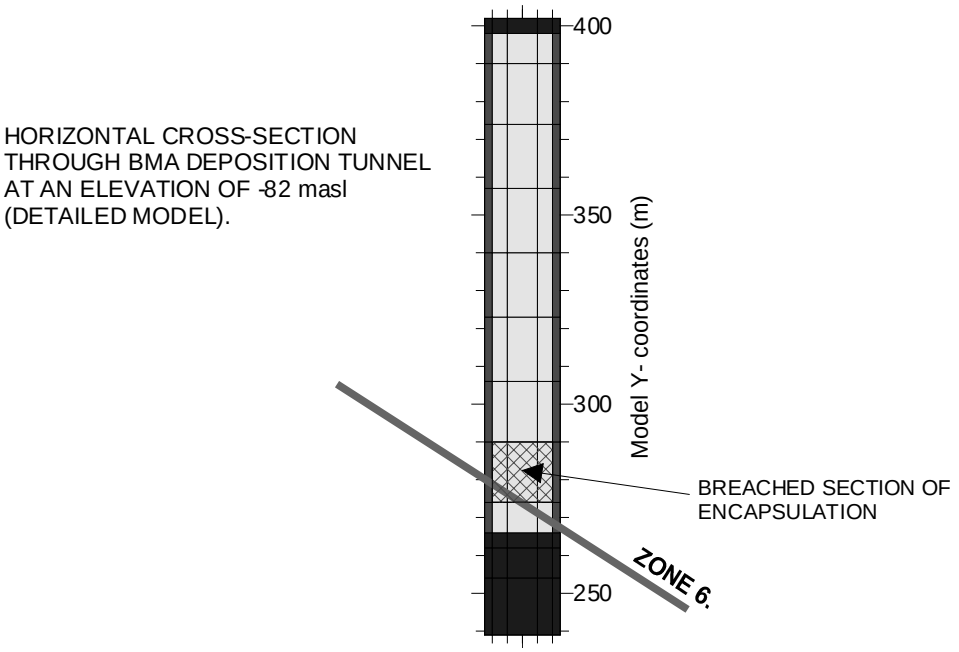

Figure 3-1. *Position of assumed breached section in the BMA encapsulation. As defined in a sensitivity case of the detailed model.*

3.2.1 BMA (breached) net flows at time 2000 AD – 7000 AD

Table 3-15. Net flows in BMA tunnel at 2000 AD. Results of detailed model, sensitivity case.

TIME 2000 AD BMA Collapsed Section 8 SECTION STUDIED Length (m)	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
				Top filling	First side Filling	Second side filling	Floor
S1–S3 L= 41 m	I-1	-0.00174	I-1	-0.26580	-0.12446	-0.00034	0.01380
	I+1	0.00034	I+1	-0.08361	0.00174	0.11305	0.04720
	J-1	0.00156	J-1	0.71830	0.11390	0.11600	0.13760
	J+1	-0.00167	J+1	-0.09801	-0.03118	-0.05271	-0.12830
	K-1	0.00770	K-1	0.97910	0.42880	0.40810	0.77430
	K+1	-0.00620	K+1	-1.24998	-0.38880	-0.58410	-0.84460
S4–S6 L= 51 m	I-1	-0.00266	I-1	-0.33470	-0.14176	-0.00043	0.01970
	I+1	0.00043	I+1	-0.07012	0.00266	0.19553	0.06650
	J-1	0.00159	J-1	1.21150	0.19580	0.18910	0.23010
	J+1	-0.00156	J+1	-0.71830	-0.11390	-0.11600	-0.13760
	K-1	0.01150	K-1	1.40480	0.61100	0.57350	1.01730
	K+1	-0.00930	K+1	-1.49318	-0.55380	-0.84170	-1.19600
S7 L= 16 m	I-1	-0.00131	I-1	-0.13760	-0.05781	0.00041	0.00745
	I+1	-0.00041	I+1	-0.03075	0.00131	0.05939	0.02180
	J-1	0.00452	J-1	1.50410	0.24700	0.20000	0.24050
	J+1	-0.00159	J+1	-1.21200	-0.19580	-0.18910	-0.23010
	K-1	0.00290	K-1	0.50780	0.22860	0.20970	0.40155
	K+1	-0.00410	K+1	-0.63155	-0.22330	-0.28040	-0.44120
S8 Collapsed L= 16 m	I-1	-0.07710	I-1	-0.11350	-0.06758	0.04910	0.00138
	I+1	-0.04910	I+1	-0.06110	0.07710	0.05760	0.02240
	J-1	0.00662	J-1	-0.02640	-0.00542	0.19740	0.42260
	J+1	-0.00452	J+1	-1.50400	-0.24700	-0.20000	-0.24050
	K-1	2.24080	K-1	2.61710	0.52470	0.11450	2.67413
	K+1	-2.11670	K+1	-0.91210	-0.28180	-0.21860	-2.88000
S9 L= 8 m	I-1	-0.00099	I-1	-0.08856	-0.04001	-0.00073	0.00299
	I+1	0.00073	I+1	-0.05711	0.00099	0.02863	0.01480
	J-1	-0.00122	J-1	0.11680	-0.04980	-0.19040	-0.74170
	J+1	-0.00662	J+1	0.02640	0.00542	-0.19740	-0.42260
	K-1	0.01120	K-1	0.53920	0.24780	0.73160	2.13711
	K+1	-0.00310	K+1	-0.53673	-0.16440	-0.37170	-0.99060

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	-0.05554
	I+1	-0.00600
	J-1	0.31187
	J+1	-0.16308
	K-1	0.08340
	K+1	-0.17066
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	-0.35165
	I+1	0.02140
	J-1	-0.22189
	J+1	0.86632
	K-1	0.99730
	K+1	-1.31148

Table 3-16. Net flows in BMA tunnel at 3000 AD. Results of detailed model, sensitivity case.

TIME 3000 AD BMA Collapsed Section 8 SECTION STUDIED Length (m)	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied Top filling	First side Filling	Second side filling	Floor
S1–S3 L= 41 m	I-1	0.01300	I-1	2.25950	2.14957	0.01010	0.28720
	I+1	-0.01010	I+1	-0.10110	-0.01300	-0.40470	-0.08785
	J-1	-0.02988	J-1	-13.91000	-2.18600	-2.21000	-2.60200
	J+1	0.02530	J+1	6.77150	1.01240	1.25090	1.37640
	K-1	0.00017	K-1	-0.26960	-0.06937	0.19200	1.14905
	K+1	0.00150	K+1	5.24970	-0.89360	1.16170	-0.12280
S4–S6 L= 51 m	I-1	0.01843	I-1	1.80430	1.84633	0.01700	0.23420
	I+1	-0.01700	I+1	-1.45500	-0.01843	-1.85250	-0.29620
	J-1	-0.03241	J-1	-15.30000	-2.38100	-2.36800	-2.77800
	J+1	0.02988	J+1	13.90700	2.18620	2.21040	2.60150
	K-1	-0.00880	K-1	-1.29700	-0.71920	-0.20790	-0.69740
	K+1	0.00990	K+1	2.34070	-0.91390	2.20100	0.93590
S7 L= 16 m	I-1	0.00993	I-1	0.33040	0.47783	0.00161	0.06110
	I+1	-0.00161	I+1	-0.74680	-0.00993	-0.79059	-0.12010
	J-1	-0.05455	J-1	-14.15000	-2.21700	-2.00300	-2.49400
	J+1	0.03241	J+1	15.30300	2.38110	2.36810	2.77770
	K-1	0.00532	K-1	-0.13240	-0.24220	-0.08982	-0.55140
	K+1	0.00850	K+1	-0.60420	-0.38980	0.51370	0.32670
S8 Collapsed L= 16 m	I-1	1.31400	I-1	-0.03343	0.08185	1.37240	0.00820
	I+1	-1.37240	I+1	-1.03600	-1.31400	-1.00210	-0.14400
	J-1	0.04670	J-1	-8.53900	-1.10900	-2.17700	-2.81600
	J+1	0.05455	J+1	14.15300	2.21720	2.00280	2.49390
	K-1	-2.25835	K-1	-2.48500	-0.01925	-0.32240	-2.14210
	K+1	2.21550	K+1	-2.05957	0.14320	0.12630	2.60000
S9 L= 8 m	I-1	0.00210	I-1	0.08560	0.19210	0.01200	0.02110
	I+1	-0.01200	I+1	-0.89870	-0.00210	-0.90797	-0.12440
	J-1	0.09280	J-1	-4.86600	-0.71470	-0.08773	0.99350
	J+1	-0.04670	J+1	8.53920	1.10880	2.17660	2.81590
	K-1	-0.03640	K-1	-1.27600	-0.62080	-2.43200	-6.79530
	K+1	0.00020	K+1	-1.58410	0.03670	1.23910	3.08920

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	1.25845
	I+1	0.76837
	J-1	-10.43651
	J+1	6.35307
	K-1	0.93238
	K+1	1.12424
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	2.46940
	I+1	-4.05840
	J-1	2.69260
	J+1	4.58213
	K-1	-3.70192
	K+1	-1.98381

Table 3-17. Net flows in BMA tunnel at 4000 AD. Results of detailed model, sensitivity case.

TIME 4000 AD BMA Collapsed Section 8 SECTION STUDIED Length (m)	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied Top filling	First side Filling	Second side filling	Floor
S1–S3 L= 41 m	I-1	0.01709	I-1	3.36120	3.06529	0.00858	0.38730
	I+1	-0.00858	I+1	0.71530	-0.01709	0.19382	-0.03570
	J-1	-0.04482	J-1	-20.82000	-3.27500	-3.32800	-3.91900
	J+1	0.03141	J+1	8.19040	1.22700	1.48310	1.68480
	K-1	-0.00110	K-1	-0.76480	-0.20110	0.08460	1.76500
	K+1	0.00600	K+1	9.31790	-0.79910	1.55790	0.11760
S4–S6 L= 51 m	I-1	0.02682	I-1	3.11620	2.85642	0.01860	0.32010
	I+1	-0.01860	I+1	-1.08300	-0.02682	-1.94310	-0.36480
	J-1	-0.05574	J-1	-26.33000	-4.11200	-4.12000	-4.84900
	J+1	0.04482	J+1	20.82000	3.27500	3.32790	3.91880
	K-1	-0.02010	K-1	-3.02400	-1.46600	-0.81120	-1.32240
	K+1	0.02280	K+1	6.50080	-0.52660	3.52780	2.29730
S7 L= 16 m	I-1	0.01721	I-1	0.82860	0.82631	-0.00094	0.08090
	I+1	0.00094	I+1	-0.75170	-0.01721	-1.00116	-0.17420
	J-1	-0.10099	J-1	-26.37000	-4.10300	-3.77500	-4.62400
	J+1	0.05574	J+1	26.33300	4.11200	4.11950	4.84930
	K-1	0.00620	K-1	-0.95440	-0.66410	-0.42990	-1.21980
	K+1	0.02090	K+1	0.91450	-0.15400	1.08750	1.08780
S8 Collapsed L= 16 m	I-1	2.01200	I-1	0.32840	0.36160	1.77920	0.02040
	I+1	-1.77920	I+1	-1.07600	-2.01200	-1.32940	-0.21890
	J-1	0.16164	J-1	-17.47000	-2.44500	-4.21300	-5.75400
	J+1	0.10099	J+1	26.37100	4.10340	3.77520	4.62400
	K-1	-7.24663	K-1	-8.10100	-0.72500	-0.64480	-7.28793
	K+1	6.75120	K+1	-0.05240	0.71700	0.63280	8.61643
S9 L= 8 m	I-1	0.00260	I-1	0.29870	0.33440	0.01930	0.02230
	I+1	-0.01930	I+1	-0.99340	-0.00260	-1.23270	-0.19160
	J-1	0.09975	J-1	-13.13000	-1.92300	-0.77660	1.52040
	J+1	-0.16164	J+1	17.47300	2.44480	4.21300	5.75410
	K-1	0.07400	K-1	-2.98200	-1.33000	-4.72400	-13.08520
	K+1	0.00460	K+1	-0.66630	0.47640	2.50100	5.98000

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	1.53690
	I+1	1.01526
	J-1	-12.61671
	J+1	7.27872
	K-1	1.13749
	K+1	1.64835
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	1.98520
	I+1	-6.14785
	J-1	0.58440
	J+1	14.20945
	K-1	-7.97104
	K+1	-2.66016

Table 3-18. Net flows in BMA tunnel at 5000 AD. Results of detailed model, sensitivity case.

TIME 5000 AD BMA Collapsed Section 8 SECTION STUDIED Length (m)	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied Top filling	First side Filling	Second side filling	Floor
S1–S3 L= 41 m	I-1	0.01758	I-1	3.46650	3.13068	0.00838	0.38990
	I+1	-0.00838	I+1	0.79480	-0.01758	0.22810	-0.03806
	J-1	-0.04572	J-1	-21.23000	-3.34000	-3.39500	-3.99900
	J+1	0.03153	J+1	8.17080	1.22500	1.48340	1.69890
	K-1	-0.00242	K-1	-0.95810	-0.28050	0.00682	1.67216
	K+1	0.00740	K+1	9.75600	-0.71760	1.66830	0.27610
S4–S6 L= 51 m	I-1	0.02778	I-1	3.26190	2.94078	0.01850	0.32110
	I+1	-0.01850	I+1	-1.02500	-0.02778	-1.95650	-0.37880
	J-1	-0.05629	J-1	-27.10000	-4.23500	-4.24200	-4.99800
	J+1	0.04572	J+1	21.22800	3.33960	3.39520	3.99870
	K-1	-0.02350	K-1	-3.38900	-1.62900	-0.96800	-1.56350
	K+1	0.02480	K+1	7.02410	-0.38860	3.75280	2.62050
S7 L= 16 m	I-1	0.01788	I-1	0.89420	0.86279	-0.00121	0.08030
	I+1	0.00121	I+1	-0.73440	-0.01788	-1.01719	-0.18120
	J-1	-0.10330	J-1	-27.30000	-4.25100	-3.90700	-4.78200
	J+1	0.05629	J+1	27.09700	4.23460	4.24210	4.99760
	K-1	0.00550	K-1	-1.12200	-0.74430	-0.50050	-1.35400
	K+1	0.02241	K+1	1.16520	-0.08421	1.18380	1.23930
S8 Collapsed L= 16 m	I-1	2.06800	I-1	0.38350	0.39550	1.77320	0.02100
	I+1	-1.77320	I+1	-1.04700	-2.06800	-1.35480	-0.22720
	J-1	0.16130	J-1	-17.86000	-2.50500	-4.35700	-6.00500
	J+1	0.10330	J+1	27.29600	4.25120	3.90650	4.78230
	K-1	-8.10890	K-1	-9.09900	-0.90140	-0.68970	-8.27110
	K+1	7.54950	K+1	0.32650	0.82770	0.72180	9.70000
S9 L= 8 m	I-1	0.00290	I-1	0.33900	0.35270	0.01970	0.02160
	I+1	-0.01970	I+1	-0.97040	-0.00290	-1.24640	-0.19790
	J-1	0.17890	J-1	-13.56000	-1.97000	-0.76170	1.74460
	J+1	-0.16130	J+1	17.85700	2.50480	4.35700	6.00540
	K-1	-0.00600	K-1	-3.21600	-1.43200	-5.03200	-14.04370
	K+1	0.00520	K+1	-0.44960	0.54740	2.66340	6.47000

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	1.54317
	I+1	1.01898
	J-1	-12.60963
	J+1	7.23009
	K-1	1.12312
	K+1	1.69429
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	2.04670
	I+1	-6.17987
	J-1	0.43350
	J+1	14.36820
	K-1	-8.39889
	K+1	-2.26964

Table 3-19. Net flows in BMA tunnel at 6000 AD. Results of detailed model, sensitivity case.

