Technical Design Note

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Infrastructure Design Studio
CONSULTING ENGINEERS

Project:	1675- Finches Lane, Baydon	**By:**	Luke Byrne
Subject:	LLFA Drainage Response		
Reference:	IDS-TN-1675-01 Rev 1	**Date:**	31/10/2023

1. INTRODUCTION

This technical note is with reference to drainage technical approvals from the LLFA for planning application reference PL/2023/04668 for Land North of Finches Lane, Baydon, SN8 2JN.

Initial drainage documents submitted for planning on the Portal were:

- Drainage plan VR-LDP-03 (Original plan - Jun 2023)
- Drainage Plan VR-DP-02 (Revised plan – Aug 2023)

Proposed plan is as Figure 1.

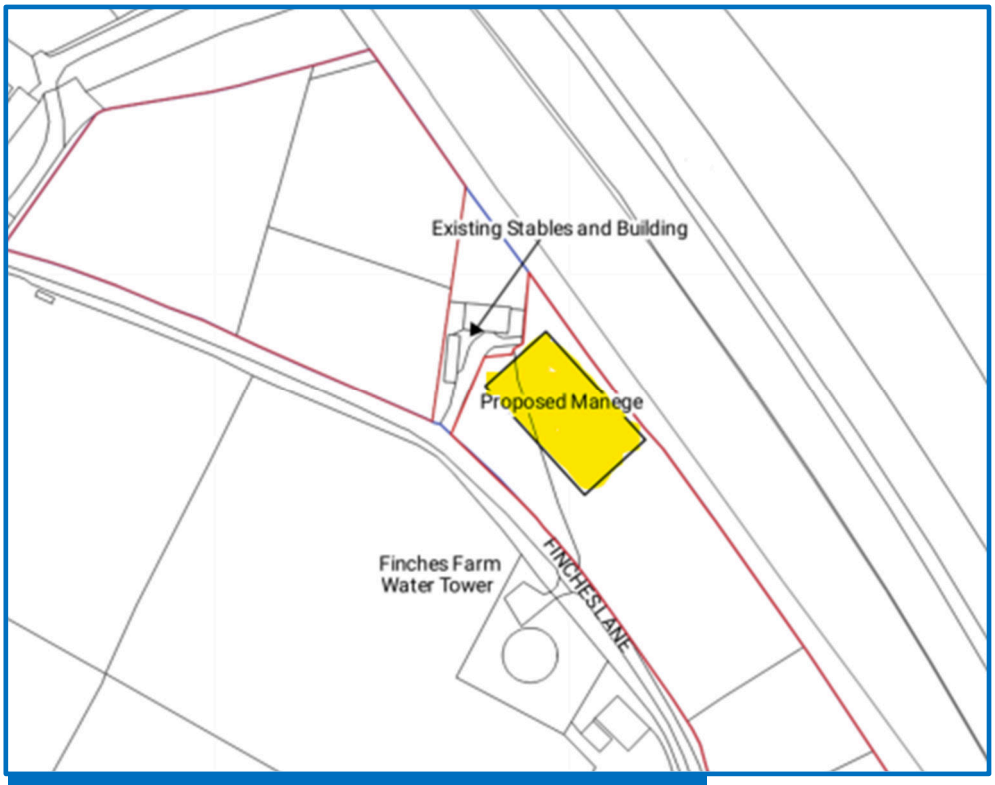


Figure 1 – Site Layout

2. LLFA RESPONSE

The LLFA response to the application from Wiltshire Council Planning in regard to the drainage elements. Drainage is covered in Condition 3 as below.

CONDITION 3

"Prior to the commencement of the development hereby approved, a detailed surface water drainage strategy shall be submitted to and approved in writing by the Local Planning Authority. The surface water drainage strategy must comply with Wiltshire Council's Surface Water Soakaway Guidance, which sets out the standards that must be met for planning approval and adoption. The submitted details must include:

- *Soakage tests undertaken in accordance with BRE 365 to demonstrate that infiltration is feasible.*
- *Calculations that demonstrate that the soakaway has been designed for:*
    - *1 in 100yr + cc flows;*
    - *Half drain time <24hrs; and*
    - *An appropriate factor of safety in line with CIRIA C753 (Table 25.2) guidance.*
- *Cross-section drawings of the proposed manege (to demonstrate the surface types) and confirm there will not be an increase in impermeability.*

The development shall then be undertaken in full accordance with the approved drainage details, and the drainage arrangements shall be maintained and retained thereafter.

