KAYA CONSULTING

Blackford Renewables Ltd.

Blackford Energy Park, Rothienorman, Aberdeenshire

Surface Water Drainage Strategy

May 2025

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1 Introduction

A battery storage system (BESS) is proposed on land near Rothienorman Substation (**Figure 1**) within the Aberdeenshire Council area. Kaya Consulting Limited was commissioned by Blackford Renewables Ltd to undertake a Surface Water Drainage Strategy suitable for submission with planning.

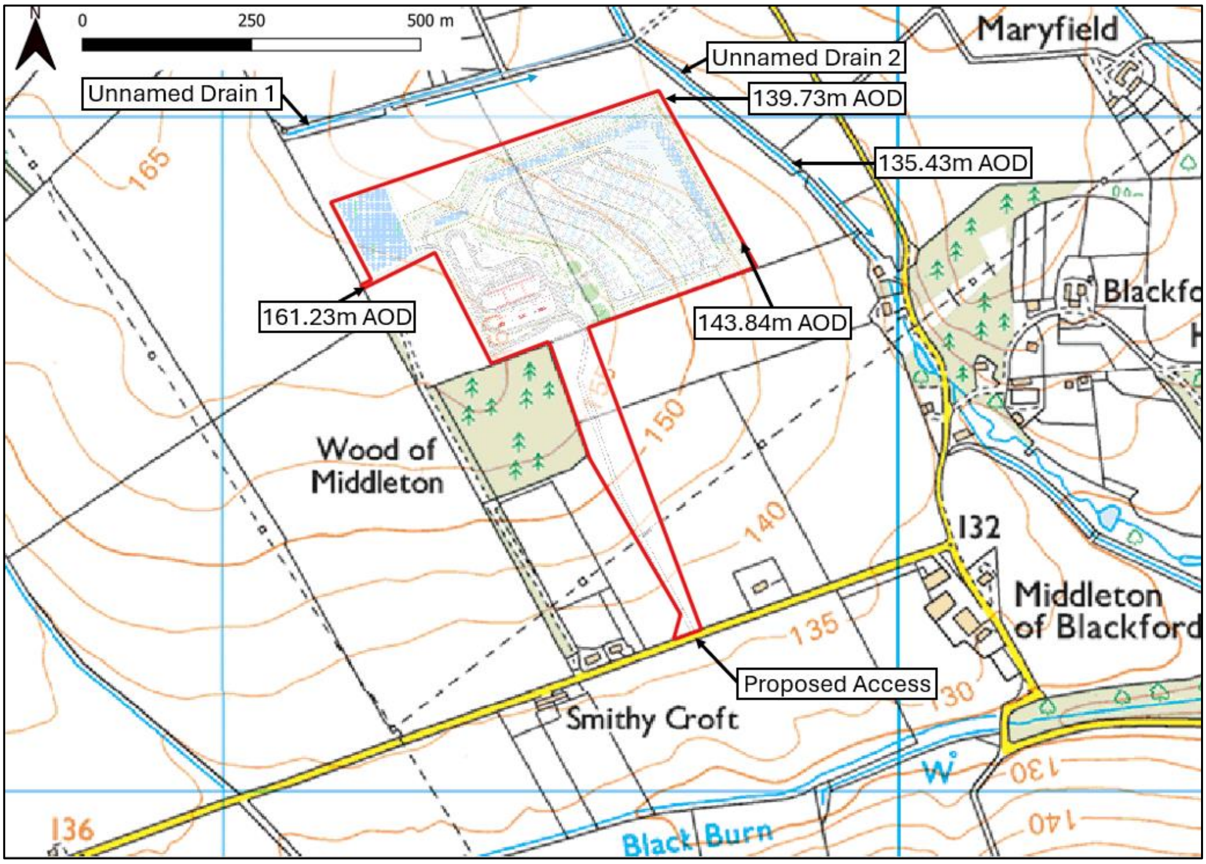
The site is located adjacent to the Wood of Middleton, some 2km to the west of the village of Rothienorman, and adjacent to Rothienorman Substation. The red-line boundary is approximately 16ha in area.

Figure 1 shows the site and surrounding area in more detail. The site is bounded by Rothienorman Substation to the west, Wood of Middleton to the south and agricultural land to the north and east. The proposed access is by a new track off the unnamed road to the south.

Two small watercourses lie near the site. A small drain flows east beyond the northern boundary of the site. This heavily overgrown drain has its confluence with a second, larger drain referred to here near the north-eastern corner of the site. This larger drain flows south-east along the eastern boundary of the site towards the Black Burn.

The proposed drainage strategy is summarised in the following sections.

Figure 1: Site Location



2 Drainage Strategy

2.1 Existing Drainage and Ground Conditions

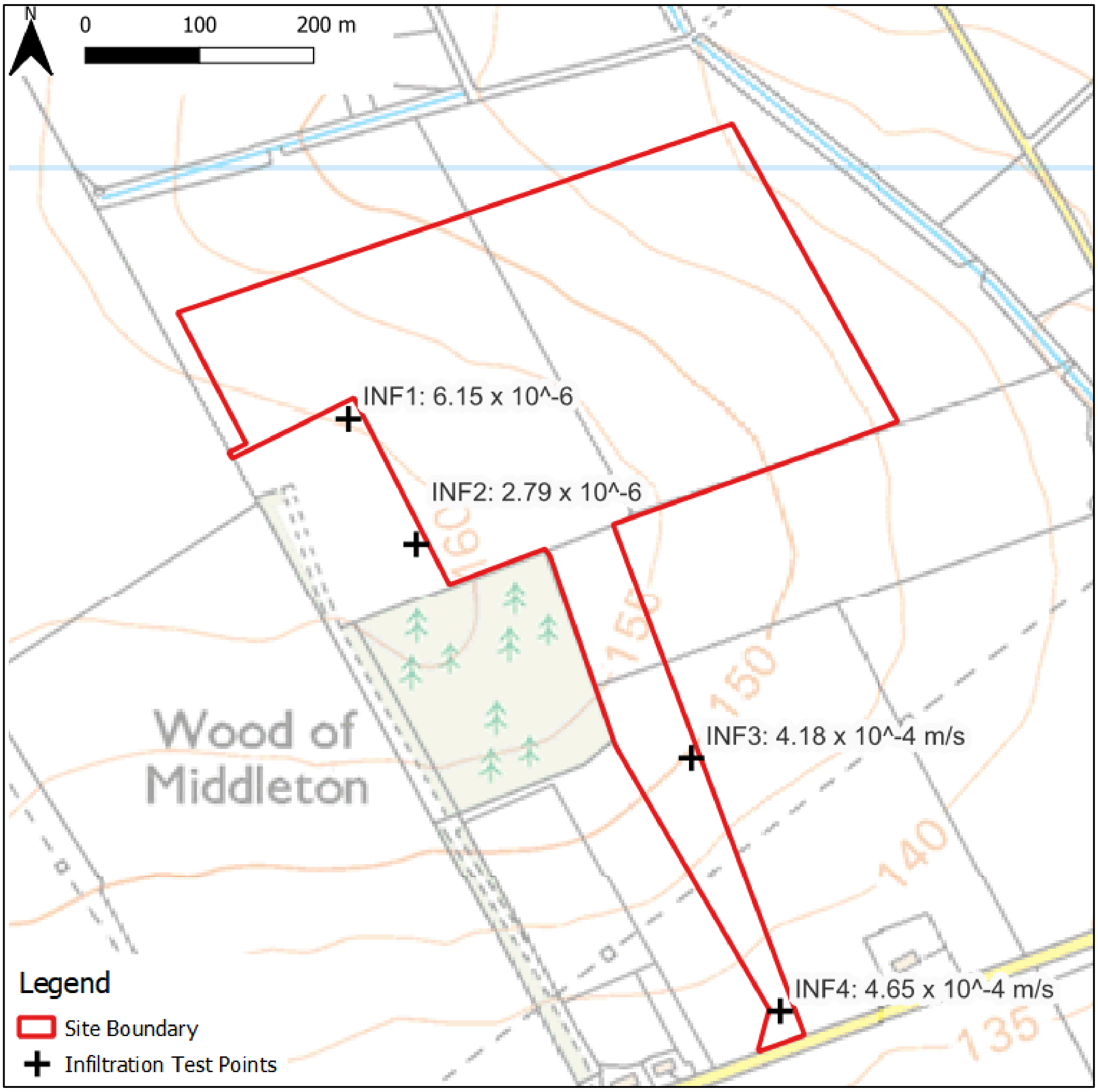
Infiltration testing was undertaken by Raeburn Drilling and Geotechnical (Northern) Limited as part of Ground Investigation works at the site and provided to Kaya Consulting by the client for use in the preparation of the drainage strategy.