TIME 6000 AD BMA Collapsed Section 8 SECTION STUDIED Length (m)	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied Top filling	First side Filling	Second side filling	Floor
S1–S3 L= 41 m	I-1	0.01748	I-1	3.46010	3.12748	0.00819	0.38840
	I+1	-0.00819	I+1	0.81500	-0.01748	0.25039	-0.03491
	J-1	-0.04571	J-1	-21.22000	-3.33800	-3.39400	-3.99700
	J+1	0.03144	J+1	8.12290	1.21780	1.47280	1.68830
	K-1	-0.00242	K-1	-0.95550	-0.28210	0.00682	1.67751
	K+1	0.00740	K+1	9.77750	-0.70770	1.65580	0.27770
S4–S6 L= 51 m	I-1	0.02770	I-1	3.26090	2.93470	0.01840	0.31910
	I+1	-0.01840	I+1	-1.00500	-0.02770	-1.94160	-0.37670
	J-1	-0.05700	J-1	-27.12000	-4.23800	-4.24600	-5.00300
	J+1	0.04571	J+1	21.21500	3.33770	3.39380	3.99700
	K-1	-0.02350	K-1	-3.40500	-1.63600	-0.97480	-1.57070
	K+1	0.02550	K+1	7.05410	-0.37070	3.75020	2.63430
S7 L= 16 m	I-1	0.01790	I-1	0.89880	0.85897	-0.00128	0.07940
	I+1	0.00128	I+1	-0.72620	-0.01790	-1.01562	-0.18080
	J-1	-0.10376	J-1	-27.34000	-4.25900	-3.91400	-4.79100
	J+1	0.05700	J+1	27.11600	4.23840	4.24600	5.00320
	K-1	0.00540	K-1	-1.14100	-0.75070	-0.50370	-1.35980
	K+1	0.02217	K+1	1.19240	-0.06977	1.18860	1.24900
S8 Collapsed L= 16 m	I-1	2.05900	I-1	0.39020	0.39810	1.75320	0.02080
	I+1	-1.75320	I+1	-1.03400	-2.05900	-1.34690	-0.22700
	J-1	0.10674	J-1	-17.86000	-2.50700	-4.36200	-6.02100
	J+1	0.10376	J+1	27.34200	4.25930	3.91400	4.79120
	K-1	-8.17680	K-1	-9.23400	-0.93350	-0.68970	-8.36400
	K+1	7.66050	K+1	0.39580	0.84210	0.73140	9.80000
S9 L= 8 m	I-1	0.00291	I-1	0.34330	0.35291	0.01970	0.02120
	I+1	-0.01970	I+1	-0.95960	-0.00291	-1.24100	-0.19770
	J-1	0.13403	J-1	-13.60000	-1.97400	-0.76250	1.76480
	J+1	-0.10674	J+1	17.86200	2.50700	4.36230	6.02110
	K-1	-0.01600	K-1	-3.23800	-1.44000	-5.05400	-14.11940
	K+1	0.00550	K+1	-0.40770	0.55700	2.67550	6.51000

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	1.53385
	I+1	1.01643
	J-1	-12.53324
	J+1	7.17149
	K-1	1.11837
	K+1	1.69309
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	2.02650
	I+1	-6.16899
	J-1	0.37050
	J+1	14.43767
	K-1	-8.45348
	K+1	-2.21220

Table 3-20. Net flows in BMA tunnel at 7000 AD. Results of detailed model, sensitivity case.

TIME 7000 AD BMA Collapsed Section 8 SECTION STUDIED Length (m)	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied Top filling	First side Filling	Second side filling	Floor
S1–S3 L= 41 m	I-1	0.01747	I-1	3.45860	3.12477	0.00818	0.38820
	I+1	-0.00818	I+1	0.81630	-0.01747	0.25102	-0.03455
	J-1	-0.04570	J-1	-21.21000	-3.33700	-3.39300	-3.99600
	J+1	0.03151	J+1	8.11750	1.21720	1.47160	1.68700
	K-1	-0.00240	K-1	-0.94930	-0.27730	0.01000	1.68565
	K+1	0.00730	K+1	9.76690	-0.71020	1.65220	0.26970
S4–S6 L= 51 m	I-1	0.02769	I-1	3.25970	2.93939	0.01840	0.31890
	I+1	-0.01840	I+1	-1.00300	-0.02769	-1.93240	-0.37630
	J-1	-0.05769	J-1	-27.11000	-4.23800	-4.24600	-5.00300
	J+1	0.04570	J+1	21.21000	3.33700	3.39310	3.99630
	K-1	-0.02290	K-1	-3.40000	-1.64000	-0.97820	-1.57700
	K+1	0.02560	K+1	7.04330	-0.37070	3.74510	2.64110
S7 L= 16 m	I-1	0.01789	I-1	0.89870	0.85946	-0.00130	0.07930
	I+1	0.00130	I+1	-0.72560	-0.01789	-1.01191	-0.18080
	J-1	-0.10435	J-1	-27.34000	-4.25900	-3.91400	-4.79100
	J+1	0.05769	J+1	27.11200	4.23790	4.24550	5.00270
	K-1	0.00530	K-1	-1.14100	-0.75070	-0.50690	-1.36250
	K+1	0.02217	K+1	1.19590	-0.06977	1.18860	1.25230
S8 Collapsed L= 16 m	I-1	2.05900	I-1	0.39040	0.40170	1.75160	0.02080
	I+1	-1.75160	I+1	-1.03300	-2.05900	-1.34190	-0.22690
	J-1	0.09816	J-1	-17.86000	-2.50700	-4.36200	-6.02100
	J+1	0.10435	J+1	27.34000	4.25890	3.91380	4.79090
	K-1	-8.18040	K-1	-9.24400	-0.93670	-0.69290	-8.37380
	K+1	7.67050	K+1	0.40660	0.84210	0.73140	9.81000
S9 L= 8 m	I-1	0.00291	I-1	0.34340	0.35181	0.01970	0.02110
	I+1	-0.01970	I+1	-0.95890	-0.00291	-1.24120	-0.19760
	J-1	0.13465	J-1	-13.60000	-1.97400	-0.76280	1.76450
	J+1	-0.09816	J+1	17.86000	2.50690	4.36180	6.02070
	K-1	-0.02500	K-1	-3.23900	-1.44000	-5.05300	-14.12670
	K+1	0.00530	K+1	-0.40550	0.55820	2.67550	6.51800

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	1.53277
	I+1	1.01605
	J-1	-12.52481
	J+1	7.16546
	K-1	1.11800
	K+1	1.69253
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	2.02380
	I+1	-6.16488
	J-1	0.36500
	J+1	14.43765
	K-1	-8.45171
	K+1	-2.20986

3.2.2 BMA average specific flow in surroundings at 2000 AD – 7000 AD

Table 3-21. Specific flow outside of BMA tunnel at 2000 AD. Results of detailed model, sensitivity case, collapsed section in encapsulation.

TIME 2000 AD Sensitivity case Collapsed Section	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	3.891707E-11	1.077107E-11	1.577231E-11	3.036999E-11
	X-direction	-2.704897E-12	-7.652307E-12	-1.248337E-11	-1.263315E-12
	Y-direction	9.760945E-13	2.315983E-13	5.972826E-13	1.174752E-13
	Z-direction	3.86546E-11	6.279803E-12	9.374479E-12	3.01391E-11
S4–S6 L= 51 m	**R**esultant	3.867617E-11	1.106057E-11	1.83517E-11	3.337056E-11
	X-direction	-3.270392E-12	-7.509876E-12	-1.543342E-11	-1.426112E-12
	Y-direction	-5.180412E-13	1.426246E-13	2.62614E-13	2.107252E-13
	Z-direction	3.840242E-11	6.663232E-12	9.848088E-12	3.310484E-11
S7 L= 16 m	**R**esultant	4.940063E-11	1.406898E-11	1.924446E-11	3.85862E-11
	X-direction	-4.582792E-12	-8.896368E-12	-1.598019E-11	-1.354441E-12
	Y-direction	-1.411038E-11	-3.046733E-12	1.191153E-13	5.304346E-12
	Z-direction	4.686623E-11	8.55316E-12	1.059709E-11	3.77444E-11
S8 Collapsed L= 16 m	**R**esultant	2.419219E-10	1.48501E-09	1.921015E-11	3.320462E-10
	X-direction	9.21405E-11	-3.101608E-11	-1.456682E-11	-1.122067E-10
	Y-direction	-7.668794E-12	8.013343E-13	2.632957E-13	2.165789E-11
	Z-direction	2.089162E-10	1.484634E-09	1.215155E-11	2.9865E-10
S9 L= 8 m	**R**esultant	4.063677E-10	1.746114E-11	2.400413E-11	4.333633E-10
	X-direction	-1.362872E-10	-1.262848E-11	-1.422147E-11	-8.333791E-12
	Y-direction	1.725975E-10	4.207592E-12	1.028672E-12	-3.11034E-11
	Z-direction	2.723795E-10	9.688698E-12	1.842202E-11	4.26514E-10

Table 3-22. Specific flow outside of BMA tunnel at 3000 AD. Results of detailed model, sensitivity case, collapsed section in encapsulation.

TIME 3000 AD Sensitivity case Collapsed Section	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	1.796175E-10	1.707389E-10	7.668472E-11	6.531761E-11
	X-direction	4.944899E-11	1.685053E-10	5.047801E-11	1.323884E-11
	Y-direction	-2.758533E-11	-1.824239E-11	-2.426349E-11	-3.980487E-12
	Z-direction	-1.688621E-10	1.903193E-12	-1.02861E-11	4.189604E-11
S4–S6 L= 51 m	**R**esultant	9.550138E-11	1.20887E-10	1.329415E-10	5.80311E-11
	X-direction	5.25184E-11	1.205517E-10	1.317839E-10	1.531067E-11
	Y-direction	-1.509463E-11	-4.167216E-12	-6.405044E-12	-3.066518E-12
	Z-direction	-6.582104E-11	7.183364E-13	-1.294777E-11	-2.501191E-11
S7 L= 16 m	**R**esultant	9.716603E-11	9.936332E-11	1.767356E-10	7.213628E-11
	X-direction	5.380744E-11	9.897365E-11	1.755713E-10	1.670063E-11
	Y-direction	-5.231345E-11	-6.373351E-12	-8.383517E-12	-7.442511E-12
	Z-direction	4.904616E-11	4.660406E-12	-1.015131E-11	-5.090411E-11
S8 Collapsed L= 16 m	**R**esultant	1.432616E-09	8.934088E-10	2.144178E-10	6.425059E-10
	X-direction	1.010771E-09	3.808911E-10	2.117052E-10	3.760629E-10
	Y-direction	-5.649581E-10	-2.964942E-12	-2.626856E-11	-2.886413E-10
	Z-direction	4.844057E-10	7.753569E-10	-6.388565E-12	-2.460385E-10
S9 L= 8 m	**R**esultant	1.802173E-09	8.147165E-11	3.615126E-10	2.13916E-09
	X-direction	1.259076E-09	8.132021E-11	3.144908E-10	9.765457E-10
	Y-direction	-8.096255E-10	3.274321E-12	-1.74962E-10	-9.740213E-10
	Z-direction	6.026084E-10	2.378958E-12	-7.269445E-12	-1.318902E-09

Table 3-23. Specific flow outside of BMA tunnel at 4000 AD. Results of detailed model, sensitivity case, collapsed section in encapsulation.

TIME 4000 AD Sensitivity case Collapsed Section	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	3.0636E-10	2.409653E-10	6.55865E-11	8.280215E-11
	X-direction	5.359161E-11	2.386729E-10	9.698037E-12	1.475466E-11
	Y-direction	-3.410935E-11	-2.025416E-11	-2.916793E-11	-5.233719E-12
	Z-direction	-2.976721E-10	-2.168587E-12	-1.744775E-11	6.376664E-11
S4–S6 L= 51 m	**R**esultant	1.898865E-10	1.855827E-10	1.467808E-10	8.23716E-11
	X-direction	6.558804E-11	1.850457E-10	1.434027E-10	1.970314E-11
	Y-direction	-1.701374E-11	-5.974177E-12	-1.141459E-11	-5.120613E-12
	Z-direction	-1.748267E-10	-7.423922E-12	-2.722156E-11	-4.76954E-11
S7 L= 16 m	**R**esultant	1.177625E-10	1.67879E-10	2.297169E-10	1.325632E-10
	X-direction	7.719723E-11	1.673799E-10	2.262853E-10	2.34349E-11
	Y-direction	-2.406371E-11	5.896311E-12	-1.418757E-11	-1.962582E-11
	Z-direction	-6.871221E-11	-1.03202E-11	-3.15268E-11	-1.138223E-10
S8 Collapsed L= 16 m	**R**esultant	1.509674E-09	2.754492E-09	2.893898E-10	1.42118E-09
	X-direction	1.050129E-09	5.732872E-10	2.835157E-10	8.29491E-10
	Y-direction	-7.814354E-10	-1.085716E-11	-3.858408E-11	-4.666848E-10
	Z-direction	-1.83703E-11	-2.692645E-09	-3.398097E-11	-8.037474E-10
S9 L= 8 m	**R**esultant	3.080721E-09	1.377611E-10	4.957108E-10	3.453001E-09
	X-direction	2.085841E-09	1.3456E-10	4.305307E-10	1.36097E-09
	Y-direction	-1.68973E-09	-2.260356E-11	-2.350888E-10	-1.282696E-09
	Z-direction	1.289641E-11	-1.719427E-11	-5.188545E-11	-2.595339E-09

Table 3-24. Specific flow outside of BMA tunnel at 5000 AD. Results of detailed model, sensitivity case, collapsed section in encapsulation.

TIME 5000 AD Sensitivity case Collapsed Section	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	3.199322E-10	2.460959E-10	6.613451E-11	8.109727E-11
	X-direction	5.378605E-11	2.438604E-10	7.715019E-12	1.492765E-11
	Y-direction	-3.434222E-11	-2.00223E-11	-2.917338E-11	-5.279393E-12
	Z-direction	-3.113666E-10	-3.539364E-12	-1.940783E-11	5.999395E-11
S4–S6 L= 51 m	**R**esultant	2.022811E-10	1.911673E-10	1.492579E-10	8.760045E-11
	X-direction	6.665831E-11	1.905741E-10	1.453417E-10	2.013913E-11
	Y-direction	-1.675036E-11	-6.071629E-12	-1.176678E-11	-5.26837E-12
	Z-direction	-1.881482E-10	-9.31255E-12	-3.001456E-11	-5.550286E-11
S7 L= 16 m	**R**esultant	1.291084E-10	1.745937E-10	2.346731E-10	1.43445E-10
	X-direction	7.936846E-11	1.738348E-10	2.307282E-10	2.401509E-11
	Y-direction	-1.765773E-11	7.687076E-12	-1.44845E-11	-2.166062E-11
	Z-direction	-8.730763E-11	-1.341505E-11	-3.530118E-11	-1.261427E-10
S8 Collapsed L= 16 m	**R**esultant	1.489183E-09	3.367892E-09	2.949307E-10	1.538263E-09
	X-direction	1.020677E-09	5.923658E-10	2.884754E-10	8.856067E-10
	Y-direction	-7.822085E-10	-1.15271E-11	-3.905187E-11	-4.806254E-10
	Z-direction	-1.047879E-10	-3.314706E-09	-3.878731E-11	-9.119565E-10
S9 L= 8 m	**R**esultant	3.206521E-09	1.457049E-10	5.027191E-10	3.593329E-09
	X-direction	2.151292E-09	1.415719E-10	4.3671E-10	1.374444E-09
	Y-direction	-1.771438E-09	-2.548782E-11	-2.365166E-10	-1.280487E-09
	Z-direction	-1.022761E-10	-2.119204E-11	-5.958268E-11	-2.771328E-09

Table 3-25. Specific flow outside of BMA tunnel at 6000 AD. Results of detailed model, sensitivity case, collapsed section in encapsulation.

TIME 6000 AD Sensitivity case Collapsed Section	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	3.199496E-10	2.453879E-10	6.539357E-11	8.082391E-11
	X-direction	5.323228E-11	2.431751E-10	5.801858E-12	1.475598E-11
	Y-direction	-3.427061E-11	-1.984729E-11	-2.901572E-11	-5.263632E-12
	Z-direction	-3.114652E-10	-3.634933E-12	-1.931433E-11	6.022274E-11
S4–S6 L= 51 m	**R**esultant	2.023109E-10	1.907388E-10	1.479928E-10	8.753414E-11
	X-direction	6.631609E-11	1.901393E-10	1.440264E-10	2.001682E-11
	Y-direction	-1.660851E-11	-6.069191E-12	-1.180233E-11	-5.275911E-12
	Z-direction	-1.883729E-10	-9.529045E-12	-3.00927E-11	-5.595398E-11
S7 L= 16 m	**R**esultant	1.301002E-10	1.743791E-10	2.336242E-10	1.443128E-10
	X-direction	7.921876E-11	1.735724E-10	2.296212E-10	2.390394E-11
	Y-direction	-1.62911E-11	7.882434E-12	-1.447029E-11	-2.194168E-11
	Z-direction	-8.949208E-11	-1.391695E-11	-3.561942E-11	-1.274362E-10
S8 Collapsed L= 16 m	**R**esultant	1.476342E-09	3.461143E-09	2.936791E-10	1.549599E-09
	X-direction	1.008235E-09	5.913142E-10	2.871554E-10	8.886293E-10
	Y-direction	-7.77038E-10	-1.157205E-11	-3.890328E-11	-4.794573E-10
	Z-direction	-1.199554E-10	-3.409674E-09	-3.933468E-11	-9.279447E-10
S9 L= 8 m	**R**esultant	3.208796E-09	1.458363E-10	5.004609E-10	3.594451E-09
	X-direction	2.148818E-09	1.415409E-10	4.347007E-10	1.366381E-09
	Y-direction	-1.774727E-09	-2.57842E-11	-2.352154E-10	-1.27041E-09
	Z-direction	-1.227323E-10	-2.182285E-11	-6.053663E-11	-2.785405E-09

Table 3-26. Specific flow outside of BMA tunnel at 7000 AD. Results of detailed model, sensitivity case, collapsed section in encapsulation.