REASON: to ensure the development can be adequately drained in a manner that would not prejudice the safe and efficient operation of the M4 motorway and to protect the integrity of the motorway geotechnical and drainage assets."

Following this response, BRE365 percolation tests were carried out on the site to determine soil permeability and potential for infiltration, and the drainage strategy below prepared.

3. HIERARCHY

Wiltshire County Council guidance notes states that the hierarchy for surface water disposal is as follows:

1. Infiltration
2. Surface waters (watercourse, ponds etc)
3. Surface water sewer
4. Combined sewer (only as a last resort)

The above hierarchy aligns with the SUDs manual (Ciria 753), therefore a solution that utilises infiltration would be sought in the first instance to provide a robust surface water drainage at source solution.

4. INFILTRATION TESTING

Planning condition 3 states, "*Soakage tests undertaken in accordance with BRE 365 to demonstrate that infiltration is feasible.*"

In order to determine whether infiltration is a viable option, percolation tests have been performed as per results in Appendix A. A deep BRE365 test (pit 4) to 2m was undertaken and a rate was available but deemed to be quite low. Several shallow tests (pit 1,2,3) were undertaken using BRE principles to consider if a porous surface solution was an option. The 3 shallow tests generated very consistent results confirming a consistent porous sub strata is available for a porous surface 'at source' solution. Below shows the calculation for the worst case test with an average infiltration rate of **7.5 x10^{-6}**m/sec. Therefore a shallow infiltration solution will be used, as this provides the lightest touch infiltration system.

Soil Permeability Calculation
to BRE Digest 365 *Soakaway Design*

Infrastructure Design Studio

Project No: 1675 *Project:* Finches Lane Arena
Date: 31.10.2023 *Designer:* L. Byrne

Soakaway test pit: Pit 2

Length of test pit =	0.600	m
Width of test pit =	0.300	m
Depth of test pit from ground level =	0.500	m

Soakaway test No. 2:

Distance from G.L. to datum water level at start of test =	0.200	m
Datum water level (always set to zero) =	0.000	m
Total drop below datum water level at end of test =	0.300	m

75% of effective depth below datum =	0.075	m	Time, t_{75} =	51	mins
50% of effective depth below datum =	0.150	m			
25% of effective depth below datum =	0.225	m	Time, t_{25} =	185	mins

V_{p75-25} = 0.027 m^3 t_{p75-25} = 134 mins
A_{p50} = 0.450 m^2

Soil infiltration rate, f = 7.5E-06 m/sec
Soil infiltration rate, f = 0.027 m/hr

Figure 2 – Infiltration testing calculations. Pit 2, Test 2

5. SURFACE WATER DISPOSAL

The type of development and topography often dictates the type of surface water disposal that is most suitable. On this site, a porous surfacing solution is ideal as it would exactly mimic the existing site. The Menage is also installed completely flat, so a porous surface will be genuine at source infiltration, with no concentration of infiltration.

The existing site is a grassed field. Any rainfall infiltrates directly into the ground at the point at which it falls. This is source control in it's purest form. During heavy exceedance rainfall events these top surface layers may become waterlogged and then any excess water would settle into depressions or discharge across the surface as greenfield run off.

A porous surfacing solution would have zero impact on offsite discharge as it replicates the way the existing site is drained at source. Any rainfall that falls on any area, infiltrates directly through that area. If we consider an area of $1m^2$, it has exactly the same area ($1m^2$) to infiltrate into the ground, as per the existing undisturbed green field.

Where conventional soakaways are used, flows generated by surface run-off are concentrated to a single point of discharge. This is NOT the case on this site, with the menage area being flat, true at source infiltration is provided as described above.

Due to the nature of the development and the replication of the source control infiltration, the risk of failure is negligible. This is discussed further in Section 8 (Factor of Safety) of this report.