Infiltration tests were carried out at two trial pits along the proposed access track and two pits adjacent to the western site boundary in general accordance with BRE 365. The trial pits were reported to encounter generally consistent ground conditions The locations of the pits and design infiltration rates are presented in **Figure 2** below. The detailed results of the infiltration tests are presented in **Appendix A**.

The trial pits encountered generally consistent ground conditions across the site. Underlying uppermost topsoil, which was encountered to a depth of 0.25cm at all exploratory locations, deposits largely comprised weathered rock, which became increasingly competent with depth. Trial pits terminated in weathered bedrock (pelite) at depths of between 1.70m (INF1) and 2.50m (INF2/ INF3/ INF4).

Groundwater was not encountered within the trial pits dug for the investigation. However, it was noted that the pits may not have been open long enough for groundwater seepage to occur.

Figure 2: Trial Pit Locations and Reported Infiltration Rates



2.2 Fire Suppression Water Runoff

The National Fire Chief Council (2023) recommend that suitable environmental protection measures should be provided at BESS developments to manage fire suppression water runoff in the event of a battery fire. System capability/capacity should be based on anticipated water application rates, including the impact of water based fixed suppression systems.

2.3 SuDS, Drainage Hierarchy and Potential Strategies

Sustainable Urban Drainage Systems (SuDS) are used to manage surface water runoff effectively within a development to mitigate against the impacts associated with an increase in the impermeable area such as increased flows and exacerbated flooding downstream.

The SuDS Manual (CIRIA Report C753, 2015) is the current best practice guidance on the use of SuDS. It promotes the use of a hierarchical approach to managing runoff in which the higher priority mechanisms should be implemented whenever possible.

Table 1 provides a summary of the hierarchy with site-specific justification provided for each level within the hierarchy.

Table 1: Application of the Hierarchy of Drainage at the site

	Hierarchy of Drainage Techniques		Implementation
1	Control at Source – Infiltration, Re-Use, Green Roofs, Run-off to grass or verge, Harvesting, Water Butts, and Permeable Layers	✓	Infiltration testing suggests infiltration rates at the site access are suitable.
2	On Site Treatment with Other SuDS Techniques – Collection for Infiltration and Detention	✓	The ground conditions suited to infiltration drainage
3	Local Treatment with Other SuDS Techniques – Collection away from the Site	x	Options higher in the hierarchy are available
4	Regional Treatment with Other SuDS Techniques – Collection in Wetlands and Balancing Ponds	x	Options higher in the hierarchy are available
5	Discharge to Watercourses – including streams, ditches, or existing swales	x	Options higher in the hierarchy are available
6	Discharge to Surface Water Sewers	x	Options higher in the hierarchy are available
7	Discharge to Combined Sewers	x	Options higher in the hierarchy are available

The most viable options within the Hierarchy of Drainage are; infiltration into the ground at source and collection on site for detention and infiltration. The available infiltration test results indicate infiltration rates at the site are suited to this form of drainage.

2.4 Proposed Surface Water Drainage Strategy

To prevent contamination by fire suppression water in the event of a fire, management of surface water runoff has been separated between:

- General site runoff: Routed through fire water detention tanks with automatic shutoff valves which activate in the event of a fire and prevent contaminated water from being infiltrated. Under normal circumstances water simply flows through these detention tanks and is attenuated in a SuDS infiltration basin sized based on the impermeable area introduced.
- Site access runoff: Drained by means of infiltration via soakaways sized based on the impermeable area introduced

In compliance with the above, the drainage strategy has been developed to meet the following key principles;

- Mimic existing (greenfield) drainage arrangements as far as possible;
- Avoid increases in the greenfield rate, volume and frequency of offsite discharge;
- Avoid significant deterioration in water quality of discharges and no detrimental impact in downstream water quality;
- Achieve the above criteria for storms up to and including the 200-year event; and
- Incorporate an allowance for climate change (37%) and urban creep (10%).

Figure 3 provides an indicative layout of the drainage structures and features proposed within the development area. The area of impermeable surfaces draining to the infiltration basin is also shown and has been measured to be approximately 5.23ha. This is comprised of impermeable hardstanding under the platformed BESS areas, electrical infrastructure units, associated structures, as well as tracks within the main site compound. Access tracks outwith the platformed site area will be constructed of Type 2 and have also been considered impermeable. These comprise a further 0.82ha. The specification of the drainage proposed to manage post development runoff from the site is outlined below:

- The results of the infiltration testing conducted in the vicinity of the site (**Section 2.1**) indicate that infiltration drainage is feasible at the site. Further infiltration should be conducted at the proposed location of the proposed infiltration pond to ensure infiltration rates in this area of the site are within a suitable range.

  Runoff from each of the BESS areas will be routed through lined drainage channels to detention tanks situated throughout the site. The outlets on these tanks will be controlled by automatic shutoff valve which will activate in the case of a fire, allowing these tanks to attenuate potentially contaminated fire suppression water during the unlikely event of a fire on site. Under normal conditions runoff will be passed through these without attenuation and be routed to an infiltration basin in the north-east of the site. The National Fire Chiefs Council (2023) recommend a minimum volume of 228m^3 (1,900L/min for 2 hours) be available on site to cool adjacent units in the event of a battery fire. The fire water detention tanks will be designed by others. However, these should be sized in such a way that the full volume of fire suppression water which could be used at the site can be safely attenuated. Their design should also ensure rainfall runoff is able to freely pass through under normal conditions with no storage of rainfall.

  The indicative infiltration basin shown in **Figure 3** has been oversized, with an assumed 10% allowance for urban creep. The proposed total volume of the pond is 8,600m^3, more than the 7,891m^3 of total runoff predicted in the 24hr 200-year plus climate change storm (37% rainfall intensity uplift). The actual volume required is likely substantially lower when infiltration is considered. As no infiltration data is available at the location of the proposed pond, two scenarios were considered based on the available infiltration testing data. The conservative scenario based on an infiltration rate of 6.15 x 10^{-6} m/s (Trial Pit 1) indicates a storage volume of 8,329m^3 would be required and a likely best-case scenario assuming a higher infiltration rate of 4.18 x 10^{-4} m/s (Trial Pit 3) suggests a storage volume of just 3,582m^3 is necessary. The infiltration basin has been sized with calculations assuming a uniform shape (65m x 65m x 2m depth), and vertical walls. Infiltration basins can be constructed in a wide range of shapes and we would recommend that the final design is guided by The SuDS Manual (see **Figure 4**). The final volume of storage should be confirmed based on network modelling and further infiltration testing.