TIME 7000 AD Sensitivity case Collapsed Section	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	3.198424E-10	2.452754E-10	6.531136E-11	8.081225E-11
	X-direction	5.317803E-11	2.430646E-10	5.62307E-12	1.473667E-11
	Y-direction	-3.425973E-11	-1.98302E-11	-2.899853E-11	-5.261442E-12
	Z-direction	-3.113652E-10	-3.632632E-12	-1.928404E-11	6.028672E-11
S4–S6 L= 51 m	**R**esultant	2.022139E-10	1.906547E-10	1.478441E-10	8.747497E-11
	X-direction	6.627657E-11	1.900551E-10	1.438783E-10	2.000082E-11
	Y-direction	-1.65978E-11	-6.068275E-12	-1.180351E-11	-5.275576E-12
	Z-direction	-1.882869E-10	-9.533376E-12	-3.007255E-11	-5.591846E-11
S7 L= 16 m	**R**esultant	1.300948E-10	1.743058E-10	2.334832E-10	1.442976E-10
	X-direction	7.918947E-11	1.734969E-10	2.294795E-10	2.388835E-11
	Y-direction	-1.621629E-11	7.886487E-12	-1.446746E-11	-2.195135E-11
	Z-direction	-8.954435E-11	-1.393848E-11	-3.561506E-11	-1.274483E-10
S8 Collapsed L= 16 m	**R**esultant	1.47533E-09	3.464878E-09	2.935185E-10	1.5497E-09
	X-direction	1.007351E-09	5.91061E-10	2.869935E-10	8.884603E-10
	Y-direction	-7.765781E-10	-1.157141E-11	-3.888715E-11	-4.792429E-10
	Z-direction	-1.206729E-10	-3.413513E-09	-3.93439E-11	-9.285519E-10
S9 L= 8 m	**R**esultant	3.208077E-09	1.457826E-10	5.002026E-10	3.593444E-09
	X-direction	2.148135E-09	1.414794E-10	4.344707E-10	1.365546E-09
	Y-direction	-1.774431E-09	-2.57902E-11	-2.350892E-10	-1.269524E-09
	Z-direction	-1.23701E-10	-2.185044E-11	-6.056101E-11	-2.785297E-09

4 BTF1 tunnel – detailed flow

4.1 BTF1 base case

The waste placed in the BTF is de-watered low-level ion exchange resin in concrete tanks, as well as some drums with ashes (in BTF1). The concrete tanks are placed in two levels, a concrete radiation protection lid is placed on top of the pile. The space between the different tanks is backfilled with concrete backfill and the space between the tanks and the rock wall will also be filled with concrete backfill. Hence, the waste will be placed in a concrete encapsulation. The space above the radiation protection lid is backfilled with sand or left unfilled.

The conductivity of the BTF1 as defined in the base case of the detailed model /Holmén and Stigsson, 2001/ is given below.

Table 4-1. The conductivity and the volumes of the BTF tunnels, as defined in the base case of the detailed model.

BTF	HYDRAULIC CONDUCTIVITY (m/s)□ IN FLOW DIRECTIONS			VOLUME (m^3)
	X-DIR.	Y-DIR.	Z-DIR.	
Top filling	1E-5	1E-5	1E-5	1 148
Waste domain. Encapsulation	6.7E-9	3.8E-9	5.3E-9	8 580
Concrete backfill at sides	8.3E-9	8.3E-9	8.3E-9	1 320
Concrete floor with sand patches	4.2E-8	4.2E-8	1.3E-9	990
Loading areas	1E-5	1E-5	1E-5	4 504

4.1.1 BTF1 net flows at time 2000 AD through 6000 AD

Table 4-2. Net flow in BTF1 tunnel at 2000 AD. Results of detailed model, base case.

TIME 2000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	0.08172	I-1	0.114640	0.091684	-0.061504	0.005521
S1–S3	I+1	0.06150	I+1	0.074076	-0.081721	0.067122	0.002573
	J-1	0.00536	J-1	-0.903620	0.001438	0.001122	0.025510
L= 41 m	J+1	-0.08120	J+1	0.358220	-0.003927	-0.003371	-0.045492
	K-1	0.41058	K-1	0.546360	0.028109	0.029441	0.480018
	K+1	-0.47797	K+1	-0.189676	-0.035583	-0.032810	-0.468130
	I-1	0.04921	I-1	1.481800	0.131073	-0.022769	-0.091429
S4	I+1	0.02277	I+1	0.071811	-0.049214	0.020592	-0.013238
	J-1	-0.13847	J-1	0.662470	-0.000928	0.000526	-0.007328
L= 17 m	J+1	-0.00536	J+1	0.903620	-0.001438	-0.001122	-0.025510
	K-1	0.51389	K-1	0.575530	0.025427	0.031346	0.708165
	K+1	-0.44204	K+1	-3.695231	-0.104920	-0.028573	-0.570660
	I-1	0.02749	I-1	0.061890	0.027931	-0.061078	-0.005898
S5	I+1	0.06108	I+1	1.470400	-0.027488	0.144678	-0.081947
	J-1	-0.27165	J-1	0.992920	-0.000603	-0.001378	-0.017707
L= 17 m	J+1	0.13847	J+1	-0.662470	0.000928	-0.000526	0.007328
	K-1	0.41169	K-1	0.496570	0.022062	0.024964	0.556944
	K+1	-0.36708	K+1	-2.359310	-0.022830	-0.106660	-0.458720
	I-1	0.02734	I-1	0.038876	0.028474	-0.039733	-0.000420
S6	I+1	0.03973	I+1	0.048983	-0.027337	0.042487	0.002256
	J-1	-0.30131	J-1	0.727460	-0.000203	-0.000364	-0.003908
L= 16 m	J+1	0.27165	J+1	-0.992920	0.000603	0.001378	0.017707
	K-1	0.20331	K-1	0.274820	0.014122	0.014670	0.216465
	K+1	-0.24072	K+1	-0.097219	-0.015659	-0.018438	-0.232100
	I-1	0.04747	I-1	0.050832	0.052161	-0.050122	0.002160
S7–S9	I+1	0.05012	I+1	0.043756	-0.047473	0.054792	0.003663
	J-1	-0.36522	J-1	0.509410	-0.002662	-0.002520	-0.036570
L= 40 m	J+1	0.30131	J+1	-0.727460	0.000203	0.000364	0.003908
	K-1	0.33225	K-1	0.418970	0.023745	0.024541	0.407379
	K+1	-0.36594	K+1	-0.295508	-0.025974	-0.027055	-0.380540

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.03456
	I+1	0.02536
	J-1	-0.22423
	J+1	0.06383
	K-1	0.11020
	K+1	-0.00972
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	0.04298
	I+1	0.03021
	J-1	0.01265
	J+1	-0.10244
	K-1	0.27669
	K+1	-0.26009

Table 4-3. Net flow in BTF1 tunnel at 3000 AD. Results of detailed model, base case.

TIME 3000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied				
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
S1–S3 L= 41 m	I-1	0.31913	I-1	0.603470	0.391112	0.207490	0.056684
	I+1	-0.20749	I+1	-0.195770	-0.319130	-0.249929	-0.042473
	J-1	-0.00529	J-1	-3.153600	0.000097	-0.001186	-0.011121
	J+1	-0.00235	J+1	1.347700	-0.008803	0.001688	-0.015249
	K-1	-0.10098	K-1	-0.000797	-0.022098	-0.003048	-0.113971
	K+1	-0.00301	K+1	1.398997	-0.041177	0.044985	0.126130
S4 L= 17 m	I-1	0.18312	I-1	5.056400	0.254213	0.142020	0.126720
	I+1	-0.14202	I+1	-0.213980	-0.183120	-0.165561	-0.020553
	J-1	-0.03543	J-1	-15.497000	-0.002855	-0.003610	-0.024883
	J+1	0.00529	J+1	3.153600	-0.000097	0.001186	0.011121
	K-1	-0.19397	K-1	-0.162800	-0.015272	-0.006701	-0.308345
	K+1	0.18300	K+1	7.663780	-0.052869	0.032666	0.215940
S5 L= 17 m	I-1	0.11721	I-1	0.158300	0.141541	0.227570	0.028189
	I+1	-0.22757	I+1	-6.416300	-0.117210	-0.375800	-0.024744
	J-1	0.12954	J-1	-4.100800	-0.000427	0.000947	0.006355
	J+1	0.03543	J+1	15.497000	0.002855	0.003610	0.024883
	K-1	-0.27841	K-1	-0.373050	-0.019618	-0.012717	-0.345423
	K+1	0.22380	K+1	-4.765150	-0.007141	0.156390	0.310740
S6 L= 16 m	I-1	0.10346	I-1	0.145110	0.128108	0.178600	0.024001
	I+1	-0.17860	I+1	-0.280630	-0.103460	-0.209024	-0.027437
	J-1	0.15679	J-1	-3.641000	-0.000434	-0.000466	-0.003307
	J+1	-0.12954	J+1	4.100800	0.000427	-0.000947	-0.006355
	K-1	-0.17176	K-1	-0.249960	-0.016249	-0.006876	-0.181782
	K+1	0.21964	K+1	-0.074320	-0.008392	0.038713	0.194880
S7–S9 L= 40 m	I-1	0.21687	I-1	0.280950	0.273025	0.426760	0.052726
	I+1	-0.42676	I+1	-0.679340	-0.216870	-0.514492	-0.071191
	J-1	0.24924	J-1	-2.263400	-0.002778	0.012701	0.054286
	J+1	-0.15679	J+1	3.641000	0.000434	0.000466	0.003307
	K-1	-0.39293	K-1	-0.581680	-0.036609	-0.013945	-0.482608
	K+1	0.51037	K+1	-0.397530	-0.017203	0.088510	0.443480

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.23171
	I+1	0.08250
	J-1	-1.32298
	J+1	0.43489
	K-1	0.14949
	K+1	0.42440
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	0.42096
	I+1	-1.16120
	J-1	-0.04346
	J+1	2.26143
	K-1	-0.87684
	K+1	-0.60089

Table 4-4. Net flow in BTF1 tunnel at 4000 AD. Results of detailed model, base case.

TIME 4000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	-0.06502	I-1	0.013621	-0.067462	0.269440	0.006074
S1–S3	I+1	-0.26944	I+1	-0.260480	0.065024	-0.314868	-0.036171
	J-1	-0.01867	J-1	-0.163780	-0.002480	-0.002778	-0.052345
L= 41 m	J+1	0.19284	J+1	0.039361	0.004147	0.007972	0.082798
	K-1	-0.88106	K-1	-1.204600	-0.063120	-0.059125	-1.003655
	K+1	1.04135	K+1	1.575878	0.063892	0.099359	1.003300
	I-1	-0.02905	I-1	0.207710	-0.176328	0.149010	0.220620
S4	I+1	-0.14901	I+1	-0.283210	0.029050	-0.164304	0.008102
	J-1	0.26996	J-1	-16.076000	-0.001276	-0.003186	-0.006880
L= 17 m	J+1	0.01867	J+1	0.163780	0.002480	0.002778	0.052345
	K-1	-1.08367	K-1	-1.253000	-0.055616	-0.062511	-1.475986
	K+1	0.97310	K+1	17.240721	0.201690	0.078213	1.201800
	I-1	-0.06346	I-1	-0.133130	-0.066826	0.237700	0.013636
S5	I+1	-0.23770	I+1	-5.654800	0.063455	-0.483756	0.142810
	J-1	0.63163	J-1	-14.140000	-0.000961	0.000714	0.016505
L= 17 m	J+1	-0.26996	J+1	16.076000	0.001276	0.003186	0.006880
	K-1	-0.95516	K-1	-1.246900	-0.051682	-0.055363	-1.242031
	K+1	0.89464	K+1	5.098830	0.054738	0.297520	1.062200
	I-1	-0.08999	I-1	-0.138180	-0.097310	0.218530	0.000748
S6	I+1	-0.21853	I+1	-0.324490	0.089994	-0.248633	-0.023577
	J-1	0.74341	J-1	-12.803000	-0.001566	-0.001311	-0.010220
L= 16 m	J+1	-0.63163	J+1	14.140000	0.000961	-0.000714	-0.016505
	K-1	-0.61495	K-1	-0.931700	-0.040905	-0.039053	-0.645356
	K+1	0.81169	K+1	0.057370	0.048826	0.071181	0.694910
	I-1	-0.26817	I-1	-0.419910	-0.311730	0.515360	-0.017490
S7–S9	I+1	-0.51536	I+1	-0.787280	0.268170	-0.609803	-0.067283
	J-1	1.08453	J-1	-9.254600	0.014236	0.019802	0.184270
L= 40 m	J+1	-0.74341	J+1	12.803000	0.001566	0.001311	0.010220
	K-1	-1.35591	K-1	-2.069500	-0.087342	-0.082750	-1.635717
	K+1	1.79832	K+1	-0.271711	0.115100	0.156080	1.526000

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.01368
	I+1	-0.02726
	J-1	-0.32712
	J+1	0.04638
	K-1	-0.20873
	K+1	0.50305
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	-1.10436
	I+1	-1.65043
	J-1	-0.84601
	J+1	7.95176
	K-1	-3.16612
	K+1	-1.18483

Table 4-5. Net flow in BTF1 tunnel at 5000 AD. Results of detailed model, base case.

TIME 5000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**		**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	-0.13869	I-1	-0.101700	-0.155092	0.280370	-0.003446
S1–S3	I+1	-0.28037	I+1	-0.274050	0.138690	-0.325915	-0.034545
	J-1	-0.01455	J-1	0.478740	-0.003013	-0.003101	-0.060835
L= 41 m	J+1	0.22374	J+1	-0.237100	0.006702	0.009232	0.102400
	K-1	-1.03592	K-1	-1.439700	-0.071459	-0.070326	-1.181274
	K+1	1.24579	K+1	1.573810	0.084171	0.109740	1.177700
	I-1	-0.07018	I-1	-0.802270	-0.260036	0.149130	0.240900
S4	I+1	-0.14913	I+1	-0.296080	0.070181	-0.162432	0.014198
	J-1	0.33695	J-1	-15.746000	-0.000856	-0.003094	-0.002814
L= 17 m	J+1	0.01455	J+1	-0.478740	0.003013	0.003101	0.060835
	K-1	-1.26409	K-1	-1.470600	-0.063842	-0.073866	-1.714919
	K+1	1.13190	K+1	18.793690	0.251540	0.087161	1.401800
	I-1	-0.09544	I-1	-0.186200	-0.103472	0.240970	0.011523
S5	I+1	-0.24097	I+1	-5.573100	0.095440	-0.507110	0.176520
	J-1	0.73817	J-1	-15.422000	-0.000931	0.000844	0.020070
L= 17 m	J+1	-0.33695	J+1	15.746000	0.000856	0.003094	0.002814
	K-1	-1.09195	K-1	-1.419700	-0.058267	-0.063979	-1.425127
	K+1	1.02715	K+1	6.855000	0.066374	0.326180	1.214200
	I-1	-0.12319	I-1	-0.186680	-0.135817	0.224380	-0.003111
S6	I+1	-0.22438	I+1	-0.329400	0.123190	-0.254033	-0.022640
	J-1	0.86457	J-1	-13.937000	-0.001664	-0.001343	-0.010383
L= 16 m	J+1	-0.73817	J+1	15.422000	0.000931	-0.000844	-0.020070
	K-1	-0.69620	K-1	-1.053200	-0.045552	-0.045080	-0.730626
	K+1	0.91737	K+1	0.084280	0.058912	0.076920	0.786830
	I-1	-0.34645	I-1	-0.529320	-0.405876	0.520180	-0.028914
S7–S9	I+1	-0.52018	I+1	-0.784760	0.346450	-0.613351	-0.065034
	J-1	1.24424	J-1	-10.114000	0.016931	0.020625	0.204340
L= 40 m	J+1	-0.86457	J+1	13.937000	0.001664	0.001343	0.010383
	K-1	-1.51451	K-1	-2.304100	-0.095929	-0.094657	-1.825875
	K+1	2.00148	K+1	-0.204820	0.136760	0.165860	1.705100

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	-0.03449
	I+1	-0.05006
	J-1	-0.10497
	J+1	-0.05126
	K-1	-0.28071
	K+1	0.52149
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	-1.30474
	I+1	-1.68837
	J-1	-0.94416
	J+1	8.62787
	K-1	-3.50189
	K+1	-1.18872

Table 4-6. Net flow in BTF1 tunnel at 6000 AD. Results of detailed model, base case.