The BRE365 percolation tests confirm that surface water disposal by infiltration is possible. The percolation rate of **7.5×10^{-6}**m/sec was achieved in Pit 2, on test 2. Pit 2 was shallow test, carried out at 600mm below ground level.

A porous surfacing solution with a sub base depth of 150mm would provide sufficient storage and infiltration to contain the 100year +40%. Porous surfacing calculations based on a 10m SQ sample area have been provided in Appendix B, showing water depth within the sub base will reach 112mm deep.

Whilst the original ground would become saturated and create surface run off, the proposed solution is more robust as it will hold the excess volume up to 100 year + 40% CC storm event for subsequent infiltration, with the storage volume provided there is no risk of failure and overland flow. Being a significant betterment on the original field drainage.

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6. CLIMATE CHANGE

Planning condition 3 states, "*Calculations that demonstrate that the soakaway has been designed for, 1 in 100yr + cc flows;*"

The climate change factor can vary across different locations and is dependant on the type of development that it is accounting for. The DEFRA website (https://environment.data.gov.uk/hydrology/climate-change-allowances/rainfall) provides climate change allowances. Figure 3 shows a screenshot from the DEFRA mapping software.

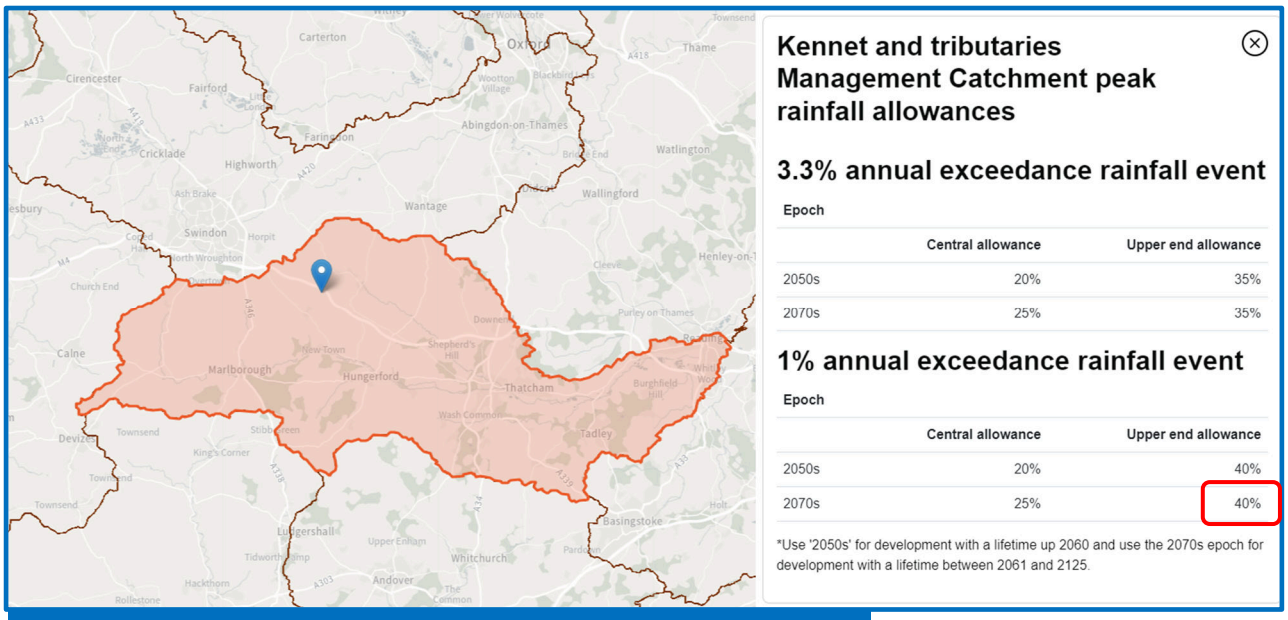


Figure 3 – Extract from DEFRA Climate Change mapping software

The value to be used for this site is **40%**. This value has been included in the rainfall data for the calculations shown in Appendix B.