- The results from Trial Pits 3 and 4 indicate that an infiltration rate of at least 4.18 x 10^{-4} m/s is achievable at the location of the north-south access. Runoff generated from this section of the access (approximately 0.49ha) will drain into 15 soakaways, spaced regularly and positioned adjacent to the road, sized for the 200-year + climate change event. Each soakaway is sized at 27.0m x 1.25m x 1.0m depth (effective depth of 0.5m due to gradient) and will be capable of draining areas up to 5000m^2. Similar infiltration rates are assumed for the secondary access which runs around the perimeter of the site. Approximately 0.33ha of this track lies out with the area drained to the infiltration basin. will drain into 10 soakaways, spaced regularly and positioned adjacent to the road, sized for the 200-year + climate change event. Each soakaway is sized at 27.0m x 1.25m x 1.0m depth (effective depth of 0.5m due to gradient) and will be capable of draining areas up to 3300m^2. Soakaways can be constructed in a wide range of shapes and we would recommend that the final design is guided by The SuDS Manual (see **Figure 5**).

Calculations for the above are presented in **Appendix B**.

Figure 3: Indicative Drainage Strategy

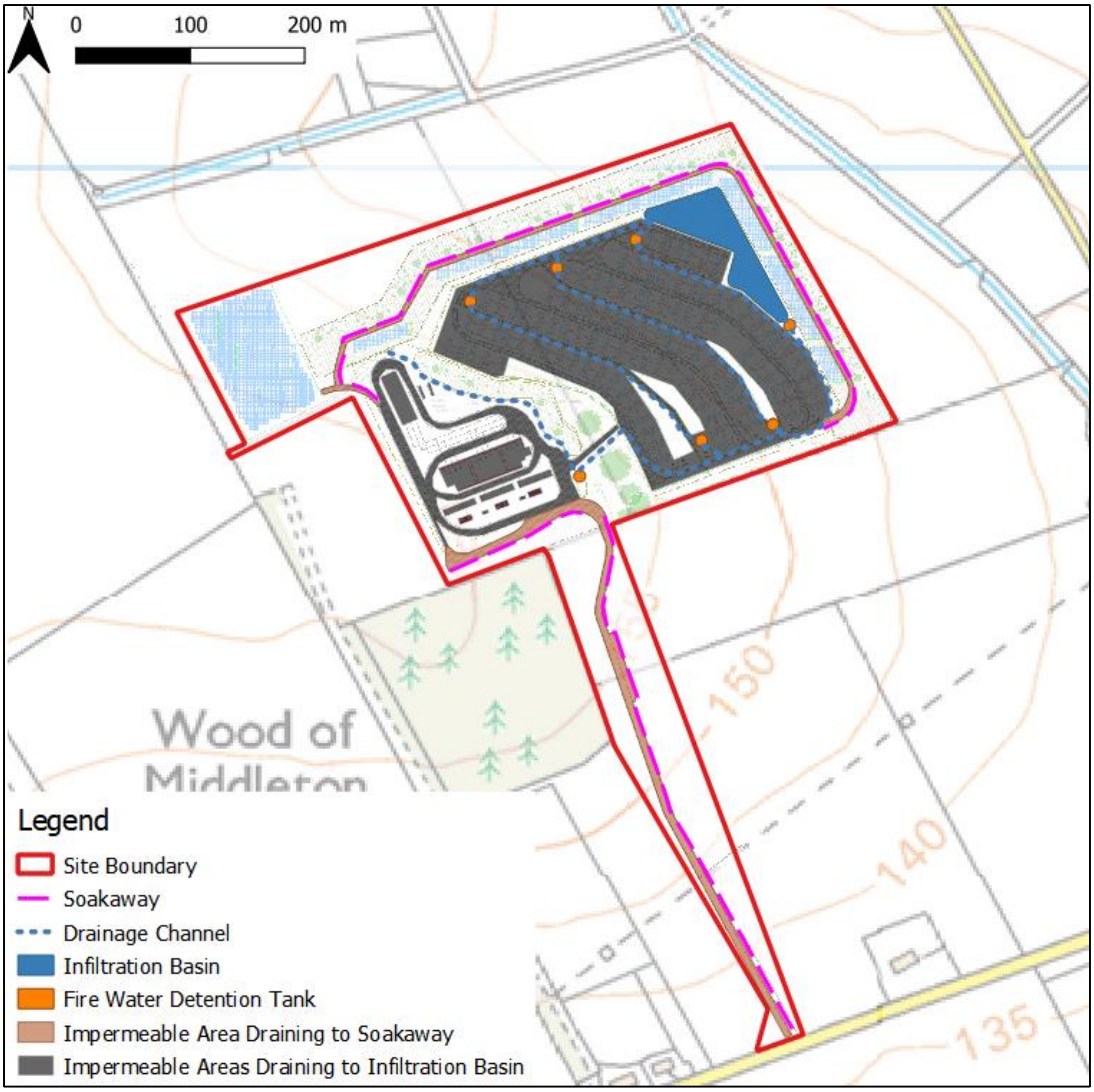


Figure 13.4 and *Figure 13.5* of The SuDS Manual provide an example plan and profile view for an infiltration basin.

Figure 4: *Figure 13.4* and *Figure 13.5* in SuDS Manual (Infiltration Basin)