TIME 6000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	-0.15759	I-1	-0.132110	-0.177713	0.280510	-0.006069
S1–S3	I+1	-0.28051	I+1	-0.274680	0.157590	-0.325660	-0.033771
	J-1	-0.01497	J-1	0.636700	-0.003131	-0.003163	-0.062598
L= 41 m	J+1	0.23137	J+1	-0.303800	0.007311	0.009456	0.106410
	K-1	-1.06670	K-1	-1.488700	-0.072922	-0.072583	-1.216172
	K+1	1.28840	K+1	1.562590	0.088865	0.111440	1.212200
	I-1	-0.08095	I-1	-1.065000	-0.280793	0.147890	0.243930
S4	I+1	-0.14789	I+1	-0.296940	0.080951	-0.160568	0.015690
	J-1	0.35059	J-1	-15.578000	-0.000748	-0.003042	-0.001740
L= 17 m	J+1	0.01497	J+1	-0.636700	0.003131	0.003163	0.062598
	K-1	-1.30101	K-1	-1.516000	-0.065461	-0.076233	-1.763178
	K+1	1.16429	K+1	19.092640	0.262920	0.088789	1.442700
	I-1	-0.10389	I-1	-0.199780	-0.113250	0.239390	0.010717
S5	I+1	-0.23939	I+1	-5.488300	0.103890	-0.508398	0.183990
	J-1	0.75874	J-1	-15.734000	-0.000934	0.000847	0.020640
L= 17 m	J+1	-0.35059	J+1	15.578000	0.000748	0.003042	0.001740
	K-1	-1.11862	K-1	-1.453600	-0.059478	-0.065701	-1.460887
	K+1	1.05376	K+1	7.297680	0.069024	0.330820	1.243800
	I-1	-0.13195	I-1	-0.199580	-0.146081	0.224140	-0.004264
S6	I+1	-0.22414	I+1	-0.328310	0.131950	-0.253447	-0.022188
	J-1	0.88824	J-1	-14.218000	-0.001693	-0.001357	-0.010490
L= 16 m	J+1	-0.75874	J+1	15.734000	0.000934	-0.000847	-0.020640
	K-1	-0.71257	K-1	-1.078300	-0.046405	-0.046331	-0.747728
	K+1	0.93916	K+1	0.090190	0.061295	0.077842	0.805310
	I-1	-0.36759	I-1	-0.559640	-0.431459	0.518160	-0.032207
S7–S9	I+1	-0.51816	I+1	-0.780220	0.367590	-0.610426	-0.063957
	J-1	1.27614	J-1	-10.327000	0.017610	0.020717	0.208530
L= 40 m	J+1	-0.88824	J+1	14.218000	0.001693	0.001357	0.010490
	K-1	-1.54706	K-1	-2.354300	-0.097474	-0.097168	-1.864556
	K+1	2.04490	K+1	-0.196841	0.142040	0.167360	1.741700

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	-0.04553
	I+1	-0.05513
	J-1	-0.05074
	J+1	-0.07136
	K-1	-0.29603
	K+1	0.51879
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	-1.36101
	I+1	-1.69376
	J-1	-0.97103
	J+1	8.80400
	K-1	-3.57756
	K+1	-1.20064

4.1.2 BTF1 average specific flow in surroundings at 2000 AD – 6000 AD

Table 4-7. Specific flow outside of BTF1 tunnel at 2000 AD. Results of detailed model, base case.

TIME 2000 AD BASE CASE	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	1.06131E-11	2.87242E-11	2.77033E-11	2.69910E-11
	X-direction	9.18221E-13	1.21529E-11	-8.25488E-12	7.46257E-13
	Y-direction	-3.93869E-13	3.46871E-12	3.03047E-12	8.99939E-12
	Z-direction	1.03516E-11	2.55038E-11	2.61304E-11	2.50954E-11
S4 L= 17 m	**R**esultant	5.44183E-10	3.62173E-09	5.05192E-11	2.91709E-10
	X-direction	2.37907E-11	9.15658E-12	-4.32696E-12	-2.11201E-10
	Y-direction	4.22668E-12	1.11470E-12	4.35135E-12	-1.47685E-11
	Z-direction	5.42514E-10	3.62101E-09	4.96432E-11	1.48008E-10
S5 L= 17 m	**R**esultant	3.50982E-10	4.03104E-11	3.67813E-09	2.28623E-10
	X-direction	-2.04116E-11	7.54913E-12	-3.10960E-11	1.51090E-10
	Y-direction	4.75498E-12	-4.00769E-12	-1.78157E-12	-3.23294E-11
	Z-direction	3.49542E-10	3.90853E-11	3.67739E-09	1.23156E-10
S6 L= 17 m	**R**esultant	1.31531E-11	2.98433E-11	3.58915E-11	2.87399E-11
	X-direction	-1.34952E-13	8.31055E-12	-1.34267E-11	-2.59706E-12
	Y-direction	3.77710E-13	-2.07189E-12	-4.59669E-12	-8.69976E-12
	Z-direction	1.30767E-11	2.84916E-11	3.29141E-11	2.70505E-11
S7–S9 L= 40 m	**R**esultant	1.63868E-11	2.28103E-11	2.46465E-11	2.28601E-11
	X-direction	2.63818E-13	6.60513E-12	-6.89081E-12	-6.12263E-13
	Y-direction	2.17088E-13	-1.94393E-12	-2.47933E-12	-4.60596E-12
	Z-direction	1.63688E-11	2.16008E-11	2.34431E-11	2.20505E-11

Table 4-8. Specific flow outside of BTF1 tunnel at 3000 AD. Results of detailed model, base case.

TIME 3000 AD BASE CASE	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	7.97558E-11	6.21533E-11	4.81366E-11	3.11666E-11
	X-direction	1.51854E-11	6.17824E-11	4.04163E-11	2.79815E-11
	Y-direction	-4.14870E-12	-1.66378E-12	-9.70147E-12	-6.63467E-12
	Z-direction	-7.56107E-11	-4.23210E-12	-2.22710E-11	-6.25177E-12
S4 L= 17 m	**R**esultant	1.09896E-09	1.19691E-09	7.02939E-11	6.46540E-10
	X-direction	1.83065E-10	4.65074E-10	6.17601E-11	4.78379E-10
	Y-direction	-1.11378E-10	-6.93878E-12	-1.15459E-11	-2.38885E-10
	Z-direction	-1.03401E-09	-1.07616E-09	-3.14682E-11	-7.55111E-11
S5 L= 17 m	**R**esultant	6.95441E-10	5.89554E-11	2.83689E-09	3.27660E-10
	X-direction	1.74552E-10	5.61763E-11	4.08190E-10	1.22822E-10
	Y-direction	-1.11315E-10	-7.43665E-12	-7.27513E-12	-2.31728E-10
	Z-direction	6.13073E-10	-1.52845E-11	-2.80708E-09	-7.08490E-11
S6 L= 17 m	**R**esultant	3.67087E-11	5.34709E-11	8.52462E-11	4.40047E-11
	X-direction	1.94771E-11	5.18489E-11	7.71933E-11	3.66028E-11
	Y-direction	-2.64778E-12	-2.37830E-12	-2.81167E-13	1.45517E-12
	Z-direction	1.18189E-11	-1.14662E-11	-3.60601E-11	-2.26628E-11
S7–S9 L= 40 m	**R**esultant	3.92378E-11	4.93813E-11	8.89168E-11	4.55469E-11
	X-direction	1.85991E-11	4.78219E-11	8.10563E-11	3.55743E-11
	Y-direction	-1.92080E-12	-3.32493E-12	3.38108E-12	2.36409E-12
	Z-direction	2.47844E-11	-1.01129E-11	-3.51446E-11	-2.59496E-11

Table 4-9. Specific flow outside of BTF1 tunnel at 4000 AD. Results of detailed model, base case.

TIME 4000 AD BASE CASE	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	8.87959E-11	5.70570E-11	8.43108E-11	5.82034E-11
	X-direction	4.94975E-12	-7.89125E-12	4.68480E-11	1.25657E-11
	Y-direction	-2.01577E-12	-8.70636E-12	-1.22836E-11	-2.17985E-11
	Z-direction	-8.82664E-11	-5.56276E-11	-6.86497E-11	-5.20346E-11
S4 L= 17 m	**R**esultant	2.47021E-09	7.98120E-09	1.31648E-10	7.81188E-10
	X-direction	7.54233E-11	4.25395E-12	5.59434E-11	6.17224E-10
	Y-direction	-1.09254E-10	-9.67812E-12	-1.46844E-11	-1.32134E-10
	Z-direction	-2.45764E-09	-7.98005E-09	-1.17089E-10	-3.05484E-10
S5 L= 17 m	**R**esultant	8.08161E-10	9.64668E-11	8.91237E-09	4.64021E-10
	X-direction	1.12871E-10	-1.95993E-11	3.32179E-10	-2.15957E-10
	Y-direction	-1.13313E-10	-6.18029E-12	-7.42576E-12	-1.03502E-10
	Z-direction	-7.78738E-10	-9.36069E-11	-8.90458E-09	-2.72239E-10
S6 L= 17 m	**R**esultant	2.62673E-11	8.94395E-11	1.33778E-10	8.24274E-11
	X-direction	8.70570E-12	-3.08325E-11	8.73364E-11	1.90136E-11
	Y-direction	-8.07428E-12	-6.99661E-12	-2.96643E-12	4.07574E-12
	Z-direction	-9.26319E-12	-8.32882E-11	-1.00856E-10	-7.98203E-11
S7–S9 L= 40 m	**R**esultant	2.62434E-11	9.34407E-11	1.32604E-10	9.14800E-11
	X-direction	7.74495E-12	-4.43289E-11	9.13960E-11	1.53946E-11
	Y-direction	-6.55643E-12	-4.80956E-13	2.87572E-12	8.80750E-12
	Z-direction	1.43405E-11	-8.03269E-11	-9.40625E-11	-8.72091E-11

Table 4-10. Specific flow outside of BTF1 tunnel at 5000 AD. Results of detailed model, base case.

TIME 5000 AD BASE CASE	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	8.93849E-11	6.99202E-11	9.22977E-11	6.72015E-11
	X-direction	2.96023E-12	-2.10863E-11	4.77601E-11	9.53066E-12
	Y-direction	-1.53603E-12	-1.00417E-11	-1.27108E-11	-2.47994E-11
	Z-direction	-8.90813E-11	-6.56921E-11	-7.76298E-11	-6.11980E-11
S4 L= 17 m	**R**esultant	2.70099E-09	9.34889E-09	1.46735E-10	8.22131E-10
	X-direction	5.20512E-11	-7.58974E-11	5.40961E-11	6.48379E-10
	Y-direction	-1.06068E-10	-9.96712E-12	-1.53375E-11	-1.09302E-10
	Z-direction	-2.69138E-09	-9.34709E-09	-1.34164E-10	-3.53008E-10
S5 L= 17 m	**R**esultant	1.04705E-09	1.14551E-10	1.01323E-08	5.20682E-10
	X-direction	1.02499E-10	-3.27526E-11	3.15571E-10	-2.84290E-10
	Y-direction	-1.10744E-10	-5.24290E-12	-6.98555E-12	-7.56986E-11
	Z-direction	-1.02754E-09	-1.08814E-10	-1.01257E-08	-3.13273E-10
S6 L= 17 m	**R**esultant	2.82867E-11	1.06919E-10	1.43775E-10	9.22436E-11
	X-direction	6.69312E-12	-4.48487E-11	8.84404E-11	1.59316E-11
	Y-direction	-8.72833E-12	-7.20982E-12	-2.64075E-12	5.60310E-12
	Z-direction	-1.39242E-11	-9.63228E-11	-1.12866E-10	-9.03623E-11
S7–S9 L= 40 m	**R**esultant	2.51068E-11	1.11337E-10	1.39754E-10	1.01311E-10
	X-direction	5.62994E-12	-5.91377E-11	9.11214E-11	1.16574E-11
	Y-direction	-7.07485E-12	3.33858E-13	3.14346E-12	1.02839E-11
	Z-direction	9.58708E-12	-9.21630E-11	-1.03924E-10	-9.73426E-11

Table 4-11. Specific flow outside of BTF1 tunnel at 6000 AD. Results of detailed model, base case.

TIME 6000 AD BASE CASE	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
S1–S3 L= 41 m	**R**esultant	8.89168E-11	7.30117E-11	9.35593E-11	6.89646E-11
	X-direction	2.38411E-12	-2.45378E-11	4.75504E-11	8.59285E-12
	Y-direction	-1.40185E-12	-1.03359E-11	-1.27321E-11	-2.54006E-11
	Z-direction	-8.86585E-11	-6.77412E-11	-7.92490E-11	-6.29903E-11
S4 L= 17 m	**R**esultant	2.74617E-09	9.63589E-09	1.49554E-10	8.25864E-10
	X-direction	4.54202E-11	-9.87464E-11	5.31622E-11	6.50160E-10
	Y-direction	-1.04648E-10	-1.00026E-11	-1.53806E-11	-1.02189E-10
	Z-direction	-2.73724E-09	-9.63381E-09	-1.37529E-10	-3.62440E-10
S5 L= 17 m	**R**esultant	1.10730E-09	1.18660E-10	1.03672E-08	5.32451E-10
	X-direction	9.84294E-11	-3.63324E-11	3.08280E-10	-3.00158E-10
	Y-direction	-1.09482E-10	-5.03972E-12	-6.86880E-12	-6.76183E-11
	Z-direction	-1.08966E-09	-1.11978E-10	-1.03609E-08	-3.21344E-10
S6 L= 17 m	**R**esultant	2.86420E-11	1.11082E-10	1.45330E-10	9.41648E-11
	X-direction	6.05245E-12	-4.86489E-11	8.80365E-11	1.48594E-11
	Y-direction	-8.89377E-12	-7.30553E-12	-2.64658E-12	5.83249E-12
	Z-direction	-1.48052E-11	-9.91076E-11	-1.15138E-10	-9.24689E-11
S7–S9 L= 40 m	**R**esultant	2.50698E-11	1.15765E-10	1.40747E-10	1.03296E-10
	X-direction	4.96952E-12	-6.32150E-11	9.04778E-11	1.04425E-11
	Y-direction	-7.20945E-12	5.15927E-13	3.13787E-12	1.05602E-11
	Z-direction	8.88536E-12	-9.47443E-11	-1.05775E-10	-9.93955E-11

5 BTF2 tunnel – detailed flow

5.1 BTF2 base case

The waste placed in the BTF is de-watered low-level ion exchange resin in concrete tanks, as well as some drums with ashes (in BTF1). The concrete tanks are placed in two levels, a concrete radiation protection lid is placed on top of the pile. The space between the different tanks is backfilled with concrete backfill and the space between the tanks and the rock wall will also be filled with concrete backfill. Hence, the waste will be placed in a concrete encapsulation. The space above the radiation protection lid is back-filled with sand or left unfilled.

The conductivity of the BTF2 as defined in the base case of the detailed model /Holmén and Stigsson, 2001/ is given below.

Table 5-1. The conductivity and the volumes of the BTF tunnels, as defined in the base case of the detailed model.

BTF	HYDRAULIC CONDUCTIVITY (m/s)□ IN FLOW DIRECTIONS			VOLUME (m^3)
	X-DIR.	Y-DIR.	Z-DIR.	
Top filling	1E-5	1E-5	1E-5	1 148
Waste domain. Encapsulation	6.7E-9	3.8E-9	5.3E-9	8 580
Concrete backfill at sides	8.3E-9	8.3E-9	8.3E-9	1 320
Concrete floor with sand patches	4.2E-8	4.2E-8	1.3E-9	990
Loading areas	1E-5	1E-5	1E-5	4 504

5.1.1 BTF2 net flows at time 2000 AD through 6000 AD

Table 5-2. Net flow in BTF2 tunnel at 2000 AD. Results of detailed model, base case.