7. HALF DRAIN TIME

Planning condition 3 states, "*Half drain time <24hrs.*"

Half drain time is important when sizing any infiltration structure as it ensure that there is suitable capacity within it when any subsequent storms hit shortly after the main a storm event. Therefore, a half drain time of less than 24 hours must be adhered to.

The full design calculations for the porous paving shown in Appendix B clearly state the half drain time for the is **60 minutes**, thus satisfying the half drain time.

8. FACTOR OF SAFETY

Planning condition 4 states, "*An appropriate factor of safety in line with CIRIA C753 (Table 25.2) guidance.*"

Below table is Table 25.2 extracted from The SUDs Manual (Ciria C753).

TABLE 25.2 Suggested factors of safety, F, for use in hydraulic design of infiltration systems (designed using Bettess (1996). Note: not relevant for BRE method)

Size of area to be drained	Consequences of failure		
	No damage or inconvenience	Minor damage to external areas or inconvenience (eg surface water on car parking)	Damage to buildings or structures, or major inconvenience (eg flooding of roads)
< 100 m²	1.5	2	10
100–1000 m²	1.5	3	10
> 1000 m²	1.5	5	10

Figure 4 – Table 25.2 from The SUDs Manual

Table 25.2 is the factor of safety matrix from The SUDs Manual (Ciria C753) and it used to inform the design of infiltration structures. As discussed in Section 5 (Surface Water Disposal) of this report, a standard soakaway is effectively concentrating run-off to a single point. A single soakaway may drain a much larger area and when flows are concentrated, the risk of failure increases and the impact of failure must be factored in to the calculations.

The porous surfacing design for this site however is not concentrating any flows to a single point. Therefore, the risk of failure of the infiltration structure is negligible, particularly given the consistent infiltration rates**.**

In the interest of reassurance and appreciating that a safety factor of 1 should not be implemented. The calculations shown in Appendix B have therefore utilise a F.O.S based on the risk matrix in Figure 3. This is based on each 1m2 of catchment has a soakaway beneath of 1m2. So a 1m2 soakaway with no damage or inconvenience.

The Factor of Safety for the porous paving design on this development is therefore **1.5**.

It should also be noted that the design only uses 112mm of the available storage, so further exceedance storage beyond 100 years is available in the sub base, together with further storage in the fibreturf layer above.

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9. CROSS SECTIONS

Planning condition 3 states, "*Cross-section drawings of the proposed menage (to demonstrate the surface types) and confirm there will not be an increase in impermeability.*"

Figure 5 has been included as a typical build up for the porous surfacing.

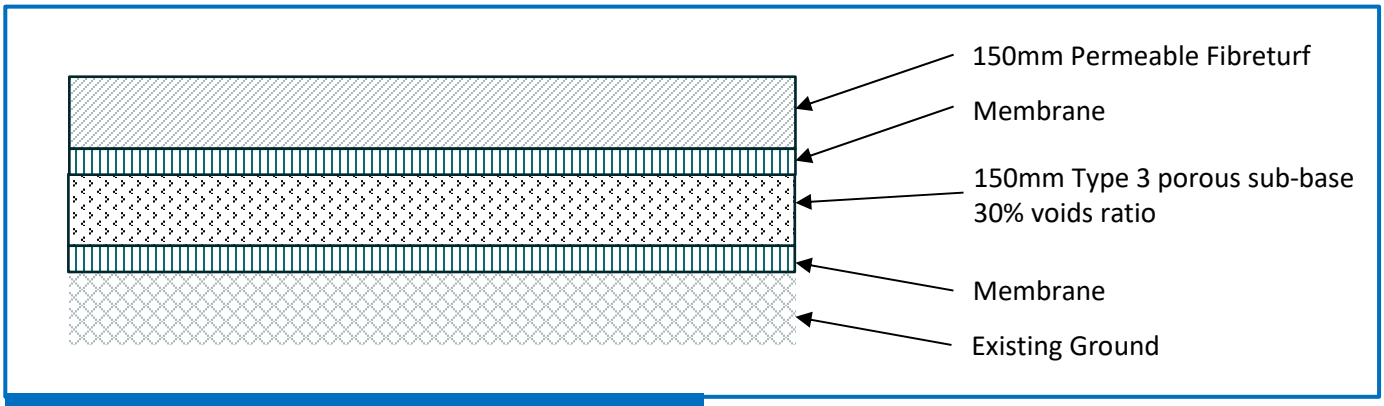


Figure 5 – Typical menage surface build up

The uppermost layer of fibreturf shall be equestrian specific and will be permeable.