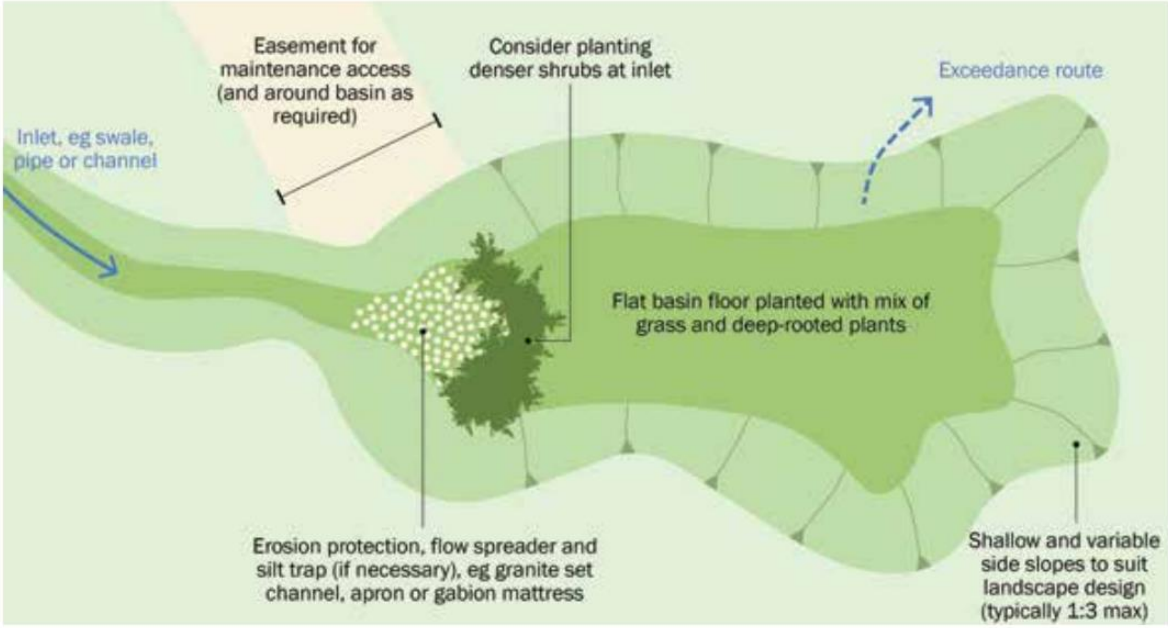


Figure 13.4 Plan view of infiltration basin

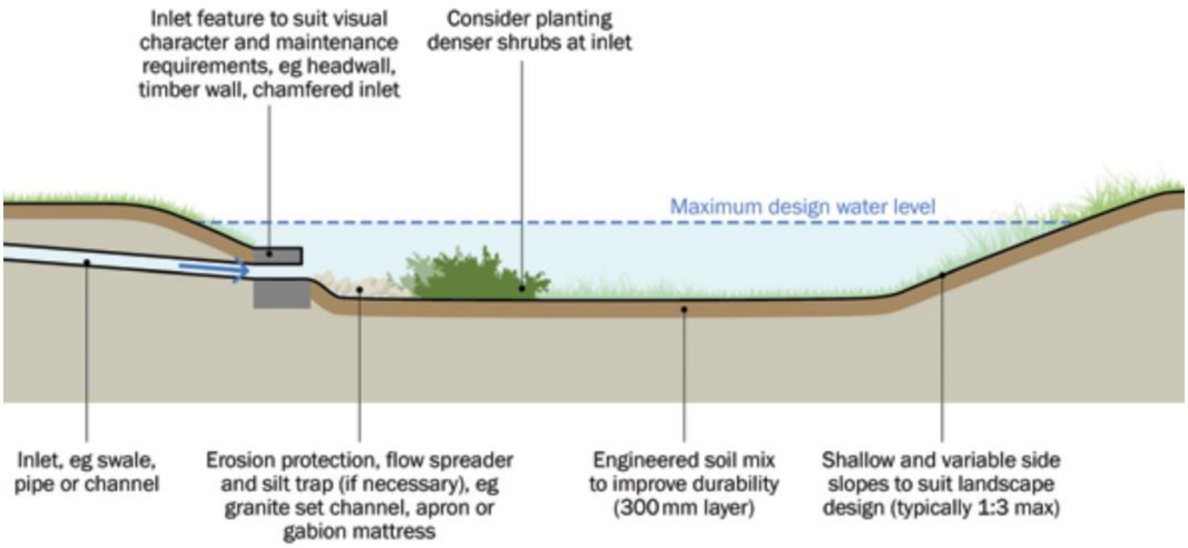
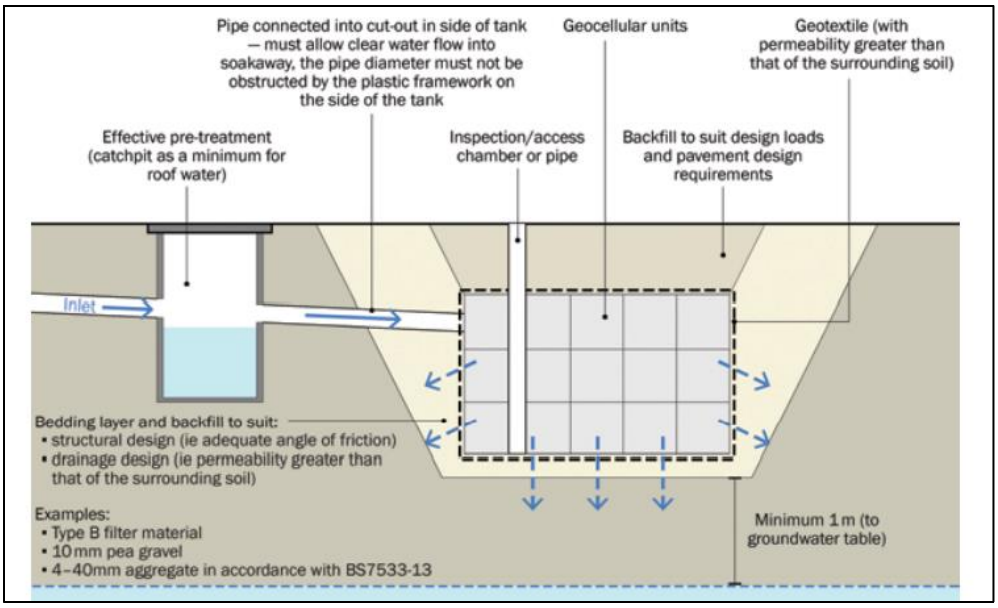


Figure 13.5 Elevation of infiltration basin

Figure 13.1 of The SuDS Manual provides an example cross section for a soakaway including examples of filling material.

Figure 5: *Figure 13.1* in SuDS Manual (Soakaway)



2.4.1 Exceedance events

During events in excess of the 200-year plus climate change uplift or in the event of a blockage to the soakaways/filter drains or infiltration pond, surface water will route through the site in a similar manner prior to the development being constructed. Hence, no new overland flow pathways will be created due to the construction of the site.

2.4.2 Maintenance

Table 13.2 of the SuDS Manual provides guidance on the type of operational and maintenance requirements that may be appropriate for Infiltration Basins.

TABLE 13.2 Operation and maintenance requirements for infiltration basins

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Remove litter, debris and trash	Monthly
	Cut grass – for landscaped areas and access routes	Monthly (during growing season) or as required
	Cut grass – meadow grass in and around basin	Half yearly: spring (before nesting season) and autumn
	Manage other vegetation and remove nuisance plants	Monthly at start, then as required
Occasional maintenance	Reseed areas of poor vegetation growth	Annually, or as required
	Prune and trim trees and remove cuttings	As required
	Remove sediment from pre-treatment system when 50% full	As required
Remedial actions	Repair erosion or other damage by reseeding or re-turfing	As required
	Realign the rip-rap	As required
	Repair or rehabilitate inlets, outlets and overflows	As required
	Rehabilitate infiltration surface using scarifying and spiking techniques if performance deteriorates	As required
	Relevel uneven surfaces and reinstate design levels	As required
Monitoring	Inspect inlets, outlets and overflows for blockages, and clear if required	Monthly
	Inspect banksides, structures, pipework etc for evidence of physical damage	Monthly
	Inspect inlets and pre-treatment systems for silt accumulation; establish appropriate silt removal frequencies	Half yearly
	Inspect infiltration surfaces for compaction and ponding	Monthly

Table 13.1 of the SuDS Manual provides guidance on the type of operational and maintenance requirements that may be appropriate for soakaways.

TABLE 13.1 Operation and maintenance requirements for soakaways

Maintenance schedule	Required action	Typical frequency
Regular maintenance	Inspect for sediment and debris in pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	Annually
	Cleaning of gutters and any filters on downpipes	Annually (or as required based on inspections)
	Trimming any roots that may be causing blockages	Annually (or as required)
Occasional maintenance	Remove sediment and debris from pre-treatment components and floor of inspection tube or chamber and inside of concrete manhole rings	As required, based on inspections
Remedial actions	Reconstruct soakaway and/or replace or clean void fill, if performance deteriorates or failure occurs	As required
	Replacement of clogged geotextile (will require reconstruction of soakaway)	As required
Monitoring	Inspect silt traps and note rate of sediment accumulation	Monthly in the first year and then annually
	Check soakaway to ensure emptying is occurring	Annually

2.5 Surface Water Quality

The site will be unmanned and will not be visited on a daily basis. In addition, when being visited, the type of vehicles are not likely to be larger vehicles such as HGVs etc.