TIME 2000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	0.10248	I-1	0.119050	0.112734	-0.088828	0.007757
S1–S4	I+1	0.08883	I+1	0.110000	-0.102480	0.097839	0.004593
	J-1	0.07433	J-1	-1.005300	0.001498	0.000323	0.008503
L= 58 m	J+1	-0.17863	J+1	0.347680	-0.003312	-0.003392	-0.043082
	K-1	0.55274	K-1	0.732500	0.039483	0.038885	0.653339
	K+1	-0.63975	K+1	-0.303930	-0.047923	-0.044827	-0.631110
	I-1	0.11733	I-1	0.304800	0.176450	-0.032144	-0.011900
S5	I+1	0.03214	I+1	0.054740	-0.117330	0.033147	-0.001871
	J-1	-0.01608	J-1	-1.754600	-0.000126	0.001400	0.024432
L= 17 m	J+1	-0.07433	J+1	1.005300	-0.001498	-0.000323	-0.008503
	K-1	0.25947	K-1	0.412500	0.016787	0.017607	0.291702
	K+1	-0.31853	K+1	-0.022740	-0.074282	-0.019687	-0.293860
	I-1	0.01060	I-1	-0.398270	0.051952	-0.053199	-0.023491
S6	I+1	0.05320	I+1	1.709000	-0.010602	0.142149	-0.096893
	J-1	-0.24170	J-1	1.226100	-0.001496	-0.001501	-0.031391
L= 17 m	J+1	0.01608	J+1	1.754600	0.000126	-0.001400	-0.024432
	K-1	0.59302	K-1	0.640510	0.056509	0.026771	0.852507
	K+1	-0.43120	K+1	-4.931940	-0.096489	-0.112820	-0.676300
	I-1	0.03144	I-1	0.043625	0.032214	-0.040578	-0.000383
S7	I+1	0.04058	I+1	0.059264	-0.031444	0.043713	0.001434
	J-1	-0.27014	J-1	0.898990	-0.000430	-0.000500	-0.006619
L= 16 m	J+1	0.24170	J+1	-1.226100	0.001496	0.001501	0.031391
	K-1	0.21273	K-1	0.292240	0.015495	0.014467	0.216867
	K+1	-0.25631	K+1	-0.068019	-0.017331	-0.018603	-0.242690
	I-1	0.03189	I-1	0.032087	0.036187	-0.037810	0.002667
S8–S9	I+1	0.03781	I+1	0.041977	-0.031889	0.043463	0.003752
	J-1	-0.31540	J-1	0.706820	-0.002975	-0.003234	-0.041712
L= 24 m	J+1	0.27014	J+1	-0.898990	0.000430	0.000500	0.006619
	K-1	0.20388	K-1	0.261970	0.014618	0.014359	0.261533
	K+1	-0.22832	K+1	-0.143864	-0.016371	-0.017278	-0.232860

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.01527
	I+1	0.01658
	J-1	-0.11926
	J+1	0.04064
	K-1	0.06188
	K+1	-0.01510
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	0.05283
	I+1	0.08286
	J-1	0.02480
	J+1	-0.34349
	K-1	0.41200
	K+1	-0.22899

Table 5-3. Net flow in BTF2 tunnel at 3000 AD. Results of detailed model, base case.

TIME 3000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	0.68649	I-1	1.236000	0.827854	0.362730	0.114730
S1–S4	I+1	-0.36273	I+1	-0.343860	-0.686490	-0.441759	-0.082676
	J-1	0.00225	J-1	-6.968700	0.003427	-0.000797	0.003458
L= 58 m	J+1	-0.08504	J+1	3.274700	-0.018003	-0.001897	-0.074552
	K-1	0.20428	K-1	0.500450	-0.012488	0.022629	0.253460
	K+1	-0.44524	K+1	2.301410	-0.114300	0.059094	-0.214420
	I-1	0.44611	I-1	1.904300	0.455322	0.165110	0.145200
S5	I+1	-0.16511	I+1	-0.216900	-0.446110	-0.195164	-0.032627
	J-1	0.01738	J-1	-9.371900	-0.007277	-0.002986	-0.040716
L= 17 m	J+1	-0.00225	J+1	6.968700	-0.003427	0.000797	-0.003458
	K-1	0.02010	K-1	0.281510	-0.007174	0.006191	-0.049279
	K+1	-0.31623	K+1	0.434290	0.008667	0.026052	-0.019120
	I-1	0.11132	I-1	1.677900	0.158493	0.217820	0.033896
S6	I+1	-0.21782	I+1	-6.033400	-0.111320	-0.349217	-0.053451
	J-1	0.14353	J-1	-1.410700	0.000199	-0.000182	0.003401
L= 17 m	J+1	-0.01738	J+1	9.371900	0.007277	0.002986	0.040716
	K-1	-0.21550	K-1	-0.302250	-0.026931	-0.005528	-0.272522
	K+1	0.19585	K+1	-3.303450	-0.027718	0.134120	0.247960
	I-1	0.10992	I-1	0.150680	0.134863	0.216790	0.025288
S7	I+1	-0.21679	I+1	-0.345460	-0.109920	-0.258158	-0.035258
	J-1	0.17544	J-1	-0.794110	-0.000162	0.000323	0.000063
L= 16 m	J+1	-0.14353	J+1	1.410700	-0.000199	0.000182	-0.003401
	K-1	-0.14187	K-1	-0.249090	-0.013764	-0.002212	-0.144542
	K+1	0.21683	K+1	-0.172720	-0.010818	0.043075	0.157850
	I-1	0.15102	I-1	0.212000	0.189488	0.278710	0.034678
S8–S9	I+1	-0.27871	I+1	-0.437490	-0.151020	-0.341930	-0.049750
	J-1	0.23246	J-1	-0.039192	-0.004368	0.013492	0.049130
L= 24 m	J+1	-0.17544	J+1	0.794110	0.000162	-0.000323	-0.000063
	K-1	-0.19535	K-1	-0.305280	-0.019170	-0.004304	-0.252815
	K+1	0.26602	K+1	-0.224148	-0.015092	0.054354	0.218820

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.47075
	I+1	0.23590
	J-1	-3.09520
	J+1	1.21195
	K-1	0.46116
	K+1	0.71545
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	0.91866
	I+1	-0.95804
	J-1	0.56935
	J+1	-0.25152
	K-1	-0.54229
	K+1	0.26383

Table 5-4. Net flow in BTF2 tunnel at 4000 AD. Results of detailed model, base case.

TIME 4000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	0.50437	I-1	1.042300	0.622282	0.595720	0.099793
S1–S4	I+1	-0.59572	I+1	-0.639830	-0.504370	-0.710589	-0.105150
	J-1	0.00000	J-1	-4.368200	0.002170	-0.001267	-0.008035
L= 58 m	J+1	0.12311	J+1	1.866200	-0.010603	0.006203	0.011121
	K-1	-0.77817	K-1	-0.870820	-0.081597	-0.042367	-0.899859
	K+1	0.74640	K+1	2.970350	-0.027882	0.152300	0.902130
	I-1	0.33514	I-1	1.870800	0.226629	0.246150	0.194760
S5	I+1	-0.24615	I+1	-0.335460	-0.335140	-0.282938	-0.034687
	J-1	0.19291	J-1	-6.201000	-0.008686	-0.005466	-0.090569
L= 17 m	J+1	0.00000	J+1	4.368200	-0.002170	0.001267	0.008035
	K-1	-0.43548	K-1	-0.377200	-0.039363	-0.023907	-0.576289
	K+1	0.15358	K+1	0.674660	0.158730	0.064893	0.498750
	I-1	0.09534	I-1	3.366100	0.058193	0.317650	0.075239
S6	I+1	-0.31765	I+1	-8.536200	-0.095340	-0.618613	0.123520
	J-1	0.74346	J-1	-11.304000	0.001271	0.001051	0.046323
L= 17 m	J+1	-0.19291	J+1	6.201000	0.008686	0.005466	0.090569
	K-1	-1.30620	K-1	-1.484500	-0.128810	-0.056094	-1.826751
	K+1	0.97796	K+1	11.757599	0.156000	0.350540	1.491100
	I-1	0.03015	I-1	0.038347	0.050056	0.316200	0.023610
S7	I+1	-0.31620	I+1	-0.492630	-0.030147	-0.367296	-0.040481
	J-1	0.84398	J-1	-9.889400	-0.000745	-0.000221	-0.000712
L= 16 m	J+1	-0.74346	J+1	11.304000	-0.001271	-0.001051	-0.046323
	K-1	-0.60316	K-1	-0.902630	-0.046533	-0.032931	-0.618714
	K+1	0.78869	K+1	-0.057687	0.028640	0.085299	0.682620
	I-1	0.03187	I-1	0.045694	0.049302	0.423330	0.022120
S8–S9	I+1	-0.42333	I+1	-0.650810	-0.031874	-0.513637	-0.066880
	J-1	1.04346	J-1	-7.960800	0.005168	0.024390	0.172440
L= 24 m	J+1	-0.84398	J+1	9.889400	0.000745	0.000221	0.000712
	K-1	-0.75029	K-1	-1.081800	-0.056579	-0.040604	-0.975862
	K+1	0.94226	K+1	-0.241683	0.033238	0.106300	0.847470

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.35288
	I+1	0.08541
	J-1	-1.99604
	J+1	0.74712
	K-1	0.13415
	K+1	0.67648
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	-0.15048
	I+1	-1.98053
	J-1	-0.68168
	J+1	6.71534
	K-1	-2.99250
	K+1	-0.91014

Table 5-5. Net flow in BTF2 tunnel at 5000 AD. Results of detailed model, base case.

TIME 5000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**		**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	0.44893	I-1	0.968350	0.558658	0.632420	0.093892
S1–S4	I+1	-0.63242	I+1	-0.690960	-0.448930	-0.751953	-0.107160
	J-1	0.00860	J-1	-3.656600	0.001724	-0.001350	-0.010759
L= 58 m	J+1	0.15854	J+1	1.519700	-0.008682	0.007864	0.030427
	K-1	-0.98798	K-1	-1.166900	-0.095693	-0.056630	-1.146700
	K+1	1.00433	K+1	3.026410	-0.007078	0.169650	1.140300
	I-1	0.29374	I-1	1.777900	0.161519	0.257980	0.199490
S5	I+1	-0.25798	I+1	-0.354790	-0.293740	-0.295201	-0.034024
	J-1	0.23691	J-1	-5.246800	-0.008676	-0.005919	-0.099536
L= 17 m	J+1	-0.00860	J+1	3.656600	-0.001724	0.001350	0.010759
	K-1	-0.53165	K-1	-0.528110	-0.045709	-0.030411	-0.684459
	K+1	0.26758	K+1	0.695200	0.188330	0.072200	0.607770
	I-1	0.08913	I-1	3.593300	0.034061	0.334280	0.083147
S6	I+1	-0.33428	I+1	-9.007600	-0.089125	-0.667350	0.160970
	J-1	0.87210	J-1	-12.484000	0.001648	0.001460	0.056505
L= 17 m	J+1	-0.23691	J+1	5.246800	0.008676	0.005919	0.099536
	K-1	-1.52682	K-1	-1.722900	-0.149400	-0.066279	-2.142658
	K+1	1.13679	K+1	14.374400	0.194140	0.391970	1.742500
	I-1	0.01290	I-1	0.014305	0.031456	0.330680	0.022874
S7	I+1	-0.33068	I+1	-0.513450	-0.012902	-0.382740	-0.040710
	J-1	0.98500	J-1	-10.930000	-0.000714	-0.000170	0.000528
L= 16 m	J+1	-0.87210	J+1	12.484000	-0.001648	-0.001460	-0.056505
	K-1	-0.68963	K-1	-1.023500	-0.052634	-0.038854	-0.707307
	K+1	0.89451	K+1	-0.031355	0.036442	0.092544	0.781120
	I-1	0.00942	I-1	0.017719	0.022791	0.439570	0.019395
S8–S9	I+1	-0.43957	I+1	-0.669980	-0.009416	-0.532427	-0.068341
	J-1	1.20723	J-1	-8.870900	0.006869	0.025840	0.192520
L= 24 m	J+1	-0.98500	J+1	10.930000	0.000714	0.000170	-0.000528
	K-1	-0.84421	K-1	-1.208100	-0.062927	-0.047153	-1.097336
	K+1	1.05213	K+1	-0.198739	0.041969	0.114000	0.954290

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.31990
	I+1	0.04809
	J-1	-1.70784
	J+1	0.62850
	K-1	0.05019
	K+1	0.66118
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	-0.26554
	I+1	-2.07977
	J-1	-0.81891
	J+1	7.43844
	K-1	-3.34668
	K+1	-0.92753

Table 5-6. Net flow in BTF2 tunnel at 6000 AD. Results of detailed model, base case.

TIME 6000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**		**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	0.43328	I-1	0.945690	0.540369	0.636400	0.091846
S1–S4	I+1	-0.63640	I+1	-0.697950	-0.433280	-0.756218	-0.106860
	J-1	0.00000	J-1	-3.473900	0.001616	-0.001365	-0.011361
L= 58 m	J+1	0.17582	J+1	1.428800	-0.008193	0.008170	0.034394
	K-1	-1.02803	K-1	-1.225400	-0.098207	-0.059367	-1.193619
	K+1	1.05532	K+1	3.022760	-0.002304	0.172380	1.185600
	I-1	0.28290	I-1	1.750100	0.145644	0.259120	0.199520
S5	I+1	-0.25912	I+1	-0.357110	-0.282900	-0.296213	-0.033648
	J-1	0.23551	J-1	-5.005300	-0.008632	-0.005991	-0.101060
L= 17 m	J+1	0.00000	J+1	3.473900	-0.001616	0.001365	0.011361
	K-1	-0.55079	K-1	-0.559410	-0.046966	-0.031720	-0.705653
	K+1	0.29150	K+1	0.697820	0.194470	0.073440	0.629480
	I-1	0.08706	I-1	3.633100	0.028008	0.336080	0.084452
S6	I+1	-0.33608	I+1	-9.061400	-0.087063	-0.674603	0.168750
	J-1	0.88673	J-1	-12.745000	0.001713	0.001539	0.058455
L= 17 m	J+1	-0.23551	J+1	5.005300	0.008632	0.005991	0.101060
	K-1	-1.56906	K-1	-1.768100	-0.153290	-0.068247	-2.203317
	K+1	1.16686	K+1	14.936100	0.202000	0.399240	1.790600
	I-1	0.00845	I-1	0.008078	0.026504	0.332040	0.022501
S7	I+1	-0.33204	I+1	-0.515380	-0.008445	-0.384006	-0.040491
	J-1	1.00188	J-1	-11.166000	-0.000713	-0.000165	0.000740
L= 16 m	J+1	-0.88673	J+1	12.745000	-0.001713	-0.001539	-0.058455
	K-1	-0.70586	K-1	-1.046100	-0.053750	-0.040004	-0.723905
	K+1	0.91431	K+1	-0.025597	0.038117	0.093674	0.799610
	I-1	0.00331	I-1	0.009622	0.015476	0.440860	0.018502
S8–S9	I+1	-0.44086	I+1	-0.671180	-0.003311	-0.533790	-0.068253
	J-1	1.22834	J-1	-9.080600	0.007262	0.026029	0.196190
L= 24 m	J+1	-1.00188	J+1	11.166000	0.000713	0.000165	-0.000740
	K-1	-0.86157	K-1	-1.231700	-0.064042	-0.048404	-1.119719
	K+1	1.07266	K+1	-0.192143	0.043903	0.115140	0.974020

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.31207
	I+1	0.03908
	J-1	-1.63899
	J+1	0.59907
	K-1	0.03075
	K+1	0.65803
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	-0.29879
	I+1	-2.09998
	J-1	-0.85696
	J+1	7.62278
	K-1	-3.42354
	K+1	-0.94351

6 BLA tunnel – detailed flow

6.1 BLA base case

The waste deposited in BLA is mainly low level waste placed in standard steel containers. In the BLA, the waste containers will not be encapsulated in concrete. As the tunnels will be refilled with sand, the containers will be surrounded by sand.

Note that in the detailed model of the BLA tunnel, the conductivity and the porosity is the same everywhere inside the tunnel, except for the tunnel floor. The waste packages will be placed in the storage area and the whole of the tunnel will be refilled with sand. The model will predict the flow through the storage area (storage domain), and not the flow through the waste packages.

The conductivity of the BLA as defined in the base case of the detailed model /Holmén and Stigsson, 2001/ is given in the table below.

Table 6-1. The conductivity and the volumes of the BLA tunnel, as defined in the base case of the detailed model.

BLA	HYDRAULIC CONDUCTIVITY (m/s)▫ IN FLOW DIRECTIONS			VOLUME (m^3)
	X-DIR.	Y-DIR.	Z-DIR.	
Top filling	1E-5	1E-5	1E-5	X
Storage area with waste packages	1E-5	1E-5	1E-5	12 672
Filling at sides	1E-5	1E-5	1E-5	X
Concrete floor with sand patches	4.2E-8	4.2E-8	1.3E-9	990
Loading areas	1E-5	1E-5	1E-5	5 594

6.1.1 BLA net flows at time 2000 AD – 6000 AD

Table 6-2. Net flows in BLA tunnel at 2000 AD. Results of detailed model, base case.