10. APPENDICES

Appendix A – BRE 365 Soakaway test results

Appendix B – Microdrainage Porous Paving Calculations 100 year +40%

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APPENDIX A

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BRE Digest 365

Method for Determining Soil Infiltration Rate

Soakaway Test Record

Project:	ARENA - FINCHES LANE	Test Pit Number	1, 2, 3
Date:	2+3-10-23		
Test By:	TEC. AARON MILLS.		
Weather during test:	DRY, OVERCAST		
		Length of pit	600MM
		Width of pit	300MM
		Depth of pit	500MM.
	If filled with gravel, depth from datum point to top of gravel		

Depth versus time measurements

Test 1 PIT 1.		Test 2 PIT 2.		Test 3 PIT 3.	
Time	Depth below datum (mm)	Time	Depth below datum (mm)	Time	Depth below datum (mm)
11-15.	300	11-30.	300	11-45	300.
13.15	120.	13.20	140.	13.25	110.
14.30	0	14.35	70.	14.40	0.
		15-10	0.		
14.45.	300.	14.50.	300.	14.55.	300.
16.30	150.	16.35	160	16.40	100
17.50.	20.	17.55	70	18.00.	0.
08-30.	300.	08.35.	300	08-40.	300.
10-00.	140	10-05	110	10-10.	100.
12-00	50.	12-05	20.	12-10.	0.

3-10-23

APPENDIX B

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31 Dyer Street Cirencester Glos GL7 2PP	1675 - FINCHES LANE, BAYDON POROUS PAVING (10m x 10m) 100 YEAR +40%	
Date 01/11/2023 15:55 File 1675 - Porous paving (1...	Designed by LTB Checked by MS	
Causeway	Source Control 2020.1	

Summary of Results for 100 year Return Period (+40%)

Half Drain Time : 60 minutes.

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
15 min Summer	99.907	0.057	0.5	1.7	Flood Risk
30 min Summer	99.927	0.077	0.5	2.3	Flood Risk
60 min Summer	99.942	0.092	0.5	2.7	Flood Risk
120 min Summer	99.949	0.099	0.5	3.0	Flood Risk
180 min Summer	99.948	0.098	0.5	2.9	Flood Risk
240 min Summer	99.944	0.094	0.5	2.8	Flood Risk
360 min Summer	99.933	0.083	0.5	2.5	Flood Risk
480 min Summer	99.923	0.073	0.5	2.2	Flood Risk
600 min Summer	99.913	0.063	0.5	1.9	Flood Risk
720 min Summer	99.906	0.056	0.5	1.7	Flood Risk
960 min Summer	99.897	0.047	0.5	1.4	Flood Risk
1440 min Summer	99.887	0.037	0.4	1.1	Flood Risk
2160 min Summer	99.878	0.028	0.3	0.8	Flood Risk
2880 min Summer	99.873	0.023	0.2	0.7	Flood Risk
4320 min Summer	99.867	0.017	0.2	0.5	Flood Risk
5760 min Summer	99.864	0.014	0.1	0.4	Flood Risk
7200 min Summer	99.862	0.012	0.1	0.3	Flood Risk
8640 min Summer	99.860	0.010	0.1	0.3	Flood Risk
10080 min Summer	99.859	0.009	0.1	0.3	Flood Risk
15 min Winter	99.917	0.067	0.5	2.0	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
15 min Summer	131.851	0.0	17
30 min Summer	88.566	0.0	31
60 min Summer	56.713	0.0	52
120 min Summer	35.004	0.0	86
180 min Summer	25.973	0.0	120
240 min Summer	20.877	0.0	154
360 min Summer	15.365	0.0	218
480 min Summer	12.341	0.0	280
600 min Summer	10.402	0.0	340
720 min Summer	9.042	0.0	398
960 min Summer	7.241	0.0	512
1440 min Summer	5.284	0.0	752
2160 min Summer	3.848	0.0	1120
2880 min Summer	3.068	0.0	1472
4320 min Summer	2.226	0.0	2204
5760 min Summer	1.771	0.0	2936
7200 min Summer	1.483	0.0	3672
8640 min Summer	1.284	0.0	4344
10080 min Summer	1.137	0.0	5120
15 min Winter	131.851	0.0	17