Surface water at the compound will be treated via filter drains and the infiltration basin. Surface water on the roads will be treated by the soakaways.

A water quality risk assessment has been carried out using the SuDS hazard mitigation indices in accordance with the SuDS Manual, CIRIA Report C753. Considering the low expected traffic volumes and appropriate containment of any hazardous substances, the residual pollution hazard level is considered to be low hazard levels similar to that of a low traffic road and non-residential car parking with infrequent change. Total Suspended Solids, Metals and Hydrocarbons are not predicted to exceed 0.4 therefore the proposals are deemed sufficient.

Table 2: Simple Index Approach

Pollution Hazard Indices for Different Land Use Classifications				
Type	**Hazard Level**	**Suspended Solids**	**Metals**	**Hydrocarbons**
Commercial Roofing: Inert Materials	Very Low	0.3	0.2	0.05
Very Low Traffic Roads	Low	0.4	0.4	0.4
Pollution Mitigation Indices				
Type of SuDS component		**Suspended Solids**	**Metals**	**Hydrocarbons**
Infiltration Basin		0.5	0.5	0.6
Filter Drain		0.4	0.4	0.4

In addition to the standard risks outlined in **Table 2**, there is a very low risk of battery fire at the site. SEPA considers fire water polluting and to be treated as hazardous waste. Consequently, such an event should be considered as having the potential to adversely impact the water environment without appropriate mitigation. The drainage system of the main site should be designed to mitigate against the pollution of the water environment by contaminated fire suppression water.

The platformed battery storage areas will be constructed of impermeable materials to eliminate the risk of infiltration of contaminants in the event of a fire. The drainage system routing water from the site compound to the infiltration basin should also be constructed of impermeable materials to prevent infiltration. Measures should be in place to allow the attenuation of contaminated water on site without infiltration. Detention tanks with automatic shutoff valves which active in the event of fire are proposed. This system is detailed in **Section 2.4**.

2.6 Foul Water Drainage Strategy

The foul water strategy is not part of this commission.

2.7 Construction Phase Drainage Arrangements

We would recommend following the good management practice techniques given in Supporting Guidance (WAT-SG-75) Sector Specific Guidance: Water Run-Off from Construction Sites (SEPA, 2021).

The guidance outlines that during the construction phase, additional drainage measures should be implemented to help attenuate the increase in surface water flows if surface water is observed discharging from the construction compound.

Runoff from these areas is anticipated to have high silt loading due to mobilised soil from excavated surfaces, fines from track aggregate and sludge due to traffic.

We would recommend that hardstanding runoff be directed to a swale on the site's lower points. This drainage scheme can be removed at the end of the construction stage and the area reinstated. It is recommended that vegetation disturbance be minimised during construction. Decompaction of ground post-construction should be provided in the areas where necessary.

If any underground culverts or land drains are damaged as part of the construction phase, then these should be repaired or replaced.

3 Summary and Recommendations

The proposed surface water drainage strategy for the development seeks to provide a sustainable and integrated surface water management scheme and aims to ensure no increase in downstream flood risk by managing discharges from the development via infiltration.

Runoff from the each of the BESS areas will be routed through impermeable drainage channels to detention tanks situated throughout the site. The outlets on these tanks will be controlled by an automatic shutoff valve which will activate in the case of a fire, allowing these tanks to attenuate potentially contaminated fire suppression water during the unlikely event of a fire on site. Under normal conditions runoff will be passed through these without attenuation and be routed to an 8,600m^3 infiltration basin in the north-east of the site. Runoff from the access tracks outwith the area draining to the infiltration basin will be managed using soakaways.

Proposed storage volumes have capacity to store the 200-year plus climate change uplift event and water quality requirements can be met.

Further infiltration testing should be conducted at the site to confirm infiltration rates in the northern and eastern portions of the site are within suitable range.

The drainage proposals outlined in this strategy demonstrate sufficient storage capacity is available in the development area.

4 References

National Fire Chiefs Council (2023) *Grid Scale Battery Energy Storage System planning – Guidance for FRS* Available at: https://nfcc.org.uk/wp-content/uploads/2023/10/Grid-Scale-Battery-Energy-Storage-System-planning-Guidance-for-FRS.pdf

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5 Appendix A – Calculation of Soil Infiltration Rate

RAEBURN DRILLING & GEOTECHNICAL (NORTHERN) LTD	Site: PROPOSED 50MW BATTERY STATION, ROTHIENORMAN	Contract No: N3853
	Client: Noriker Power Ltd	Trial Pit No: INF 01
	Engineer:	Test No: 1

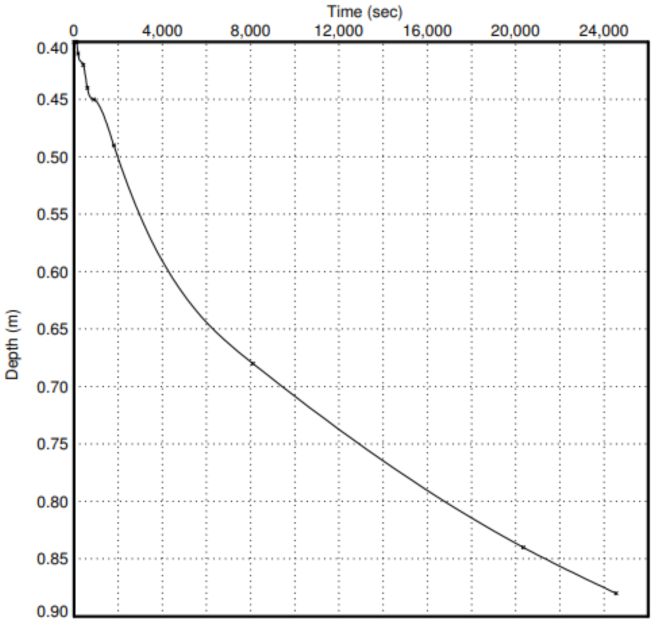
Test Pit Dimensions

Depth to Base (m bGL)	**1.20**
Length (m)	**2.00**
Width (m)	**0.80**
Depth to Ground-Water (m bGL)	**Dry**

Test Results

Maximum Effective Depth (m bGL)	**0.40**
75% Effective Depth (m)	**0.60**
25% Effective Depth (m)	**1.00**
Effective Storage Volume (m^3)	**0.64**
Surface Area (m^2)	**3.84**
Time to 75% (min)	**91**
Extrapolated time to 25% (min)	**543**
t_{p75-25}	**452**

Soil Infiltration Rate (m/s) **6.15E-6**



Time (minutes)	Depth to Water (m below GL)
0	0.40
1	0.40
2	0.40
3	0.41
7	0.42
10	0.44
15	0.45
30	0.49
135	0.68
339	0.84
409	0.88

Depth (m)	Description of Strata
0m to 0.25m :	TOPSOIL: Dark brown slightly organic slightly gravelly to gravelly silty fine to coarse sand with occasional roots. Gravel is angular to sub-angular, fine to coarse and of psammite, pelite, and quartzite.
0.25m to 1.7m :	Brown light brown weathered PELITE. Breaking during excavation into cobbles with low boulder content and some very sandy silty gravel. Sand is fine to coarse. Gravel is angular, tabular, fine to coarse, and of grey laminated pelite. Cobbles are angular, tabular, up to 200mm and of grey laminated pelite. Boulders are angular, tabular, up to 250mm and of grey laminated pelite. [weathered bedrock]

Originator		Title: RESULTS OF INFILTRATION TEST	RAEBURN	Fig No:
	ADP			
Chk & App	Status			
IH	Final			