BLA TIME 2000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
S1–S4 L= 58 m	I-1	0.06481	I-1	-0.11670	0.15978	-0.24530	0.02160
	I+1	0.24530	I+1	-0.02702	-0.06481	0.32068	0.02870
	J-1	-0.24620	J-1	-0.24470	-0.06667	-0.06668	0.00008
	J+1	-0.00611	J+1	0.05090	0.01520	0.01340	-0.01245
	K-1	0.66150	K-1	0.97620	0.08940	0.10190	0.81487
	K+1	-0.71930	K+1	-0.63868	-0.13290	-0.12400	-0.85280
S5–S6 L= 34 m	I-1	0.20450	I-1	-0.05094	0.18246	-0.19990	0.01850
	I+1	0.19990	I+1	-0.01273	-0.20450	0.21695	0.01830
	J-1	-0.39140	J-1	-0.79590	0.00114	-0.03625	0.01440
	J+1	0.24620	J+1	0.24470	0.06670	0.06670	-0.00008
	K-1	0.48910	K-1	0.98260	0.07000	0.07100	0.57898
	K+1	-0.74830	K+1	-0.36773	-0.11580	-0.11850	-0.63010
S7 L= 16 m	I-1	3.43400	I-1	-0.63870	4.66881	-2.42200	-0.00491
	I+1	2.42200	I+1	-0.66350	-3.43400	3.50449	-0.00317
	J-1	0.06740	J-1	0.63320	-0.04057	0.00671	-0.01481
	J+1	0.39140	J+1	0.79590	-0.00114	0.03620	-0.01443
	K-1	1.03850	K-1	9.90230	0.11190	0.11860	1.30632
	K+1	-7.35330	K+1	-10.02920	-1.30500	-1.24400	-1.26900
S8 L= 16 m	I-1	0.07062	I-1	-0.03378	0.05419	-0.23990	0.00638
	I+1	0.23990	I+1	-0.02459	-0.07062	0.28471	0.02070
	J-1	0.03131	J-1	0.17770	0.03150	0.02510	-0.00244
	J+1	-0.06740	J+1	-0.63320	0.04060	-0.00671	0.01480
	K-1	0.25770	K-1	0.72970	0.03120	0.04750	0.29696
	K+1	-0.53213	K+1	-0.21583	-0.08687	-0.11070	-0.33640
S9 L= 8 m	I-1	0.00408	I-1	-0.01884	0.01668	-0.04195	0.00273
	I+1	0.04195	I+1	-0.00888	-0.00408	0.02317	0.00464
	J-1	0.06655	J-1	0.12360	0.03220	0.02990	-0.01346
	J+1	-0.03131	J+1	-0.17770	-0.03147	-0.02512	0.00244
	K-1	0.08380	K-1	0.18920	0.01080	0.01400	0.11225
	K+1	-0.16507	K+1	-0.10738	-0.02413	0.00000	-0.10860

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	0.00604 0.01458 -0.06094 0.03416 0.05912 -0.05295
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	-0.01746 0.12738 -0.01327 -0.23879 0.48115 -0.33900

Table 6-3. Net flows in BLA tunnel at 3000 AD. Results of detailed model, base case.

BLA TIME 3000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	2.32800	I-1	1.51520	2.66010	1.59790	0.14490
S1–S4	I+1	-1.59790	I+1	-0.01447	-2.32800	-0.94999	-0.06846
	J-1	-5.39785	J-1	-5.30900	-1.47400	-1.46300	-0.00451
L= 58 m	J+1	2.74554	J+1	2.12230	0.57970	0.60850	-0.03517
	K-1	0.54471	K-1	-1.96800	0.25250	-0.07421	0.68624
	K+1	1.37750	K+1	3.65397	0.30970	0.28080	-0.72300
	I-1	1.87100	I-1	0.56040	1.15770	1.16930	0.06470
S5–S6	I+1	-1.16930	I+1	-0.35490	-1.87100	-1.05460	-0.06536
	J-1	-6.84045	J-1	-5.10900	-0.97800	-1.55300	-0.00935
L= 34 m	J+1	5.39785	J+1	5.30860	1.47450	1.46290	0.00451
	K-1	-0.08120	K-1	-1.03600	0.09150	-0.11320	-0.09740
	K+1	0.82210	K+1	0.63090	0.12530	0.08860	0.10290
	I-1	6.93600	I-1	2.13080	5.70500	10.29000	0.06500
S7	I+1	-10.2900	I+1	-3.69200	-6.93600	-9.94611	-0.09536
	J-1	-1.16215	J-1	-0.87920	-0.47940	-0.06529	-0.00239
L= 16 m	J+1	6.84045	J+1	5.10880	0.97800	1.55300	0.00935
	K-1	-0.36530	K-1	2.96260	0.02900	-0.12460	-0.43750
	K+1	-1.95900	K+1	-5.63100	0.70340	-1.70700	0.46090
	I-1	0.92550	I-1	0.14310	0.34224	2.78590	0.01870
S8	I+1	-2.78590	I+1	-1.06900	-0.92550	-3.03311	-0.13090
	J-1	1.01336	J-1	0.71830	0.12900	0.35670	0.00577
L= 16 m	J+1	1.16215	J+1	0.87920	0.47940	0.06530	0.00239
	K-1	-0.39464	K-1	-0.05066	0.00694	-0.17800	-0.46166
	K+1	0.07953	K+1	-0.62094	-0.03208	0.00321	0.56570
	I-1	0.28130	I-1	0.08880	0.18327	0.49650	0.00973
S9	I+1	-0.49650	I+1	-0.17390	-0.28130	-0.41818	-0.02415
	J-1	1.43427	J-1	0.79670	0.22780	0.32270	0.02100
L= 8 m	J+1	-1.01336	J+1	-0.71830	-0.12900	-0.35670	-0.00577
	K-1	-0.12002	K-1	0.09130	0.00484	-0.04432	-0.16032
	K+1	-0.08569	K+1	-0.08460	-0.00561	0.00000	0.15950

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	0.93953 0.52930 -6.02087 2.90250 0.66198 0.98757
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	1.62124 -0.99810 1.35040 -2.80247 -0.44010 1.26903

Table 6-4. Net flows in BLA tunnel at 4000 AD. Results of detailed model, base case.

BLA **TIME** **4000 AD** **BASE** **CASE**	**ENCAPSULATION** **NET FLOW** (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			**OUTSIDE OF ENCAPSULATION** **NET FLOW** (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
S1–S4 L= 58 m	I-1	2.69800	I-1	1.99540	2.86550	2.50250	0.13700
	I+1	-2.50250	I+1	-0.09428	-2.69800	-1.91020	-0.13660
	J-1	-5.27120	J-1	-5.17600	-1.44000	-1.43000	-0.00547
	J+1	2.59180	J+1	1.93390	0.52150	0.56550	-0.02010
	K-1	-0.35900	K-1	-3.95700	0.16300	-0.25390	-0.42473
	K+1	2.84290	K+1	5.29798	0.58800	0.52610	0.44990
S5–S6 L= 34 m	I-1	1.96100	I-1	0.84650	1.15706	1.96200	0.04990
	I+1	-1.96200	I+1	-0.44030	-1.96100	-1.79080	-0.11750
	J-1	-6.84736	J-1	-3.85500	-1.02500	-1.68600	-0.03902
	J+1	5.27120	J+1	5.17560	1.43990	1.43020	0.00547
	K-1	-0.95794	K-1	-3.28500	-0.00636	-0.26990	-1.13305
	K+1	2.53510	K+1	1.55820	0.39540	0.35450	1.23420
S7 L= 16 m	I-1	3.20700	I-1	4.92880	-0.43050	17.14800	0.09880
	I+1	-17.14800	I+1	-2.50300	-3.20700	-18.56080	-0.11120
	J-1	-6.04016	J-1	-5.95500	-1.42400	-0.95330	0.02160
	J+1	6.84736	J+1	3.85450	1.02490	1.68630	0.03900
	K-1	-2.42700	K-1	-20.83000	-0.17070	-0.38210	-3.02800
	K+1	15.56080	K+1	20.50470	4.20730	1.06190	2.97980
S8 L= 16 m	I-1	0.77200	I-1	0.21230	0.22504	3.94520	0.00540
	I+1	-3.94520	I+1	-1.18000	-0.77200	-4.16110	-0.19780
	J-1	-2.91570	J-1	-3.17900	-0.95580	-0.67320	0.00664
	J+1	6.04016	J+1	5.95470	1.42360	0.95330	-0.02160
	K-1	-1.04426	K-1	-1.48600	-0.06524	-0.31280	-1.21494
	K+1	1.09300	K+1	-0.32200	0.14440	0.24860	1.42230
S9 L= 8 m	I-1	0.36270	I-1	0.09360	0.10521	0.65740	0.00152
	I+1	-0.65740	I+1	-0.23790	-0.36270	-0.60052	-0.04300
	J-1	-2.83269	J-1	-2.25900	-0.74180	-0.63740	0.05980
	J+1	2.91570	J+1	3.17920	0.95580	0.67320	-0.00664
	K-1	-0.38061	K-1	-0.66290	-0.02711	-0.09268	-0.51209
	K+1	0.59230	K+1	-0.11300	0.07060	0.00000	0.50040

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1	0.92865
	I+1	0.42758
	J-1	-5.59260
	J+1	2.60526
	K-1	0.51274
	K+1	1.11837
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1	0.52450
	I+1	-2.75318
	J-1	-0.26911
	J+1	6.41109
	K-1	-3.16926
	K+1	-0.74404

Table 6-5. Net flows in BLA tunnel at 5000 AD. Results of detailed model, base case.

BLA **TIME** **5000 AD** **BASE** **CASE**	**ENCAPSULATION** **NET FLOW** (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow			**OUTSIDE OF ENCAPSULATION** **NET FLOW** (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**	**FACE**	**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	2.68500	I-1	2.03480	2.80830	2.61960	0.12970
S1–S4	I+1	-2.61960	I+1	-0.10910	-2.68500	-2.05820	-0.14790
	J-1	-5.06010	J-1	-4.96600	-1.38200	-1.37300	-0.00548
L= 58 m	J+1	2.49170	J+1	1.83770	0.49390	0.53940	-0.01552
	K-1	-0.57980	K-1	-4.27600	0.13350	-0.28970	-0.69681
	K+1	3.08280	K+1	5.47860	0.63130	0.56190	0.73600
	I-1	1.90300	I-1	0.87640	1.10764	2.07120	0.04400
S5–S6	I+1	-2.07120	I+1	-0.44580	-1.90300	-1.89360	-0.12520
	J-1	-6.57684	J-1	-3.43500	-0.99770	-1.65400	-0.04462
L= 34 m	J+1	5.06010	J+1	4.96650	1.38230	1.37310	0.00548
	K-1	-1.13616	K-1	-3.66300	-0.03064	-0.29720	-1.34366
	K+1	2.82110	K+1	1.70090	0.44140	0.40050	1.46400
	I-1	2.09400	I-1	5.31210	-2.01900	18.17200	0.10230
S7	I+1	-18.17200	I+1	-2.22400	-2.09400	-19.96690	-0.11080
	J-1	-6.37284	J-1	-6.45800	-1.47600	-1.01300	0.02700
L= 16 m	J+1	6.57684	J+1	3.43510	0.99770	1.65370	0.04460
	K-1	-2.82880	K-1	-25.09000	-0.21270	-0.42900	-3.53360
	K+1	18.70280	K+1	25.02480	4.80400	1.58320	3.47050
	I-1	0.73890	I-1	0.22700	0.20041	4.06550	0.00267
S8	I+1	-4.06550	I+1	-1.17300	-0.73890	-4.28610	-0.20660
	J-1	-3.20085	J-1	-3.49800	-1.04000	-0.75330	0.00724
L= 16 m	J+1	6.37284	J+1	6.45760	1.47560	1.01330	-0.02699
	K-1	-1.15259	K-1	-1.78200	-0.07841	-0.33290	-1.34022
	K+1	1.30720	K+1	-0.23160	0.18130	0.29350	1.56390
	I-1	0.36640	I-1	0.10010	0.09599	0.67490	0.00012
S9	I+1	-0.67490	I+1	-0.23690	-0.36640	-0.61355	-0.04532
	J-1	-3.16339	J-1	-2.51000	-0.82090	-0.71530	0.06590
L= 8 m	J+1	3.20085	J+1	3.49770	1.04020	0.75330	-0.00724
	K-1	-0.42016	K-1	-0.77460	-0.03229	-0.09935	-0.56526
	K+1	0.69120	K+1	-0.07630	0.08340	0.00000	0.55180

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	0.91705 0.40016 -5.34718 2.51628 0.46759 1.04610
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	0.44950 -2.91385 -0.41331 7.14369 -3.54713 -0.71890

Table 6-6. Net flows in BLA tunnel at 6000 AD. Results of detailed model, base case.

BLA TIME 6000 AD BASE CASE	ENCAPSULATION NET FLOW (m^3/year) Net flow over faces Neg. flow= outflow Pos. flow= inflow		FACE	OUTSIDE OF ENCAPSULATION NET FLOW (m^3/year) Flow balance over face studied Negative flow = outflow of volume studied Positive flow = inflow to volume studied			
SECTION STUDIED Length (m)	**FACE**	**NET FLOW**		**Top filling**	**First side Filling**	**Second side filling**	**Floor**
	I-1	2.66600	I-1	2.03140	2.78380	2.61780	0.12760
S1–S4	I+1	-2.61780	I+1	-0.11100	-2.66600	-2.05940	-0.14870
	J-1	-5.00875	J-1	-4.91500	-1.36800	-1.35900	-0.00547
L= 58 m	J+1	2.46665	J+1	1.80730	0.48540	0.53110	-0.01473
	K-1	-0.61120	K-1	-4.30500	0.12770	-0.29330	-0.73550
	K+1	3.10510	K+1	5.49230	0.63710	0.56280	0.77680
	I-1	1.87700	I-1	0.87790	1.09027	2.07490	0.04250
S5–S6	I+1	-2.07490	I+1	-0.44440	-1.87700	-1.89700	-0.12570
	J-1	-6.50732	J-1	-3.35500	-0.99260	-1.64400	-0.04555
L= 34 m	J+1	5.00875	J+1	4.91520	1.36820	1.35920	0.00547
	K-1	-1.16373	K-1	-3.71400	-0.03537	-0.30040	-1.37622
	K+1	2.86020	K+1	1.72030	0.44650	0.40730	1.49950
	I-1	1.84900	I-1	5.35970	-2.34340	18.27800	0.10230
S7	I+1	-18.27800	I+1	-2.16100	-1.84900	-20.13670	-0.10990
	J-1	-6.40952	J-1	-6.53300	-1.48000	-1.02200	0.02800
L= 16 m	J+1	6.50732	J+1	3.35540	0.99260	1.64370	0.04550
	K-1	-2.89560	K-1	-25.80000	-0.22040	-0.43600	-3.61790
	K+1	19.22680	K+1	25.77890	4.90020	1.67300	3.55200
	I-1	0.72690	I-1	0.22840	0.19453	4.06430	0.00204
S8	I+1	-4.06430	I+1	-1.16400	-0.72690	-4.28400	-0.20700
	J-1	-3.24305	J-1	-3.55600	-1.05500	-0.76940	0.00730
L= 16 m	J+1	6.40952	J+1	6.53260	1.48040	1.02230	-0.02796
	K-1	-1.16777	K-1	-1.82800	-0.08073	-0.33480	-1.35769
	K+1	1.33870	K+1	-0.21300	0.18770	0.30160	1.58330
	I-1	0.36500	I-1	0.10050	0.09242	0.67370	-0.00020
S9	I+1	-0.67370	I+1	-0.23540	-0.36500	-0.61170	-0.04548
	J-1	-3.21727	J-1	-2.55900	-0.83620	-0.73130	0.06680
L= 8 m	J+1	3.24305	J+1	3.55650	1.05540	0.76940	-0.00730
	K-1	-0.42568	K-1	-0.79520	-0.03322	-0.10010	-0.57282
	K+1	0.70860	K+1	-0.06740	0.08660	0.00000	0.55900

LOADING AREA South of encapsulation, the volume that connects to Sections S1. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	0.90876 0.39237 -5.27572 2.47966 0.45744 1.03750
LOADING AREA North of encapsulation, the volume that connects to Sections S9. **NET FLOW** (m^3/year)	I-1 I+1 J-1 J+1 K-1 K+1	0.42220 -2.92429 -0.45290 7.27697 -3.59841 -0.72357

6.1.2 BLA average specific flow in surrounding rock at different times

Table 6-7. Specific flow outside of BLA tunnel at different times. Results of detailed model, base case.