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Date 01/11/2023 15:55 File 1675 - Porous paving (1...	Designed by LTB Checked by MS	
Causeway	Source Control 2020.1	

Summary of Results for 100 year Return Period (+40%)

Storm Event	Max Level (m)	Max Depth (m)	Max Infiltration (l/s)	Max Volume (m³)	Status
30 min Winter	99.940	0.090	0.5	2.7	Flood Risk
60 min Winter	99.957	0.107	0.5	3.2	Flood Risk
120 min Winter	99.962	0.112	0.5	3.4	Flood Risk
180 min Winter	99.958	0.108	0.5	3.2	Flood Risk
240 min Winter	99.950	0.100	0.5	3.0	Flood Risk
360 min Winter	99.933	0.083	0.5	2.5	Flood Risk
480 min Winter	99.916	0.066	0.5	2.0	Flood Risk
600 min Winter	99.904	0.054	0.5	1.6	Flood Risk
720 min Winter	99.897	0.047	0.5	1.4	Flood Risk
960 min Winter	99.889	0.039	0.4	1.2	Flood Risk
1440 min Winter	99.880	0.030	0.3	0.9	Flood Risk
2160 min Winter	99.872	0.022	0.2	0.7	Flood Risk
2880 min Winter	99.868	0.018	0.2	0.5	Flood Risk
4320 min Winter	99.863	0.013	0.1	0.4	Flood Risk
5760 min Winter	99.860	0.010	0.1	0.3	Flood Risk
7200 min Winter	99.859	0.009	0.1	0.3	Flood Risk
8640 min Winter	99.857	0.007	0.1	0.2	Flood Risk
10080 min Winter	99.857	0.007	0.1	0.2	Flood Risk

Storm Event	Rain (mm/hr)	Flooded Volume (m³)	Time-Peak (mins)
30 min Winter	88.566	0.0	31
60 min Winter	56.713	0.0	58
120 min Winter	35.004	0.0	92
180 min Winter	25.973	0.0	130
240 min Winter	20.877	0.0	166
360 min Winter	15.365	0.0	234
480 min Winter	12.341	0.0	294
600 min Winter	10.402	0.0	346
720 min Winter	9.042	0.0	400
960 min Winter	7.241	0.0	520
1440 min Winter	5.284	0.0	762
2160 min Winter	3.848	0.0	1128
2880 min Winter	3.068	0.0	1468
4320 min Winter	2.226	0.0	2204
5760 min Winter	1.771	0.0	2880
7200 min Winter	1.483	0.0	3672
8640 min Winter	1.284	0.0	4312
10080 min Winter	1.137	0.0	5208

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Rainfall Details

Rainfall Model	FSR	Winter Storms	Yes
Return Period (years)	100	Cv (Summer)	0.750
Region	England and Wales	Cv (Winter)	0.840
M5-60 (mm)	20.000	Shortest Storm (mins)	15
Ratio R	0.350	Longest Storm (mins)	10080
Summer Storms	Yes	Climate Change %	+40

Time Area Diagram

Total Area (ha) 0.010

Time (mins) From:	To:	Area (ha)
0	4	0.010

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Model Details

Storage is Online Cover Level (m) 100.000

Porous Car Park Structure

Infiltration Coefficient Base (m/hr)	0.02700	Width (m)	10.0
Membrane Percolation (mm/hr)	1000	Length (m)	10.0
Max Percolation (l/s)	27.8	Slope (1:X)	0.0
Safety Factor	1.5	Depression Storage (mm)	5
Porosity	0.30	Evaporation (mm/day)	3
Invert Level (m)	99.850	Membrane Depth (m)	0

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