Style: RDG SOAKAWAY File: W:\GINT\PROJECTS\N3853 - ROTHIENORMAN.GPJ Printed: 19/04/2023 10:28:46 Raeburn Drilling and Geotechnical, Whistleberry Rd, Hamilton ML3 0HP Tel: 01698-711177 E-mail: enquiries@raeburndrilling.com

RAEBURN DRILLING & GEOTECHNICAL (NORTHERN) LTD	Site: PROPOSED 50MW BATTERY STATION, ROTHIENORMAN	Contract No: N3853
	Client: Noriker Power Ltd	Trial Pit No: **INF 02**
	Engineer:	Test No: **1**

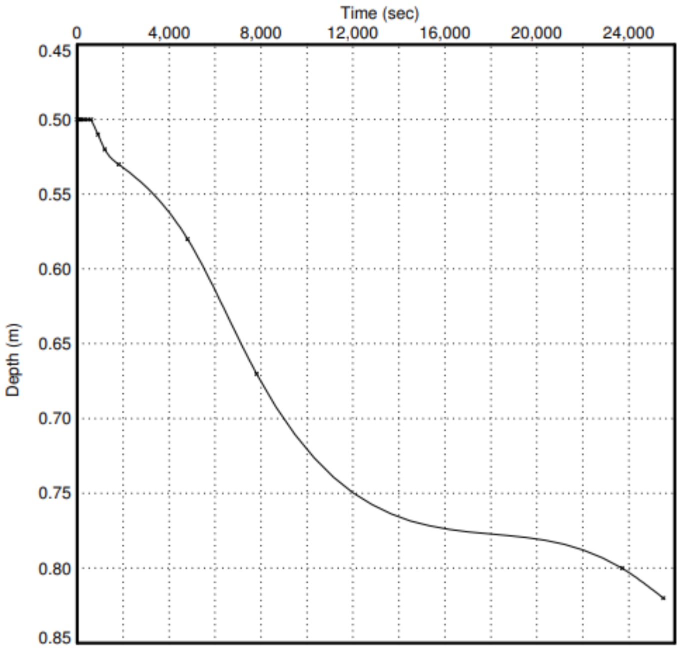
Test Pit Dimensions

Depth to Base (m bGL)	**1.50**
Length (m)	**1.90**
Width (m)	**0.70**
Depth to Ground-Water (m bGL)	**Dry**

Test Results

Maximum Effective Depth (m bGL)	**0.50**
75% Effective Depth (m)	**0.75**
25% Effective Depth (m)	**1.25**
Effective Storage Volume (m^3)	**0.67**
Surface Area (m^2)	**3.93**
Time to 75% (min)	**293**
Extrapolated time to 25% (min)	**1312**
t_{p75-25}	**1019**

Soil Infiltration Rate (m/s) **2.79E-6**



Time (minutes)	Depth to Water (m below GL)
0	0.50
1	0.50
2	0.50
3	0.50
5	0.50
8	0.50
10	0.50
15	0.51
20	0.52
30	0.53
80	0.58
130	0.67
395	0.80
425	0.82

Depth (m)	Description of Strata
0m to 0.25m :	TOPSOIL: Dark brown slightly organic slightly gravelly to gravelly silty fine to coarse sand with occasional roots. Gravel is angular to sub-angular, fine to coarse and of psammite, pelite, and quartzite.
0.25m to 1.8m :	Brown / light brown very sandy silty GRAVEL with medium to high cobble content, and localised very silty pockets. Sand is fine to coarse. Gravel is angular, locally tabular, fine to coarse and of grey laminated pelite. Cobbles are angular, up to 200mm and of laminated pelite. [probable weathered bedrock]
1.8m to 2.5m :	Brown light brown weathered PELITE. Breaking during excavation into cobbles with low boulder content and some very sandy silty gravel. Sand is fine to coarse. Gravel is angular, tabular, fine to coarse, and of grey laminated pelite. Cobbles are angular, tabular, up to 200mm and of grey laminated pelite. Boulders are angular, tabular, up to 250mm and of grey laminated pelite. [weathered bedrock]

Originator		Title: RESULTS OF INFILTRATION TEST	RAEBURN	Fig No:
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IH	Final			

Style: RDG SOAKAWAY File: W:\GINT\PROJECTS\N3853 - ROTHIENORMAN.GPJ Printed: 19/04/2023 10:28:48 Raeburn Drilling and Geotechnical, Whistleberry Rd, Hamilton ML3 0HP Tel: 01698-711177 E-mail: enquiries@raeburndrilling.com

RAEBURN DRILLING & GEOTECHNICAL (NORTHERN) LTD

Site: PROPOSED 50MW BATTERY STATION, ROTHIENORMAN		**Contract No:** N3853
Client: Noriker Power Ltd		**Trial Pit No:** INF 03
Engineer:		**Test No:** 1

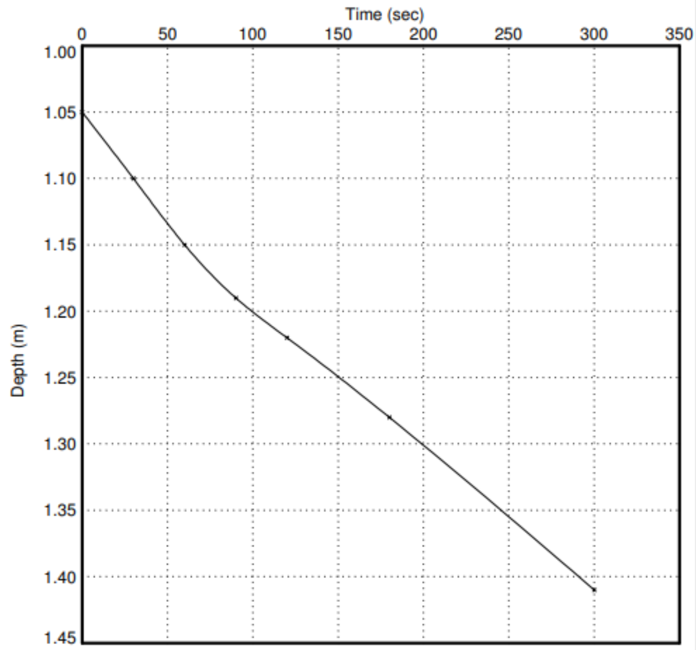
Test Pit Dimensions

Depth to Base (m bGL)	**1.50**
Length (m)	**2.10**
Width (m)	**0.70**
Depth to Ground-Water (m bGL)	**Dry**

Test Results

Maximum Effective Depth (m bGL)	**1.05**
75% Effective Depth (m)	**1.16**
25% Effective Depth (m)	**1.39**
Effective Storage Volume (m^3)	**0.33**
Surface Area (m^2)	**2.73**
Time to 75% (min)	**1**
Time to 25% (min)	**5**
t_{p75-25}	**4**

Soil Infiltration Rate (m/s) **5.04E-4**



Time (minutes)	Depth to Water (m below GL)
0	1.05
0.5	1.10
1	1.15
1.5	1.19
2	1.22
3	1.28
5	1.41