BASE CASE **TIME 2000AD through 7000 AD**	**FLOW** Compo-nents	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.			
SECTION STUDIED Length (m)		VOLUME **Above Top filling**	VOLUME **Outside of First side filling**	VOLUME **Outside of Second side filling**	VOLUME **Below Floor**
TIME 2000 AD S1–S9 L= 132 m	**R**esultant	1.65204E-10	2.40637E-10	3.59599E-10	8.37179E-11
	X-direction	-5.38181E-13	8.16711E-11	-6.34630E-11	-6.37944E-12
	Y-direction	-1.29990E-13	-1.18545E-13	2.93210E-11	-7.94422E-14
	Z-direction	1.64806E-10	2.20908E-10	3.42852E-10	6.15731E-11
TIME 3000 AD S1–S9 L= 132 m	**R**esultant	1.94605E-10	2.85270E-10	8.90190E-10	1.14265E-10
	X-direction	7.34474E-11	2.74186E-10	3.57154E-10	9.51513E-11
	Y-direction	-7.97049E-12	-4.38636E-12	-7.36561E-10	-3.60046E-12
	Z-direction	1.21771E-11	-7.24659E-12	-6.51103E-12	-9.78852E-12
TIME 4000 AD S1–S9 L= 132 m	**R**esultant	4.34873E-10	5.99668E-10	1.43103E-09	2.35930E-10
	X-direction	9.23223E-11	2.14230E-10	5.58164E-10	1.33136E-10
	Y-direction	-9.81802E-12	-4.89519E-12	-9.47082E-10	-4.60858E-12
	Z-direction	-4.08004E-10	-4.57348E-10	-7.53297E-10	-1.26468E-10
TIME 5000 AD S1–S9 L= 132 m	**R**esultant	5.03710E-10	6.81327E-10	1.53846E-09	2.61531E-10
	X-direction	9.38481E-11	1.88884E-10	5.85856E-10	1.36783E-10
	Y-direction	-9.60521E-12	-4.76332E-12	-9.62931E-10	-4.58864E-12
	Z-direction	-4.79876E-10	-5.45290E-10	-8.92322E-10	-1.49706E-10
TIME 6000 AD S1–S9 L= 132 m	**R**esultant	5.14207E-10	6.94902E-10	1.55073E-09	2.65197E-10
	X-direction	9.37549E-11	1.82419E-10	5.87601E-10	1.36502E-10
	Y-direction	-9.51871E-12	-4.71568E-12	-9.59945E-10	-4.57132E-12
	Z-direction	-4.90960E-10	-5.60630E-10	-9.14179E-10	-1.53381E-10
TIME 7000 AD S1–S9 L= 132 m	**R**esultant	5.14620E-10	6.95512E-10	1.55093E-09	2.65324E-10
	X-direction	9.37294E-11	1.81980E-10	5.87503E-10	1.36435E-10
	Y-direction	-9.51241E-12	-4.71234E-12	-9.59521E-10	-4.57001E-12
	Z-direction	-4.91407E-10	-5.61377E-10	-9.15093E-10	-1.53539E-10

7 Silo tunnel – detailed flow

7.1 SILO base case

The main part of the radioactivity of the waste of the SFR repository is to be stored in the SILO. Inside the SILO there is a cylindrical concrete encapsulation, protected at all sides by bentonite barriers. The waste will be stored in vertical shafts in the encapsulation.

The conductivity of the SILO as defined in the base case of the detailed model /Holmén and Stigsson, 2001/ is given in the table below.

Table 7-1. The conductivity and volumes of the SILO, as defined in the base case of the detailed model.

SILO	HYDRAULIC CONDUCTIVITY (m/s)□ IN FLOW DIRECTIONS			VOLUME (m^3)
	X-DIR.	Y-DIR.	Z-DIR.	
Top filling	1E-5	1E-5	1E-5	5 226
Concrete/Bentonite at top	1E-9	1E-9	1E-9	1 206
Waste domain. Encapsulation	4.5E-9	4.5E-9	7.4E-9	30 456
Concrete/Bentonite at base	9.3E-10	9.3E-10	9.2E-10	1 608
Concrete/Bentonite at sides	1.1E-11	1.1E-11	3.4E-10	12 960

7.1.1 SILO net flows at time 2000 AD through 6000 AD

Table 7-2. Net flows in SILO tunnel at 2000 AD. Results of detailed model, base case.

SILO **TIME 2000 AD BASE CASE**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	0.26800	-0.48800	0.22000	0.00000	–	–	–
Bentonite at top Layer 19	0.23175	-0.26800	0.03625	0.00000	–	–	–
Waste domain Layers 12–18	0.22900	-0.22500	0.00000	-0.00400	Side barrier Layers 12–18	0.00574	-0.00675
Waste domain Layers 10–11	0.22800	-0.22900	0.00100	0.00000	Side barrier Layers 10–11	0.00523	-0.00574
Waste domain Layer 9	0.22700	-0.22800	0.00100	0.00000	Side barrier Layer 9	0.00553	-0.00523
Waste domain Layer 8	0.22500	-0.22700	0.00206	-0.00006	Side barrier Layer 8	0.00437	-0.00553
Waste domain Layers 5–7	0.21850	-0.22500	0.00650	0.00000	Side barrier Layers 5–7	0.01230	-0.00437
Bentonite at base Layer 4	0.22956	-0.22287	0.00000	-0.00669	–	–	–

Table 7-3. Net flows in SILO tunnel at 3000 AD. Results of detailed model, base case.

SILO **TIME 3000 AD BASE CASE**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	-0.32240	1.28300	0.00000	-0.96060	–	–	–
Bentonite at top Layer 19	-0.22227	0.32240	0.00000	-0.10013	–	–	–
Waste domain Layers 12–18	-0.21690	0.21580	0.00332	-0.00222	Side barrier Layers 12–18	-0.00634	0.00647
Waste domain Layers 10–11	-0.21140	0.21690	0.00000	-0.00550	Side barrier Layers 10–11	-0.00422	0.00634
Waste domain Layer 9	-0.20550	0.21140	0.00000	-0.00590	Side barrier Layer 9	-0.00356	0.00422
Waste domain Layer 8	-0.20160	0.20550	0.00000	-0.00390	Side barrier Layer 8	-0.00390	0.00356
Waste domain Layers 5–7	-0.19510	0.20160	0.00000	-0.00650	Side barrier Layers 5–7	-0.00900	0.00390
Bentonite at base Layer 4	-0.20497	0.19900	0.00597	0.00000	–	–	–

Table 7-4. Net flows in SILO tunnel at 4000 AD. Results of detailed model, base case.

SILO **TIME 4000 AD** **BASE CASE**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	0.04404	-1.42600	1.61150	-0.22954	–	–	–
Bentonite at top Layer 19	-0.08868	-0.04404	0.13272	0.00000	–	–	–
Waste domain Layers 12–18	-0.09860	0.08610	0.01250	0.00000	Side barrier Layers 12–18	-0.00518	0.00258
Waste domain Layers 10–11	-0.11040	0.09860	0.01180	0.00000	Side barrier Layers 10–11	-0.00270	0.00518
Waste domain Layer 9	-0.11960	0.11040	0.00920	0.00000	Side barrier Layer 9	-0.00042	0.00270
Waste domain Layer 8	-0.12400	0.11960	0.00440	0.00000	Side barrier Layer 8	-0.00374	0.00042
Waste domain Layers 5–7	-0.12470	0.12400	0.00229	-0.00159	Side barrier Layers 5–7	0.00436	0.00374
Bentonite at base Layer 4	-0.13486	0.12844	0.00642	0.00000	–	–	–

Table 7-5. Net flows in SILO tunnel at 5000 AD. Results of detailed model, base case.

SILO **TIME 5000 AD** **BASE CASE**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	-0.07190	-1.12000	1.52800	-0.33610	–	–	–
Bentonite at top Layer 19	-0.18046	0.07190	0.11248	-0.00393	–	–	–
Waste domain Layers 12–18	-0.18760	0.17520	0.01240	0.00000	Side barrier Layers 12–18	-0.00337	0.00526
Waste domain Layers 10–11	-0.19820	0.18760	0.01060	0.00000	Side barrier Layers 10–11	-0.00567	0.00337
Waste domain Layer 9	-0.20610	0.19820	0.00790	0.00000	Side barrier Layer 9	-0.00680	0.00567
Waste domain Layer 8	-0.20940	0.20610	0.00360	-0.00030	Side barrier Layer 8	-0.00832	0.00680
Waste domain Layers 5–7	-0.20800	0.20940	0.00145	-0.00285	Side barrier Layers 5–7	-0.01790	0.00832
Bentonite at base Layer 4	-0.22930	0.21632	0.01298	0.00000	–	–	–

Table 7-6. Net flows in SILO tunnel at 6000 AD. Results of detailed model, base case.

SILO **TIME 6000 AD BASE CASE**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	-0.10090	-1.05300	1.51540	-0.36150	–	–	–
Bentonite at top Layer 19	-0.20425	0.10090	0.10390	-0.00055	–	–	–
Waste domain Layers 12–18	-0.21070	0.19830	0.01240	0.00000	Side barrier Layers 12–18	-0.00394	0.00595
Waste domain Layers 10–11	-0.22120	0.21070	0.01050	0.00000	Side barrier Layers 10–11	-0.00615	0.00394
Waste domain Layer 9	-0.22890	0.22120	0.00770	0.00000	Side barrier Layer 9	-0.00730	0.00615
Waste domain Layer 8	-0.23200	0.22890	0.00346	-0.00036	Side barrier Layer 8	-0.00919	0.00730
Waste domain Layers 5–7	-0.22980	0.23200	0.00131	-0.00351	Side barrier Layers 5–7	-0.01890	0.00919
Bentonite at base Layer 4	-0.25333	0.23899	0.01434	0.00000	–	–	–

Table 7-7. Net flows in SILO tunnel at 7000 AD. Results of detailed model, base case.

SILO **TIME 7000 AD BASE CASE**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	-0.10290	-1.05000	1.51480	-0.36190	–	–	–
Bentonite at top Layer 19	-0.20590	0.10290	0.10380	-0.00080	–	–	–
Waste domain Layers 12–18	-0.21240	0.19990	0.01250	0.00000	Side barrier Layers 12–18	-0.00398	0.00600
Waste domain Layers 10–11	-0.22280	0.21240	0.01040	0.00000	Side barrier Layers 10–11	-0.00618	0.00398
Waste domain Layer 9	-0.23050	0.22280	0.00770	0.00000	Side barrier Layer 9	-0.00733	0.00618
Waste domain Layer 8	-0.23360	0.23050	0.00346	-0.00036	Side barrier Layer 8	-0.00924	0.00733
Waste domain Layers 5–7	-0.23100	0.23360	0.00130	-0.00390	Side barrier Layers 5–7	-0.01900	0.00924
Bentonite at base Layer 4	-0.25465	0.24024	0.01441	0.00000	–	–	–

7.1.2 SILO average specific flow in surroundings 2000 AD – 7000 AD

Table 7-8. Specific flow outside of SILO tunnel at 2000 AD. Results of detailed model, base case.

TIME **2000 AD** **BASE CASE**	**FLOW** Components	**AVERAGE SPECIFIC FLOW** **OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal** **Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.43397E-11 4.25463E-13 7.20005E-13 1.39887E-11	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.37791E-11 4.13545E-13 -3.30710E-13 1.37124E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.47905E-11 4.33602E-13 -1.97942E-12 1.45031E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.60917E-11 2.84180E-13 -3.85984E-12 1.51411E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.83897E-11 -5.67586E-15 -6.09299E-12 1.65181E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	2.12308E-11 1.42869E-12 -1.56611E-13 2.06939E-11	1.75525E-11 1.99481E-12 3.16385E-12 1.05458E-11	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.76724E-11 7.07657E-13 2.14852E-12 1.55248E-11	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.32148E-11 2.97191E-13 -9.50150E-12 1.90346E-11	2.15178E-11 2.71717E-12 -1.20283E-11 8.13550E-12

Table 7-9. Specific flow outside of SILO tunnel at 3000 AD. Results of detailed model, base case.

TIME 3000 AD **BASE CASE**	**FLOW** Compo-nents	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.20387E-11 3.49832E-12 -2.65705E-12 -2.00717E-11	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.28662E-11 2.64613E-12 -2.02386E-12 -1.14376E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.07525E-11 2.96547E-12 -1.49069E-13 -7.75710E-12	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.24270E-11 4.07376E-12 3.15688E-12 -5.88082E-12	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.51454E-11 4.09041E-12 6.81979E-12 -7.52915E-12	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	6.80514E-11 6.70408E-12 1.21692E-11 -6.15935E-11	5.05735E-11 1.47291E-11 -3.55675E-12 -2.14375E-11	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	4.12331E-11 6.46440E-12 -5.11056E-12 -3.35632E-11	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.95399E-11 4.59729E-12 1.04264E-11 -1.01874E-11	2.05597E-11 2.25084E-12 1.36195E-11 -6.55893E-12

Table 7-10. Specific flow outside of SILO tunnel at 4000 AD. Results of detailed model, base case.

TIME 4000 AD **BASE CASE**	**FLOW** Compo-nents	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.17768E-11 7.42552E-12 -1.61023E-11 6.83944E-12	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.03440E-11 2.98752E-12 -1.08250E-11 -1.10494E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.05660E-11 3.87371E-12 -5.96861E-12 -1.57159E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.43516E-11 6.27772E-12 3.56342E-13 -1.83031E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.29649E-11 6.59709E-12 7.19246E-12 -2.69246E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	8.80930E-11 1.15050E-11 -3.86115E-11 6.42321E-11	9.37986E-11 2.51303E-11 -5.99317E-11 2.15056E-11	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.48529E-11 1.17391E-11 -3.11506E-11 3.05865E-11	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	4.76898E-11 7.49683E-12 1.30060E-11 -3.74144E-11	3.44333E-11 2.64624E-12 1.76715E-11 -8.68406E-12

Table 7-11. Specific flow outside of SILO tunnel at 5000 AD. Results of detailed model, base case.

TIME 5000 AD **BASE CASE**	**FLOW** Compo-nents	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal** **Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.93644E-11 7.47089E-12 -1.69440E-11 4.27088E-13	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.34811E-11 3.37526E-12 -1.14154E-11 -1.57063E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.37944E-11 4.26091E-12 -6.21376E-12 -2.00912E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.76945E-11 6.59853E-12 4.83787E-13 -2.27262E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.73156E-11 6.86705E-12 7.80614E-12 -3.16829E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	7.78675E-11 1.06657E-11 -3.85500E-11 5.09410E-11	8.74191E-11 2.43231E-11 -6.24643E-11 1.51955E-11	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	4.83606E-11 1.15562E-11 -3.28921E-11 2.17666E-11	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.35450E-11 7.79691E-12 1.42342E-11 -4.30012E-11	3.86128E-11 2.38868E-12 1.93422E-11 -1.18018E-11

Table 7-12. Specific flow outside of SILO tunnel at 6000 AD. Results of detailed model, base case.

TIME 6000 AD **BASE CASE**	**FLOW** Compo-nents	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal** **Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.92391E-11 7.53004E-12 -1.72529E-11 -1.04961E-12	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.44633E-11 3.49993E-12 -1.16872E-11 -1.68652E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.47804E-11 4.36891E-12 -6.44689E-12 -2.12788E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.85396E-11 6.66004E-12 2.70544E-13 -2.39885E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.83539E-11 6.90479E-12 7.63669E-12 -3.30384E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	7.58599E-11 1.05041E-11 -3.86335E-11 4.80235E-11	8.65027E-11 2.42496E-11 -6.33439E-11 1.37727E-11	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	4.74434E-11 1.15715E-11 -3.34764E-11 1.98123E-11	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.49661E-11 7.85513E-12 1.41065E-11 -4.46011E-11	3.92152E-11 2.34437E-12 1.92070E-11 -1.26833E-11

Table 7-13. Specific flow outside of SILO tunnel at 7000 AD. Results of detailed model, base case.