Depth (m)	Description of Strata
0m to 0.25m :	TOPSOIL: Dark brown slightly organic slightly gravelly to gravelly silty fine to coarse sand with occasional roots. Gravel is angular to sub-angular, fine to coarse and of psammite, pelite, and quartzite.
0.25m to 1.8m :	Brown / light brown very sandy slightly silty to silty GRAVEL with medium to high cobble content and low boulder content. Sand is fine to coarse. Gravel is angular, locally tabular, fine to coarse and of light grey brown laminated pelite. Cobbles are angular, up to 200mm and of laminated pelite. Boulders are angular, tabular, up to 260mm and of light grey-brown laminated pelite. [probable weathered bedrock]
1.8m to 2.5m :	Brown light brown weathered PELITE. Breaking during excavation into cobbles with low to medium boulder content and some to much very sandy silty gravel. Sand is fine to coarse. Gravel is angular, tabular, fine to coarse, and of grey laminated pelite. Cobbles are angular, tabular, up to 200mm and of grey laminated pelite. Boulders are angular, tabular, up to 260mm and of grey laminated pelite. [weathered bedrock]

Originator: ADP	**Title:** RESULTS OF INFILTRATION TEST	RAEBURN	Fig No:
Chk & App: IH / Status: Final			

Style: RDG SOAKAWAY File: W:\GINT\PROJECTS\N3853 - ROTHIENORMAN.GPJ Printed: 19/04/2023 10:28:49 Raeburn Drilling and Geotechnical, Whistleberry Rd, Hamilton ML3 0HP Tel: 01698-711177 E-mail: enquiries@raeburndrilling.com

Site: PROPOSED 50MW BATTERY STATION, ROTHIENORMAN	Contract No: N3853
Client: Noriker Power Ltd	Trial Pit No: INF 03
Engineer:	Test No: 2

RAEBURN DRILLING & GEOTECHNICAL (NORTHERN) LTD

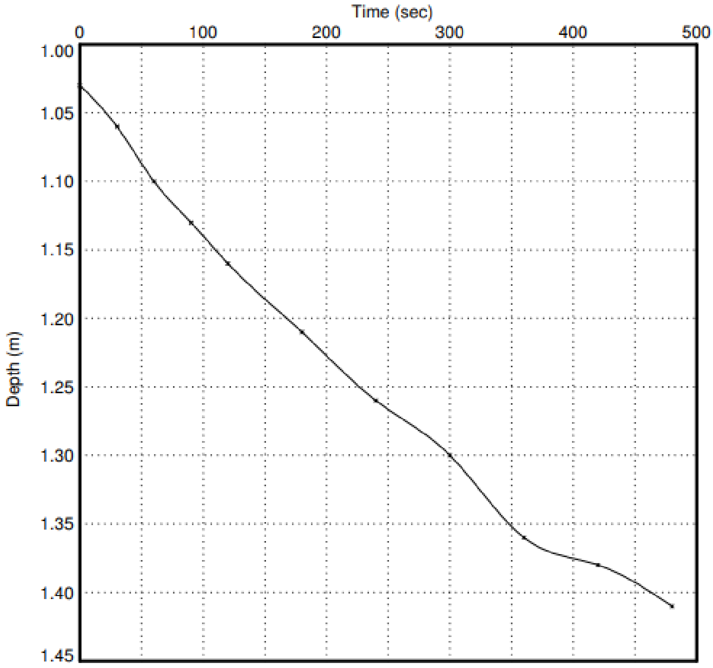
Test Pit Dimensions

Depth to Base (m bGL)	**1.50**
Length (m)	**2.10**
Width (m)	**0.70**
Depth to Ground-Water (m bGL)	**Dry**

Test Results

Maximum Effective Depth (m bGL)	**1.03**
75% Effective Depth (m)	**1.15**
25% Effective Depth (m)	**1.38**
Effective Storage Volume (m^3)	**0.35**
Surface Area (m^2)	**2.79**
Time to 75% (min)	**2**
Time to 25% (min)	**7**
t_{p75-25}	**5**

Soil Infiltration Rate (m/s) 4.18E-4



Time (minutes)	Depth to Water (m below GL)
0	1.03
0.5	1.06
1	1.10
1.5	1.13
2	1.16
3	1.21
4	1.26
5	1.30
6	1.36
7	1.38
8	1.41

Depth (m)	Description of Strata
0m to 0.25m :	TOPSOIL: Dark brown slightly organic slightly gravelly to gravelly silty fine to coarse sand with occasional roots. Gravel is angular to sub-angular, fine to coarse and of psammite, pelite, and quartzite.
0.25m to 1.8m :	Brown / light brown very sandy slightly silty to silty GRAVEL with medium to high cobble content and low boulder content. Sand is fine to coarse. Gravel is angular, locally tabular, fine to coarse and of light grey brown laminated pelite. Cobbles are angular, up to 200mm and of laminated pelite. Boulders are angular, tabular, up to 260mm and of light grey-brown laminated pelite. [probable weathered bedrock]
1.8m to 2.5m :	Brown light brown weathered PELITE. Breaking during excavation into cobbles with low to medium boulder content and some to much very sandy silty gravel. Sand is fine to coarse. Gravel is angular, tabular, fine to coarse, and of grey laminated pelite. Cobbles are angular, tabular, up to 200mm and of grey laminated pelite. Boulders are angular, tabular, up to 260mm and of grey laminated pelite. [weathered bedrock]

Originator	Title:	Fig No:
ADP	RESULTS OF INFILTRATION TEST	
Chk & App: IH	Status: Final	

RAEBURN

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RAEBURN DRILLING & GEOTECHNICAL (NORTHERN) LTD	Site: PROPOSED 50MW BATTERY STATION, ROTHIENORMAN	Contract No: N3853
	Client: Noriker Power Ltd	Trial Pit No: INF 04
	Engineer:	Test No: 1

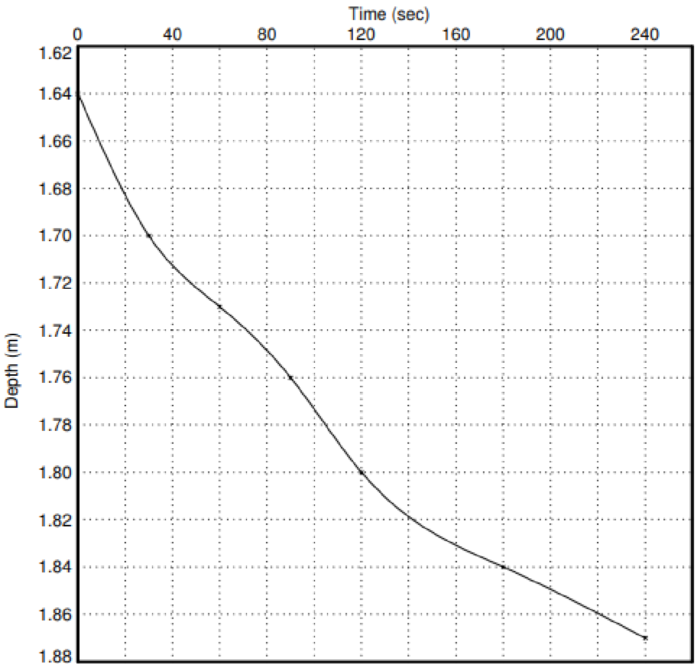
Test Pit Dimensions

Depth to Base (m bGL)	**2.00**
Length (m)	**2.30**
Width (m)	**0.80**
Depth to Ground-Water (m bGL)	**Dry**

Test Results

Maximum Effective Depth (m bGL)	**1.64**
75% Effective Depth (m)	**1.73**
25% Effective Depth (m)	**1.91**
Effective Storage Volume (m^3)	**0.33**
Surface Area (m^2)	**2.96**
Time to 75% (min)	**1**
Extrapolated time to 25% (min)	**5**
t_{p75-25}	**4**