TIME 7000 AD **BASE CASE**	**FLOW** Compo-nents	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal** **Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.92425E-11 7.53513E-12 -1.72727E-11 -1.14393E-12	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.45354E-11 3.50786E-12 -1.17039E-11 -1.69505E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.48585E-11 4.37615E-12 -6.45988E-12 -2.13732E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.86109E-11 6.66472E-12 2.59857E-13 -2.40919E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.84445E-11 6.90880E-12 7.63027E-12 -3.31512E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	7.57520E-11 1.04960E-11 -3.86411E-11 4.78592E-11	8.64648E-11 2.42497E-11 -6.34019E-11 1.36900E-11	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	4.74017E-11 1.15746E-11 -3.35142E-11 1.96983E-11	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.50899E-11 7.86169E-12 1.41058E-11 -4.47343E-11	3.92760E-11 2.34297E-12 1.92076E-11 -1.27491E-11

7.2 SILO sensitivity case – flow of a failed encapsulation

As a sensitivity case we have studied the flow through a failed SILO encapsulation. This case represents a situation for which the concrete barriers and the bentonite barriers of the SILO encapsulation are breached. A motivation of the case is a theoretical collapse of the concrete walls of the encapsulation, and the following collapse of the bentonite barriers.

The case studied represents a situation for which the concrete barriers and the bentonite barriers of the SILO encapsulation are breached/collapsed, but the tunnel plugs are intact. For this case, the assumed properties of the SILO are given in Table 7-14. All other parts of the model have the same properties as in the previous discussed detailed model (the base case). The difference compared to the previous definition of the detailed model is that the low permeable barriers of the SILO encapsulation and the inside of the SILO encapsulation, are defined as having the same conductivity, equal to 1×10^{-8} m/s, in all directions.

The conductivity value of the SILO encapsulation (1×10^{-8} m/s) used in these simulations is an assumed value, which represents the permeability of the SILO encapsulation after a theoretical crack/collapse of its concrete walls. It is however likely that much of the bentonite will remain in the barriers, even if the concrete walls are cracked/failed. And inside the encapsulation there will probably be both cracked and intact concrete containers. Hence, even if the concrete walls of the SILO collapses, the SILO will still carry a significant resistance to flow.

Table 7-14. Conductivity and volumes of the collapsed SILO encapsulation, a sensitivity case of the detailed model.

SILO Collapsed	HYDRAULIC CONDUCTIVITY (m/s)□ IN FLOW DIRECTIONS			VOLUME (m^3)
	X-DIR.	Y-DIR.	Z-DIR.	
Top filling	1E-5	1E-5	1E-5	5 226
Concrete/Bentonite at top	1E-8	1E-8	1E-8	1 206
Waste domain and encapsulation	1E-8	1E-8	1E-8	30 456
Concrete/Bentonite at base	1E-8	1E-8	1E-8	1 608
Concrete/Bentonite at sides	1E-8	1E-8	1E-8	12 960

7.2.1 SILO (collapsed) net flows at time 2000 AD through 6000 AD

Table 7-15. Net flows in SILO tunnel at 2000 AD. Results of detailed model, sensitivity case, collapsed encapsulation.

SILO **TIME 2000 AD COLLAPSED ENCAP.**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	0.72500	*-0.67510*	0.00000	-0.04990	–	–	–
Bentonite at top Layer 19	0.67990	-0.72500	0.04510	0.00000	–	–	–
Waste domain Layers 12–18	0.38900	-0.46100	0.07477	-0.00277	Side barrier Layers 12–18	0.16100	-0.21890
Waste domain Layers 10–11	0.37200	-0.38900	0.02055	-0.00355	Side barrier Layers 10–11	0.15800	-0.16100
Waste domain Layer 9	0.36700	-0.37200	0.03930	-0.03430	Side barrier Layer 9	0.15800	-0.15800
Waste domain Layer 8	0.35800	-0.36700	0.05630	-0.04730	Side barrier Layer 8	0.18060	-0.15800
Waste domain Layers 5–7	0.26740	-0.35800	0.19160	-0.10100	Side barrier Layers 5–7	0.18080	-0.18060
Bentonite at base Layer 4	0.41040	-0.44800	0.10050	-0.06290	–	–	–

Table 7-16. Net flows in SILO tunnel at 3000 AD. Results of detailed model, sensitivity case, collapsed encapsulation.

SILO **TIME 3000 AD COLLAPSED ENCAP.**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	-1.32350	1.66560	0.04890	-0.39100	–	–	–
Bentonite at top Layer 19	-1.18000	1.32350	0.00000	-0.14350	–	–	–
Waste domain Layers 12–18	-0.45830	0.76970	0.00750	-0.31890	Side barrier Layers 12–18	-0.18020	0.41030
Waste domain Layers 10–11	-0.29080	0.45830	0.01980	-0.18730	Side barrier Layers 10–11	-0.11770	0.18020
Waste domain Layer 9	-0.19500	0.29080	0.03230	-0.12810	Side barrier Layer 9	-0.07730	0.11770
Waste domain Layer 8	-0.16140	0.19500	0.06530	-0.09890	Side barrier Layer 8	-0.09030	0.07730
Waste domain Layers 5–7	-0.10400	0.16140	0.14720	-0.20460	Side barrier Layers 5–7	-0.09030	0.09030
Bentonite at base Layer 4	-0.17900	0.19430	0.04965	-0.06495	–	–	–

Table 7-17. Net flows in SILO tunnel at 4000 AD. Results of detailed model, sensitivity case, collapsed encapsulation.

SILO **TIME 4000 AD COLLAPSED ENCAP.**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	0.88300	-1.66000	1.18660	-0.40960	–	–	–
Bentonite at top Layer 19	0.68170	-0.88300	0.23030	-0.02900	–	–	–
Waste domain Layers 12–18	-0.02780	-0.39400	0.52160	-0.09980	Side barrier Layers 12–18	-0.03210	-0.28770
Waste domain Layers 10–11	-0.25170	0.02780	0.33900	-0.11510	Side barrier Layers 10–11	-0.11800	0.03210
Waste domain Layer 9	-0.34990	0.25170	0.21170	-0.11350	Side barrier Layer 9	-0.15000	0.11800
Waste domain Layer 8	-0.41660	0.34990	0.13890	-0.07220	Side barrier Layer 8	-0.28480	0.15000
Waste domain Layers 5–7	-0.42000	0.41660	0.23990	-0.23650	Side barrier Layers 5–7	-0.28500	0.28480
Bentonite at base Layer 4	-0.68700	0.70480	0.07311	-0.09091	–	–	–

Table 7-18. Net flows in SILO tunnel at 5000 AD. Results of detailed model, sensitivity case, collapsed encapsulation.

SILO **TIME 5000 AD COLLAPSED ENCAP.**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	0.52400	-1.27000	1.18640	-0.44040	–	–	–
Bentonite at top Layer 19	0.35020	-0.52400	0.22060	-0.04680	–	–	–
Waste domain Layers 12–18	-0.18820	-0.17400	0.51630	-0.15410	Side barrier Layers 12–18	-0.09710	-0.17620
Waste domain Layers 10–11	-0.38630	0.18820	0.34540	-0.14730	Side barrier Layers 10–11	-0.17380	0.09710
Waste domain Layer 9	-0.47540	0.38630	0.21780	-0.12870	Side barrier Layer 9	-0.20330	0.17380
Waste domain Layer 8	-0.53730	0.47540	0.13960	-0.07770	Side barrier Layer 8	-0.34240	0.20330
Waste domain Layers 5–7	-0.51900	0.53730	0.24720	-0.26550	Side barrier Layers 5–7	-0.34200	0.34240
Bentonite at base Layer 4	-0.83400	0.86140	0.08349	-0.11089	–	–	–

Table 7-19. Net flows in SILO tunnel at 6000 AD. Results of detailed model, sensitivity case, collapsed encapsulation.

SILO **TIME 6000 AD COLLAPSED ENCAP.**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	0.44100	-1.18000	1.19210	-0.45310	–	–	–
Bentonite at top Layer 19	0.27340	-0.44100	0.21890	-0.05130	–	–	–
Waste domain Layers 12–18	-0.22740	-0.12200	0.51800	-0.16860	Side barrier Layers 12–18	-0.11290	-0.15140
Waste domain Layers 10–11	-0.42140	0.22740	0.35140	-0.15740	Side barrier Layers 10–11	-0.18840	0.11290
Waste domain Layer 9	-0.51030	0.42140	0.22340	-0.13450	Side barrier Layer 9	-0.21810	0.18840
Waste domain Layer 8	-0.57190	0.51030	0.14040	-0.07880	Side barrier Layer 8	-0.35840	0.21810
Waste domain Layers 5–7	-0.55000	0.57190	0.24420	-0.26610	Side barrier Layers 5–7	-0.35800	0.35840
Bentonite at base Layer 4	-0.87900	0.90840	0.08460	-0.11400	–	–	–

Table 7-20. Net flows in SILO tunnel at 7000 AD. Results of detailed model, sensitivity case, collapsed encapsulation.

SILO **TIME 7000 AD COLLAPSED ENCAP.**	**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow		**RADIAL FLOW** (horizontal flow) (m^3/year)			**AXIAL FLOW** (vertical flow) (m^3/year) Net flow over face Neg. flow= outflow Pos. flow= inflow	
SECTION STUDIED	**Face K-1**	**Face K+1**	**Inflow** Positive	**Outflow** Negative	**SECTION STUDIED**	**Face K-1**	**Face K+1**
Topfill Layers 20–21	0.43500	-1.18000	1.19240	-0.44740	–	–	–
Bentonite at top Layer 19	0.26820	-0.43500	0.21830	-0.05150	–	–	–
Waste domain Layers 12–18	-0.23000	-0.11900	0.51880	-0.16980	Side barrier Layers 12–18	-0.11400	-0.14920
Waste domain Layers 10–11	-0.42380	0.23000	0.35130	-0.15750	Side barrier Layers 10–11	-0.18940	0.11400
Waste domain Layer 9	-0.51270	0.42380	0.22370	-0.13480	Side barrier Layer 9	-0.21920	0.18940
Waste domain Layer 8	-0.57430	0.51270	0.14040	-0.07880	Side barrier Layer 8	-0.35970	0.21920
Waste domain Layers 5–7	-0.55200	0.57430	0.24400	-0.26630	Side barrier Layers 5–7	-0.36000	0.35970
Bentonite at base Layer 4	-0.88200	0.91170	0.08490	-0.11460	–	–	–

7.2.2 SILO average specific flow in surroundings at 2000 AD – 7000 AD collapsed encapsulation

Table 7-21. Specific flow outside of SILO tunnel at 2000 AD. Results of detailed model, sensitivity case, collapsed encapsulation, intact plugs.

TIME 2000 AD	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.40766E-11 3.25466E-13 2.12262E-12 1.28090E-11	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.34496E-11 3.33141E-13 -2.38148E-13 1.33798E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.38266E-11 3.72294E-13 -2.71351E-12 1.35406E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.48348E-11 1.15387E-13 -5.73485E-12 1.35481E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.84014E-11 -1.01183E-13 -9.48828E-12 1.46819E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	2.70243E-11 1.44779E-12 -3.11618E-13 2.66563E-11	1.48877E-11 1.88663E-12 3.51709E-12 9.79997E-12	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.35942E-11 7.85917E-13 2.88049E-12 9.78052E-12	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.58919E-11 6.92393E-13 -1.27255E-11 1.85737E-11	2.78642E-11 2.40652E-12 -1.24298E-11 1.64134E-11

Table 7-22. Specific flow outside of SILO tunnel at 3000 AD. Results of detailed model, sensitivity case, collapsed encapsulation, intact plugs.

TIME 3000 AD	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.47875E-11 6.26832E-12 -6.80335E-12 -1.64605E-11	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.51066E-11 4.33764E-12 -3.75415E-12 -1.17772E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.10365E-11 4.71537E-12 -8.95475E-13 -7.94029E-12	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.08755E-11 6.27815E-12 4.23192E-12 -5.71013E-12	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.59063E-11 6.45956E-12 9.94846E-12 -6.75168E-12	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	7.78599E-11 6.32168E-12 1.24374E-11 -7.37986E-11	3.72300E-11 1.32007E-11 -4.15902E-12 -1.76813E-11	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.29638E-11 9.25488E-12 -6.75176E-12 -1.64193E-11	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.17542E-11 5.17718E-12 1.35250E-11 -9.63855E-12	2.30121E-11 2.98618E-12 1.35692E-11 -7.36856E-12

Table 7-23. Specific flow outside of SILO tunnel at 4000 AD. Results of detailed model, sensitivity case, collapsed encapsulation, intact plugs.

TIME 4000 AD	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.29051E-11 9.81622E-12 -2.57402E-11 1.23327E-12	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.88235E-11 4.12762E-12 -1.53852E-11 -8.05668E-12	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.74233E-11 6.12070E-12 -8.80944E-12 -1.19186E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	1.99964E-11 9.93879E-12 8.17730E-13 -1.40124E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.04983E-11 1.09700E-11 1.15105E-11 -2.03074E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	9.04030E-11 1.07403E-11 -3.75851E-11 6.96265E-11	8.39604E-11 2.29944E-11 -5.53962E-11 1.49694E-11	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.58527E-11 1.72436E-11 -4.24660E-11 8.96269E-12	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	4.44165E-11 8.83880E-12 1.81705E-11 -2.98365E-11	4.68963E-11 3.94532E-12 1.80719E-11 -2.79501E-11

Table 7-24. Specific flow outside of SILO tunnel at 5000 AD. Results of detailed model, sensitivity case, collapsed encapsulation, intact plugs.

TIME 5000 AD	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.27910E-11 1.01740E-11 -2.79058E-11 -4.30228E-12	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.22621E-11 4.76783E-12 -1.64461E-11 -1.29910E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.10947E-11 6.72480E-12 -9.19857E-12 -1.65337E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.33307E-11 1.04821E-11 1.03622E-12 -1.84974E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.47603E-11 1.14739E-11 1.25800E-11 -2.49409E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	7.84379E-11 9.97700E-12 -3.75507E-11 5.39797E-11	8.03134E-11 2.22704E-11 -5.81759E-11 9.53130E-12	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.33589E-11 1.71721E-11 -4.48880E-11 4.16616E-12	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.06206E-11 9.18493E-12 2.00049E-11 -3.55387E-11	5.36659E-11 3.77449E-12 1.98609E-11 -3.38016E-11

Table 7-25. Specific flow outside of SILO tunnel at 6000 AD. Results of detailed model, sensitivity case, collapsed encapsulation, intact plugs.

TIME 6000 AD	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.34933E-11 1.03278E-11 -2.86127E-11 -5.62167E-12	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.33601E-11 4.96105E-12 -1.68850E-11 -1.42380E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.22424E-11 6.88699E-12 -9.53414E-12 -1.77861E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.42298E-11 1.05893E-11 7.26011E-13 -1.97716E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.56539E-11 1.15651E-11 1.23553E-11 -2.62315E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	7.61161E-11 9.83442E-12 -3.76446E-11 5.05625E-11	8.01604E-11 2.22112E-11 -5.91020E-11 8.28945E-12	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.38682E-11 1.72481E-11 -4.57064E-11 3.06632E-12	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.18826E-11 9.27441E-12 1.98846E-11 -3.70915E-11	5.50358E-11 3.74756E-12 1.97195E-11 -3.55794E-11

Table 7-26. Specific flow outside of SILO tunnel at 7000 AD. Results of detailed model, sensitivity case, collapsed encapsulation, intact plugs.

TIME 7000 AD	**FLOW** Components	**AVERAGE SPECIFIC FLOW OUTSIDE OF VOLUME STUDIED** (m/s) Average flow in rock, within a radius of ca. 5 m from tunnels. Resultant always given as a positive number. Negative flow = flow in negative direction of axis. Positive flow = flow in positive direction of axis.		
SECTION STUDIED Height (m)		VOLUME **Above**	VOLUME **Horizontal Outside**	VOLUME **Below**
Encapsulat. L12–L18 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.35442E-11 1.03388E-11 -2.86592E-11 -5.71053E-12	–
Encapsulat. L10–L11 H = 12 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.34349E-11 4.97538E-12 -1.69134E-11 -1.43227E-11	–
Encapsulat. L9 H = 11.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.23221E-11 6.89964E-12 -9.55525E-12 -1.78730E-11	–
Encapsulat. L8 H = 8 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	2.42961E-11 1.05984E-11 7.06223E-13 -1.98613E-11	–
Encapsulat. L5–L7 H = 11 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	3.57191E-11 1.15738E-11 1.23409E-11 -2.63230E-11	–
Top fill L20–L21 H = 6.5 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	7.59649E-11 9.82467E-12 -3.76503E-11 5.03367E-11	8.01537E-11 2.22073E-11 -5.91625E-11 8.20699E-12	–
Top of encapsulat. Bentonite / Sand L19 H=1.5m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.39063E-11 1.72535E-11 -4.57600E-11 2.99233E-12	–
Base of encapsulat. Bentonite / Sand L4 H = 2 m	**R**esultant **X**-direction **Y**-direction **Z**-direction	–	5.19732E11 9.28408E-12 1.98776E-11 -3.72017E-11	5.51339E-11 3.74908E-12 1.97109E-11 -3.57051E-11

8 References

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