Soil Infiltration Rate (m/s) **4.65E-4**



Time (minutes)	Depth to Water (m below GL)
0	1.64
0.5	1.70
1	1.73
1.5	1.76
2	1.80
3	1.84
4	1.87

Depth (m)	Description of Strata
0m to 0.25m :	TOPSOIL: Dark brown slightly organic slightly gravelly to gravelly silty fine to coarse sand with low boulder content, and occasional roots. Gravel is angular to sub-angular, fine to coarse and of psammite, pelite, and quartzite. Boulders are angular, up to 380mm and of brown grey pelite.
0.25m to 1.2m :	Brown / light brown very gravelly silty fine to coarse SAND with medium cobble content, and localised very silty pockets. Gravel is angular (locally sub-angular), tabular, fine to coarse, and of grey pelite. Cobbles are angular, tabular, up to 150mm and of grey pelite.
1.2m to 2.5m :	Brown light brown weathered PELITE. Breaking during excavation into cobbles with low to medium boulder content and some sandy slightly silty gravel. Sand is fine to coarse. Gravel is angular, tabular, fine to coarse, and of grey pelite. Cobbles are angular, tabular, up to 200mm and of grey laminated pelite. Boulders are angular, tabular, up to 250mm and of grey laminated pelite. [weathered bedrock]

Originator	Title: RESULTS OF INFILTRATION TEST	RAEBURN	Fig No:
ADP			
Chk & App: IH	Status: Final		

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6 Appendix B – Sizing of Infiltration Basin and Soakaway

Infiltration Basin Calculation – Low Infiltration Scenario (Infiltration Rate of 6.15 x 10^{-6})

Infiltration Basin Design in Accordance with BRE Digest 365

Characteristics		
Impermeable area drained to the system A (m2)	52300	
Permeable area drained to the system A (m2)	20171	
Impermeable Area Runoff Coefficient	1	**Either 1 or 0.7**
Permeable Area Runoff Coefficient	0.291	**Set from Greenfield Runoff Calc SPR**
Return Period	200	
Ratio 60min to 2 day rainfall of 5yr return period	0.2	
M5_60min (mm)	16	
Climate Change (%) inc 10% urban creep	1.47	
M5_60min + CC (mm)	24	

Soakaway and infiltration trench details	
Minimum depth of pit below invert d (mm)	2000
Width of the pit w (mm)	65580
Length of the pit l (mm)	65580
Percentage free volume Vfree (%)	100
Indicative Soil Infiltration Rate from SI f (m/s)	0.000006
Wetted area of pit 50% full as50 = l x d + w x d (mm2)	262320000

Duration, D (Min)	200yr rainfall M200 (mm)	200yr + CC rainfall M200 (mm)	Inflow (m3)	Outflow (m3)	Storage required (m3)
5	11.3	16.7	968.82	0.48	968.34
10	17.8	26.2	1522.07	0.97	1521.10
15	22.5	33.0	1922.25	1.45	1920.80
30	32.0	47.0	2735.45	2.90	2732.55
60	42.5	62.5	3636.72	5.81	3630.91
120	50.5	74.3	4321.65	11.62	4310.04
240	60.4	88.7	5160.50	23.23	5137.27
360	67.2	98.8	5744.53	34.85	5709.68
600	77.2	113.5	6604.76	58.08	6546.68
1440	99.0	145.6	8468.01	139.39	8328.62

Required Storage volume	Sreq=	8329	m3
Storage Volume	Sprovided= l x w x d x Vfree=	8601	m3
Time for emptying to half volume	Ts50= Sreq x 0.5 / (as50 x f) =	717	hr

Equal Sreq OK	YES
equal or less 24hrs OK	NO

Infiltration Basin Calculation – High Infiltration Scenario (Infiltration Rate of 4.18 x 10^{-4})

Infiltration Basin Design in Accordance with BRE Digest 365

Characteristics		
Impermeable area drained to the system A (m2)	52300	
Permeable area drained to the system A (m2)	20171	
Impermeable Area Runoff Coefficient	1	**Either 1 or 0.7**
Permeable Area Runoff Coefficient	0.291	**Set from Greenfield Runoff Calc SPR**
Return Period	200	
Ratio 60min to 2 day rainfall of 5yr return period	0.2	
M5_60min (mm)	16	
Climate Change (%) inc 10% urban creep	1.47	
M5_60min + CC (mm)	24	

Soakaway and infiltration trench details	
Minimum depth of pit below invert d (mm)	2000
Width of the pit w (mm)	65580
Length of the pit l (mm)	65580
Percentage free volume Vfree (%)	100
Indicative Soil Infiltration Rate from SI f (m/s)	0.000418
Wetted area of pit 50% full as50 = l x d + w x d (mm2)	262320000

Duration, D (Min)	200yr rainfall M200 (mm)	200yr + CC rainfall M200 (mm)	Inflow (m3)	Outflow (m3)	Storage required (m3)
5	11.3	16.7	968.82	32.89	935.93
10	17.8	26.2	1522.07	65.79	1456.28
15	22.5	33.0	1922.25	98.68	1823.57
30	32.0	47.0	2735.45	197.37	2538.08
60	42.5	62.5	3636.72	394.74	3241.98
120	50.5	74.3	4321.65	789.48	3532.17
240	60.4	88.7	5160.50	1578.96	3581.54
360	67.2	98.8	5744.53	2368.43	3376.10
600	77.2	113.5	6604.76	3947.39	2657.37
1440	99.0	145.6	8468.01	9473.74	-1005.73

Required Storage volume	Sreq=	3582	m3
Storage Volume	Sprovided= l x w x d x Vfree=	8601	m3
Time for emptying to half volume	Ts50= Sreq x 0.5 / (as50 x f) =	5	hr

Equal Sreq OK	YES
equal or less 24hrs OK	YES

Soakaway on Access Roads (effective depth conservatively assumed 0.5m due to slope)

Soakaway desing in accordance with BRE Digest 365

Characteristics	
Impermeable area drained to the system A (m2)	8200
Return Period	200
Ratio 60min to 2 day rainfall of 5yr return period	0.2
M5_60min (mm)	16
Climate Change (%)	1.47
M5_60min + CC (mm)	24

Soakaway and infiltration trench details	
Minimum depth of pit below invert d (mm)	500
Width of the pit w (mm)	1250
Length of the pit l (mm)	648000
Percentage free volume Vfree (%)	40
Soil Infiltration Rate from SI f (m/s)	0.000418
Wetted area of pit 50% full as50 = l x d + w x d (mm2)	324625000

Duration, D (Min)	200yr rainfall M200 (mm)	200yr + CC rainfall M200 (mm)	Inflow (m3)	Outflow (m3)	Storage required (m3)
5	11.3	16.7	136.57	40.71	95.86
10	17.8	26.2	214.56	81.42	133.15
15	22.5	33.0	270.97	122.12	148.85
30	32.0	47.0	385.61	244.25	141.36
60	42.5	62.5	512.66	488.50	24.16
120	50.5	74.3	609.21	976.99	-367.78
240	60.4	88.7	727.46	1953.98	-1226.52
360	67.2	98.8	809.79	2930.97	-2121.19
600	77.2	113.5	931.05	4884.96	-3953.91
1440	99.0	145.6	1193.71	11723.90	-10530.19

Required Storage volume	Sreq=	148.85	m3
Soakaway Storage volume	Sprovided= l x w x d x **Vfree=**	162.00	m3
Time for emptying soakaway to half volume	Ts50= Sreq x 0.5 / (as50 x f) =	0.15	hr

Equal Sreq OK	YES
equal or less 24hrs OK	YES